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"DEVELOPMENT OF SCIENCE AND TECHNOLOGY IN THE LAST 50 YEARS IN INDIA WITH SPECIAL REFERENCE TO NORTH-EAST INDIA"

May 27 — 30, 1998

As part of the Golden Jubilee Celebrations of India's Independence

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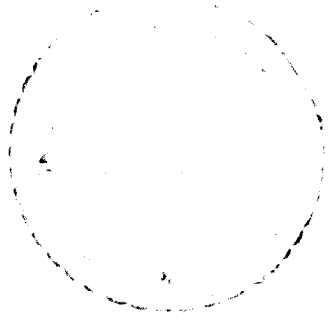

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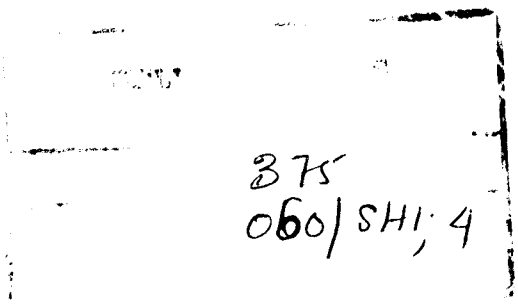
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PROGRAMME

27th May 1998 (Wednesday) — **STATE CENTRAL LIBRARY AUDITORIUM**

REGISTRATION OF DELEGATES
8.00 AM to 8.45 AM

INAUGURAL SESSION
9.00 A.M.

Chairman	:	**Dr (Mrs) M.P.R. Lyngdoh** Chairperson & Principal
Welcome Address	:	**Dr S.K. Gupta** Joint Convener
Inaugural Address	:	**Sri M.M. Jacob** His Excellency, Governor of Meghalaya
Address by Guest of Honour	:	**Sri B.B. Lyngdoh** Hon'ble Chief Minister of Meghalaya
Popular Scientific Talk	:	**Dr A.K. Barooah** Director NEIGRIHMS, Shillong
Address by	:	**Shri T. Ringu, I.A.S.** Secretary North Eastern Council, Shillong **Prof. B. Pakem** Vice-Chancellor North Eastern Hill University, Shillong **Sri H.W.T. Syiem, I.A.S.** Chief Secretary, Govt. of Meghalaya **Sri P. J. Bazeley, I.A.S.** Principal Secretary, Govt. of Meghalaya
Chairperson's Address	:	**Dr(Mrs) M.P.R. Lyngdoh** Chairperson & Principal
Key Note Address	:	**Prof. T.S.B. Narasaraju** Head, University Sophisticated Instrumentation Centre North Eastern Hill University, Shillong
Vote of Thanks	:	**Sri R K. Datta** Joint Convener
INAUGURATION OF EXHIBITION **2.30 P.M.**	:	**SHILLONG COLLEGE**
Chairman	:	**Sri R. Kharpor** President, G. B. Shillong College, Shillong

Welcome Address	:	**Sri R. K. Datta** Jt. Convener
Inaugural Address	:	**Sri T.H. Rangad** Hon'ble Minister, Science and Technology etc. Govt. of Meghalaya
Guest of Honour	:	**Prof B. Pakem** Vice-Chancellor North Eastern Hill University, Shillong
Chairman's Address	:	**Sri R. Kharpor**
Chairperson's Remark	:	**Dr(Mrs) M.P.R. Lyngdoh**
Vote of Thanks	:	**Sri N.K. Sarkar** Co-Convener

TECHNICAL SESSIONS

28th May 1998 (Thursday) : **SHILLONG COLLEGE SEMINAR HALL**

SESSION – I : **Human Resources & Health Sciences**
9.00 A.M.

(Forensic Science Laboratory, Guwahati, Public Health Engineering Deptt., North Eastern Indira Gandhi Institute of Medical Sciences, Central Ground Water Board, Ministry of Health & Family Welfare (Regional Office) Shillong, Anthropological Survey of India, Bio-Chemistry Deptt., Bio-Physics Deptt., Anthropology Deptt. of North Eastern Hill University).

Chairman : **Sri P.J. Bazeley I.A.S.**
Principal Secretary, Govt. of Meghalaya, Shillong

SESSION – II : **Geological & Mineral Resources**
11.00 A.M.

(Directorate of Geology & Mining, Guwahati, Directorate of Geology & Mineral Resources, Meghalaya, Atomic Mineral Division, Oil & Natural Gas Corp., Assam, Coal Resources, Geological Survey of India)

Chairman : **Dr B.P. Bhattacharyya**
Dy Director General
Geological Survey of India, (NER), Shillong

LUNCH BREAK

SESSION – III : **Agricultural Sciences & Life Sciences**
2.00 P.M.

(National Bureau of Plant Genetic Resources, Agriculture Deptt., Govt. of Meghalaya, Soil Conservation Deptt., Govt. of Meghalaya, Indian Council of Agricultural Research, Zoology Deptt. of North Eastern Hill University, Fisheries Deptt. Arunachal Pradesh, Botanical Survey of India)

Chairman : **Dr G.K. Srivastava**
Addl. Director
Zoological Survey of India, Calcutta

29th May 1998 (Friday)

SESSION – IV : **Environmental Sciences**
9.00 A.M.

(Ministry of Environment & Forests, Govt. of India, Forest Deptt., Govt. of Meghalaya, Botanical Survey of India, Central Pollution Control Board, Botany Deptt, Geography Deptt. of North Eastern Hill University, Zoological Survey of India, Oil & Natural Gas Corp., Assam, Meghalaya Pollution Control Board)

Chairman : **Prof. B.K. Sharma**
Head, Department of Zoology
North Eastern Hill University, Shillong

SESSION – V : **Application of Sciences**
11.00 A.M.

(Indian Meteorology Deptt., Guwahati Airport; Survey of India, Shillong; North Eastern Council (Science & Technology); Airports Authority of India, New Delhi; Indian Meteorology Deptt., Shillong; Central Seismological Observatory, Shillong; Magnetic Observatory, Shillong; Department of Telecommunication, Govt. of India, Shillong; Physics Deptt. of North Eastern Hill University, Forensic Science Laboratory, Meghalaya)

Chairman : **Prof. D. Khathing**
Head, Regional Sophisticated Instrumentation Centre
Shillong

LUNCH BREAK

SESSION – VI : **Power and Industry**
2.00 P.M.

(Meghalaya State Electricity Board, Agricultural Deptt., (Planning) North Eastern Regional Electricity Board, North-Eastern Electric Power Corp., Central Water Commission, State Bank of India, North Eastern Council (Industry & Banking), Brahmaputra Board, Guwahati)

Chairman : **Sri A.D. Mohile**
Chairman, Brahmaputra Board, Guwahati

30th May 1998 (Saturday)

SESSION – VII : **Application of Technology, Planning, Administration and Role of Universities & Colleges**
9.30 A.M.

(Assam Science Technology & Environment Council, Guwahati, State Council of Science, Technology & Environment, Meghalaya, Institute of Advance Study in Science & Technology, Guwahati, Regional Sophisticated Instrumentation of Centre (NEHU, North Eastern Council (IFC & WSM), Planning Deptt., Govt. of Meghalaya, Health & Family Welfare, Govt. of Meghalaya, Meghalaya State Transport Corporation, Meghalaya, Centre for Science Education, College Development Council, Shillong College)

Chairman : **Dr(Mrs) M.P. Rina Lyngdoh**
Principal
Shillong College, Shillong

LUNCH BREAK

VALEDICTORY FUNCTION : **STATE CENTRAL LIBRARY AUDITORIUM**
3.00 P.M.

Chairman : **Dr(Mrs) M.P.R. Lyngdoh**
Chairperson & Principal

Valedictory Address : **Dr B.P. Bhattacharyya**
Deputy Director General,
Geological Survey of India (NER), Shillong

Chief Guest : **Sri T.H. Rangad**
Hon'ble Minister of Science & Technology,
Govt. of Meghalaya

Chairman's Address	:	**Dr(Mrs) M.P.R. Lyngdoh**
Joint Convener's Remark	:	**Shri R.K. Datta** Joint Convener
Observation by the Participants	:	**(i) Dr A. K. Verma** Director, Science & Technology North Eastern Council, Shillong
		(ii) Sri R.D. West Member Secretary SCSTE, Meghalaya
		(iii) Dr K.C. Barua Director, Forensic Science Laboratory Shillong

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FOREWORD

The past 50 years of India have been both turbulent and triumphant. Fifty years in the life of a nation is not a very long time, but when viewed in terms of activities and endeavour in various fields, it assumes significance. India has made tremendous progress in the fields of science and technology and it has to an extent, accelerated the development pace. But it is believed, even by the scientific community, that the inputs obtained from this progress have not adequately gone back to planned development nor have the remote areas of the country benefited much from such progress.

It is in this context that the 'National Conference or Development of Science and Technology with special reference to North-East India' held in Shillong from May 27 to 30, 1998 was an important step towards identifying the related problems and offering positive solutions. The four-day conference was very successfully organised and conducted by the Shillong College and the Shillong College Academic Society.

The Conference was all the more relevant and beneficial because the entire north-eastern region comprising the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura have generally remained an under-developed area because of geographical isolation and other historical reasons. The region's vast potentialities of hydel-power, forest, agricultural and mineral resources have remained virtually untapped. Various State and Central government departments relating to science and technology have been working in the region for varying periods of time but a common forum for assessment and interaction was lacking. The 'National Conference on Science and Technology in the last fifty years of India with special reference to North-East India, was an attempt to bring together the scientists and scholars working in various organisations, policy-makers and administrators so that the current status of knowledge on various fields of science and technology can be examined, the potentialities of the regions resources focussed, their utilisations imaginatively pursued and recommendations forwarded to funding and concerned implementing agencies.

The proceedings volume in your hand is an outcome of the four-day National Conference containing the seminar papers read in different technical sessions, and informative articles including those from various governmental agencies on their working and objectives in the north-east region. It is hoped that the valuable information and experience made available through this compiled Volume will help researchers, planners and administrators.

As a member of the Advisory Committee of the Conference, I congratulate all those who had so successfully organised a truly useful and informative conference and who have now brought out a valuable publication. The Joint Conveners Shri R.K. Datta and Dr S.K. Gupta deserve special mention and thanks for the commendable job they have done by organising and conducting the said conference. Dr(Mrs) M.P. Rina Lyngdoh, Principal and Chairperson has been a true guiding spirit of an enthusiastic team and she rightfully deserves our appreciation.

Finally I wish a great success for this complied volume and its fruitful use by all concerned.

B. PAKEM

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18. Mineral Resources & Mining, Govt. of Meghalaya.
19. State Council of Science, Technology & Environment, Meghalaya, Shillong.
20. North Eastern Hill University, Shillong (Departments: Geography, Anthropology, Physics, Bio-Chemistry, Bio-Physics, Zoology, Botany and others).
21. Department of Telecommunication Govt. of India, Shillong.
22. Soil Conservation Department Govt. of Meghalaya.
23. Central Pollution Control Board Govt. of India, Shillong.
24. Central Water Commission, Govt. of India, Shillong.
25. Agriculture Department, Govt. of Meghalaya.
26. Forest Department, Govt. of Meghalaya.
27. Central Ground Water Board, Govt. of India.
28. Sericulture Department, Govt. of Meghalaya.
29. Public Health Engineering Department Govt.of Meghalaya.
30. North Eastern Electric Power Corporation Ltd. Shillong.
31. North Eastern Regional Electricity Board, Shillong.
32. Airports Authority of India, New Delhi.
33. Brahmaputra Board, Guwahati.
34. Central Ground Water Board, Govt. of India Guwahati.
35. Meghalaya State Electricity Board, Shillong.
36. State Bank of India, Regional Office, Shillong.
37. Forensic Science Laboratory, Assam.
38. Centre for Science Education, NEHU, Shillong.
39. Institute of Advanced Study in Science & Technology, Guwahati.
40. Ministry of Health & Family Welfare, Regional Office, Govt. of India, Shillong.
41. Indira Gandhi Regional Institute of Health and Medical Sciences, Shillong.
42. Magnetic Observatory, Shillong.
43. National Bureau of Plant Genetic Resources Shillong.
44. St. Anthony's College, Shillong.
45. St. Edmund's College, Shillong.
46. St. Mary's College, Shillong.
47. Ladykeane College, Shillong.
48. North Eastern Handloom & Handicrafts Development Corporation, Shillong.
49. Meghalaya Pollution Control Board Govt. of Meghalaya.
50. Assam Science, Technology & Environment Council, Guwahati, Assam.
51. Shillong College, Shillong.

DELEGATES

1. Dr D. Khathing, Head, RSIC, NEHU, Shillong.
2. Dr M.M. Singh, Director (CSE), NEHU, Shillong.
3. Dr C.S. Shastry, Head, Dept. of Physics NEHU, Shillong.
4. Dr B.K. Dev Sarma, Director (CDC) NEHU, Shillong.
5. Dr M.K. Kalita, Institute of Advanced Study in Science & Technology), Guwahati.
6. Dr A.N. Rai, Dept. of Biochemistry NEHU, Shillong.

7. Dr T.B. Subba, Head, Dept. of Anthropology NEHU, Shillong.
8. Dr R. Gopalakrishnan, Head Dept. of Geography, NEHU, Shillong.
9. Dr R. Aravamudhan, Dept. of Chemistry NEHU, Shillong.
10. Dr B.K. Borgohain, Director, Ministry of Health & Family Welfare, Govt. of India, Shillong.
11. Sri R.D. West, Member Secretary, State Council of Science, Technology & Environment, Meghalaya.
12. Dr K. Barua, Director, Institute of Advanced Study in Science & Technology, Guwahati.
13. Sri R. Chatterjee, I.A.S., Chairman Airports Authority of India, New Delhi.
14. Sri S.J.S. Hattar, Zoological Survey of India Shillong.
15. Dr N. Sen, Zoological Survey of India, Shillong.
16. Sri R.B. Purakayastha, Addl. Chief Engineer, Public Health Engineering, Govt. of Meghalaya, Shillong.
17. Sri H. Prasad, Superintending Engineer, PHE.
18. Sri T. Bhattacharjee, Executive Engineer, PHE.
19. Dr R.B. Dympep, Agriculture Marketing Officer Dept. of Agriculture, Govt. of Meghalaya.
20. Sri S.N. Das, Deputy Director (Planning) Dept. of Agriculture, Govt of Meghalaya.
21. Sri R.R. Bang, Deputy Director, Sericulture & Weaving Dept., Govt. of Meghalaya.
22. Dr A. Khonglam, Depiuty Director Sericulture & Weaving Dept., Govt.of Meghalaya.
23. Dr B. Dhar, Anthropological Survey of India Shillong.
24. Dr B.R. Rizvi, Deputy Director Anthropological Survey of India, Shillong.
25. Sri B. Tripathy, Survey of India, Shillong.
26. Sri D.B. Rana, Survey of India, Shillong.
27. Dr T.M. Hynniewta, Head Botanical Survey of India, Shillong.
28. Dr K.P. Singh, Deputy Director Botanical Survey of India, Shillong.
29. Sri A.K. Chakraborti, Chief Engineer Central Water Commission, Shillong.
30. Sri S. Mahto, Superintending Engineer Central Water Commission, Shillong.
31. Sri S. Masood Hussain, Superintending Engineer Central Water Commission, Shillong.
32. Dr B.P. Bhattacharyya, Deputy Director General Geological Survey of India (NER), Shillong.
33. Sri R.K. Roy, Deputy Director General Geological Survey of India, Calcutta.
34. Sri Y. Kumar, Sr. Geologist Geological Survey of India (NER), Shillong.
35. Dr V. Kumar, Sr. Geologist Geological Survey of India (NER), Shillong.
36. Dr U.K. Mishra, Sr. Geologist Geological Survey of India (NER), Shillong.
37. Dr S.N. Kak, Regional Director Atomic Mineral Division, Shillong.
38. Dr R. Saran, Scientific Officer Atomic Mineral Division, Shillong.
39. Sri N.K. Sarkar, Shillong College Academic Society, Shillong.
40. Dr A.K. Verma, Director (Science & Technology), North Eastern Council, Shillong.
41. Sri D.K. Singh, Adviser (IFC & WSM) North Eastern Council, Shillong.
42. Sri K.N. Hazarika, Adviser (Banking, Industries etc.) North Eastern Council, Shillong.
43. Sri W. Synrem, Director (Manpower & Development) North Eastern Council, Shillong.
44. Dr A.K. Barooah, Director, NEIGRIHMS, Shillong.
45. Sri A.D. Mohile, Chairman Brahmaputra Board, Guwahati.
46. Sri O. Basaiawmoit, Director, DMR, Meghalaya.
47. Sri K.K. Deka, Jt. Director, DMR, Meghalaya.
48. Sri S.C. Sahu, Meteorologist, IMD, Shillong.
49. Sri P. Krishnamurthy, IMD, Shillong.
50. Sri Subash Ashutosh, IFS, Conservator of Forests, Govt. of Meghalaya, Shillong.
51. Sri Sunil Kumar, IFS, Conservator of Forests Govt. of Meghalaya, Shillong.
52. Dr S.K. Chakrabarty, Magnetic Observatory, Shillong.
53. Dr V.T. Darlang, Jt. Director, ME&F, Shillong.
54. Dr K.C. Baruah, Director, FSL, Shillong.
55. Dr G.K. Srivastava, Jt. Director Zoological Survey of India, Calcutta.
56. Dr N.D. Verma, Director, Indian Council of Agricultural Research (NEHR), Barapani, Shillong.
57. Dr B.K. Sarma, Scientist, ICAR, Shillong.
58. Sri P.S. Agarwal, Member Secretary North Eastern Regional Electricity Board, Shillong.
59. Sri A. Magudapati, Superintending Engineer NEREB, Shillong.
60. Sri M.K. Choudhuri, CPCB, Shillong.
61. Dr Z. Changsan, Scientist, CPCB, Shillong.
62. Sri R.N. Tamuli, Sr. Manager, NEEPCO, Shillong.
63. Sri A.K. Dam, Addl. Chief Engineer NEEPCO, Shillong.
64. Sri B.C. Choudhury, Superintending Engineer NEEPCO, Shillong.

65. Sri B. Gohain, Sr. Manager
NEEPCO, Shillong.
66. Dr R.P. Bajpai, Head, ISOS & Bio-Physics
NEHU, Shillong.
67. Dr B.K. Sharma, Head, Dept. of Zoology
NEHU, Shillong.
68. Dr B.B.P. Gupta, Reader, Dept. of Zoology
NEHU, Shillong.
69. Sri P.J. Bazeley, IAS, Govt. of Meghalaya.
70. Sri S.C. Katiyar, Chief Chemist, MPCB, Shillong.
71. Sri K.L. Tariang, Director, Soil Conservation
Department, Govt. of Meghalaya.
72. Sri H. Das, RMC, Guwahati.
73. Sri Rajesh Prakash, IMD, Guwahati.
74. Smt D.P. Shadap, Scientist, FSL, Shillong.
75. Sri S.K. Dey, Supdtg Engineer, MSEB, Shillong.
76. Sri E. Slong, Executive Engineer, MSEB Shillong.
77. Sri J.R. Borthakur, DMR, Assam.
78. Sri M.K. Dhar, DMR, Assam.
79. Dr I.D. Goswami, DMR, Assam.
80. Dr D.K. Hore, Scientist, NBPGR, Shillong.
81. Dr Kamal Nain, ONGC, Jorhat, Assam.
82. Dr K.C. Deka, ASTEC, Guwahati.
83. Dr A.K. Barua, ASTEC, Guwahati.
84. Dr N.C. Das, ONGC, Silchar, Assam.
85. Dr A.K. Jain, ONGC, Sibsagar, Assam.
86. Sri S.S. Chyne, Principal, CTTC, Shillong.
87. Sri U. Gogoi, CGWB, Shillong.
88. Sri B.C. Kalita, CGWB, Shillong.
89. Dr R.C. Shukla, GSI (NER), Shillong.
90. Sri H.W.T. Syiem, IAS, Govt. of Meghalaya.
91. Dr M.D. Nautiyal, Regional Director
Central Ground Water Board, Guwahati.
92. Dr S.K. Datta, Director
Forensic Science Laboratory, Assam, Guwahati.

RAPPORTEURS

1. Dr M.M. Barooah, Petrologist
Directorate of Mineral Resources
Govt. of Meghalaya, Shillong.
2. Sri N.C. Khaund
Central Seismological Observatory, Shillong.
3. Smt Jrialsibon Kharbteng, Orchidologist
Office of the Chief Conservator of Forests
Govt. of Meghalaya, Shillong.
4. Sri A. Bhattacharjee
Zoological Survey of India, Shillong.
5. Sri T. Bhattacharjee, Executive Engineer
Public Health Engineering Dept.
Govt. of Meghalaya, Shillong.
6. Sri M. Konglah, Agriculture Information Officer
Directorate of Agriculture
Govt. of Meghalaya, Shillong.
7. Dr (Mrs) R.R. Gowloog
Anthropological Survey of India, Shillong.
8. Sri P.B. Das
Survey of India, Shillong.
9. Dr A.A. Mao, Scientist (SD)
Botanical Survey of India, Shillong.
10. Sri A.J. Baruah, Dy Manager (C)
NEEPCO, Shillong.
11. Smt A. Ahmed, Dept. of Botany
Shillong College, Shillong.
12. Smt Eva Kharkongor, Dept. of Economics
Shillong College, Shillong.
13. Smt D.L. Buam, Dept. of Chemistry
Shillong College, Shillong.

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WELCOME ADDRESS AT THE INAUGURAL SESSION : DR S.K. GUPTA, JOINT CONVENER

His Excellency, the Governor of Meghalaya, Shri M.M. Jacob, Hon'ble Chief Minister Shri B.B. Lyngdoh, Respected Members of the Advisory Committee, Shri T. Ringu, Secretary, North Eastern Council, Prof. B. Pakem, Vice Chancellor, North Eastern Hill University, Shri H.W.T. Syiem, Chief Secretary, Govt. of Meghalaya, Shri P.J. Bazeley, Principal Secretary, Govt. of Meghalaya, Air Marshall P.S. Brar PVSM and Distinguished Scholars and Scientists, Delegates and Participants, Beloved Students and Fellow Teachers, Ladies and Gentlemen,

I sincerely welcome you all to this inauguration of our conference on the Development of Science and Technology on behalf of the Organiser and on own behalf. It's a wonderful privilege and opportunity for us to have you all this morning in our midst for a successful beginning of a series of meaningful sessions we have been preparing for and looking forward to for the last couple of months. Your valued presence here today will greatly encourage us to go ahead with our humble mission in creating an awareness about the development of science and technology in the region so far, the resource-potential available and its judicious exploitation for human need within the overall economic scenario of the north-east and against the back-drop of a free and developing nation's policy on science and technology.

If science today has turned the world into a global village, it should equally take upon itself the task of removing hunger and poverty, ignorance and fears, inequalities and injustices from every corner of the globe. It is possible to do so only when science and technology have enough freedom and string free funding to do so. The problem is not any dearth of talent in science, difficulties lie in its flowering with enough nurturing and patronage for a right cause.

India in the four preceding decades have made enormous progress in the field of science and technology particularly in the areas of space, atomic energy, electronic system and even in agricultural sciences to a great extent. But our problems are too many and too diverse to be put in a straight-jacket and solved. If we have the daunting draught at Kalahandi in Orissa, we have our very own Brahmaputra washing away cruelly life and property every year at regular intervals. We have pockets in the hills where people have to survive on roots for months together. Scientists and technologists have to address themselves to these serious challenges affecting our people with right priorities and passion. If we talk of priorities more, the list will be endless. It is admitted on all hands that the whole of north-east is an extremely sensitive earthquake-prone zone. The question in the mind of the common man is : have we done anything in earthquake engineering so far for saving the region from a possible disaster?

A layman looks at science today with both trust and distrust. Trust because he knows that science alone can solve his basic problems of food, health, shelter, education and environment. Distrust because he has seen the ugly face of science too. He has seen how in the name of development, his surroundings have been polluted, the jungle of concrete has eaten up his vitality and his existence as an individual has been threatened. We, the organisers of this meet thought that the best way is to meet and sit together to discuss, interact to build up confidence and allay fears. So we invited as many relevant organisations and departments as possible and create an opportunity for all of us to know what is happening where, how and why. The response, we must admit, was tremendous and we are indeed grateful to all of you.

Shillong College and the Shillong College Academic Society which are holding this conference and exhibition look upon themselves primarily as humble hosts with the generous help of man, money and material from different well-meaning organisations. We are discharging probably more of an academic role of pointing out to the problems and the vast resource-potential of the region and how the scientists and technologists may play their role to ashen in a new era and pace of development of the region. We would like to see ourselves more as a bridge between class-room and developmental agency, research-development and common man and above all to strive for the involvement of all classes of people in the scientific progress of the society.

We believe science is a team work which should engage itself not only to explore matter for humanity's good but also to broaden an individual's mind and outlook free from narrowness, superstitions, ignorance and false pride.

We thought the 50th year of our independence is an ideal time to perform our little bit towards the cause of Science and Development in the region by holding this conference and exhibition which begins today.

My hearty welcome to each one of you once again and a big thank you for your kind presence amongst us this morning.

ADDRESS : SHRI P.J. BAZELEY, IAS, PRINCIPAL SECRETARY GOVERNMENT OF MEGHALAYA

Madame Chairperson, His Excellency Shri M.M. Jacob, the Governor of Meghalaya, Esteemed Chief Minister Shri B.B. Lyngdoh, Honourable Minister for Science & Technology Shri T.K. Ryngad, Air Marshal P.S. Brar, Prof. T.S.B. Narasaraju, Head, Sophisticated Instrumentation Centre of the North Eastern Hill University, Dr A.K. Barooah, Director, NEIGRIH&MS, Dr S.K. Gupta, Sri R.K. Dutta, Jt Conveners, Members of the Media and Press Corps, Learned Participants, Members of the Shillong College Faculty and the Shillong College Academic Society, Students, Ladies and Gentlemen.

The organisation of this National Conference & Exhibition on the Development of Science & Technology in India during the last fifty years with Special Reference to North East India, is an outcome of the sincerity and commitment of the members of the Shillong College Academic Society to the cause of promoting general awareness of the development and adaptation of Science & Technology, for increased, meaningful and interactive cooperation between all stake holders in the state and the region.

These efforts of the society, in collaboration with Shillong College, which is a leading undergraduate college of the North Eastern Region with the largest intake of students in Meghalaya, are not only laudable but will, for sure, result in the generation of an useful shelf of valuable information for Research Institutions, Scholars, Social Scientists and the Planners and Managers of Development and Social Change, for long years to come.

It has been a great privilege for some of us to have been associated with the Advisory Committee, but the successful organisation of this 4-day National Conference and Exhibition is entirely due to the ceaseless hard work of Dr(Mrs) M.P. Rina Lyngdoh, Principal, Shillong College, Dr S.K. Gupta, Sri R.K. Dutta, Jt Conveners and the dedicated members of her Organising Committee, along with the spontaneous cooperation and participation of a very large number of NGO's, private and public sector undertakings and Central and State Government Departments and Regional Directorates. May their efforts succeed in preparing the region and its people, in their march towards the new millenium of hope and promise.

The gracious presence of His Excellency the Governor, the Honourable Chief Minister and the galaxy of distinguished intellectuals and leaders of different walks of life, in this august inaugural assemblage, underscores the importance of the occasion and reassures the organisers and the participants of the utility of their efforts.

Fifty years ago, the hilly areas of the region depended on the slash and burn method of cultivation, commonly known as Jhumming for its food requirements. Today, this destructive and uneconomic practice is fast being substituted with cost-effective modern methods of cultivation of high value agricultural and cash-crop produce.

Fifty years ago, the North Eastern Region was divided into two halves by the mighty & unbridled Brahmaputra. Ferry-services were the only means for south bankers to ford across to the north bank and beyond. The march of Science & Development now spans the same Brahmaputra with mighty bridges at three major locations, linking the region with the rest of mainland India.

Fifty years ago, the region depended on oil-fired generators for its energy requirements. Today, we have all major river systems of the region tapped for hydel power, besides state-of-the-art thermal and gas-cracker plants in position.

Fifty years ago, the White Memorial Hospital at Dibrugarh and the Robert's Hospital at Shillong were the only centres for qualified medicare in the region. Today, we have half a dozen medical colleges and dozens of excellent centres of referral medicare, all over the region.

Fifty years ago, barely 20% of the region's population had access to literacy, that too provided by universities located outside the region. Today, we have over a dozen universities besides a host of other centres of educational excellence, in position.

Such and a myriad other notable socio-economic benchmarks of progress over the last five decades could have done us 'proud', but these decades have also seen a down-hill transformation in the status of social harmony and progress in the country and more particularly in the N.E. Region. Undoubtedly, the result of the widening gap of socio-economic imbalances of our times, particularly the ever increasing pool of educated-unemployables. It is said that all major changes of human-history have emanated from the need for

bread. The progress and development of science and technology have therefore, to simultaneously ensure sufficiency of this basic human need.

The inventory of 'then' and 'now' would be endless. The technical sessions of the conference will focus on the progress of development in the country with particular reference to the region. It is expected that the deliberations will reflect on the achievements, highlight critical shortfalls and throw-up feasible models of corrective interventions for the consideration of planners and managers of development and social change. This and this alone would be abundant reward for the planners, organisers and participants of this four-day National Conference, which in a few minutes from now, would receive the gracious blessings of His Excellency the Governor.

I wish the deliberations of this conference over the course of the next few days, every and abundant success.

Thank you Your Excellency.

Thank you Ladies & Gentlemen.

INAUGURAL ADDRESS : HIS EXCELLENCY SHRI M.M. JACOB, GOVERNOR OF MEGHALAYA

I deem it a great honour and a privilege to be invited to inaugurate today's National Conference and Exhibition on "Development of Science andTechnology in the Last Fifty Years in India with Special Reference to North-East India" organised by the Shillong College in collaboration with the Shillong College Academic Society. I am grateful to the Principal of the Shillong College and its professors and members of the Shillong College Academic Society for giving me this opportunity. I am sure this conference will provide an opportunity for the meeting of minds where you can sit and deliberate upon important scientific issues concerning the country in general and the North-East in particular.

I understand that in this conference a number of different development-oriented departments and organizations from the Central and the State Governments are represented. It is, therefore, not only a prestigious gathering but also a representative one.

During the last few decades, the country has made commendable strides in the field of science and technology. Our scientific and technical manpower is one of the largest and the best in the world. India has had a distinguished tradition in both science and technology over its long history. The period of renaissance in Indian science is associated with the names of J.C. Bose, C.V. Raman, Meghnath Saha, H.J. Bhaba, S. Chandrashekhar and others. We had leaders with vision like Pandit Jawaharlal Nehru who recognised the importance of science and technology in the life of the nation. It was their vision which laid the foundation of scientific research and technological development in the country.

The geography and the history of the North-Eastern Region have created a very distinctive socio-economic, cultural and political milieu. The topography, geology and the general natural setting of the region have endowed it with considerable natural resources – fertile soil, lush forests, fossil fuels, minerals and abundant water potential. The geographical isolation, coupled with a series of socio-political and historical obstacles, kept this region out of the caravan of national progress.

Study of science and technical courses assumes importance in the modern context. A modern state acknowledges the important role science and technology have to play in economic development and social transformation. The North-Eastern Region lags far behind the advanced states of the country in the study of science and technical courses. It is through science and technology that the potential of this region can be exploited by local talent for the benefit of the people.

It is high time to think how best the information and knowledge of science and technology could be passed on to the rural people, so that their lives could be modernised with the available knowledge. So it is important that we should emphasise the transfer of technologies to the villages. This will help in increasing agricultural production and a general improvement in the quality of life of the people.

I am confident that the deliberations in the ensuing seven technical sessions will provide rich insights and valuable exchange of scientific information will take place here. I hope such interaction will also facilitate better awareness of area-specific problems and offer reasonable and satisfactory solutions for the benefit of our people. I hope this conference will also help our educational planners in evolving new ideas for spread of teaching of science and technical courses in the North East.

With these words, I declare this National Conference and Exhibition open and wish it all success.

Thank You,

Jai Hind,

Khublei,

Mithela.

CHAIRPERSON'S ADDRESS AT THE INAUGURAL FUNCTION : Dr(Mrs) M.P. Rina Lyngdoh

His Excellency Shri M.M. Jacob, the Governor of Meghalaya, Honourable Chief Minister Shri B.B. Lyngdoh, Honourable Minister for Science & Technology Shri T.H. Rangad, Air Marshall P.C. Brar, Prof. T.S.B. Narasaraju, Dr A.K. Barooah, Distinguished Scholars and Scientists, Delegates & Participants, Fellow Teachers, Beloved Students, Ladies and Gentlemen,

I welcome you all in this inaugural function of the National Conference on the Development of Science Technology in India during the last fifty years with special reference to North-East India.

As you are aware that in this conference a number of different scientific departments and organisations, from both the central and the state governments are participating, therefore, it is a very prestigious gathering. Your valued presence here today will greatly encourage us to go ahead with our humble mission in creating an awareness about the development of Science & Technology in the region. So far, the resource–potential available and its judicious exploitation for human need within the overall economic scenario of the North East and against the backdrop of a free and developing nation's policy on science and technology.

During the four preceding decades, India have made commendable progress in the field of science and technology particularly in the field of atomic energy, space science, telecommunication and agricultural sciences.

The North Eastern Region of India comprising of seven states constitutes a total area of 2.55 lakhs sq. kms. stretching from 21^0 57' to 29^0 25' N and from 89^0 40' to 97^0 25' E physiographically, the region is divided into the North-Eastern Hills and basins, the Meghalaya plateau and the Brahmaputra valley. The entire region has remained as a backward area due to geographical isolation and other historical reasons. However, the region is endowed with vast potentialities of mineral, hydel power, agricultural, forest and such other resources, which again have remained virtually untapped. Various central and state government organisations have been working in the region for quite sometime. The totality of the informations have, however, not been discussed on a common forum to explore the potentialities and natural endowments and convert these into assets for the well being of the people of the country as a whole and those of the North-Eastern Region in particular.

It is because of the above considerations, that the Shillong College and the Shillong College Academic Society decided to organise a National Conference on Development of Science & Technology in the last 50 years of India's independence with special reference to N.E. India. An attempt is made through this conference to bring together Scientists working in various central and state governments agencies in the region, the administrators as well as the makers of public policies, so that the existing status of our knowledge on various potentialities of the region can be focussed and then the various aspects of their utilisation as well as the future course of action could be discussed on a common forum. It was felt that a realistic assessment of the available resources of the North-Eastern Region would help in evolving a well planned and integrated strategy for their effective utilisation. An exhibition is also being organised simultaneously by the different Central and State Departments to focus on the region.

I hope the deliberations in the seven technical sessions will be of considerable use to all those interested in exploring the natural resources of this region for the benefit of the people.

Thank You, Jai Hind, Khublei

KEY NOTE ADDRESS : DEVELOPMENT OF SCIENCE & TECHNOLOGY IN INDEPENDENT INDIA

T.S.B. Narasaraju
Professor-in-Charge , University Science Instrumentation Centre
North-Eastern Hill University, Shillong

1. DEFINITION AND SCOPE OF SCIENCE AND TECHNOLOGY

The word "science" has a Latin root meaning knowledge which can be considered as a fundamental knowledge of our world and the cosmos and a steady pursuit of it in all its aspects based on experimentation, observation and inference.

"Technology", on the other hand, has a Greek root which means application of science. Science is amoral or unbiased in its scope while technology can be both good and bad. To sight an example, a knowledge of the outer space of our planet is science while its application is space technology which can be beneficial in areas such as mass communication, meteorological survey and related fields and harmful in causing destruction through remotely controlled devices.

2. RAPID STRIDES OF SCIENCE AND TECHNOLOGY

A span of 50 years, the post-independence period of India, is a considerable period in the context of rapidity and explosive expansion of science and technology. To have a measure of the pace of such an advancement it can be said that the changes of last 100 years are more than those of the preceding 1000 years and of 100 thousand years prior to them.

A prolific contemporary writer of science and technology, Carl Sagan says, "We live in an extraordinary age. These are times of stunning changes in our understanding of the vast universe in which we are embedded like grains of sand in a cosmic ocean. We have posed deep and fundamental questions on the origin of consciousness, life on our planet, the beginnings of the earth, the formation of the sun, the possibility of intelligent human beings up there in the depths of the sky, as well as the grandest enquiry of all, namely, the advent, nature and ultimate destiny of the universe. As a result of knowledge painfully extracted from nature through generations of careful thinking, observing and experimenting, we are on the verge of at least preliminary answers to many of these questions. Had we been born 50 years earlier we could have wandered, pondered and speculated about these issues. Had we been born 50 years later, the answer would have been already there. By far the most exciting, satisfying and exhilarating time to be alive is the time in which we pass from ignorance to knowledge on these fundamental issues – the age in which we begin to wonder and end in understanding. In all the 4 billion years of history of life of our planet and in all the 4 million years of history of human family, there is only one generation privileged to live through that transitional moment and that generation is ours. He goes on to say on technology, "we are at cross roads in human history." Never before has there been a moment so simultaneously perilous and promising. We are the first species to have taken our evolution into our hands. For the first time we possess the means for intentional or inadvertent self-destruction. We have also the means for passing through technological adolescence into a long-lived rich and fulfilling maturity for all the members of our species."

3. PRE-INDEPENDENT SCENARIO OF SCIENCE AND TECHNOLOGY IN INDIA

Rich scientific tradition of India enabled it to absorb western science in the 19th Century. India produced some outstanding scientists during the first three decades of the present century which is vindicated by the fact that nine among them received the Fellowship of Royal Society of London, F.R.S., while one of them was awarded the Nobel Prize in Physics. In spite of limitations in opportunities, the standard of research in pre-independent India was very high.

A decade before independence of India witnessed the intervention of the Second World War with the scientific activity being directed to meet specific needs of a temporal nature.

There existed about 20 universities, out of which only 8 offered post-graduate teaching in different branches of science, about 500 arts and science colleges and about 150 colleges of professional and technical education. The average turnover of post-graduate students was about 900 while it was about 1000 for engineering graduates.

An important milestone in the direction of development of science and technology in pre-independence India was the setting up in 1939 of National Planning Committee with a sub-committee for science and technology.

4 POST-INDEPENDENCE SCENARIO OF SCIENCE AND TECHNOLOGY IN INDIA

4.1 Nehru's Role :

Science and technology in India assumed new dimensions soon after its independence motivated by an active encouragement and support by the government due to the vision and foresight of the first Prime Minister of India, Jawaharlal Nehru. There has been a continuity of scientific tradition resulting in a changing profile of science and technology in India.

A moving point behind the concept of planning for development in which science and technology played a significant role was Nehru. He could establish a firm conviction that political freedom is only a beginning to achieve economic freedom and freedom from dogmas. He was the founding Chairman of the Planning Commission of India in 1950, a position held by him till his death. He said, "planning is science in action and scientific method means planning", this firm conviction about suitability of a scientific approach to develop post-independence India is indicated by his own words "It is science alone that could solve the problems of hunger and poverty, of insanitation and illiteracy, of superstition and deadening customs, of vast resources running to waste, and of a rich country inhabited by starving people."

Another important milestone leading to the development of science and technology in independent India was the adoption of scientific policy resolution by the Indian Parliament in 1958. The other notable events have been creation of a Ministry of Scientific Research and Natural Resources and passing of Atomic Energy Act for peaceful purposes.

4.2 Scientific Man-Power and Organizations :

Backbone of scientific research is availability of scientific and technical manpower. India witnessed a steady growth of higher educational institutions contributing to an increase in production of scientific and technical manpower.

Based on the figures published by the University Grants Commission, in 1995-96, the following are the numbers of higher educational institutions in India :

(i)	Central/State and Deemed Universities	207
(ii)	Colleges of Missionaries	9278
(iii)	Institutes of Technology	6
(iv)	Engineering Colleges	150
(v)	Medical Colleges	106
(vi)	Polytechnic Colleges	350

There has been a several fold increase in all these numbers in comparison with the corresponding pre-independence figures.

In addition, several organisations and agencies for promotion of science and technology such as Departments of – (i) Atomic Energy, (ii) Science and Technology, (iii) Space and (iv) Electronics and Council of Scientific and Industrial Research (CSIR), Indian Council of Agricultural Research (ICAR) and Indian Council of Medical Research (ICMR) were set up. In addition, there has been enunciation of technology policy and establishment of National Biotechnology Board.

5. ADVANCEMENT OF SCIENCE AND TECHNOLOGY IN THE NORTH-EASTERN REGION

Among the 7 states of the north-eastern region, six of the existing states were under Assam till about 1970. The north-eastern region had a notable participation in independence struggle. In spite of its shortcomings due to its location, primarily in areas of transport and communication, there has been a phenomenal development of science and technology since independence.

Establishment of a total of 11 universities including 4 central universities, an Indian Institute of Technology in Guwahati, Agricultural Universities in Assam and Manipur, Regional Research Laboratory in Jorhat, Assam and Medical Colleges in Dibrugarh, Guwahati and Imphal and an Engineering College in Silchar could be achieved during the post independence period. There has been a steep rise in the number of colleges of the north-eastern region as shown by the following figures of the University Grants Commission published in 1995-96.

STATE	NO. OF COLLEGES
Arunachal Pradesh	4
Assam	230
Manipur	51
Meghalaya	20
Mizoram	10
Nagaland	13
Tripura	19

There have been notable contributions by the academic departments of the North-Eastern Hill University and the Gauhati University.

In spite of these developments in science and technology of the north-eastern region, there have been several lacunae still existing. Non-availability of clean drinking water, lack of adequate maintenance of health and hygiene in terms of measures to eradicate diseases characteristic of the region, non-availability of new technology in agriculture to the farmers of the region, absence of adequate seismological work to minimize loss due to earthquakes to which the region is vulnerable, lack of adequate professional colleges in the region, non-availability of adequate counselling to create awareness of hazards of alcoholism and drug addiction are the principal shortcomings which are to be overcome.

CONCLUSION

India witnessed a phenomenal growth in science and technology in the post-independence period, occupying thus a place of pride among the nations. The quality of research in India in the contemporary competitive areas has been outstanding. The north-eastern region has also been taking rapid strides to catch up with the rest of the country in this highly challenging field of science and technology.

VOTE OF THANKS AT THE INAUGURAL FUNCTION : Sri R.K. Datta, Joint Convener

On behalf of the Organising Committee of the National Conference and Exhibition, I stand here to offer the vote of thanks.

We are privileged to have with us, H.E., Governor of Meghalaya, Shri M. M. Jacob for the inauguration of the Conference. Sir, in spite of your busy schedule you could find time for this conference. This shows your concern for Science and Technology in this part of the country. Thank you Sir, for your kind words.

We are proud that Hon'ble Chief Minister of Meghalaya, Shri B.B. Lyngdoh who in spite of his failing health graced the occasion as a guest of honour. Sir, we are deeply moved to realise your commitment towards Science and Technology. Kindly accept our heartfelt thanks. We are grateful to Shri T.H. Rangad, Minister of Science and Technology for his kind presence in this inaugural function.

I sincerely thank Air Marshal, P.S. Brar, P.V.S.M. who in spite of being burdened with lots of responsibilities could find time for this conference. Thank you Sir for your kind presence.

We feel elated to have amidst us Dr A.K. Barooah, who spoke on high-blood-pressure in a very lucid language to make it intelligible to all. I am confident, Sir, your illuminating speech will have the desired effect. Thank you very much, Sir.

We are grateful to Prof. T.S.B. Narasaraju of the University Science Instrumentation Centre, who took much pains to prepare the Key Note address covering almost the entire history of modern Science and Technology. Kindly accept our sincere thanks, Sir.

Our thanks go to the members of the Advisory Committee for their help and guidance all along our preparation for the conference particularly Sri P.J. Bazeley for his kind presence and thought-provoking words today.

I shall be failing in my duty if I do not mention our gratitude towards, Shri H.W.T. Syiem, Chief Secretary, Government of Meghalaya, Shri P.J. Bazeley, Principal Secretary, Government of Meghalaya, Dr B.N. Roy Choudhuri, Jt Secretary, University Grants Commission (NER), Guwahati, Prof. D. Khathing of Regional Sophisticated Instrumentation Centre, Dr T.M. Hynniewta, Head of Botanical Survey of India, Shillong, Shri R.D. West, Member Secretary, State Council for Science, Technology and Environment, Meghalaya, Dr K.C. Barua, Director Forensic Science Laboratory, Dr R. Saran, Scientific Officer of Atomic Mineral Division of Atomic Energy Commission, Shillong, Brig. P.K. Gupta, Director, Survey of India, Dr G.K. Shrivastava of Zoological Survey of India, Dr A.K. Verma, Director (S&T), North Eastern Council, Dr B.K. Sharma, Head, Zoology Department, North-Eastern Hill University, Dr R.N. Sharan, Head, Deptt. of Bio-Chemistry, North Eastern Hill University for their extraordinary help at each stage of our preparation. Thank you all Sirs.

I offer my vote of thanks to the Principals of different Colleges and their Staff, the Headmasters and Headmistresses and their staff and all the students for their presence this morning to make the inauguration a success.

I sincerely offer vote of thanks to the organisations and institutions who sponsored this conference and exhibition, namely, the University Grants Commission, (N.E. Region, Guwahati), the North Eastern Council, the Planning Department, Government of Meghalaya, the North Eastern Electric Power Corporation, National Council for Science and Technology Commission, Central Pollution Control Board, North Eastern Hill University, Geological Survey of India, N.I.I.T., Rapsang Group of Industries and a few others.

My sincere vote of thanks goes to the delegates, other dignitaries and distinguished guests for their kind presence to make the inaugural function a success.

We are thankful to the authorities of the different State and Central Scientific agencies for their participation. The important among them are – 1) Anthropological Survey of India, Shillong 2) Atomic Mineral Division, Shillong 3) Botanical Survey of India, Shillong 4) Geological Survey of India, Shillong 5) Forensic Science Laboratory, Meghalaya 6) Health & Family Welfare Department 7) Planning Department, Govt. of Meghalaya 8) Ministry of Environment & Forests, N.E. Regional Office, Shillong 9) Zoological Survey of India, Shillong 10) Regional Sophisticated Instrumentation Centre 12) Survey of India, Shillong 13) University Sophisticated Instrumentation Centre 14) Indian Council of Agricultural Research, Barapani, Shillong 15) North Eastern Council, Shillong 16) Oil & Natural Gas Corporation, Assam 17) Regional Meteorological Centre, Guwahati 18) Mineral Resources & Mining, Shillong 19) State Council of Science,

Technology & Environment, Meghalaya, Shillong 20) North Eastern Hill University, Shillong (Deptt. Geography, Anthropology, Physics, Bio-Chemistry, Bio-Physics, Zoology, Botany and others) 21) Department of Telecommunication, Govt. of India, Shillong 22) Soil Conservation Department, Meghalaya 23) Central Pollution Control Board, Shillong 24) Central Water Commission, Shillong 25) Agriculture Department, Govt. of Meghalaya 26) Forest Department, Govt. of Meghalaya 27) Central Ground Water Board, Shillong 28) Public Health Engineering Department, Govt. of Meghalaya 29) North Eastern Electric Power Corporation, Shillong 30) North Eastern Regional Electricity Board, Shillong 31) Airports Authority of India, New Delhi 32) Brahmaputra Board, Guwahati 33) Central Ground Water Board, Guwahati 34) Meghalaya State Electricity Board, Shillong 35) Centre for Science Education, North Eastern Hill University, Shillong 36) Ministry of Health & Family Welfare, Regional Office, Shillong 37) Indira Gandhi Regional Institute of Health and Medical Sciences, Shillong 38) Magnetic Observatory, Shillong 39) National Bureau of Plant Genetic Resources, Shillong 40) Meghalaya Pollution Control Board 41) Assam Science Technology & Environment Council, Guwahati.

We sincerely thank the Directorate of Information and Public Relations for allowing us to use their Public address system and the authorities of the State Central Library Auditorium for allowing us to hold the Inaugural Function this morning.

My sincere vote of thanks goes to the Deputy Commissioner, East Khasi Hills, the director of Soil Conservation and the Department of Police for their kind cooperation and help.

Last but not the least I offer my sincere thanks to the President and other members of the Governing Body, Shillong College, the Principal, Staff and Students of Shillong College for their help and cooperation, the headmen of different localities particularly of Laitumkhrah, the Members of the Organising Committee and different Sub-Committees.

Once again I offer my vote of thanks to all the invitees and distinguished members of the Public present here this morning.

Thank you all.

VALEDICTORY ADDRESS : Dr B.P. Bhattacharyya, Deputy Director General Geological Survey of India (NER), Shillong

Hon'ble Minister of Science and Technology, Shri T.H. RANGAD, Dr(Mrs) M.P.R. Lyngdoh, Chairperson and Principal, Shillong College, Sri R. Kharpor, President, Governing Body, Shillong College, Distinguished Scientists & Technologists, The Delegates in the Conference, Faculty members of Shillong College, Members of Shillong College Academic Society, Students Community, Ladies & Gentlemen,

I feel honoured for having been asked to deliver the Valedictory Address to the august gathering here on this occasion of the National Conference & Exhibition on Development of Science and Technology in the last 50 years of India, with special reference to N.E. India, organised by Shillong College in collaboration with Shillong College Academic Society in order to commemorate the Golden Jubilee Celebrations of India's Independence. I was particularly impressed to see that the various Central and State Agencies including Private Sectors have lent their support to the organisation of this National Conference and Exhibition.

During the course of the 4-day National Conference there have been thread-bare discussions on various topics as per programme of Seven Technical Sessions. The themes had focussed attention to their relevance in N.E. Region.

Now, digressing a little bit and seeking indulgence, I may say that :

If any region of the globe, is considered, immediate picture that comes in mind is the environment which includes Man as the most important element amongst others such as Geomorphology, Forests, Water Bodies. In short, a total picture emerges in our mind in which the position of man and the biota stands as the towering heights. Without man & biota (plant and animal), Environment is meaningless. All the developmental activities that are the results of the civilisation taken to the modern age when we are about to step into another millenium within two years will be of no use provided we can not ensure the safety, prosperity and the evolutionary trend in the human population. It should also take into account its harmonious existence along with all other elements in the environment. The Science & Technology has shown tremendous explosion in all fields of development during the last two centuries as compared to the entire history of civilisation. The most rapid strides are observed now, after the World Wars during this twentieth century. We are amazed at the developments in the field of Space Technology and Electronics apart from Biotechnology. In fact, in all the spheres of science, the specialisation has reached a point when there has been a necessity of having a generalisation also to take stock of the situation. For example, a Cardiologist can not advise on the dermatology i.e. skin infections. The patient should therefore be examined by a general physician who understands something about everything, rather than everything of something.

The diversity in various science disciplines, as of today, is tremendous. We can exemplify by citing just one example. Let us take surfacial survey as an instance. What is depicted in the overall projection made in Plate-I.

Therefore, as a corollary it is not an exaggeration that the scientific discussions as done here during the last 4 days by the Specialists should be analysed from the Generalist's point of view in order to extract the essence for further strategy formulation.

I deem it a privilege to say a few words in this connection in this august gathering as a Generalist, because I can not claim to be a Specialist in other science disciplines except a tiny branch of Geology.

The entire N.E. Region presents a picture of unfortunate contradictions where, in spite of abundant natural resources, the industrial growth, the general prosperity has not been commensurate with the resources available. There are mineral resources, oil and natural gas, abundant water both on the surface and underground, special resources like tea and coal, and an abundance of forest wealth. Yet the region is not placed on the industrial map of India.

Attempts at bringing about an all round development of the region are not new and, in fact the process of planned development is going on, but a special impetus should be given to the whole process of planned development.

Management of resources is becoming an increasingly complex phenomenon and due to the range of technologies involved and the various stages of infrastructural framework available in different regions, the strategies have to be re-oriented to suit a particular region. More often than not, it is not the financial constraints that limit the results, but it is the lack of coordinated approach and an orchestrated effort with a

view to bringing about maximum results that is wanting. The mechanisms of growth required for the new and sectoral development programme must take into account the other available resources and how best they can be utilised, so as to reinforce the results of each other in proper time.

When we talk about the management of natural resources a large number of agencies present themselves up. There are Governmental agencies, the various Boards, NGOs and also some Companies. Exploitation of natural resources is also done by private sector for commercial purpose. Then, there are institutions which provide academic and technological back up. In our country, we have no dearth of technology to harvest most of the natural resources that nature has given to us. There is also no dearth of ideas. The aspect which perhaps we sometimes lack and where there is scope of going a long way, is a step by step evolution of linkages between the various institutions and agencies involved in the process of application of S&T for industrialisation and planned development.

I have not had the opportunity of participating in your entire deliberations but I understand that many areas have been covered and technological as well as practical aspects of the problem have been discussed and very useful suggestions have been made. On the point of technology, however, I would like to make a suggestion which is more relevant in the context of N.E. Region. The choice of the path of technology should be influenced primarily by what is possible in the existing conditions and the environment in which the projects have to take shape. Highly sophisticated advanced techniques of actual exploitation of the resources as well as impracticable ambitious plans of exploitation, that may be successful in a different set of circumstances in other areas, may not necessarily bear fruits in such situation till the time comes when the infrastructure is built up to the required extent. The method of technology of tapping the resources has to be conceived keeping in mind the local ingenuity, the traditional practices and skills of the local population, their capabilities and aspirations as well as the needs of the area. I should think that this is an aspect which requires more attention that the discussion of technology themselves, and it is here that the real test of an academic exercise lies.

I would like to take this opportunity to mention that the N.E. Region is getting a special attention for the solution of its problems to ensure a faster industrial growth. A number of central projects have come up and others are under way which would make use of the local resources and give impetus to the industrial growth in the area. Through the concept of 'Nucleus Plants', it is proposed to make the best use of the available resources by establishing a medium or large scale plant and setting up a cluster of small-scale industrial units by the entrepreneurs of this region. Apart from this, the Government is also taking a stock of the existing industrial infrastructure and some special Groups have been set up to make a study of the existing system.

An important aspect of the process of exploitation of the natural resources and faster industrialisation is the availability of technically trained manpower. The Programmes of development envisaged in the 9th Plan require sufficient scientific, technological, managerial personnel in various fields. Here also, attempts are being made to bridge the gap and make available suitably trained personnel who can be involved in the developmental processes. There is a deficiency of suitably trained manpower in N.E. Region and this aspect should be kept in mind while preparing plans and schemes for the various sectors. It would be advisable that the State Governments may like to arrange to accelerate training more and more people in various fields of Science & Technology and their application.

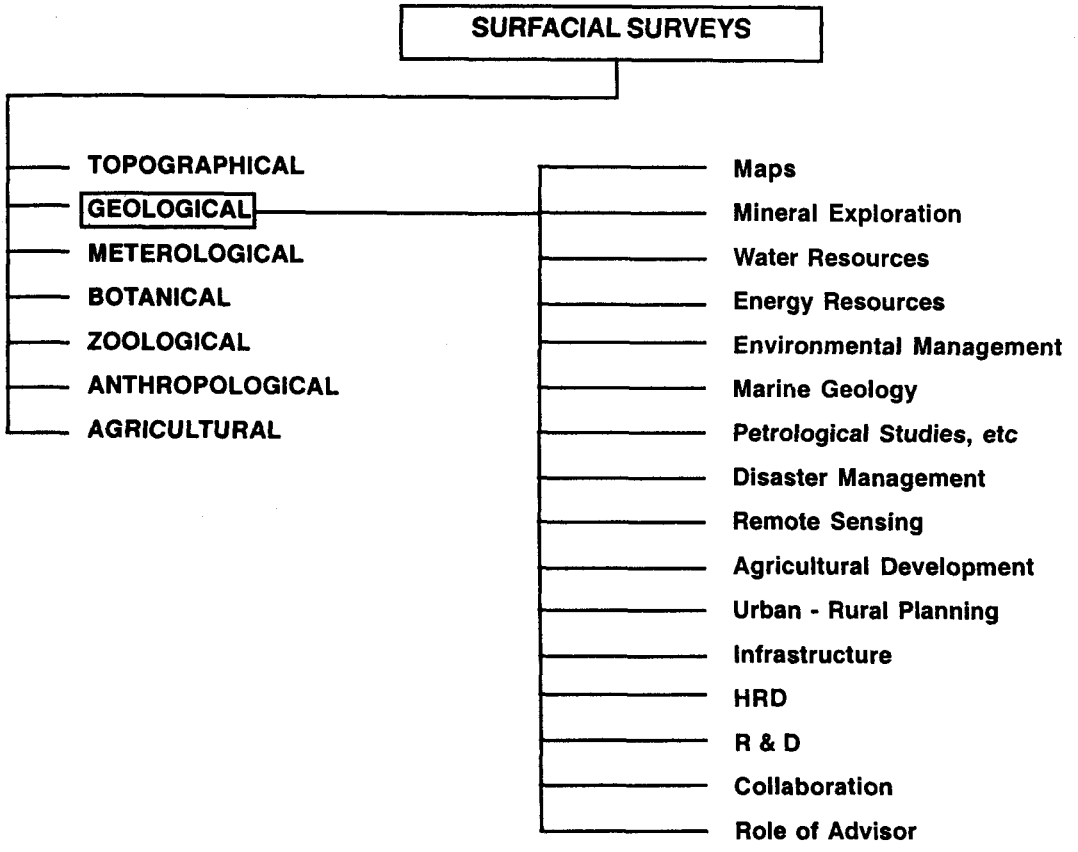
While we talk of the exploitation of natural resources, a note of caution needs to be sounded. Exploitation should not mean destruction of resources. For example, it is our responsibility to see that forest wealth including the flora and fauna are judiciously used with proper management. Utilisation of natural resources calls for an optimum rate of use of the resources and proper measures for its regeneration (replenishment).

The example shown earlier in my talk regarding the diverse nature of any systematic, scientific work of which only I exemplified Survey Component, and took up the element of Geological Survey having quite a number of products as was shown in the OHP, it would be amply clear that generation of tremendous amount of data would require meaningful synthesis for visualising the specific requirements of the region in general and all the localities in particular. For that matter, Scientists, Administrators, Economists, Social Workers should put their brain together to formulate the meaningful programmes and attempt their time-bound implementation.

The Computer application (Information Technology) will be a major tool for attempting this sort of synthesis. I would like to conclude that while the S&T developments in the country as well as in the Northeast are recognised to be important, it would be worthwhile to attach topmost priority for infrastructure development in the North Eastern Region for improvement of communication linkages because without such infrastructural

developments, application of Science and Technology will not bear the desired fruits of the economic development of the region.

I am delighted to see so many learned Scientists, Technologists, Academicians coming together to discuss in this National Conference how best the resources of this region could be utilised. I am sure, the deliberations and conclusions of this conference would show better ways of making future plans and also of making adjustments in the schemes and projects wherever necessary to make them feasible. I also wish that such meets are arranged more often with more pointed subjects selected for discussions.



I profusely thank the organisers of giving me this opportunity to be here and to share thoughts with you all. Let our joint efforts bring the fruits of technology and management quicker to this region, so that it can catch up with the rest of the country in those spheres where it has been lagging behind. A good start has been made, let us run the race for successful completion and enjoy the sense of achievement.

THANK YOU

KHUBLEI

MITHELA

JOINT CONVENER'S REMARKS AT THE VALEDICTORY FUNCTION : SRI R.K. DATTA

Madame Chairperson, Hon'ble Minister for Science and Technology, Shri T.H. Rangad, Shri B.P. Bhattacharyya, Dy D.G., GSI, Shillong, Shri R. Kharpor, President Governing Body, Shillong College, Members of the Advisory Committee, dignitaries, Scientists, Educationists, Distinguished Guests, Members of the Press, AIR, Doordarshan, Ladies and Gentlemen and my Dear Students:

After the hectic activities for four days it is time to make an assessment.

We in Shillong College decided to know the state of Science and Technology in this part of the country as developed after independence. We therefore started consultation with various State and Central Scientific agencies and the related people, so as to bring all of them under one umbrella. This would provide the all needed forum for mutual interaction. Initially we were hesitant and were not sure of the response we might receive. But the response was overwhelming and the result is the success of the conference and the exhibition.

Meanwhile the Indian Scientists created sensation by the mega event the Pokhran Implosion. This established the excellence of the Indian Scientists and demonstrated the country's capability in Science and Technology as developed during the last fifty years.

Apart from other activities of the conference, one main attraction was the seminars which were divided into seven sessions in which 55 papers were either read and discussed or accepted for publication. The outcome is highly interesting and encouraging. It is difficult to make a critical review of all the sessions which continued for more then 16 hours, in a short span of time. I shall therefore mention some salient features of common interest. This is actually an aerial survey.

Health was one of the important topics of discussion in which the menace of AIDS & DRUGS was discussed. Some useful measures to combat AIDS have been suggested. It is reported that 40 million people in the world misuse drug regularly and in India, the figure is 2.3% of the population. However, we feel relaxed when the health management assures that India now marches towards a healthy twenty first century.

The PHE of Meghalaya while dealing with the types of water supply and related developments mention the constraints and difficulties. One important information is that the ASI, for the propagation of knowledge and dissemination of bio-cultural information, the Zonal Anthropological Museum was opened in Shillong in 1979. It holds the cultural canvas of the traditional indigenous population of the N.E. Region.

As for the Mineral Sciences, the GSI reports that in 1997 a programme of development of Village Economy by Mineral Appraisal has been initiated, to generate grass root level plans on small scale in order to mobilise rural resources by population and contribute in the development activities of the region.

DMR Meghalaya, reports of huge deposit of minerals like Coal, Limestone, Clay, Kaolin, Glass Sand, Granite etc.

AMD reports of commercially viable near surface Uranium deposit of 9 million ton of 0.104% of an Oxide of Uranium (U_3O_8) at Domiasiat in West Khasi Hills of Meghalaya. AMD is also extending analytical support to ICAR, Earth Science Department of Manipur University, DMR Meghalaya, Forensic Science Laboratory, Meghalaya, Dept of Mining & Geology of Assam & Nagaland and is also pursuing some activity in collaboration with Dept of Chemistry of North Eastern Hill University.

The Dept of Agriculture of Meghalaya reveals that the productivity in the state has increased many fold due to some measures like agro-bio-diversity, Pest Management, Pest Harvest Technique adopted by farmers. But the department is not complacent and looks forward for better yield.

According to ICAR, the improved technology packages evolved by research and extension institutions of the region played an important role in enhancing agricultural production in N.E. India. The statistical data provided by them bears testimony to this effect.

The BSI reveals that the presence of a large number of primitive Angiosperns make the region important and is called the cradle of flowering plants.

Another report says Mawflaing Sacred grove has an amazing life form and it is an island of bio-diversity. The grove can serve as a genebank to the ecosystem and is a natural living laboratory.

The ZSI reports that, altogether 2545 genera & 5538 species are reported from Meghalaya and that the faunal picture is encouraging.

In an interesting revelation the Dept of Zoology of NEHU declares that due to higher standards of teaching and research, this department has been awarded DRS I and DRS II by the UGC. A few other departments of Science Faculty gave accounts of their activities.

According to Dept of Soil Conservation of Meghalaya the thrust is on control of natural resources of Soil, Water and Vegetation and gearing them up towards activising sustained food production and generating employment.

Concern for environment is evident from all the organisations and ONGC have indicated some measures they have adopted including effluent treatment.

The Environment and Forests department describes its role in regulation and development, environment & forestry in N.E. India.

The Department of Forest of Meghalaya puts emphasis on research and use of latest technology.

The Central Pollution Control Board, in collaboration with State Pollution Control Board has established Water Quality Monitoring Network and also helps in Mass Awareness Programme through NGOs. The State Pollution Control Board, Meghalaya, informs that in Coal Mining areas the surface water and ground water have become contaminated with acid mine drains and coal dump runs off due to unplanned and unscientific mining.

The Survey of India is on the path of multidirectional modernisation in the field survey Cartography and hope to improve quality and reduce time lag and cost.

According to Air Navigation the modern technique of satellite based system for Communication, Navigation, Surveillance and Air Traffic management will revolutionise the air traffic and the programme is likely to be completed by 2005.

The basic aim of Forensic Science is to provide evidence in the courts of law, but some N.E. States do not have this facility and take the help from other neighbouring states.

According to Seismological Laboratory, about 55% of land area of the country falls under active seismic zones.

The extreme change in geomagnetic field and the occurrence of shock is being studied and important conclusions are expected says the Indian Institute of Geomagnetic Observatory, Shillong.

An assessment by Central Water Commission reveals that in India only 15% of hydropower potential has been harnessed, 35% of cultivable land is irrigated & 70% of utilisable river water flows into the sea and that 400 on going projects are now held up for want of funds.

Me.S.E.B. have proposed to implement Leishka H.E.P. (4x33 MW) in the 9th Plan and are not complacent even after their achievement in Power Sector.

The NEREB is of the opinion that even the liberalised economic policy of the Govt. of India has been unable to attract private participation in power sector in spite of the fact that this region is rich in potential.

North Eastern Electric Power Corporation admits that in spite of having taken a number of steps the power situation has not improved to meet the demand but argues that the hydro-resource of the N.E. Region with its abundance can play a remarkable role if genuine interest is shown to develop certain major projects.

With its proven record of excellence, NEEPCO perhaps remains as the viable answer in this programme of harnessing potential hydro-power of the NE Region though sustained planning is also claimed.

The NEC plays an important role in the development of the N.E. States and their experts interact with common people in their activities.

Planning Department of Meghalaya assures of well oriented future plans along with strategies adopted in different countries to bring socio economic changes in a balanced manner.

Assam Science, Technology & Environment says it became an autonomous body in 1986 and conduct activities through S & T. Energy, Environment and Remote Sensing applications.

State Council of Science, Technology and Environment, Meghalaya suggest that for effective utilisation of Science and Technology a coordinated effort among the scientific community, the society, the policymakers, voluntary agencies and Govt. Machineries ought to be evolved.

However, the Centre for Science & Mathematics Education sound a note of caution about the threat posed by Technology in the industrialized countries for its nature and incompatibility with sustainable bio-sphere.

The different sessions were chaired by personalities like, Shri P.J. Bazeley, Principal Secretary, Govt. of Meghalaya and former Commissioner of Health & Family Welfare, Dr B.P. Bhattacharyya, Dy Director General, GSI, Dr G.K. Shrivastava, Addl Dy Director General, ZSI, Calcutta, Prof. B.K. Sharma, Head, Dept of Zoology NEHU, Prof. D. Khating, Director, RSIC, Shri A.D. Hohile, Chairman, Brahmaputra Board, Guwahati, Dr(Mrs) M.P.R. Lyngdoh, Principal, Shillong College.

The second important component of the conference was exhibition in which altogether 21 Scientific Organisations including one from Guwahati took part. The exhibitions were lively and more or less as per the theme Development of Science and Technology in the last 50 years. The participants took much pain to prepare their models and making arrangement for the exhibits. The inadequecy in the infrastructural facility was no impediment.

In an extra-ordinary gesture, H.E. Governor of Meghalaya, Shri M.M. Jacob paid an unscheduled visit to Shillong College after the Inaugural Function at the State Central Library Auditorium and went round the exhibition stalls along with other dignitaries and had shown interest. The Hon'ble Minister for Science & Technology, Mr. T.H. Rangad after inaugurating the exhibition went round the exhibition stalls.

The Hon'ble Chief Minister Shri B.B. Lyngdoh and Hon'ble Minister, Shri A.L. Heck also paid unscheduled visit to the exhibitions. These facts are pointers to the success of the exhibition.

Students found lot of interest, in models and puzzles in a few stalls, other stalls were educative.

The third component of the conference was popular talk on science. The one at the Inaugural Function was delivered by Dr A.K. Barooah of North Eastern Indira Gandhi Regional Institute of Medical and Health Science, Shillong. His topic was High Blood Pressure. In a very lucid language Dr Barooah explained the causes, gave statistics of different countries about the HBP patients and suggested preventive measures. The presentation was impressive & thought provoking.

Ladies & Gentlemen,

We tried our best to organise the conference in a befitting manner. Our sincere apology is for the short comings. The efforts will be considered successful if as a follow up action the different Scientific Agencies make a coordinated effort for the all round development of the region.

Thank you all.

VOTE OF THANKS AT THE VALEDICTORY SESSION : Dr S.K. GUPTA, JOINT CONVENER

Like all fruitful activities of life, our 4-day long Conference and Exhibition on the Development of Science and Technology have also come to an end today. The last half of the week has been a hectic period of learned deliberations, a comprehensive picture of the region's scientific progress and potential being projected simultaneously by enthusiastic scholars, teachers, students, administrators and exhibitors.

A Conference and Exhibition on such scale and of such large participation was possible because we the organisers – Shillong College and the Shillong College Academic Society received unstinted support of men, material and financial assistance from every conceivable sources – Governmental, Private, NGOS, Educational Institutions, teachers, students and members of the public in general. The list indeed is endless and it will need pages to name all of them individually. We do remain extremely grateful to each one of them for their large-hearted cooperation, patronage, encouragement and valuable emotional support too.

This 4-day spectacle on Science and Technology was mainly possible because of the financial support of University Grants Commission (NER), Guwahati, North-Eastern Council, Meghalaya State Planning Department, North-Eastern Electric Power Corporation, North-Eastern Hill University, Geological Survey of India, National Council of Science, Technology and Museum, New Delhi, State Council of Science, Technology and Environment, Meghalaya, Central Pollution Board, New Delhi, Department of Atomic Energy, Mumbai.

A large number of Scientific Organisations and Government Departments came forward to make the grand Exhibition Programme a highly successful and popular show by their exhibits, most interesting demonstration and by also providing us with necessary infrastructural support, including accommodation, provision and vehicles. While we acknowledge every organisation's support and assistance, whether small or big, as most valuable, I would be failing in my duty if I do not mention the generous and multifarious support of the Atomic Mineral Division, Survey of India, Dept of Zoology (NEHU), Centre for Science Education (NEHU), Dept of Bio-chemistry (NEHU), Botanical Survey of India, North-Eastern Electric Power Corporation, Public Work's Department (Govt. of Meghalaya).

Dignitaries who graced the Inaugural and Valedictory Programmes and other interim sessions by their valuable presence have made us indebted to them for ever. His Excellency Shri M.M. Jacob, the Governor of Meghalaya, Hon'ble Chief Minister Shri B.B. Lyngdoh, Hon'ble Minister of Science & Technology, Shri T.H. Ryngad, the learned Vice-Chancellor of North-Eastern Hill University, Prof. B. Pakem, constantly guiding and encouraging. Shri H.W.T. Syiem, Chief Secretary and Shri P.J. Bazeley, Principal Secretary, Government of Meghalaya gave tremendous psychological support by their active presence and encouragement.

Eminent scholars who chaired the different sessions and learned participants representing different organisations raised the deliberations to a high level of excellence. We are grateful to them. The presence of noted Scientist-administrators like Dr B.P. Bhattacharyya, Deputy Director General, Geological Survey of India, Shri A.D. Mohile, Chairman, Brahmaputra Board, Prof. H.L. Duarah, Vice-Chancellor, Gauhati University greatly enthused us and went a long way to make our programme really useful and educative.

The intellectual exercise during all these days would have been incomplete had it not been accompanied with a refreshing dose of high tea, lunch and dinner. These were generously sponsored by Shri Gautam Bhattacharjee of NIIT, the Rapsang Group of Industries and several other generous individual and organisations. We appreciated their gestures with gratitude. We are very grateful to the media including the regional and national press, AIR Shillong, DDK, Shillong, DIPR, Government of Meghalaya and others for their wide coverage of our plans, programme and various sessions. We convey our sincere gratitude to Local Durbars, particularly the functionaries of the Laitumkhrah Durbar for their presence, patronage and cooperation.

The teachers, staff and students of Shillong College feel rewarded for the hard work and dedicated service they rendered towards making the whole exercise overwhelmingly successful. We feel equally rewarded by the encouraging presence and patronage of numerous students, teachers, principals from different educational institutions during all the days of our conference and exhibition.

Finally we owe an enormous amount of gratitude to the College Management, particularly Shri Ramesh Kharpor, President of Shillong College Governing Body and its other learned members and the College Principal Dr(Mrs) M.P. Rina Lyngdoh who was the principal source of our courage and conviction.

Thank you once again.

NATIONAL CONFERENCE & EXHIBITION ON DEVELOPMENT OF SCIENCE & TECHNOLOGY IN THE LAST 50 YEARS IN INDIA WITH SPECIAL REFERENCE TO NORTH EAST INDIA MAY 27–30, 1998

RECOMMENDATION COMMITTEE

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RECOMMENDATIONS

1. Keeping in view that –

   (a) over eighty per cent of the people of North East India depend upon agriculture and allied activities for their livelihood,

   (b) the topography, climate and soil-chemistry of the North Eastern Region are conducive for horticulture, floriculture and the cultivation of aromatic and medicinal plants,

   (c) there are limitations for expanding area covered by foodgrain-crops in the N.E. Region due to the region's topography, climatic conditions and irrigible-profile which are naturally more suited for horticulture and cash crop plantations.,

   (d) the productivity of agriculture as well as horticulture crops in the region is uneconomically low due to inadequate transfer of appropriate technology, as well as critical inadequacies in the level of support services and essential backward and forward linkages.,

   (e) inadequate investments due to resource constraints of the public-exchequer and indifferent apathy of financial institutions have left the agro-horticultural potential of the North Eastern States largely untapped,

   (f) the incidence of 'jhumming' remains largely unchecked in spite of five decades of jhum-control programmes resulting in reduced jhum-cycle, ever-declining productivity and degradation of around 40% of the landmass of the region.

IT WOULD BE APPROPRIATE to launch a Centrally-Assisted Action Programme for the fullest exploitation of the agro-horticultural potential of the region, including floriculture and aromatic and medicinal plants. It would be necessary to suitably modify norms and conditions for the flow of institutional finance for funding the aforesaid Action Plan for cost-effective commercial exploitation of the potential in question, with adoption of appropriate and user-friendly technologies for stabilisation of jhumming and improvement of methods of traditional land use, to ensure socio-economic growth.

2. Keeping in view the fast disappearing profile of a large number of endangered species of the flora and fauna which were once unique to the North Eastern Region, it is essential to launch an accelerated programme for the insitu preservation and propagation of the gene-pool of such and other rare species in protected and community owned lands. It is also essential to take steps to intensify creation of public awareness and people's involvement in protection and preservation of such endangered species.

3. Keeping in view the diversity of germoplasm reserves of the region, such as Citrus, Orchids, Bannana and other important medicinal plants, it is essential to upgrade and strengthen the Regional Station for Plant Genetic Resources located at Umiam, to accelerate ongoing programme for identification of latent genetic strains, research thereon and evolution of technologies for successful release of suitable breeder material for introduction of suitable new strains, for fullest exploitation of such potential of the region.

4. Keeping in view the continuing incursions on the forest cover of the region resulting in the increasing decline of the total area under forests, as reflected in successive State of Forest Reports, while focussing on the reality that the overwhelming majority of the region's indigenous population are wholly dependent on forested-area and forest-based resources for their survival and socio-economic sustenance since the millennia, it is essential to capitalise on the present moratorium on felling and removal of forest cover brought about by the Hon'ble Supreme Court Order dated 12 December, 1996, with a view to protect, preserve and increase present levels of forested areas. This may be achieved by operationalising comprehensive forest management and conservation action plans drawn up to accommodate ground realities and provide for sustainable socio-economic growth and development of the indigenous people of the region, while ensuring the regeneration of ecological harmony and gradual expansion of forest cover to above critical minimum levels. It is also essential to expedite the establishment of a Regional Remote Sensing Centre for the North Eastern Region, to enable the tapping and generation of essential data for correct perspective planning.

5. Noting that unplanned and unscientific mining of major minerals such as coal, limestone, other minerals and road-side quarrying for extraction of sand, stone and shingles in the region, especially in Meghalaya

has resulted in extensive destabilisation of the ecological harmony, pollution of surface and ground water, and rendered extensive valley lands unsuitable for foodgrains cultivation, it is essential to launch a massive awareness campaign to educate the masses of the paralysing long term effects and to motivate introduction of planned, scientific mining procedures. It is also essential for the state to cause suitable corrective legislation with a view to arrest the degradation of the habitat of tomorrow from soon becoming wholly incapable of sustaining healthy human life and economy in such areas.

6. There are very large number of Regional Organisations and Institutions in the North East such as the SOI, BSI, ZSI, ASI, GSI, AEC, NBPGR, NERICAR etc. It is essential for the State Governments of the region to tap the expertise of such organisations for developing a long term master plan for sustainable planned exploitation of the region's abundant natural resources, for the balanced integrated socio-economic growth and development of the region, in a manner which is compatible to sustained ecological and environmental harmony and capable of removing urban-rural imbalances.

7. Keeping in view the seismic status of the entire north eastern region, it is essential for the construction of all major public works, particularly the major road and rail bridges, major public buildings, dams and reservoirs to be built using suitable state-of-the-art seismic-shock proof technologies based on sound seismic data and uniformity with standing codes in such regard. HRD measures should be initiated by the states to ensure that all future public and private constructions are based on seismic shock-proof technologies and conform to standing building codes for seismically active zones. It is also essential to intensify creation of public awareness of the dangers of construction which do not conform to building codes for such seismically active zones.

8. Taking note of the vulnerability of the region to drug-trafficking and arms-running, it is essential for the Institutions of Forensic Science in the region to be suitably upgraded and strengthened along with training facilities for human resource development in this highly specialised field. Steps should also be intensified for establishing adequate facilities for fuller rehabilitation of drug addicts.

9. The immense hydel and mineral reserves of the region should be fully exploited with a view to ensure optimum utilisation of the regions abundant coal, limestone, natural gas and uranium ore reserves.

10. Inadequate industrial-infrastructure, poor communication network, lack of trained human resource, out-dated rail transport set-up, want of streamlined inland water transport system, inadequate marketing outlets and critically low absorption of Institutional Finance have thwarted industrial growth, in spite of the region's rich resource-base. It is essential for the Central Government to intervene to remove such major bottlenecks and to accelerate the pace of industrialisation of the region, with a view to ensure its absorption into the national mainstream.

11. The healthcare services of the region lack adequate specialised medical manpower. It is essential for the Central Government to accelerate the establishment of centrally funded facilities for post-graduate studies in medical and paramedical sciences, with a view to ensure balanced healthcare services in rural areas.

12. The vulnerability of the region to Malaria and AIDS is well known. It is essential for existing NMEP, NACP and NDCP to be strengthened and pursued vigorously.

13. Keeping in view the limitations of the public exchequer to provide adequate investment for the fullest exploitation of the regions abundant hydel resources, accelerated steps should be taken to attract private investment for optimum commercial exploitation of such natural reserves, for rapid economic growth of the region.

14. Watershed based integrated resource management approach with tested location-specific improved technology as a major input, fullest participation of the stake-holders at all stages coupled with selective support of state agencies, are essential for the development of the numerous rainfed Micro Watersheds of the region. As such, it is necessary to properly plan and conceptualise the various social, political, geo-ecological, technical and economical parameters of Watershed Development Projects taking into consideration stake-holder's interests, past experience in similar projects, expert opinion and critical missing links in essential backward and forward linkages, while formulating, finalising and implementing such projects.

TECHNICAL SESSION – I

HUMAN RESOURCES & HEALTH SCIENCES

AIDS - THE MENACE : ITS PRESENT GLOBAL & COUNTRY'S SCENARIO WITH SPECIAL IMPORTANCE TO THE NORTH EASTERN REGION AND THE CONTROL STRATEGIES

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ABSTRACT

Aids which in other words termed as 'AUTO IMMUNE DEFICIENCY SYNDROME' has been becoming the subject of panic and attention in the entire world and snatching away thousands of lives. The window period of the disease and non-availability of its cure has been the greatest concern and social stigma lying underneath is becoming instrumental in diagnosis of many hidden cases. The subject needs special attention and discussion. An endeavour will be made to discuss the pros and cons in details.

INTRODUCTION

AIDS the Menace, otherwise termed as the '**Acquired Immuno Deficiency Syndrome**' is defined as a disability or life threatening illness caused by human immunodeficiency virus (HIV) characterised by HIV encephalopathy (Disease Process in the Brain), wasting syndrome etc. due to immunodeficiency in a person with laboratory evidence of HIV infection or without certain other causes of immunodeficiency.

The Centre for Disease Control (C.D.C.), Atlanta, USA has now revised the definition of AIDS as **anyone within fewer than 200 lymphocystes (CD) and control as Full-Blown AIDS case.**

On the other hand, World Health Organisation (WHO) has come out with separate strategy specially for the underdeveloped countries where modern sophisticated tools and implements for diagnosis of AIDS are limited. It states that merely by existence of two major signs associated with one minor sign, **in the absence of known causes of immunodepression like** malignancy or severe malnutrition or other recognised factors leads to the **Provisional Presence of AIDS.** These are :

Major Signs :

(a) Weight loss more than 10% of body weight.
(b) Chronic Diarrhoea more than one month.
(c) Prolonged fever more than one month (intermittent or constant).

Minor Signs :

(a) Persistent cough for one month.
(b) Generalised itching (dermatitis).
(c) Recurrent Herpes Zoster.
(d) Oropharyngeal candidasis.
(e) Chronic progressive herpes simplex.
(f) Generalised lymphatic glandular enlargement.

In case of children it differs from adult. Clinically, it is non-specific. The child may show glandular enlargement, enlargement of the liver and the spleen, fever or diarrhoea. The child suffers from more serious infections and is very prone to malignant diseases.

HISTORY OF THE DISEASE

AIDS was virtually unknown during the 70's and has become widely known during the last decade. After it was known, the people belonging to all segments of the society have become much more disturbed and seriously concerned about the disease and are having tireless efforts for solutions both for its cure and control effectively.

In 1981, AIDS was first recognised among the homosexual males in USA and at the same time physicians in some of the African countries had been noticing unusual types of infection which later could be recognised as nothing but AIDS. Likewise, **in India, the first case was reported in May 1986 in Bombay.**

The causative agent was the Human **Immunodeficiency virus which had been identified during 1984,** but clearly there was extensive spread throughout the world by 1980.

ACTIOLOGY (CAUSATIVE FACTOR) OF THE DISEASE

By 1983, **the cause of AIDS was discovered to be** a virus. Barre-Sonossi and Luc Montagnier and his colleagues at the Pasteur Institute in Paris discovered the virus and named it as Lymphadenopathus Associated Virus (L.A.V.). In 1984, Dr Robert Gallo and co-workers of National Cancer Institute, USA, reported the same virus but called it as Human T. Lymphocytic virus (H.T.L.V. III).

EPIDEMIOLOGY

Agent Factors :

(a) Agent :

By 1985, an International Committee of Scientists by consensus named the agent as **Human Immuno Deficiency Virus** (H.I.V.). This virus is a member of Lente virus family of Retrovirus which includes Visna virus of sheep, Caprine Arthritis, Encephalitis virus. It causes slowly progressive neutrogenerative (involving nerves) and progressive immunodeficiency.

The virus has got a complex structure. The virus uses the human cells to perpetuate itself. The virus can remain in lymphoid cells in a latent state which can be activated. The virus has the unique ability to destroy human T_4 helper cells, a subset of the human T Lymphocytes. The virus able to spread throughout the body. It can pass through the blood brain barrier and can destroy some brain cells. H.I.V. mutates rapidly, new strains are continually developing.

There are two types of virus, namely HIV-1 & HIV-2. The virus is easily killed by heat. It is readily inactivated by ether, acetone, ethonol 20% and beta propiolactone (1:400) but it is relatively resistant to ionising radiation and ultraviolet light.

(a) Reservoir of Infection :

These are cases and carriers. Once a person is infected the virus remains in the body lifelong. The person may remain symptomless but is a permanent carrier.

(b) Source of Infection :

The virus has been found in greatest concentration in blood, semen and cerebrospiral fluid. Lower concentrations have been detected in tears, saliva, breast milk, urine, cervical and vaginal secretions. H.I.V. has also been isolated in brain tissue, lymphnodes, bone marrow cells and skin. Presently only blood and semen have been conclusively shown to transmit the virus.

Host Factors :

(a) Age : Most cases have occurred among sexually active persons between 20–49 years. Children under 15 make up less than 3% of cases.

(b) Sex : About 70% of cases are homosexual or bisexual men. Certain sexual practices increases the risk of infection more than others like multiple sexual partners, anal intercourse and male homosexuality. Higher rate of H.I.V. infection is found in prostitutes.

(c) High Risk Groups : Male homosexuals, bisexuals, heterosexual partners (including prostitutes), intravenus drug users, transfusion recipients of blood and blood products, haemophilliacs and clients of S.T.D.

(d) Immunology : It occurs primarily from the gradual depletion in a specialised group of white blood cells (Lymphocytes) called T helper of T_4 cells. It is also commonly known as CD_4 cells.

H.I.V. selectively infects T. helper cells apart from several other cells in the immune system such as B cells, microphages and nerve cells. Consequently, AIDS cases leads to leukopenia. Whereas healthy individuals twice as many as helper cells as suppressor cells. In the AIDS patients the ratio is reversed.

EPIDEMIOLOGICAL TREND OF THE DISEASE

Two important features are important to know the transmission and spread of the disease. These are :

(i) Modes of transmission
(ii) Latency period of the disease.

There are three known features in the mode of transmission :

(a) Sexual Transmission :

It includes both heterosexual and homosexual intercourse. It has been established that in Asia about 90% of H.I.V. infections has resulted from sexual intercourse.

(b) Transmission through Blood and Blood Products :

The main component of this results from transfusion of infected blood and from infection of infected blood which may be either from the health-care selling or by injecting drugs. Further infection of blood products like plasma or Factor VIII is another predominant factor for transmission.

(c) Transmission from Mother to Child :

Infection before, after and during birth may give rise to the disease. Approximately 1/3 children born to H.I.V. infected mother will be infected with H.I.V.

(d) Racial Factor :

Till now there is no evidence that any racial or ethnic group has greater susceptibility or greater resistance to the virus.

H.I.V. is not transmitted by Casual Social Contact, by Kissing or by Mosquito Bites

Latency Period :

It is very grave to know that, the time between becoming infected with H.I.V. and onset of AIDS is unusually long. Approximately 50% of these infected become ill within 10 years after infection. **Current evidence suggests that all H.I.V. infected people will ultimately die of AIDS. Once an individual develops AIDS, the average survival time appears to be between 1-3 years. In the developing countries the survival time may be less than one year.**

CLINICAL MANIFESTATIONS

The clinical appearance have been classified into four broad groups :

(1) Initial Infection (Acute Infection)
(2) Asymptomatic Carrier state
(3) AIDS Related Complex (ARC)
(4) AIDS

(1) Acute Infection :

Except for general mild illness (Fever, Sore throat or Rash), about 70% of people experience a few weeks later no symptoms for the first five years or so. They are apparently healthy, although right from the start they can transmit the virus to others. **Once infected it is for the whole life.** There is not yet any cure nor any chance to make them uninfectious to others.

H.I.V. antibodies usually take between 2-12 weeks to appear in the blood stream. The period before antibodies are produced is the **Window period.**

(2) Asymptomatic Carrier State :

Infected people have antibodies but to overt sign of the disease except generalised glandular enlargement.

(3) AIDS Related Complex (ARC) :

A person with ARC has illness caused by damage to the immune system but without the opportunistic infections and cancer associated with AIDS but they exhibit one or more of the following clinical signs :

(a) Unexplained diarrhoea lasting longer than a month
(b) Loss of 10% or more body weight
(c) Fever
(d) Night sweats and
(e) Oral thrush etc.

(4) AIDS :

People with a healthy immune system usually have more than 950T cells in each cubic mm of blood. If AIDS infected they come down below 200.

AIDS is the end stage of H.I.V. Infection :

A number of opportunistic infection occurs at this stage. Death is due to uncontrolled or untreatable infection. Tuberculosis and Kaposis Sarcoma are usually seen relatively early. Serious fungal infection like candida oesophagitis and parasitic infection like premocystitis tend to occur.

Many people may suffer from wasting syndrome specially in Africa it is called as SLIM DISEASE. It may also give rise to AIDS dementia. An alarming factor is the link of AIDS with Tuberculosis.

DIAGNOSIS OF AIDS

(1) Clinical : Already discussed.
(2) Screening Tests

Finding the antibodies in the blood stream is the basis for most widely used test of H.I.V. infection **as it is very difficult to isolate the virus.**

A person whose blood contains H.I.V. antibodies is said to be H.I.V. positive or Seropositive meaning that he or she is infected with H.I.V.

There are two different tests used to detect H.I.V. antibodies. At first a sensitive test is used to detect H.I.V. antibodies while a second confirming test is used to weed out any false positive result.

The first is known as **ELISA TEST** and the confirming test is known as **WESTERN BLOT** which is a highly specific test.

(3) Isolation of the virus is done for cultured lymphocytes.

CONTROL OF AIDS

As outlined already, there is **NO CURE** of AIDS although Medical Scientists have many tiring nights in extensive researches for finding out the CURE but far reaching results are yet to be in the scene. Hence the motto behind the scene '**PREVENTION IS BETTER THAN CURE**' must be individualised for each and every citizen of the globe.

There are however 4 (four) basic approaches for the CONTROL OF AIDS. These can be outlined as :

(1) Extensive Health Education :

This is the only weapon to be applied so that people are able to make life saving choice like :

(i) Avoiding indiscriminate sexes
(ii) Using condoms.

Other measures for personal protection are :

(iii) Not to use shared razor in shavings and tooth brushes.
(iv) Not to share the same needle and syringe if he or she is an intravenous drug-user.
(v) Infected woman should not try to become pregnant again as she would be transmitting the virus to the offspring.

And other education pertaining to AIDS should be made available to each and every one which should be able to bring about awareness among the people. This can be made possible through —

(a) Personal counselling
(b) Exhibition
(c) Contact : personal/group
(d) Discussion : in group, in school
(e) Distributing of pamphlets incorporated with the knowledge of AIDS
(f) Debating competition/Essay competition etc.

All the multi-media like Doordarshan, All India Radio, News Papers etc. should be extensively used to such purpose.

(2) Prevention of Blood Borne HIV Transmission :

People in high risk group should be urged to refrain from donating blood, body organs, sperm and other tissues. All blood should be screened for HIV-1 and HIV-2 before transmission. Transmission of infection to Haemophilics can be stopped by introducing heat treatment of factors VIII and IX.

Strict sterilisation should be mandatory in hospitals and clinics. As far as practicable, disposable pre-sterilised needles should be used.

(3) Specific Prophylaxis :

Antiviral Chemotherapy with the chemical compound ZIDOVUDINE (AZT) while not a cure has been proved useful in prolonging life of several ill patients.

(4) Vaccines :

Since 1987 many vaccines have been developed but none is so far found to be effective and hence we are to await for the further outcome of the researchers.

AIDS SCENARIO

GLOBAL OVERVIEW

HIV made inroads into North America, West Europe and Australia in the early 1980's with HIV registering its presence in USA in 1981 when the first case of AIDS was reported. AIDS has reached most of the regions of the world with reports of high prevalence coming from South America, Sub-Saharan Africa and the Caribbean.

During 1996 while high figures of HIV prevalence are pouring in from the worlds second most populous region i.e. South and South East Asia, new populations in Central and East Europe and Central Asia are reporting HIV infections.

Hence HIV/AIDS has now become a truly global epidence with an estimated **22.6 million people living with HIV/AIDS** including 3.1 million new infections in 1996 alone.

ESTIMATED HIV PREVALENCE RATE *(%) BY REGION (END OF 1996)

1.	East Asia & Pacific (EAP)	:	0.01
2.	Central & East Europe and Central Asia (CEECA)	:	0.02
3.	North Africa and Middle East (NAME)	:	0.1
4.	Australia and New Zealand (ANZ)	:	0.1
5.	West Europe (WE)	:	0.2
6.	South and South East Asia (SSEA)	:	0.6
7.	Latin America (LA)	:	0.6
8.	Caribbean (C)	:	1.7
9.	Subsaharan Africa (SA)	:	5.6

* HIV prevalent rate equals the number of persons living with HIV/AIDS in a specific region at a specific time divided by the total population of the region (Fact Sheet Nov. 1996).

UNDERLYING OBSERVATIONS

- Majority of the 2.7 million newly infected adults are under 25 years of age.
- Around 50% of the new infection now occur in women.
- There are 4,00,000 new infections among children in 1996, bringing the total of children living with HIV/AIDS to 8,30,000.
- A New York based orphan project estimated that nearly 1 million children under 14 years of age have been orphaned by AIDS in Kenya, Rwanda, Uganda and Zambia which may rise to 2 million by the year 2000.

PEOPLE LIVING WITH HIV/AIDS

Male	:	12.7	million
Female	:	9.2	million
Children	:	0.83	million
Total	:	22.63	million

NEW INFECTIONS IN 1996

Adults	:	2.7	million
Children	:	0.4	million
Total	:	3.1	million

ESTIMATED DISTRIBVUTION AS OF MID 1996 OF ADULTS AND CHILDREN INFECTED WITH HIV SINCE LATE 1970'S

1. North America (NA)	:	1.2	million
2. Canbarian (C)	:	3.3	million
3. Latin America (LA)	:	1.6	million
4. West Europe (WE)	:	0.64	million
5. East Europe and Central Asia (EECA)	:	0.31	million
6. North Africa as Middle East (NAME)	:	0.22	million
7. Subsaharan Africa (SA)	:	19	million
8. East Asia Pacific (EAP)	:	0.36	million
9. India & South East Asia (ISEA)	:	5	million
10. Australia (A)	:	0.23	million

For the year 2000, the current WHO Projection is that there will be cumulative total of about 40 million HIV infection of which 90% will be in the developing countries

The epidemic is expanding rapidly in South & South East Asia and will soon surpass Africa in the annual number of new infections.

Asia is projected to have 8 million HIV infections. The cumulative no. of HIV related deaths is projected to rise to more than 8 million for its current total of 6.4 million. In 1996 alone, that are above 1.1 million AIDS deaths among adults.

SCENARIO IN THE NORTH EASTERN REGION

The entire country is now alert that the state of Manipur in N.E. Region followed by Nagaland have become the torch bearers regarding the painful incidence of HIV/AIDS in the region which is mainly due to the fact of similar geographical, climatic and topographical aligness with highly incidental International countries like Myanmar, China and other S.E. Asian origin. Further having similar culture, habitats and sociological behaviours and easy approachability to the Golden Triangle both Manipur and Nagaland have become the victims of HIV positivity and AIDS cases.

The recent scientific seminar held at RMRC, Dibrugarh held during April 1998 have come out with the following facts and figures :

(A) MANIPUR : (CASE FINDINGS AS ON 28TH FEB. 1998)

1. Total No. of HIV positive cases (HIV)	:	6194
2. Total No. of Population Screened (PS)	:	49141
3. Total No. of AIDS Cases (AIDS)	:	301
4. Total No. of AIDS Death (AD)	:	94

5. Sero Positive Rate (SPR) : 126.04 per thousand
6. Percentage of Contribution to the current cases of AIDS (PCCAC) : 0.2

Serio Positive Rate is incidentally higher than that of Tamil Nadu

(B) NAGALAND

The total projections are under :

Year	Blood sample screened	Result
1994	1842	144 positive of HIV
1996	7011	389 positive for HIV
1997	8518	429 positive for HIV

(C) ASSAM

Total No. of blood sample screened : 55266
No. of Sero positive cases : 81

(D) MEGHALAYA

In 1990 first HIV positive cases was detected :
No. of Samples screened : 13189
No. of Sero positive cases found : 57

(E) ARUNACHAL PRADESH

Total No of samples screened : 2990
Sero positivity : Nil

However, it could be known that 2 full blown AIDS cases have been found out (diagnosed outside) from this state also, which otherwise is termed as **Nil** contributing state in the country.

(Figures of Tripura and Mizoram not recorded)

It can also pointed out here that poppy cultivation is in abundance specially in Arunachal Pradesh and Nagaland. Also the entire region has got a bad reputation of consuming alcohol and in near future alcohol can take the second priority among the drug users. Due to the non-processing of proper scientific studies there may be much more hidden cases and it can be predicted that if adequate steps are not taken right from now the entire N.E. region may come to the grips of HIV/AIDS in near future.

GLOBAL DEVELOPMENTS

HIV/AIDS pandemic has now become truly global. Only few areas in the world remain untouched. It is also well understood that **Prevention** is the only tool truly available with medical scientists although some hopes are still looming at large in front of us in the form of a vaccine which is the phase III of human trials and as an interim analysis of a phase III randomised, placebo controlled trial to evaluate the efficiency, safety and tolerance to AZT (Zidovudine) which reduces vertical transmission in preventing maternal foetal HIV transmission which has shown a highly significant reduction of the risk among women who received AZT.

INDIAN SCENARIO

- Sincerely speaking India is going ahead with the danger signal of HIV positivity in last two years. WHO currently estimates 2.5 million HIV infections in India. As reported to NACO there are 49,527 (Cumulative till Dec. 1996) infections with sero positivity rate 17.00 per thousand. The number of reported cases of AIDS are 3,161 (Dec.'96). However, there may be hidden cases in spite of availability of tool and equipments for case findings.

Observations by NACO :

- Heterosexual contact is still by far the most prevalent mode of transmission (73.1%).
- Increasing sero positive rate has been found among injectable drug users (IDU) in Manipur and Nagaland
- 77% of the AIDS cases are males, 23% are females.
- About 1% of the total cases are among the Antenatal mother who are **'low risk group'**.
- Higher incidence of HIV prevalence has found among major track rates.
- Migrant workers and transport facilities has increased the chance of HIV spread.

While Maharashtra has reported highest to both HIV/AIDS cases. Arunachal Pradesh has shown with ZERO POSITIVITY. Dimapur which is one of the important commercial towns is having more than 8,000 drug users out of which 1100 are hardcore drug users. Out of 276 blood test done among IDU 192 had been found positive.

STRATEGIES FOR PREVENTION OF AIDS AND CARE

As pointed out by World Bank Developing countries cannot ignore the HIV/AIDS epidemic. According to UNAIDS, about 1.5 million people died of AIDS in 1996. Each day about 8500 people including 1000 children become newly infected and 90% of these occur in developing countries where the disease is likely to exacerbate.

It is a fact that after 2 decades of the appearance of HIV, an estimated 30 million people have contracted the virus and 6 million have died of the disease. Hence clearly human toll of the epidemic is great. But the developing countries get this uphill task to complete.

Since, as pointed out earlier we have got severe limitations for case findings and treatment and since we do not have enough potent tools to fight against the disease, therefore, prevention and allied measures are the only tools in front of us which can be summarised as below :

EFFICIENT AND EQUITABLE STRATEGIES FOR PREVENTING HIV

Despite the private nature of the behaviours that spread HIV, Govt. have the options for influencing the decisions among those most likely to contract and spread the virus.

Public policy can directly influence individual high risk behaviour, either by lowering the cost of safer behaviour (subsiding information of various types, condoms and access to clear injecting equipment or for raising the cost of behaviour spread HIV e.g. restricting prostitution or use of injected drugs).

AIDS SCENARIO

GLOBAL

As per WHO estimation by mid 1993, 13 million adults and 1 million children worldwide have been injected with HIV infection. The bifurcations are as under :

1.	Sub-Saharan Africa (SSA)	:	8	millions
2.	North America and Latin America including the Caribbeans (nalac)	:	2	millions
3.	European Region (ER)	:	0.5	millions
4.	South East Asia (SEA)	:	1.5	millions

WHO predicts that by 2000 AD, 30 to 40 million men, women and children would be injected with AIDS which is 4 times of the present situation.

As of mid 1993, total over 650000 adult AIDS cases have been reported from 168 countries, but as these are likely to have been **misguided cases** it would be closer to 3 million cases.

Another surprising factor is the parallel epidemic of tuberculosis as a result of HIV which is of much concern to all health organisations. Some are likely to happen in Asia where 40% of the population are infected with tuberculosis.

SITUATION IN ASIA

As of 28th October 1993, a total of 3600 cases of AIDS have been reported in South-East Asia. Thailand and India have reported largest number of cases, 300001 and 444 respectively accounting to more than 95%

of the cases reported from the region. Four countries viz. Bhutan, Korea, Maldives and Mongolia are yet to report AIDS cases. Majority of the reported cases are within the age group of 15-40 years.

OUR NATIONAL SCENARIO (INDIA)

Sl. No.	State/Union Territories	AIDS Case
1.	Andhra Pradesh (AP)	2
2.	Assam (AS)	10
3.	Arunachal Pradesh (AR)	0
4.	Andaman & Nicobar Islands (AN)	0
5.	Bihar (BH)	1
6.	Chandigarh [UT] (CN)	100
7.	Punjab (PN)	
8.	Delhi (DE)	87
9.	Daman & Diu [UT] (DD)	0
10.	Dadra & Nagar Haveli [UT] (DN)	0
11.	Goa (G)	12
12.	Gujrat (GJ)	12
13.	Haryana (HR)	1
14.	Himachal Pradesh (HP)	9
15.	Jammu & Kashmir (JK)	2
16.	Karnataka (KN)	51
17.	Kerala (KR)	76
18.	Lakshadweep [UT] (LK)	0
19.	Madhya Pradesh (MP)	60
20.	Maharashtra (MH)	1041
21.	Manipur (MN)	99
22.	Mizoram (MZ)	0
23.	Meghalaya (ME)	0
24.	Nagaland (NG)	4
25.	Orissa (OR)	2
26.	Pondicherry [UT] (PN)	94
27.	Rajasthan (RJ)	3
28.	Sikkim (SK)	0
29.	Tamil Nadu (TM)	372
30.	Tripura (TP)	0
31.	Uttar Pradesh (UP)	8
32.	West Bengal (WB)	39
	Total	2093

N.B. : Courtesy NACO.
Figures as on 31st October, 1995.

STRATEGIES FOR PREVENTION AND CARE

The global strategy for prevention and control of AIDS was first developed by WHO during 1987 and has been updated recently with proper modifications from the valuable observations made in the past. **As per this, there are mainly three pillars for HIV preventions :**

1. **To prevent Infection with HIV.**
2. **To promote and provide care for already infected persons including those with AIDS.**
3. **To mobilise support for AIDS prevention efforts.**

These are further outlined more elaborately as follows :

(i) Adequate and equitable provision of health-care to the growing numbers of HIV infected people ill.

(ii) Treatment for other sexually transmitted diseases which increases people's biological vulnerability to HIV infection.
(iii) Reduction of women's social vulnerability to HIV infection by improving their health, education, legal status and economic prospects.
(iv) A more supportive socio-economic environment for AIDS prevention.
(v) Immediate planning in anticipation of the pandemic socio-economic impact.
(vi) A greater focus on conveying effectively the compelling public health rational for overcoming stigmatisation and discrimination.

The three main objectives of the strategy hence remain :

A. To prevent infection with HIV.
B. To reduce the personal and social impact of HIV infection.
C. To mobilise and unify both **National** and **International** efforts against AIDS.

PROGRAMME SCENARIO IN INDIA

The Government of India formulated a National AIDS Committee in 1986 and on the recommendations of that Committee '**National AIDS Control Programme**' was also formulated during 1986. In the following four years, its activities were mainly focussed on screening of so-called sexually promiscuous groups and evidently blood donors. Some educational activities were also undertaken.

In June 1992, the NATIONAL AIDS CONTROL ORGANISATION (NACO) was officially created as the executive governmental organisation to oversee AIDS prevention and control efforts in India. NACO is supported in its task by multisectoral committees and National AIDS Control Board as well as various specialised advisory committees. Likewise every state and union territories has set up similar high powered committees for implementation of Control Programmes.

The objectives of the Programme Component are :

(a) Establishment of an effective Programme Management mechanism at the National and State level.
(b) Provision of technical, financial and operational support on staff and organisations implementing programme activities.

CONCLUSION

It is crystal clear that the menace of AIDS is not only fatal but it is so far taking the most serious turn for its spread far and wide. It has also been found out to be invincible. Except we fight it through prevention there are no other ways in the fore-front and hence sometimes "**Newton's Third Law of Motion**" denoting '**to every action there is an equal and opposite reaction**' must be applied so that the menace can be brought under the grip of cure and control and till we can do that no effort should be left behind as otherwise human being will come to an extent from this lively planet.

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ACTIVITIES OF THE ANTHROPOLOGICAL SURVEY OF INDIA – NORTH EAST REGIONAL CENTRE

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ABSTRACT

Soon after the independence of our country, His Excellency Jairam Das Daulatram, the then Governor of the erstwhile Assam expressed his interest on the indigenous communities of the highland and thus he requested the Union Government of India to provide His Excellency with some anthropological information on the tribal communities inhabiting the area known as the North East Frontier Agency (NEFA) now known as Arunachal Pradesh. Subsequently, a few expeditions were carried out in the NEFA which were successfully completed and the report was submitted. Further, as a follow up measure and with the mission for expediting anthropological research in this part of the country, the Assam Station with the headquarters at Shillong was opened in the year 1953. The Assam station of the Anthropological Survey of India is at present known as the North East Regional Centre. This regional centre located at Shillong subsequently got equipped to undertake various anthropological research works in all the states of the North-East India except Tripura which is covered from the Eastern Regional Centre, Calcutta. Researches were since carried out by this regional centre both in cultural and physical anthropology and also in human ecology, linguistics and psychology. A number of individual, regional and national projects were undertaken and were successfully completed by this regional centre. Scientific laboratories attached to this regional centre are the photographic laboratory and the units of cartography and statistics. For the propagation of knowledge and dissemination of bio-cultural information, the Anthropological Survey of India decided to open the Zonal Anthropological Museums in all the regional centres in the various parts of the country. Under this programme the Zonal Anthropological Museum was opened at Shilliong, attached to the North East Regional Centre, in the year 1979. It holds the colourful cultural canvas of the traditional and indigenous population of the region.

INTRODUCTION

It was in 1945 that Dr S. Guha of the Anthropological Section of the Zoological Survey of India submitted a proposal for the establishment of a separate institution for Anthropology. The proposal was supported by Dr R.B. Seymonr Swell and in 1945 the decision was taken by the British Government to transfer the subject of anthropology to the Department of Education and to set up a separate institution, the Anthropological Survey of India.

Thus, this survey began in December, 1945 with Dr B.S. Guha as its first Director. The main thrust of this organisation was to act as a specialised centre for research in anthropology.

Soon after the independence of India, His Excellency, Jairam Das Daulatram, the then Governor of the erstwhile Assam expressed his keen interest in indigenous tribal communities of the region occupying the highlands of the region and requested the Government of India to provide His Excellency with some anthropological information on the tribal communities inhabiting the sierra known as the North East Frontier Agency (NEFA) now known as Arunachal Pradesh. (Rakshit : 1979).

A team of anthropologists comprising the founder Director of Anthropological Survey of India, Late Dr B.S. Guha and late B.C. Gohain was deputed to carry out an intensive study in the erstwhile Siang Division of NEFA as a follow up measure during early years i.e. 1945-1954. This was the first ever expedition of its type in NEFA or in the North East. The team marched into the hills with the mission of carrying out intensive study of anthropometric and dermatoglyphic variation, nutrition, blood group variation, social organisation and such other works among the different sub-groups of the Adi, who were earlier known as Abor. This was one of the largest expeditions which reached even the most obscure and remote locations of the area subsequently, the Government of India felt that a permanent station at Shillong would be of much help for doing research among various indigenous communities of the region. Hence, to facilitate continuous field investigations on the ethnic and cultural groups the Assam Station of the Anthropological Survey of India was established on 5th October, 1953 at Shillong. Today, it is known as the North East Regional Centre of Anthropological Survey of India. The Regional Centre at Shillong was subsequently equipped to undertake anthropological researches in all the states of the North East India excepting Tripura which is under Eastern Regional Centre of Anthropological Survey at Calcutta at present.

This Centre was initially started with a small component of staff but soon it developed into a full fledged regional centre to carry out research in anthropology and allied disciplines such as human biology, human ecology, linguistics and social psychology, etc. The Regional Centre possess a well developed and organised library with a collection of 8781 books on anthropology and allied disciplines and 58 journals both Indian and foreign are subscribed every year. The research activities at the Centre are bolstered by a photographic

laboratory, a sound laboratory and the services of catography and statistics section are also made available to the scholars.

CULTURAL ANTHROPOLOGY

Studies were carried out in ethnography and social anthropology among the Khasi and the Jaintia. The different divisions of the Khasi including the Lyngngams of the West Khasi Hills, who are still considered to be a relatively unexplored group of people in anthropological literature. Studies were also conducted on culture change among the War Khasi, land tenure system among the Bhoi Khasi, land ownership and social structure among the Pnars and the role of the traditional deities was also examined in the initial period when ethnographic and social anthropological studies were conducted. The Seng Khasi festivals and dances such as, the Shad-Suk-Mynsim and the Nongkrem dance were recorded by the cinematography unit of the Anthropological Survey of India, Calcutta. This Regional Centre organised and participated in the second expedition to NEFA in 1954 and discovered four out of the fifteen sub-tribes of the Adis. Projects were also carried out on the material culture traits and the techniques of pottery making in the various pockets of the North East India. Pottery making was studied among the Khasis, Jaintias and in the states of Manipur, Mizoram and Assam. The aspect of trade and business carried out by the women folk of Shillong since the traditional period in the matriarchal set up were studied in depth. Ethnographic study was done extensively on the Lalungs and the Rajbanshi of Assam.

This Regional Centre has undertaken studies on the weaker sections in the populations of the North East region as a part of a national project. Under this project the political movements of the various tribes of the North-East India were studied. Another study was conducted on the culture and society among the tribes of Arunachal Pradesh, namely, Khamti, Mishmi, Padam, Apatani, Nishi and Hill-Miris of the state. Under the tribe-caste continum studies were undertaken among the Koch and Hajongs. Studies were also undertaken on the Darranga fair, held every winter on the Assam-Bhutan border near Rangia.

During the Fifth Five Year Plan this Survey contributed towards the study of tribal movements, tribal economy, tribal customary law and tribal education. Field investigations were conducted among the Bodo-Kacharis of Assam, Naga, the Kabui Naga, Dimasas. Reports were subsequently published and were highly acclaimed by the academic circle. During 1982-85 the important areas of research were identified in the form of tribal ethnography and area study in Northeast India. The tribal communities covered were the Monpas of Arunachal Pradesh and a few tribes in Assam and Manipur. Another two projects, viz. The Tribes in Contemporary India and the Survey of indigenous Health Practices were subsequently launched in Arunachal Pradesh, Manipur and Mizoram. The reports were subsequently published.

During the Seventh Five Year Plan the survey launched the prestigious national project on 'People of India' wherein all the communities in India were studied. This study of the entire human surface of the country earned fame for the survey not only in the country but also abroad. A few more national projects were also launched and were carried out and continued through the Eight Five Year Plan. These projects are 'Structure Pattern and Transformation', 'Agrarian Laws and Agrarian System in Tribal India', 'Stratification and Social Change in Tribal India'. 'Women, Poverty and Rural Development' and 'Tribal Art and Oral Tradition'. The areas covered under the above mentioned projects were Assam, Arunachal Pradesh and Meghalaya.

During the Eighth Five Year Plan, five personal projects were also launched :

1. A Comparative study of Child Care Issues among the Hmars of Manipur.
2. Two Little known tribal Communities of Tawang District, Arunachal Pradesh.
3. Inter-tribal Relations in a hill city : Case Study of Shillong.
4. Ecology of disease and indigenous health practice in Meghalaya.
5. Problems of ageing in India : Case Study analysis and psychological observation.

PHYSICAL ANTHROPOLOGY

Systematic survey on the nature and extent of biological variations in the populations of North Eastern region and the processes of micro-evolution in them has been initiated by this Regional Centre in 1957 with the establishment of a Physical Anthropology Laboratory. Prior to this, the survey had conducted intensive studies on nutrition, demography, anthropometry, serology and dermatoglphics among the Adis and Noctes of Arunachal Pradesh. Besides, genetical studies have also been conducted among the offsprings of Khasi-European marriages and physiological development of Khasi children.

Scholars of this Regional Centre conducted extensive research work in the North - Eastern states under the Fifth Five Year Plan in the national projects viz. Anthropometric Survey and Bio-Anthropological Survey. Samples were systematically collected from almost the entire region on body size, incidence of diseases, deformaties, injuries and also types of marriages in about 100 families from each location.

Researches were also conducted on the request of the Director of Health Department, Government of Arunachal Pradesh on the aspect of demo-genetical and Anthropometric study on the incidence of dwarfism and goitre in some Adi villages of the erstwhile Siang district. Members from this Regional Centre also participated in the study of nutritional anthropology of the Koya tribe in Orissa.

During the Sixth Five Year Plan a project on Anthropometry of Indian women was launched and under the project the population groups of Brahmins, Kaibartas, Kalitas and Garos were studied. This project was subsequently renamed as Bio-anthropology of Indian Women. During the Eighth Five Year Plan the projects launched were :

1. Genetical structure of Indian population and under the project studies were conducted on the different communities of Assam, Arunachal Pradesh and Mizoram.
2. The second project was on the Nutritional Status of Indian population and data was collected from the Dimasa tribal population of the North Cachar Hlls.

ALLIED DISCIPLINES

Linguistics :

Studies on linguistics were initiated in 1969 with the analysis of the Thadou-Kuki Language, classification of the languages of Arunachal Pradesh and the analysis of the kinship terms among the Khasi, Garo and the Assamese.

During the Eighth Plan Period Studies were undertaken on the Tribal Art and Oral Traditions in Arunachal Pradesh and Meghalaya.

Psychology :

In 1975 psychological studies were conducted on the aspect of Intelligence and Interest Patterns among the Mizo students and participated in a miero-demographic study of social change among the Mizo population of Shillong.

In 1994 a study was conducted on gerontology on the aged population and the final report was submitted. The study was undertaken in Shillong.

Human Ecology :

The Human Ecology section conducted studies on shifting cultivation and its effects in Meghalaya, Mizoram, Manipur and Tripura. During the Eighth Five Year Plan, under the National Project 'Ecology, Environment and Human Population in India', field work was carried out in Meghalaya and report was submitted. In 1997 the project, viz. 'Ecology, Disease and Indigenous Health Practice in Meghalaya' was undertaken and the report was submitted.

Zonal Anthropological Museum :

During the Fifth Five Year Plan the survey developed a chain of Anthropological Museum attached to the Head Office and the respective Regional Centres. Artifacts were collected and preserved and displayed after their proper documentation. The Zonal Anthropological Museum attached to the North East Regional Centre was started in 1978 to play the role of general awareness about unity in diversity of the people and their bio-cultural adaptation to ecology of the north eastern region. Keeping this view in mind the Zonal Anthropological Survey has collected altogether 910 ethnographic specimens from all the North Eastern States. Exhibitions were organised with the display of museum specimen from time to time.

SEMINARS AND WORKSHOPS

Some of the important seminar/workshop held in this Regional Centre are as follows :

1. In 1973 a seminar was organised on the 'Cultural Profile of Shillong' which was inaugurated by the then Chief Minister of Meghalaya, Captain W.A. Sangma.

2. In 1977 in collaboration with the North East India Council for Social Science Research (NEICSSR), Shillong, this survey held the seminar on the 'Political Institutions of the Hill People'.
3. Workshop was held in this Regional Centre for three days in the first week of December 1985 on the national project 'People of India'.
4. The second workshop on the above project was held in the month of April 1991 from the 22nd to the 28th April in this Regional Centre.

SCHOOL OF ANTHROPOLOGY

School of Anthropology conducts In-Service Orientation programmes under the aegis of School of Anthropology, Calcutta for the benefit of the Scientific and Technical Officers of this Regional Centre every year.

JUBILEE CELEBRATIONS

The Silver Jubilee of this Regional Centre was observed in the month of April (25th-27th) in the year 1979. In this connection the exhibition 'Man And Culture In North East India' was held and amid many other functions a seminar was organised on the theme-'Bio-Cultural Profile of the North East India'.

Subsequently, the Golden Jubilee of the Anthropological Survey of India was observed at this Regional Centre on 12th December 1996. It was inaugurated by the then Chief Minister Shri Slaseng C. Marak in the State Central Library, Shillong. In this connection among many other programmes, an exhibition on 'Environment And Culture' was organised and a seminar held on the 'Ethnic Situation In North East India : Filed And Frontier' from 13th to 14th September 1996.

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WATER SUPPLY SCENARIO IN THE STATE OF MEGHALAYA

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ABSTRACT

Air, Water and Food are the three basic necessities for the existence of mankind. Fortunately in our country the people inhabiting the rural areas can breathe fresh clean air. The food in the village is by and large unadulterated, but the water that the villagers drink is mostly polluted. Water may be clean, free of any smell but still may contain harmful objects and thus is unsafe from health consideration. Much of the ill health in our country results from drinking polluted water. Poliomyelitis, Viral Hepatitis, Cholera, Acute Diarrhoeal Diseases, Typhoid Fever are some of the common water borne diseases prevalent in our country. The country has been emphasizing the use of uncontaminated water since times immemorial. The purity of water for human use finds mention in "Oisruta Sanghita", a medical book in Sanskrit of 2000 BC also.

The paper deals with policies of the successive governments. On provision of drinking water facilities since independence, various developments in the water supply sector, the approach of the department and types of water supply systems commissioned in the state, investment made in the sector, constraints and difficulties.

INTRODUCTION

When India achieved freedom, organised water supply was restricted to larger towns/cities only, but that too was inadequate. The rural population which constitutes approx 80% of the total population was without any safe drinking water supply. Water supply at that time was a provincial or a state subject and the State Governments were independently pursuing their own programme to a limited extent, depending on their financial resources.

The Bhore Committee (1946) and the Environmental Committee (1949) recommended comprehensive plans to provide water supply and sanitation on a priority basis. No concerted efforts could be taken to implement the recommendation. In the year 1954, National Water Supply and Sanitation Programme was initiated with the objective of providing safe water supply and adequate drainage facilities for the entire urban and rural population of the country. Till third year plan (61-66), water supply was part of Integrated Rural Development approach linking rural water supply with other rural development activities like sanitation, health etc. In 1972, a special programme known as Accelerated Rural Water Supply Programme (ARWSP) was also started as a supplement to the National Water Supply And Sanitation Programme with 100% grants-in-aid to the state for covering the 'Problem Villages'. A 'problem' village was defined as one where no source of safe water is available, within a distance of 1.6 km or where is available at a depth more than 15 metres or water source has excess salinity, iron, fluorides and other toxic materials or where water is exposed to the risk of Cholera or Guinea Worm. The minimum needs programme (MNP) was introduced during the fifth five year plan (74-78) under State Sector. The objective of the programme was to provide certain basic minimum needs and thereby to improve the living standards of the people. It was the expression of commitment of the Govt. for the social and economic development of the community. The programme apart from others included rural water supply. With the introduction of State sector MNP, central sector ARWSP was withdrawn from 74-75, but subsequently reintroduced in 77-78, when the progress of the supply of safe drinking water was not found as per expectation. It was decided in the 30th World Health Assembly of WHO in 1977 to launch a movement known as "Health For All By The Year 2000" for" attainment of level of Health, that will enable every individual to lead a socially and an economically productive life. "In 1978, the Alma Ata International Conference on Primary Health Care reaffirmed health for all as the major social goal of the governments and called up on all the governments to formulate national policies, strategies and plans of action to achieve the objective. In 1981, a global strategy for "HFA" was evolved by WHO. The Govt. of India also launched the "INTERNATIONAL WATER SUPPLY AND SANITATION DECADE (81-90) PROGRAMME" in 1981 with a target of :–

(i) 100% coverage of rural and urban population with safe drinking water supply facilities;
(ii) 80% coverage of urban population with sanitation;
(iii) 25% coverage of rural population with sanitation;

by 1990. To supplement the effort of the State Govt. in providing drinking water, Technology Mission for drinking water [TM] was set up in 1986 by Govt. of India to establish area based Mini Mission Projects for

sustainable supply of safe drinking water and to establish Sub-Mission of scientific source finding of water, control of Flurosis, eradication of Guinea Worm, removal of excess iron and control of brackishness. In 1991, TM was renamed as Rajiv Gandhi National Drinking Water Mission [RGNDWM] with the broad objective of providing sustainable safe drinking water to all uncovered/no source villages and creating awareness among the rural people about the hazards of using unsafe water. During the year 1991-92, a field survey was conducted all over the country to ascertain the status of water supply in the habitations, as per the directives of Govt. of India. According to the survey, a village is generally made up of 'Main Habitation' and 'Other Habitation'. The definitions are as follows :–

Main Habitation :– Is the part of the village having major facilities like school, market, health centre, post office etc.

Other Habitation :– Are the hamlets/areas surrounding the main habitation. The Conference of Chief Ministers on "Basic Minimum Services" held on 4-5th July, 1996 under the Chairmanship of then Prime Minister of India included provision of safe drinking water supply as one of the seven basic minimum services to be given utmost priority in next 2-3 years so that adequate safe water supply can be provided to the entire population of the country by 2000 AD.

In Meghalaya, the task of providing safe drinking water supply is almost entirely rested with State Public Health Engineering Department.

Meghalaya is a land with verdant hills and fast flowing streams. Most of the villages are situated on the top of the hills and the sources like streams and rivers flow at the bottom of the hills. In some places, springs at higher altitudes are available, but due to vagaries of rainfall and deforestation in the catchment area as also due to shifting cultivation, the yield of the springs is decreasing gradually. Ring wells or Shallow wells are not successful in hilly areas. Ground water potentiality of the state has not been explored fully. Some deep tube wells and hand tube wells sunk along the plain areas adjoining Assam and Bangladesh border were found to be successful. With the increase in population and man made activities, the quality of water is also degrading continuously.

Ideally, the approach is to tap underground water, which is more or less found to be free from any harmful objects and does not require any treatment except chlorination. These are cheaper both in terms of capital and recurring cost. The various methods of ground water, as practised in the state are :–

(i) Ring Wells
(ii) Dug Wells/Drinking Wells
(iii) Spring Tapped Chambers (STC)
(iv) Shallow Hand Pump Tube Wells
(v) India Mark-II Hand Pump Tube Well
(vi) Deep Tube Well with Power Pump

While (i), (ii), (iii) are preferred, these are not feasible in many places. The next in the order of preference will be to go for Shallow hand pump tube well, which can be used if the suction lift of the pump is within the recommended value, as below, based on altitude of the place :

Sl.No.	Altitude	Maximum Practical Suction Lift of Pump (Metres)
1.	1194 metre above sea level	6.40
2.	1584 metre above sea level	6.10

Generally, in the state ground water is available at depths in excess of 6.00m below the ground surface. In such cases, India Mark-II hand pumps are put to use, where pump is lowered into the well. The cylinder is located below the working water table at least 1.2 – 1.5m below to keep it always under submerged condition, so that it works with a positive suction. India Mark-III hand pump are the improvements over Mark-II hand pump, when water is available at greater depths, requiring lots of energy to pump out water manually through Mark-II hand pump. In the state, generally India Mark-II hand pumps are installed.

When the quantity of water required is more and the ground water is available at greater depths (ranging from 100ft to 600ft), deep tube wells with power pumps are installed. Bore size in such cases are 6"/8" and diesel/electrical driven vertical turbine pumps or submersible pumps are used for pumping out the water.

The surface sources are tapped through :

(i) Gravity scheme
(ii) Pumping scheme

Except for spring sources, treatment of water is generally necessary for such schemes. When we talk about water treatment, the term 'filtration' comes automatically. Water treatment is a physical-chemical process for separating suspended and colloidal impurities from water by passage through a granular material. Over the years, the meaning of the word 'filtration' as used by the water works industry has changed. In 1800s, the slow sand filter was dominant. It incorporated sand with an effective size of 0.2mm. This very fine sand produced good quality water from applied water of low turbidity at rates on the order of 0.12 to 0.32 m/h of bed area. Because of the low surface rates, slow sand filters required large areas of land. The removal of impurities take place by following mechanism :

1. The attachment and absorption of particles preset in water to the surface of sand grains.
2. Retention of particles larger than the pores of the granular medium, known as staining.
3. Formation of a layer of organic materials and other nutrients present in water at the top of the sand bed, known as 'Schmutzdecke', that efficiently strains very minute particles.

When the quantity of effluent water becomes very less due to deposit of excessive impurities, it is cleaned generally once in 2-3 months, by scrapping top 2-3 cm of schmutzdecke manually.

In early 1900s under the stimulus of epidemic water borne disease, the rapid sand filter came into general use and it largely replaced the slow sand filter. Rapid sand filter media might vary in effective size from 0.35 to 1.00mm with a typical value being 0.5mm with an uniformity co-efficient of 1.3 to 1.7. This type of media has demonstrated the ability to handle applied turbidity of 5 through 10 NTU at rates upto 4.88 m/h. Sand being bigger in size than the slow sand filter, rate of filtration is much higher (approx. 20 times) in rapid gravity filter requiring less space than the slow sand filter in treating the same quantity of water. The pore opening in a rapid gravity filter ranges from 0.1mm to 0.2mm in size. In the water applied to the filter, floc size ranges from 2mm to less than 0.1mm. It follows from these dimensions that the large floc particles can be removed by simple staining of the filter surface, but that much of the flocculated matter will pass into the filter bed and lodge within it largely in the top 10cm of the sand bed. The rapid sand filter requires cleaning generally once in 24 hrs. as against 2/3 months for a slow sand filter.

Rapid sand filters are cleansed by reversing the flow through the filter and backwashing the trapped particles from the bed. After back washing, the very fine sand accumulates at the top of the bed and the coarser particles lie below. More than 90% of the particles removed are taken out in the top few cm of the bed. Once a suspended particle has penetrated this top layer of the fine sand, its chances are greatly increased for passing through the entire bed, because the void spaces become larger and opportunities for contact decrease, as the particles travel downward. This is a well recognized limitation of the rapid sand filter.

In conventional filters, narrated above, water is passed from fine to coarse sand grains, leaving a lot of void space unutilized. If the filter media could be fully utilized, the filter run would have been more, the filtration rate would increase, improving both quality and quantity of filtered water.

First attempt of coarse to fine filtration was by reversing the flow of water from bottom to top in Up Flow Filtration. This removed the shortcomings of conventional filters, but if the adequate attention is not given for timely cleaning, previously removed particles trapped in the bed could escape in the effluent, giving rise to quality problem.

It was not until early 1940s, the development of coarse to fine principle of filtration took place, resulting in introduction of mixed media filter units, where three materials coal, sand and garnet/ilmenite having specific gravities of 1.4, 2.65 and 4.5 with coal at the top, sand at the middle and garnet/ilmenite at the bottom are placed. The particles are sized in such a way that after backwashing, controlled intermixing of these materials occur and no discrete interface exists between them. With applied turbidity of less than 15 NTU, dual media

filters can operate under steady state condition at 9.76 to 12.2 m/h with production of high quality water. Thus the filtration rate in mixed media filter is approx 2 to 3 times higher than the rapid gravity filter and 40 to 60 times higher than the slow sand filter. However, if the raw water contains excessive amount of finer particles, quality problem of filter effluents is encountered. Such type of filters have been constructed in the state with modification in simplified water treatment plants.

Some of the major Water Supply Schemes, where Slow Sand Filters and Rapid Gravity Filters have been constructed for drinking water purposes are :–

SLOW SAND FILTERS

(i) Umkhen W.S.S. (for Shillong Area)
(ii) Dalu W.S.S. preceded by a UPFLOW FILTER
(iii) Baghmara W.S.S. preceded by a UPFLOW FILTER
(iv) Rajasimla W.S.S.
(v) Chibonga W.S.S
(vi) Wage Asi W.S.S.

RAPID GRAVITY FILTERS

(i) Greater Shillong Water Supply Scheme (G.S.W.S.S.) Phase-I, Capacity-7.5 MGD.
(ii) Tura Phase-II W.S.S, Capacity-3.6 MGD.
(iii) Jowai W.S.S., Capacity-0.75 MGD.
(iv) Mawlai W.S.S., Capacity-0.75 MGD.
(v) Simsanggiri W.S.S., Capacity-0.75 MGD.
(vi) Baghmara Civil Sub Divn. Complex W.S.S.
(vii) Nongpoh W.S.S.
(viii) Mairang W.S.S.
(ix) Maulakandi W.S.S.

The simplified treatment plant is a new technique, developed by Dr. J.N. Kardile of Nasik, Maharashtra, which is used in the state also. Presently three schemes namely Goramara W.S.S., Konarchar W.S.S. and Goiragiri W.S.S. have been commissioned with such type of treatment plants. Here crushed coconut is used as a media along with sand. This media enables a very high rate of filtration compared to conventional filters. Raw water with high turbidity can be treated very well. This is also economical in the long run, as the crushed coconut shell media has a longer life of about 10 years and need not be replaced soon.

Water can be treated directly with the filter, provided turbidity of raw water is less than 1 NTU for Slow Sand Filter and less than 15 NTU for rapid gravity and mixed media filter. The raw water in the state generally conform to this for most of the period in a year, except for rainy season, when turbidity can go as high as 1000 NTU. The process of removing turbidity to make water ready to be used in the filter is known as Clarification/Sedimentation. Turbidity arises due to presence of suspended and colloidal materials. Turbidity of raw water is reduced by removing these materials.

In plain sedimentation, water is allowed to pass through a rectangular tank. The tank is so designed that most of the suspended materials are deposited at the bottom, before water leaves the tank. It has been established that the efficiency of a sedimentation tank depends on the surface area of the tank and the rate of flow of water. More the surface area, more the efficiency of the sedimentation tank in removing turbidity. This principle has been utilized in recent development of tube/plate settlers for removing turbidity. In plate settlers, a series of inclined plates are placed at an angle in a small tank increasing the surface area of flow of water, thereby removing the turbidity to a great extent.

The shortcoming of the Plain Sedimentation Tank is that the very fine particles do not settle down in the tank, which can be economically constructed, due to their small size. To arrest the smaller particles, Coagulation is done, which is the process of joining smaller particles with the addition of Alum, whose chemical formula is $Al_2(SO_4)_3 . 18H_2O$, the most commonly used coagulant, so that bigger flocs form and settle at the bottom of the tank. In such a case, instead of a rectangular tank, circular tanks are used, known as

Clarifier, instead of a rectangular tank, for slow mixing of particles/flocs, so that they grow in size and deposit at the bottom of the tank. However, with the addition of the alum, pH of the water decreases, making it acidic. To bring pH to the range of 6-8, generally lime is used in the treatment of water, after Coagulation.

In the state, plain rectangular sedimentation tank generally precedes slow sand filters, whereas Clarifiers precede Rapid Gravity Filters and Tube Settlers precede simplified filters. In some cases, sedimentation is also done in a pebble bed filter.

Filters produce a clear effluent, virtually free from any organic matter. Pathogenic bacteria removal is between 99 to 99.9%. Cysts, helminthic ova are removed even to a higher degree. Significant reduction in colour takes place. Viruses are virtually completely removed. Effluent from a filter may be bacteriologically unsafe, if a single pathogen remains in the water. Water after filtration is invariably disinfected with the objective of destroying or inactivating pathogenic organisms, more precisely bacteria of intestinal origin. Disinfection is done by adding Chlorine in the filter effluent. If the drinking water contains residual chlorine of 0.2-0.3mg/1, the water is considered to be bacteriologically safe. In the state, disinfection is done through addition of bleaching powder, whose chemical formula is Ca(OC1)C1, in a solution form in the water, which approx. contains 30% Chlorine. Dose of bleaching powder required to be provided is found out by actual test, so that minimum residual Chlorine is maintained at the farthest consumer's point. In European countries, O_3 is gradually taking the place of Chlorine, as disinfectant, but in India Chlorine in gas and solution form is the dominant disinfectant.

It needs a mention of rain water harvesting structures, constructed under Technology Mission in the West Khasi Hills District of the state. In this system, polythene sheets are placed over the thatched roof and the rain water is collected through a gutter system to a tank via a pre-fabricated filter unit. The water in the tank is used for drinking purpose through an ordinary hand pump. Some of the disadvantages of such structures are as below :

- The water available is limited by rainfall and roof area. Supplementary water sources are therefore needed.
- Mineral free water has a flat taste, while people prefer the taste of mineral rich water.
- Mineral free water may cause nutrition deficiencies in people, who are already on mineral deficient diets.

However, where there is no other feasible source of drinking water exists, such structures can be put to use.

When Meghalaya was carved out of the erstwhile state of Assam in January, 1972, only 60 nos of villages were provided with safe drinking water supply. Garikhana, Nongpoh, Umsning, Naya Bunglaw, Cherrapungee, Lawsohtun, Mawsynram, Madanriting, Sohkha, Darran, Muktapur were some of the gravity feed schemes completed during that period. Total number of villages as per 1971 census was 4586 nos, out of which problem villages numbered 3306. The coverage was barely 1.81% of the total problem villages, at that time. Since then, consequent upon validation survey and subsequent coverage, of the 5522 nos of Main Habitation and 2354 nos of Other Habitations of the state, the number of uncovered (NC) habitations in the state as on 1.4.98 is as below :

(i) NC Main Habitations = 65 nos.
(ii) NC Other Habitations = 182 nos.

Apart from this, 763 nos of newly grown up habitations, which came up after the survey, need also to be provided with water supply. Due to decrease in discharge of the source, increase in population in the habitations, the supply level in 1621 nos of habitations has been identified to be less than the GOI's norm of 40 LPCD. These are termed as 'Partially Covered Habitations' (PC). Efforts are being made by State PHED to provide water supply in these NC and PC habitations.

The various types of water supply schemes that have been commissioned in the state of Meghalaya upto 31.3.97 are as follows :

1. Gravity Feed Schemes = 1899 nos.
2. River Pumping Schemes = 119 nos.
3. DTW Pumping Schemes = 62 nos.
4. Hand Pump Schemes = 336 nos.

5. Spring Tapped Chamber Schemes = 327 nos.
6. Ring Wells = 409 nos.
7. Dug well / Drinking well = 200 nos.
8. Rain Water Harvesting Schemes = 124 nos.

Total Number of Schemes = 3476 nos.

Of these, 264 nos of schemes are not functioning due to various reasons such as damage of components due to natural calamities, theft of pipes from laid pipe lines, collapse/drying up of bores, deforestation of catchment area leading to drying up of source, resource crunch affecting proper maintenance of schemes etc. The details of these schemes are as below :–

DETAILS OF NON FUNCTIONING SCHEMES

Sl.No.	Types of Schemes	Numbers not Functioning
1.	Piped Water Supply Schemes	109
2.	Hand Pump Schemes	43
3.	Rain Water Harvesting Schemes	106
4.	Dug Wells / Drinking Wells	4
5.	Spring Tapped Chambers	2
	TOTAL	264

Of late, water quality problem, mostly the presence of excess iron (more than 1 mg/l) has been causing concern in the state. The problem is mostly present in those habitations, where deep tube well/hand pump have been installed. This is attributed to solution of rocks and minerals chiefly oxides, sulphides, carbonates of iron in the presence of carbon-di-oxide. The presence of excess iron imparts water a bitter characteristic, metallic taste and cause coloration of water apart from staining of plumbing fixtures and laundered materials. The coal extraction in different parts of the state is also giving rise to water quality problem.

So far, a total of 355 nos of habitations in the state have been identified, having presence of excess iron. The affected habitations are mostly in West Garo Hills, West Khasi Hills, Jaintia Hills district of the state. A total of 71 nos of quality affected habitations have so far been provided with safe drinking water supply in West Garo Hills District, by installation of Iron Removal Plants (IRPs). The principle of iron removal in IRPs involves transformation of iron present in dissolved Fe++ form in the ground water, due to absence of oxygen and presence of carbon-di-oxide, to precipitate in the form of Fe+++ with the help of oxygen present in air. This is effected by allowing water to pass through a spray aerator. Water falls through six number of trays, placed one above the other containing sand and lime, in the form of spray, so that drops of water having large surface area are formed thus facilitating easy mixing with atmospheric oxygen. Lime is placed over the trays to increase the reaction rate about 100 times. The following reaction takes place :–

$$Fe^{++} + \tfrac{1}{4} O_2 + 2 (OH^-) = Fe(OH)_3$$

The precipitated iron is removed from sedimentation and filter tank. The name of the schemes where IRPs have been successfully commissioned in the state are PUTAMATI W.S.S., TIKRIKILLA ZONE-A W.S.S., DOMAPARA W.S.S., AMPATI W.S.S., PAHAMPATARKATA W.S.S., BAINAPARA W.S.S., PHERSAKANDI W.S.S., HARIPUR W.S.S., MARAKAPARA W.S.S. Works are also in progress in 16 nos of schemes in west Garo Hills District. In Borato W.S.S. of Jaintia Hills District, old source has been discarded due to presence of excess iron and new source has been tapped for safe drinking water. The work is in progress in the scheme. Recently, sanction from GOI has been received for construction of another 13 nos of IRPs in the state.

WATER SUPPLY IN THE CAPITAL CITY

Shillong town and its suburbs were originally supplied since British Period from seven numbers of spring tapped sources at 'Wahjalnoh', 'Pattakhana', 'Crinoline', 'Wahrisa', 'Wahdienglieng', 'Umjasai' and 'Madan Laban'. These sources are presently maintained by Shillong Municipal Board. With reduction in discharges of these sources and the increase in population, these are not able to meet the demand of the town. In the seventies, PHED commissioned schemes such as Umkhen W.S.S., NNP Areas W.S.S., Mawlai W.S.S., Pynthorumkhrah W.S.S. for various areas of Shillong Urban Agglomeration. But still the supply was

inadequate. To cater to the drinking water needs of Shillong and its surroundings including en route villages, G.S.W.S.S. was sanctioned in 1979. The scheme envisages supply of water to an urban and suburban population of 3 lakhs and to a population of 40,000 in some of the rural areas falling within the boundary of the scheme. The ultimate supply of water would be 11.30 MGD. The Phase-I of the scheme has been completed and at present 7.5 MGD of water is supplied to Mawlai, Mawkhar, Jaiaw, Mawprem, Police Bazar, European Ward, Assembly Areas, Laitumkhrah, Shillong Cantonment, Army Area and enroute villages from the scheme. The work for laying of distribution network in Nongthymmai, Bishnupur, Kenches Trace, Laban, Madan Laban are in progress. Recently, construction of 50m high concrete dam over river 'Umiew' has been started to impound the water under the scheme at an estimated cost of Rs.36.00 crores (approx). On completion of dam and other appurtenant works, 11.3 MGD of water can be supplied from the scheme. The distribution network will also be laid in Malki, Pasteur Institute, Lachumiere area in future.

INVESTMENT IN THE SECTOR

The approximate investment during last 26 years in the state for rural and urban water supply is as below :

Sl.No.	Sector	Total Investment	Out of Which	
			State Share	Central Share
1.	RURAL WATER SUPPLY	219.44	134.78	84.66
2.	URBAN WATER SUPPLY	47.47	46.80	0.67
	TOTAL	266.91	181.58	85.33

CONCLUSION

Water Supply is a continuous process. The supply level goes below the designed level with increase in population and decrease in discharge of the source and improvement/augmentation schemes are necessary for this. The water supply schemes are designed for 15 years, after which renovation/reconstruction of these are required. Further with the improvement in quality of life, requirement of quantity of water will be more. Urbanization/Industrialization has given rise to pollution of drinking water sources, which were earlier free from that. Massive investment is thus necessary. Assets so far created needs also to be maintained properly to maximize benefits. It is also necessary to motivate, educate and involve the beneficiaries, especially the women, for proper upkeep.

Government investment alone is not sufficient. A sense of willingness needs to be developed in the community to pay for the assets created as well as for its maintenance.

DRUG MENACE AND TECHNOLOGIES REQUIRED TO CONTAIN IT

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ABSTRACT

Factual and accurate information on drug abuse together with national drug laws are essential weapon in all areas of national efforts to control drug abuse. Appearance of new drugs, new forms of old drugs, unexpected new illicit drugs or combination of drugs and misuse/abuse of drugs used for medical purposes not only have substantial and detrimental effects on the health and welfare of the people but also have given rise to other serious sociological problems. In India, about 2.3% of population regularly abuse drugs. This figure if calculated for the young age group only then this will be almost 3 fold. Unfortunately there is no authentic statistics of drug abuser in the North Eastern Region. There is, however, no denying of the fact that some of the states of this region have been severely affected by the drug menace and therefore there is urgent need to evolve some mechanism to contain it.

During the last fifteen years, there has been enormous increase in the production, supply and abuse of drugs. This paper deals with the various aspects of drug abuse and the different methods of detection for diagnostic purpose because the final outcome of the legislative procedure for the control of drug abuse rests upon the laboratory tests.

INTRODUCTION

Factual and accurate information on drug abuse together with national drug laws are essential weapons in all areas of national efforts to control drug abuse. The vital need for controlling drug abuse and drug trafficking demands improvement in the information technology in the area of (i) international cooperation, (ii) education and prevention, (iii) treatment, (iv) research and (v) national drug law enforcement. It is particularly important to give much efforts and attention in the areas of education and drug law enforcement. Appearance of new drugs, new forms of old drugs, unexpected new illicit drugs or combination of drugs and misuse/abuse of drugs used for medical purposes not only have substantial and detrimental effects on the health and welfare of the people but also have given rise to other serious sociological problems. Devastating consequences for the abuser apart, the family and community, drug abuse and trafficking lead to, economic and political dislocation. According to the available information there are about 40 million people regularly abuse drugs worldwide. In India, the figures are mostly impressionistic and consensus is about 2.3% of population regularly abuse drugs. This figure if calculated for the young age group only, then this will be almost 3 fold. Unfortunately there is no authentic statistics of drug abuser in the North Eastern Region. There is, however, no denying of the fact that some of the states of this region have been severely effected by the drug menace and therefore there is urgent need to evolve some mechanism to contain it.

Intensifying the regulatory efforts notwithstanding the extent and diversity of drug abuse demands that the drug testing laboratories evolve methodologies for specific, accurate, reliable qualitative and quantitative results. The analysis of biological specimens present additional challenge because of the need to separate target substances from interference in the blood and urine which are complex biological matrices. Development of internationally acceptable methods of detection and assay, speedy exchange of analytical data between laboratories as well as between laboratories and law enforcement agencies on national and international levels and also between the laboratories and diagnostic centres for treatment and rehabilitative purposes would contribute greatly towards the achievement of these objectives. In the later case, a positive analytical result would not necessarily involve subsequent legal proceedings but may serve as a reliable indicator to base future medical treatment of the addict.

TECHNOLOGY

Heroin, morphine and codeine are among the most abused opiates besides benzodiazepenes and other CNS active drugs. Different methodologies adopted in drug testing laboratories are enzyme multiplied immunoassay technique (EMIT), radio immuno assay (RIA), thin layer chromatography (TLC), gas chromatography (GC), high performance liquid chromatography (HPLC), gas chromatography – mass spectrometry (GC/MS) etc. The above analytical technique when applied singly or in combinations form the procedures which require different levels of interpretation for determining the result in seized drugs as well as in biological specimens. Based on the several studies it has been recommended that at least three independent tests must be carried out before reporting the result of drug analysis. The use of GC/MS instrument in drug analysis is of special significance as it has several modes of analysis including library search facilities and thus help in arriving at the conclusion which are accurate, specific and legally defensible.

Over the last one and half decades there has been enormous increase not only in the production and supply of illicit drugs but also in the abuse of the same. Alarmingly, there are reports of expanding misuse/abuse of drugs used for medical purposes. The extent and diversity of drug abuse have put increasing pressure on the nation to intensify regulatory efforts with the introduction of stringent legislation which may have serious consequences on the individual charged with drug offences. Ultimately the final outcome of these legislative procedure rests upon the results of laboratory tests. This has placed greater pressure and responsibilities on the drug testing laboratories. The laboratories are now required not only to identify the seized materials but also to detect the drugs of abuse. In addition, the laboratories are now required to produce reliable qualitative and quantitative results which can stand the judicial scrutiny. The analysis of biological specimens like urine and blood present additional challenge because of the need to separate the target substance from the interferences of the body fluids. Analysis of body fluids assumes greater responsibility as the result of such analysis are not only required for the drug law enforcement but also required for diagnostic, treatment and rehabilitative purposes.

DISCUSSION

The positive analytical results are of much significance both for the drug law enforcement agencies as well as for the diagnostic purposes. The general recommended strategy is that an initial screening test should be performed to ascertain the nature of the sample under examination and this must be followed by confirmatory tests on such presumptive positive sample. For initial screening of the samples, techniques like radio immunoassay (RIA), enzyme multiplied immunoassay technique (EMIT) and thin layer chromatography (TLC) may conveniently be applied. This will provide a rapid means of eliminating negative specimens. A positive result on any of the above tests should then be followed by confirmation analysis using a method based on a different chemical and physical principle like gas chromatography (GC), high performance liquid chromatography (HPLC) and gas chromatography - mass spectrometry (GC/MS) etc.

The mass spectrometric methods of analysis are highly valued and widely used for their intrinsic capabilities in providing analytical results of high specificities. Gas chromatograph - mass spectrometer has the ability of separating different constituents of drug from a mixture like gas chromatograph using suitable column and experimental conditions to give independent retention time (RT) and then each of the component can be conveniently fragmented to ions. The fragmentation pattern of component is unique in nature and with the library search facilities available in the instruments, each of the compound can be identified with positive certainty and results so obtained are legally defendable in the court of law. Furthermore, with the availability of different ionisation modes viz. electron impact (EI), positive and negative chemical ionisation (CI) in the GC – MS instrument, this instrument provides absolute identification of drugs and its metabolites extracted from body fluids. Quantitation of the target drugs can easily be performed with such instrument using the usual techniques generally employed in GC analysis with some minor modification.

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RESEARCH ACHIEVEMENTS OF THE INSTITUTE OF SELF ORGANISING SYSTEMS AND BIOPHYSICS

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ABSTRACT

The Institute of Self Organising Systems and Biophysics pursues research in new and emerging fields of interdisciplinary areas. The Institute trains students to ask relevant questions and to investigate their hunches. Seven students have been awarded Ph.D. degree so far; and all of them are employed in prestigious institutions in the country and abroad. The work carried out in association with the faculty members and students have been acclaimed by the national and international scientific community. The Institute is quite flexible and informal in approach if research goals are achieved. There are no rigid academic structures in the Institute and the Institute is always eager to enter in a dialogue or debate on any issue of fundamental significance. The contributions of the Institute are in many fields. The themes of the important publications are given below:

1. Chemical basis of the action of Carcinogenic compounds
2. Effect of trace elements (micro-nutrient) in the yield of rice in Meghalaya
3. Behaviour of Biological Clock as revealed by the experiments on field mouse
4. Measurement of biophoton emission by plant tissues and its modelling
5. Measurement of the conditional probability of subsequent photon emission in 10 micro seconds to 10 mili seconds in biophotons
6. Establishment of the coherent nature of biophotons
7. Detection of response calls of female frogs (Anurans) and the existence of a social structure in lower vertebrates
8. Drug targeting and mechanism of the action of Ribosome Inactivating Proteins
9. Chaotic and non intuitive solutions in the models of population dynamics
10. Behaviour of multi-sites multi-states neural networks
11. Study of poverty measures and mechanism of decision making
12. Anurans and Salamanders as indicators of ecological degradation

INTRODUCTION

The objective of the Institute has always been to seek the answer of a fundamental question "What is the origin of biological organisation in all the manifestations from DNA to human mind?" The question is profound; and its answer is elusive. Two different approaches are being followed to seek the answer. The approaches are reductionist and holistic. In the reductionist approach, a specific phenomenon is selected for investigations and its controlling genes and operating pathways are identified. In the holistic approach, the emphasis is in identifying the processes and organisational structure common to all living systems and to understand the mechanism and principle responsible for creating the quality called "Life". The success in the reductionist approach has been phenomenal, and the approach abounds with beneficial applications. The approach is considered essential for getting grants and recognition. In contrast, the holistic approach has nothing substantial to show as success. One has to content with the satisfaction of attempting a challenging problem. Any success in the holistic approach is expected to cause a paradigm shift. Most of us do want to make a discovery capable of shifting the prevalent paradigm; but we hardly succeed. The lack of success, however, does not deter us from pursuing challenging problems.

The Institute has encouraged its faculty members and students to try both approaches. It has yielded rich dividends. The Institute has recommended to the university to award Ph.D. degree to 7 students and M.Phil. degree to 3 students. All these students have been employed in prestigious institutions in India and abroad. One of our student was awarded the INSA young scientist award in 1998 on the work done for his Ph.D. degree. He is the first and the only student from NEHU to get the award. The faculty members of the Institute have also been honoured by various fellowships to visit international laboratories in recognition of their research contributions. We give below a birds eye view of their research work carried out during 12 years of the institute's existence.

We begin with the reductionist approach classified as biochemical research. The main objective of the group has been to design and synthesize a cytotoxic hybrid molecule for selective targeting of the specific cells in the gonads. The gonadal cells are predominant cells which express gonadotropin receptors and their action is mediated by internalization. The gonadotropin receptors are expected to act as homing device for a harmone plus a toxin conjugate, called harmonotoxin. The harmonotoxin after internalization releases the toxin from the conjugate by breaking the disulphide bond. The toxin arrests the synthesis of some vital protein leading to the killing of the cell. We have synthesised the conjugates of gonado-tropins (specially of OLH and

HCG) to the single chain plant ribosome inactivating protein gelonin. The conjugation was initiated with the use of different heterobifunction cross linking agents. These conjugates were subjected to spectroscopic, physiochemical, immunochemical and biological characterisations. The in vitro cytotoxicity and bio-effectiveness of the conjugate are being investigated in collaboration with Central Drug Research Institute, Lucknow.

Our another utility oriented investigation was the determination of the amounts of 11 trace elements present in the soil and different tissues of rice plants at various stages of growth. The rice plants were grown at different altitude in the state of Meghalaya. We have found the soil at many place to be deficient in Zn as compared to the national average. The amount of Fe was always in excess. We suspect that the low yield of rice in Meghalaya has some linkage with the deficiency of Zn.

We were also involved in the ab initio quantum calculations for determining chemical carcinogenesis. We were particularly interested in finding the molecular mechanism underlying the phenomenon of N-nitroso carcinogenesis and the role of DNA constituents modified by polycyclic aromatic amines. We have suggested a mechanistic model for determining the presence and absence of carcinogenic activity in any nitrosoamine. We have learned about the causes of organ specificity, and can also determine the relative degree of carcinogenic potency.

The next batch of investigations belong to the conventional Physiology. Three phenomena were investigated in the institute. These are biological clock, acoustic behaviour of Anurans, and biophotons. The investigations remained in phenomenological stage and we did not attempt to locate and identify the relevant genes. We, still got some interesting results. Biological clock is responsible for the observed rhythms in biological systems. The frequency ranges from 10^3 Hz to 10^{-9} Hz. The rhythm of nearly 24h duration is called circadian rhythm. It occurs in many systems including human beings and influences our behaviour. Its study has a pharmacological significance. We have investigated its behaviour in the rodent M. Booduga. We have measured the free running period and its sensitivity to photo reception in different samples. We have found both inter and intra individual variations in the free running period and also an increase in it during the early days of development.

The study of acoustic behaviour involved recording of calls and their Fourier analysis to discover species specific patterns. We have studied 10 species of Anurans (frogs) under natural and semi natural conditions and have found their call patterns to be species specific. We feel that a call pattern contains parameters of taxonomic relevance. We are trying to determine the gene profiles and its linkage with the call pattern. It is pertinent to mention that we were the first group to observe feeble female response calls in Anurans. We have, therefore, started speculating about the existence of a social structure in Anurans. We would like to explore its consequences. Acoustic behaviour is a non invasive probe to measure biodiversity. It has an obvious ecological significance. We propose to combine it with the observation of the distribution of Salamander which do not give acoustic signals. The combination is likely to yield better indicators of ecological health or degradation.

The measurement of biophoton intensity was used in the reductionist mode to estimate the presence of biomass in lichens. The growth of lichens in old monuments is considered harmful. One has to use chemicals to eradicate them. The use of the chemicals may also damage the monument. One has to devise appropriate doses that are not harmful to the monuments. The measurement of biophoton emission provides a quick technique for estimating the effective doses of different biocides. We have done it for many agricultural biocides in a number of lichen species found in Shillong.

Biophotons were also the centre of our holistic investigations. Biophotons are the photons in the visible range emitted by a living system. All living systems emit biophotons of ultra weak intensity. The origin and purpose of biophotons is still unknown. We have measured the conditional probability of zero photon detection in a biophoton signals during a time interval ranging from 10 μs to 10ms. The behaviour of the conditional probability shows that the nature of biophotons is coherent. The coherent nature implies that biophotons are in a definite quantum state and remain in the state for many hours. Coherent nature is responsible for the strange behaviour of biophoton signals. We have proposed a model that describe the quantum state of biophotons to be a squeezed state given by a frequency stable damped oscillator. Photons in a squeezed state can transfer information without any losses. Such a state is also useful in detecting the presence of an object with an interaction weaker than the thermal noise. If it is so then the biophotons in a squeezed state confer an evolutionary advantage to a living system. Such biophotons will also have a role in the evolution of

consciousness. We have, therefore, investigated the phenomenon of consciousness and the functioning of the brain as well. The functioning of the brain was sought to be understood through a network of multi-state multi-site neurons. We have investigated its fixed points and the chaotic regime. Another problem being investigated is the exceptional situations in prey-predator models and their ecological applications in devising harvesting strategies.

CONCLUSION

The pursuance of holistic approach invariably invites antagonistic responses from funding agencies. The Institute has also faced them. The antagonistic responses have forced us to find out the minimum support level needed for the survival of a research venture. Our experience and investigations have relevance in economic policies and decision making. We have found that it is possible to sustain a research activity with only 15% of the normal recurring academic funding. But the sustenance invite predatory wrath of the fully funded users of the corpus. We have further noticed that it is possible to exploit the administrative delay and indecision to improve one's competitiveness if one utilises the waiting period. The waiting gives another option and has a quality that is measurable. Finally, we have noticed grave irrationality in resource distribution even in democratic institutions. We, therefore, suggest that distribution of resources should be based on holistic parameters. Our views have implication in planning and resource sharing in any context, be it national, state, university or any other organisation.

The above presentation is a collage of our activities and ideas. The common link is our motivation to find ways and means for taking scientific and rational decisions to improve the economic, social and intellectual conditions.

GROUND WATER – THE INVISIBLE RESOURCE, DEVELOPMENT & PROJECT IN NORTH EAST INDIA

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ABSTRACT

Water is the most important fluid needed by living beings including plants. However, with the increasing population, alternate areas of habitation & source of water located, sequel to this ground water development & its use became prevalent.

Ground water with its natural storage facility, purity, less prone to contamination & many other factors, make a preferred choice over surface water. This leads to an accelerated development and utilisation of ground water.

Ground water will continue to play a dominant role in meeting water supply requirements for irrigation, domestic and industry but it should not be taken as an unlimited quantity and needs to be cared, conserved, managed, augmented and protected from over exploitation as well as from pollution.

Central Ground Water Board, being the apex body to look after the whole gamut of ground water development and exploitation, undertakes surveys and exploration work phase wise and have come to a stage where it can guide user agencies for better management of ground water schemes. With its vast data bank accumulated over the years and trained scientific personnel, Central Ground Water is now ready to shoulder the responsibility entrusted upon it by the Hon'ble Supreme Court declaring C.G.W.B. as the Ground Water Authority under the Environment Protection Act 1986.

INTRODUCTION

Ground water is one of the world's most valuable natural resources. Majority of the world's developed countries meet their drinking water requirement by ground water. Use of ground water through wells is also well known in India from the Vedic times. The excavations of Mohenjodaro reveal existence of brick lined wells as early as 3000 BC. The pace of ground water development in India and elsewhere in the world increased with the increasing demand and dissemination of ground water development techniques.

Ground water as a source of water supply offers a number of advantages against surface water like —

(a) nature has provided storage facility for ground water which is fairly well distributed in time and space, consequent to which ground water supplies are generally not affected by draughts,
(b) ground water is commonly free of pathogenic organism and need no or little purification for domestic and industrial use,
(c) contamination of ground water is more difficult than surface water,
(d) the temperature and chemical composition of ground water are nearly constant and
(e) water is generally free from turbidity and colour. These factors make ground water a preferred commodity causing accelerated development and utilisation. In the post Independence era ground water development has become essentially a people's programme causing minimum burden on the exchequer. However, with the rapid expansion of population, industry and agriculture in recent years throughout the world and particularly in developing countries like India, has brought about a steep increase in water demand. As the number of suitable surface storage sites dwindles, greater stress on ground water is inevitable to meet the ever increasing water demand. For sustained water supply to the ever increasing population, ground water resources have to be explored, evaluated and managed in scientific manner in conjunction with surface water.

ACTIVITIES OF C.G.W.B. (NER)

Central Ground Water Board being the apex organisation under the Ministry of Water Resources, Govt. of India is vested with the responsibility to carry out scientific surveys, exploration, monitoring of development, management and regulation of countries vast ground water resources. With the above objectives C.G.W.B. North Eastern Region has started functioning from May, 1974 and has surveyed and explored extensively throughout the seven states of N.E.R.

The following discussion encompasses a brief review of the activities and experiences gathered by C.G.W.B. during the last two decades of functioning in north eastern region.

To monitor and guide ground water development and promote its sustainable management on principles of ecology, economics, efficiency and equity C.G.W.B. (NER) has established 488 (Table-I) hydrograph network stations in the N.E.R. The water levels of these stations are monitored four times in a year covering

the pre and post-monsoon periods. These measurements generally represent water levels of phreatic aquifer within 90 meter depth range. Based on the monitored data, areas are identified where the rise and fall in ground water level is noticed and water level fluctuation maps are prepared. These fluctuations are used in quantifying the replenisible ground water resource.

To assess the changes in quality and quantity in ground water regime with the passage of time Reappraisal Hydrogeological Surveys are being carried out. Nearly fifty per cent of the area of N.E.R. have been covered and reports published districtwise.

The aquifer system in nature occur under diverse environments. Demarcation of its lateral and vertical continuation and evaluation of various hydro-geological parameters are essential for design of suitable ground water structures and assessing their yield capabilities especially under deeper conditions. Ground water exploration through drilling contributes to a large extent in guiding the states to adopt follow up action with regard to ground water development and its utilisation on a scientific way. With this aim C.G.W.B. (NER) is carrying out exploration work throughout the N.E.R. from its inception. Till date 279 tubewells have been constructed by C.G.W.B. in N.E.R. Distribution of wells districtwise is as per Table-II.

HYDROGEOLOGICAL CONDITIONS

With the information gathered from detailed hydrogeological surveys and exploration a brief idea of the hydrogeological conditions of N.E.R. can be summed up as follows —

The Brahmaputra valley is largely underlain by unconsolidated alluvial sediments of which sand, gravel and pebble form the bulk of the sediments. Since these granular zones are saturated, the ground water resource are immense. In the northern part of the valley, about ten kilometer wide belt along the foothills of Himalayas, coarse elastics comprising cobbles and boulder occur. The water table in this belt is relatively deep and varies between 8m to 22m below land surface. Since boulders are encountered at shallow depth of 10m to 15m, construction of tubewells become difficult for want of proper drilling equipments. In the southern part of the Brahmaputra valley along the foothills of Shillong Plateau and the Naga – Patkai hill ranges, the sediments are predominantly argillaceous (clayey).

In the synclinal valleys of Cachar and Karimgang districts of Assam and Tripura respectively ground water is found in the semi-consolidated soft sandstones of Tertiary age. The aquifers are very productive & deep tubewells are feasible. Discharge of tubewells, 150m to 200m deep varies from 80 to 150 cubic meter per hour. Shallow tubewells within 50m depth yield 20 to 30 cubic meter per hour in Tripura but not in Barak valley. In the undulating plains with low lying flat top mounds and narrow to wide valley fills shallow to moderate deep aquifers with good ground water potential have been identified.

Potential deep aquifer in the Upper Tertiary areas of Meghalaya have also been identified in the western and south western part of West Garo Hills district. Tubewells constructed by the C.G.W.B. in parts of Selsela, Zikzak and Betosing Blocks have resulted in artesian conditions. The free flow discharge varies from 9 to 95 cubic meter per hour (35 to 250Lps).

In the intermontane valleys of Nagaland and Manipur, such surveys have revealed that the aquifers within 100m depth are moderately productive yielding 10 to 20 cubic meter per hour with heavy drowdowns.

Large part of the remaining areas are hilly and forested with sparse population. The various rock types occurring in the hilly terrains of N.E.R. can broadly be classified into crystallines with effusive and intrusive rocks of Archaean to Precambrian age and the compact siltstone, mudstone and shales of Lower Tertiary to Cambrian age, the semi consolidated soft sandstones of Mio Pliocene Age and the unconsolidated alluvial sediments. Large parts of Meghalaya and Karbi Anglong district of Assam represent remnant of an ancient plateau of Pre Cambrian Indian Peninsular shield where ground water occurrence is strikingly different from that in the unconsolidated and semi consolidated sediments. The mode of occurrence of ground water in these litho units are those of fissured formations and weathered residum. Extraction of ground water is mainly through large diameter open wells and yield prospects are generally between 5 to 10 cubic meter per hour. Yield of wells are dependent upon factors like thickness of saturated weathered zone, area of infiltration and number of joints and fractures tapped.

The hill states of Nagaland, Manipur, southern Assam, Tripura and Mizoram geologically constitute part of Naga – Lushai geosynclines accentuated by post Miocene and Neogene upliftments. These terrains are made up of Tertiary Group of rocks comprising sandstone, siltstone, mudstone and shales are fairly compact

in nature. The sediments are largely argillaceous and have little prospects of ground water. The terrain is rugged and the hills are steep. The only source of water are the perennial springs.

CONCLUSION

In the north eastern region development of ground water is still at a low stage causing rise in water table at places in the Brahmaputra valley. On the other hand states like Haryana and Punjab have over exploited their ground water resources and need augmentation through artificial recharge.

Recently the falling ground water levels in the National Capital Region of Delhi caught the attention of Hon'ble Supreme Court through an inter-locutory application and the Hon'ble Court passed order declaring C.G.W.B. as the Ground Water Authority under the Environment Protection Act 1986. The main object for the constitution of the Authority is the urgent need for regulating the indiscriminate withdrawal of ground water and control of over draft.

Ground water will continue to play a dominant role in meeting water supply requirements for irrigation, domestic and industry but it should not be taken as an unlimited resource and needs to be cared, conserved, managed, augmented and protected from over exploitation as well as from pollution.

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TABLE – I
STATUS OF HYDROGRAPH NETWORK STATIONS AS ON MARCH 1998

Sl. No.	District	No. of Stations			
		Dug	ob	pz	tot
STATE : **ARUNACHAL**					
1.	Changlang	4	0	0	4
2.	Lohit	2	1	0	3
3.	Papumpare	3	0	0	3
4.	Siang	5	0	0	5
5.	Tirap	3	0	0	3
Total Districts : 5	No. of Stations :	17	1	0	18
STATE : **ASSAM**					
1.	Barpeta	11	1	0	12
2.	Bongaigaon	9	0	0	9
3.	Cachar	11	4	6	21
4.	Darrang	25	1	0	26
5.	Dhemaji	16	0	0	16
6.	Dhubri	9	0	0	9
7.	Dibrugarh	8	1	1	10
8.	Goalpara	9	2	0	11
9.	Golaghat	6	1	1	8
10.	Hailakandi	3	2	0	5
11.	Jorhat	13	1	1	15
12.	Kamrup	31	2	0	33
13.	Karbi anglong	26	4	0	30
14.	Karimganj	8	2	2	12

Sl. No.	District	No of Stations			
		Dug	ob	pz	tot
15.	Kokrajhar	16	0	0	16
16.	Lakhimpur	20	0	0	20
17.	Morigaon	10	1	0	11
18.	Nagaon	30	3	1	34
19.	Nalbari	12	2	0	14
20.	Sibsagar	14	1	1	16
21.	Sonitpur	19	0	0	19
22.	Tinsukia	13	3	2	18
Total Districts : 22	No. of Stations :	319	31	15	365
STATE : **MANIPUR**					
1.	Bishenpur	1	2	0	3
2.	Chandel	2	0	0	2
3.	Churachandpur	1	2	0	3
4.	Imphal	2	1	0	3
5.	Senapati	4	0	0	4
6.	Tamenglong	1	1	0	2
7.	Tengnopal	1	0	0	1
8.	Thoubal	2	5	0	7
Total Districts : 8	No. of Stations :	14	11	0	25
STATE : **MEGHALAYA**					
1.	East Garo Hills	8	0	0	8
2.	East Khasi Hills	5	0	0	5
3.	Jaintia Hills	2	0	0	2
4.	Ri-bhoi	3	0	0	3
5.	South Garo Hills	1	0	0	1
6.	West Garo Hills	10	4	0	14
7.	West Khasi Hills	2	0	0	2
Total Districts : 7	No. of Stations :	31	4	0	35
STATE : **NAGALAND**					
1.	Kohima	5	1	0	6
2.	Mokokchung	0	1	0	1
3.	Mon	1	0	0	1
Total Districts : 3	No. of Stations :	6	2	0	8
STATE : **TRIPURA**					
1.	North Tripura	9	0	0	9
2.	South Tripura	9	2	0	11
3.	West Tripura	17	0	0	17
Total Districts : 3	No. of Stations :	35	2	0	37
Grand Total :		422	51	15	488

TABLE – II
STATUS OF DEEP TUBEWELLS DRILLED AS ON MARCH 1998

State	District	No. of DTW
ASSAM	Dhubri	3
	Goalpara	7
	Barpeta	3
	Nalbari	5
	Kamrup	9
	Darrang	4
	Sonitpur	11
	Jorhat	11
	Nagaon	13
	Golaghat	8
	Morigaon	4
	Sibsagarh	8
	Dibrugarh	5
	Tinsukia	3
	Karbi Anglong	24
	N.C. Hills	10
	Cachar	8
	Hailakandi	5
	Karimgang	7
	Lakhimpur	1
ARUNACHAL PRADESH	Lohit	1
	Changlang	1
MANIPUR	Imphal	4
	Thoubal	6
	Chandel	5
	Bishenpur	2
	Tamenglong	3
MEGHALAYA	East Khasi Hills	9
	Jaintia Hills	9
	West Khasi Hills	7
	West Garo Hills	27
	South Garo Hills	2
	East Garo Hills	2
MIZORAM	Aizawl	3
NAGALAND	Kohima	7
	Mokokchang	2
TRIPURA	North Tripura	17
	South Tripura	10
	West Tripura	13

SCIENCE, TECHNOLOGY AND ANTHROPOLOGY IN INDIA : AN OVERVIEW

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ABSTRACT

This paper deals with the interlinkages between science, technology and anthropology. It argues that science and technology stand beyond the comprehension of the common people and are still held with great respect and awe. As a result, they have no accountability to the people. Time has now come to demand from scientists and technologists results proportionate to the hefty expenditure in the establishment of the laboratories, purchases of expensive consumables and import of highly sophisticated equipment many of which are never used. The paper also argues that despite so much of emphasis on science and technology by India during the past fifty years hardly any of the human problems in India are solved leave alone understand the man.

INTRODUCTION

Whether anthropology is a science or arts is still debated by anthropologists in many parts of the world. In India, it is taught as one of the science subjects on both undergraduate and postgraduate levels. Sophisticated laboratories exist in some of the leading departments of anthropology in India and 'practical' is an essential part of the daily routine for anthropology students. This is at least true of one of the branches of anthropology popularly known as physical anthropology. Hence, anthropology is broadly within the realm of science and the hope of being able to approximate some of the truly science subjects is still alive.

What about technology? If technology is defined as a study of techniques of doing certain things there is perhaps no subject which does not involve some kind of technology or the other. But if technology is used in its restricted sense it does not affect all the disciplines equally. The computer technology has helped the students of anthropology as much as it has done to students of other subjects; the carbon dating or DNA technology has brought about tremendous changes in some branches of anthropology as much as it has in the field of archaeology, criminology and law.

Hence the relationship that exists between science, technology and anthropology is neither specific nor surprising. The scientific developments or technological changes directly affect our knowledge systems and therefore our culture as well. Culture, which is the subject matter of cultural anthropology, is traditionally seen as an obstacle to science and technology and such an idea still exists in the minds of many. However, culture not only adapts itself to the changing scientific and technological scenario but also gives it the stamp of its own peculiarity. Certain technological changes or scientific projects have been rejected or thwarted in some parts of the world, particularly in tribal or backward areas, and the blame has been put on the culture. But the fault lies elsewhere, in the lack of cultural understanding and appreciation, in the most unmindful or brazen show of the state power by its representatives, in the narrow and selfish interests of some powerful persons, and in the colonial mind-set of the development planners and those who implement the plans. The patron-mentality is often obvious even in the actions of the agricultural extension officers or the block development officers. The intentions may be pious but that is not enough : the actions must also show a sensitivity towards the culture of a people.

The objective of this paper is to briefly elaborate on this theme. There are numerous literature on this subject but I will not burden the readers with the volume of already published literature. I shall present what they contain and say what they have said or unsaid for whatever worth it has.

SCIENCE, TECHNOLOGY AND CULTURE

In the post 80's there is a lot of rethinking on science and technology. More than 90 percent of the research and development expenses of the various educational institutions in the world go to science and technology. This is also true of the maintenance expenditure. Most science departments of North-Eastern Hill University, for instance, receive five to seven lakh rupees each per year as maintenance grant while the so-called non-science departments rarely get more than 50 thousand each. Many of them manage with about a mere 20 thousand per year. Besides the expenditure on equipment and consumables the science departments also eat away about 90 percent of the library fund because the standard journals in sciences, which are imported, are highly expensive but research and teaching cannot be up to date without them.

All this is fine and acceptable in scientific spirit. But what about the feedback that science departments have given to the institution or the society? When I am talking about feedback I am not talking about 'applied' feedback only. How many formulae/theorems/principles are there as our contribution? What problems of humanity have we been able to solve even locally? Has science contributed to the reduction of poverty, illiteracy, ill-health, etc. even in Shillong?

The fact is science and technology have solved some problems and created others and it is difficult to say whether they have solved more or created more. The post-modernists would say the latter but it is not necessary to be as critical. However, we have to accept the fact today that science and technology are more a liability than an asset. The burden of science and technology is very heavy both in terms of foreign debt and in terms of our mind-set.

Science and technology have created an aura around themselves and common people have no idea of the commonplace experiments they indulge in. On closer observation, it is found that one scientist has neither access to the laboratory of another scientist nor can he often handle the equipment in another laboratory. In each educational institution there are some equipments which are never used for no one knows how to use them and for what purpose. Most of the expensive and imported equipments in the various laboratories are not giving any service to science or to the country and yet year after year there are proposals to import this or that equipment. Are our scientists brokers of some foreign technology firms? If they do not know how to use the equipment or repair the same by themselves why import at such expenditure and keep the facade of scientific research?

The equipment in anthropology laboratories are no exception. My personal experience has been very disappointing. I am a specialist in social anthropology and have no knowledge of the equipment considered necessary by my colleagues in physical stream. I do not claim to be a scientist even in the widest sense of the term and my view of science is that of a necessary evil. Anyway I made special efforts so that our department could have the semblance of a laboratory. Some of the equipment which my colleagues insisted that they should be bought were a double distillation plant and an electrophoresis. The first is used hardly once in a year, to distill about two bottles of water which can be bought for 10 rupees in the market, and the latter has not been used ever since it was bought in 1995. The same is true of many other equipment in my department. I am at least not in favour of such a science.

If such is the culture of science, I wonder why the tribal and rural people should not express their reservation or even apprehension about the so-called scientific methods of cultivation, scientific methods of insemination, scientific methods of cooking or conserving the natural resources. People's ignorance and wisdom of the scientists are both taken for granted. This is precisely why anthropologists, who seem to be able to appreciate the feelings and apprehensions of the people better because of their prolonged and intimate interaction with them, often join the people in opposing many of the so-called scientific developments in rural and tribal areas. Because of such roles, anthropologists are often condemned as traditionalists, opposed to change and development etc.

Anthropologists are not fazed by such comments of the people in charge of the society. Today, they often oppose such projects merely on the ground that the consent of the people was not taken before implementing the same on them. Their consent was taken for granted. That the project was good for them was already decided by someone else in the district headquarters or in the state capital. What after all do the people know? Those illiterate, dirty, superstitious, ignorant people! On the other hand, the claims are based on scientific research involving a couple of years and at the expense of crores of rupees. The experimental conditions are claimed to have shown less than 3 percent chances of wastage or failure. And above all it is being given to the people free of cost!

Anthropology today seeks to unmask such hypocrisy and wants to make science more accountable to the society. Anthropologists are not against the bread and butter of the scientists but against their exaggerated sense of capability to solve the problems of humanity, their lack of awareness about the hefty expenditure on their training and research, their insensitivity about social responsibility, and the feeling that they are superhumans whereas others are an ignorant, stupid, lot.

This fight of anthropologists is not only outside the discipline but also within it. Within the discipline there are colleagues who bear all the cultural paraphernalia of the so-called scientists. They claim to be as accurate and precise in their calculations, findings and predictability as their counterparts in zoology or botany probably

are. What they forget however is that they deal with human beings and human beings are in no way the same as other animals and plants. They define anthropology as 'science' whereas it is also 'arts'.

THE SCIENCE IN MAN

Is man by nature scientific? The answer to this question is partly yes and partly no. Yes, because every sane human being has the quest for knowledge, truth, etc. He ponders over the events that take place around him and seeks to find the causes of the same. He does not accept any cause without subjecting it to his system of beliefs and thoughts. In other words, the cause must satisfy itself as a cause. He has wondered about the stars and planets, rivers and mountains, air and fire etc. for thousands of years and sought to explain how they have come about. He has also tried to solve the mystery of the origin of man himself. He has listened to many sages and philosophers but arrived at his own conclusion based on his own repeated observation or experience.

But man has not always been as systematic as made out above. He has been reckless, careless, and senseless about his family, people, environment and the events taking place around him. He has chosen to believe in what his kind believes in, say what his kind wants him to say, and do what his kind have been doing.

Whether or not he is by nature scientific he has always been a tool maker and user. Whether or not his action is rational, he has always made use of the available technology and contributed to its development and appropriateness. If a particular tool is discarded it is not for the tool in itself but its inappropriateness to him. What has been appropriate to him has been used or developed by him, or exchanged by him, or imported, pirated, and even stolen. Because the quest for comfort, power, supremacy – all of which depend to a large extent on technology – has been one of the oldest habits of man.

CONCLUSION

Man has been seeking to find answers to hundreds of mysteries around the world but the greatest mystery is the man himself. What he is and what makes him what he is are perhaps never fully known. When and why he chooses to be a biological, cultural or psychological being is still one of the biggest challenges to science and technological revolution in the present century, is a trickle to aid science in unravelling these aspects of man. One of the greatest attractions of anthropology lies here.

TECHNICAL SESSION – II

GEOLOGICAL & MINERAL RESOURCES

SCOPE AND PROSPECT OF LIME BASED INDUSTRIES IN NORTH-EAST INDIA

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ABSTRACT

Limestone is one of the abundant mineral available in almost all parts of the N.E. Region. The quality of these limestones varies from chemical grade (CaO>50%), cement grade (CaO>40%) to low grade (CaO 40%). This huge reserve of limestone remained unutilised in the pre-independence period. After independence exploration work started reserve estimated and exploitation of these limestones began by setting up a cement factory at Cherrapunjee, near Shillong in Meghalaya. Based on these reserves some more medium and mini cement plants were established in this region. Along with these, some lime producing units, using these limestones are also growing up side by side.

Chemical grade limestone has wide application as a raw material in the production of quick lime, bleaching powder, calcium carbide, insecticide etc. Low grade limestone on the other hand for production of mineral wool, washing powder and in some construction work.

Even after fifty years of independence limestone is mainly used for the production of cement and lime only in this region. Wide scope of utilising limestone in different other industries as stated above are still untapped. Some of these points are highlighted in this paper for economic and industrial development of the N.E. Region.

INTRODUCTION

Limestone is found in almost all the states of North-East Region. Exploration of these limestones started only after independence and about two thousand million ton reserve were proved. Exploitation of this reserve started by setting up a medium sized cement factory at Cherrapunjee, Meghalaya in fifties and another medium sized cement factory at Bokajan, Assam in seventies. In the last decade a number of mini cement plants came up in several states of North-East. Along with the cement factories some lime producing units are also growing up using the local limestone. No other lime base industries are attempted till new due to lack of proper entrepreneurship and infrastructure facilities. Scope of some such industries are discussed in this paper.

Production of High Grade Quick Lime :

For high grade quick lime chemical grade limestone with CaO percentage above fifty, silica less than 1.5%, Fe_2O_3 and Al_2O_3 together less than 2% are necessary. For efficient burning lump of these limestone are crushed to the size of 3-5 cm and calcined in a klin gradually raising the temperature to about 1200^{O}C and calcined at this temperature for about two hours. The fuel use are good quality (low ash) coal, natural gas etc. After cooling the finished products are taken out, screened, graded and sealed in airtight container for despatch. Lime so produced can be used in paper industry, sugar industry, in the production of hydrated lime, bleaching powder, calcium carbide etc.

Production of calcium carbide :

Calcium carbide can be manufactured by beating quick lime mixed with coke in an electric furnace at 2000^{O}C.

$$CaO + 3C \longrightarrow CaC_2 + CO$$

The molten calcium carbide is removed from the furnace, cooled and the solid calcium carbide formed is crushed or grounded to required size. About one ton of quick lime will give same amount of carbide. This carbide has a wide market in the production of acetylene gas, pesticides, pharmaceuticals, organic and inorganic chemicals, permanent antifreeze compound etc.

Bleaching Powder Production :

Bleaching powder can be manufactured by bubbling chlorine gas into a milk of lime (calcium hydroxide) solution.

$$Cl_2 + Ca(OH)_2 - CaOCl_2 + H_2O$$

The bleaching powder so produced is used as disinfectant, in water purification and other bleaching purposes.

Production of Lime Based Insecticides :

Different type of insecticides such as calcium arsenate, lead arsenate, lime sulphur spray, bordea-ux mixture are widely used in agriculture.

Arsenic acid is reacted in a milk of lime to form calcium arsenate. The dry powder calcium arsenate is mixed with additional hydrated lime which act as a filler. This insecticide is effective against cotton boll weevil. Similarly lead arsenate is also diluted with hydrated lime which acts as an adhesive for lead arsenate for longer attachment to foliage.

Lime sulphur dust is prepared by mixing two parts of sulphur to one part of hydrated lime. Lime sulphur solutions are made by heating sulphur with milk of lime. Bordeaux mixture is made by mixing copper sulphate and lime and hydrated lime is used as a filler. All these three are good fungicides.

Mineral Wool Production :

Low grade limestone is used in the production of mineral wool. These limestones are mixed with cocke (4:1) and heated to 1500^{O} C in a furnace. The molten mass collects at the bottom of the furnace. This molten mass is allowed to trickle out of the furnace where it meets with a jet of steam (100 psi) creating fine thread which collects into a soft fluffy mass, called mineral wool. Mineral wool is used as an insulator of heat.

Utensil Washing Powder :

Powdered low grade high silica limestone are often used as abrasive in the production of utensil cleaning powder.

Construction Activity :

Medium grade lime mixed with sand is used as a plaster mixture for construction of low cost houses. Though the strength of this mortar is less then cement mortar, it still finds uses in economic housing and other activity.

CONCLUSION

From the above discussion it is evident that there is a wide scope for lime base industries in the North-East region. At present except production of cement and lime no other lime based industries have come up. At least the local requirement of lime in paper and sugar mills, calcium carbide requirement for acetylene production and other above mentioned lime products may be made available from the local resources. To fulfil this object both the government and people should come forward to create necessary infrastructure facility and follow-up action for early implementation of various lime base industries.

CONTRIBUTION OF GEOLOGICAL SURVEY OF INDIA IN NORTH EASTERN REGION IN THE LAST FIFTY YEARS OF INDIA'S INDEPENDENCE

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ABSTRACT

Geological Survey of India (GSI) is a premier geo-scientific organisation in the country since 1851 and is now approaching its 150 years of existence. The GSI has been rendering services to the nation and the global earth sciences, by providing at large, the data in the field of geosciences, natural resources inventory and their optimal utilisation in the on-going developmental activities in various sectors of national economy. The North Eastern Region of GSI being one of the six regions in the country, has received due attention for the geoscientific endeavours particularly because of its special characteristics of remoteness and the necessity for rapid development for the growth in this region as a whole. The North Eastern Region (NER) of GSI caters to the geoscientific needs of the seven sister states namely, Assam, Arunachal Pradesh, Meghalaya, Nagaland, Manipur, Tripura and Mizoram. It is a fact that the NER of GSI has made significant progress in its geoscientific endeavours through sustained efforts leading to the considerable development of this region in recent past in the post-independence era although the geoscientific endeavours in the North Eastern part of India by the GSI actually date back to as far as 1858 when Sir Thomas Oldham first studied parts of the North East India to unravel the geological characters of NEFA (now Arunachal Pradesh).

Prior to independence, the prime role of GSI was for exploration of coal and limestone in this region. In the post-independence era, the emphasis was primarily given to geological studies and other investigations related to the development of minerals and energy sector, harnessing of land and water resources for sustainable development, assessment of natural hazard, environmental degradation and providing the geological inputs for optimum development in the transport and communication sectors.

Geological knowledge gained through 50 years of strenuous and devoted field investigation inputs comprising geological mapping, mineral exploration and terrain evaluation supplemented by intensive laboratory studies by the GSI has enabled bringing to light the significant reserves of mineral commodities such as coal, limestone, dolomite, graphite, fireclay, fuller's earth, iron ore, bauxite, basemetal, glass sand, sillimanite and dimensional stones with grade and other details which are useful to the industries for planning and development. Oil and gas are being exploited by Oil and Natural Gas Corporation Ltd., and Oil India Limited, while the atomic minerals belong to the purview of the Atomic Minerals Division, Department of Atomic Energy. Apart from the contribution in the mineral sector and the general geological aspects, there has been tremendous data accumulation in respect of the geo-environmental appraisal of the whole N.E. Region with emphasis on the major river basins. In this region the sedimentary piles along the Brahmaputra basin have been studied in detail from geomorphological point of view with implications on flood control and drainage congestions. Geotechnical studies in regard to the numerous hydel power projects and site stability related work for roads, railways and power projects have covered many of the applied geological aspects. Attempts at landslide hazard zonation, geo-environmental studies and evaluation of the seismo-tectonic scenario in this highly earthquake prone region (Fig-3) have progressively brought out the specific informations for mitigation and R&D endeavours. Most recently a specially conceived programme of "Development of Village Economy by Mineral Appraisal" (DOVEMAP) has been the product of a new concept which has been initiated in NER since 1997. This will generate grass-root level geoenvironmental data on large scale cadastral base map that will have practical application in formulating viable plans on small scale for mobilisation on the rural resources by the local population in particular, to contribute to the developmental activities of the region as a whole on cumulative basis.

INTRODUCTION

Since inception, the Geological Survey of India (GSI) had as its primary role in exploration for coal and other minerals. In subsequent years, regional geological mapping aimed at creation of a national geoscience information and knowledge base had been included in its programme. In the post-independence era, the direction of National Development was redefined expanding the role of GSI on management of water resources, assessment and mitigation of natural hazards, delineation of areas susceptible to environmental degradation and providing geological inputs for major geotechnical projects. The thrust areas of GSI have changed consequently with national priorities throughout the eight plan periods. Now its sphere of scientific activities spread over a wide spectrum.

The Director General (GSI) is the head of the Organisation (GSI) having its central headquarters at Calcutta. There are six geographically defined regions : Eastern, North Eastern, Northern, Western, Central and Southern, with headquarters respectively at Calcutta, Shillong, Lucknow, Jaipur, Nagpur and Hyderabad. In addition, there are three specialized wings which are activity-based, namely, Coal, Marine and Airborne Mineral Survey & Exploration with headquarters at Calcutta (for the first two) and Bangalore respectively besides a few zonal functional units. Each of the regions comprises state-based operational units besides functional units at their respective headquarters. The Training Institute in Hyderabad has training centres in

different parts of the country. The GSI functions through its establishment located in 33 cities spread out through the country.

Apart from GSI's primary role of repository of reliable geoscientific data relating to the entire length and breadth of the country and providing these information, it has a major responsibility of discovering more and more mineral resources, particularly those which are deficient or fast-depleting ones. The country has been more or less very well covered by surface survey and some parts have been subjected to aerial surveys. In this manner many mineral deposits of economic significance for industrial growth have been discovered and developed during the post-independent era. The resources of major minerals estimated so far by GSI are given in Table-1.

G.S.I. in North Eastern Region :

During the earliest part of post-independence era, the North Eastern India used to be studied by GSI from Calcutta. With the decentralisation process the North-Eastern Region (NER) of GSI was created in 1974 with its headquarters at Shillong, which has provided due thrust in programme formation and implementation for the rapid progress of geological studies in NER. With the snow capped, lofty Himalaya in the north, the picturesque Meghalaya plateau in the south, the Naga-Arakan hills forming a festoon in the east and the mighty Brahmaputra winding through an extensive alluvial plain in between, the North Eastern Region presents a unique geological, geomorphological and geoenvironmental set-up in the country.

The earliest geological information in NER, was provided by Mclaren (1804) in N.E.F.A. (Arunachal Pradesh), followed by various expeditions from time to time by Oldham (1858), Medlicott (1865), Austin (1875), Mallet (1876), Oldham, R.D. (1883), Brown (1912), Pascoe (1912), Evans (1932), Franklin (1948) and Das Gupta (1948) and many geologists of the Burma Oil Company were pioneers in unravelling the geological set up of this remote and inaccessible terrain. Mineral prospecting and utilisation in the northeast dates back to more than eight centuries, as emerges from the records of gold extraction from the Subansiri Valley during the regime of the Ahom Kings. After setting of GSI under the British rule in the middle of the 19th century, the exploration of mineral resources got some fillip. The discovery of coal in Makum (Assam) in 1838 and in Garo Hills in 1868, the laying down of the railway line to Dibrugarh and beyond, and the accidental discovery of petroleum at Digboi triggered intensification of geoscientific endeavours.

REGIONAL GEOLOGICAL SET UP

The major physiographic and tectonic belts recognised in the N.E. Region are as follows :

Shillong-Mikir Massif :

The Shillong and Mikir Hills represent the N.E. promontory of the peninsular India. These consist of basement complex made up of gneisses and migmatites with enclaves of amphibolites and patches of high grade and granulitic supracrustals. The basement rocks are unconformably overlain by low to medium grade metamorphite cover rocks of the Shillong Group of rocks representing Middle Proterozoic sequence deposited in intracratonic rift basin. The migmatitic gneisses from Sonapahar area containing massive sillimanite bearing supracrustal have yielded 1.7 Ga Rb-Sr whole rock are. The resource of massive sillimanite from the area is presently near depletion. The basement and cover rocks are intruded by anorogenic granite plutons and veins. The granite plutons have yielded Rb-Sr whole rock age ranging from 885 – 480 Ma (Ghosh et al, 1991, 1994), although the major thermal events cluster around 700-500 Ma. These events are also recorded from N.E. Himalaya.

Shelf Sediments :

The southern and southeastern flanks of the Pre-Cambrian basement high are covered by the marine shelf sequence of late Mesozoic and Tertiary age representing the Assam shelf. The Shillong Hills are flanked further south by the Bengal basin alluvium.

The presence of Permian Lower Gondwana basin is recorded only to the N.W. corner of the Shillong massif. The coal resources is restricted in this basin because it extends into the flood prone Brahmaputra valley and is truncated by the Jamuna fault.

The recent studies in post-independence era has led to the added knowledge above mid-Cretaceous Sylhet volcanics to the south of Shillong which overly the basement and continues at depth to the west and to Mikir Hills to the northeast. The Tertiary sedimentation on the Assam shelf began with the deposition of the

Palaeocene-Eocene sediments which has a large spread in subsurface in Assam shelf and Bengal Basin. From bottom upwards and laterally, it is mainly made up of basal arkose locally associated with coal, limestone and black shale association representing unstable shelf to sub-littoral environment (Murth., 1983). The Barail Group of Oligocene age in Assam shelf is represented by thick sandstone-dominated lower part and upper argillaceous facies which were deposited in shallow marine/lagoonal and estuarine environments. The upper Eocene shale grades upwards into the coal bearing sandy facies of the Oligocene. The Oligocene Barails are the main source of coal in Upper Assam, Naga foothills and Changlang area (Arunachal Pradesh). The Assam shelf was uplifted and eroded after the deposition of the Barails (Oligocene). In frontal tectonised belt of Naga foothills, known as the 'belt of schuppen', the thrust movements have taken place from a detachment level located within the Barail sediments unconformably underlying the Neogene cover.

Geosynclinal Sediments :

The geosynclinal facies of sediments comprises northern segments of the Indo-Burman Range broadly displaying N-S to NE–SW trend. Parts of its different segments represent outer Neogene molasse basin, Palaeogene shelf – trench, Mesozoic – Eocene ophiolites, along with basement. The ophiolite belt along its eastern margin is generally inferred to represent the eastern suture of the Indian plate. The western and lower tectonic limit is provided by the inner most Disang thrust of the 'belt of schuppen' to the north and by the inferred thrust along the outer limit of the folded Tertiary sediments of the Sylhet Trough and Tripura-Chittagong fold belt to the south. The eastern and upper tectonic limit is represented by the nappe of ophiolite and metamorphic rocks (Acharyya et al, 1986a, 1990).

The facies alternations in the upper Disang and the Nagaon formations, locally preserved faunal content (invertebrates and larger foraminifera), the common occurrence of Ophiomorpha and other trace fossils, plants fragments, rare and local development of coaly facies (Konya area, Naga Hills), indicate shallow distal shelf to deltaic nature of sedimentation (Rao, 1983) and not a deep water trough as generally believed (Mishra, 1992). In the eastern ranges of Naga Hills which are usually higher, ophiolitic rocks and a higher sheet of continental metamorphic rocks are emplaced as flat-lying open folded nappe, structurally overriding the Disang Formation.

A folded pile of Neogene molasse sediments is exposed to the west of Naga-Chin Hills in Tripura-Mizoram region (Fig.1). Subsurface data indicate the presence of folded Palaeogene as well as Miocene shelf sediments in the Sylhet Trough (Johnson & Alam, 1991). The Sylhet Trough having the characteristics of a shelf during the Palaeogene is inferred to have subsided dramatically during Pliocene (Johnson & Alam, 1991).

In Manipur hills, an argillaceous sequence from eastern part of the belt and often underlying the ophiolites host a distinctive olistostromal facies with olistoliths of limestone, ophiolitic rocks and some continental metamorphic rocks in various sizes. This facies is very poorly exposed in Naga hills. The olistostromal sequence is indirectly dated at mid-Eocene based on foraminifers and on the age of youngest olistolithic blocks, (Mishra 1985). The olistostromal facies represent Eocene trench bordering the accreted mass of ophiolitic rocks and minor continental basement rocks from the overriding eastern Burmese continent (Acharyya et al, 1989, 1990; Sengupta et al, 1990). The limestone occurrences associated with these trench sediments are expectedly erratic in geometry and quality.

The N.E. Himalaya has E-W to N.E-SW trend. The most extensive rock unit consists of the high grade crystalline rocks which overrides moderate to low grade Proterozoic metasediments, granitoid basement rocks and locally present late Palaeozoic metasediments. The granitoids from N.E. Himalaya have yielded Rb-Sr whole rock ages like : 1650, 1050 and 500 Ma (Bhalla and Bishui, 1989). The exposed sequence of the Tertiary foreland basin in the Himalayan foothills consists of both Palaeogene and Neogene sediments, of which the latter occupies the sub-Himalayan belt almost continuously.

The regular trends of these major pre-Tertiary thrust sheets is interrupted by the presence of a few domal structures. Erosion of the upper level nappes at these sites have carved out windows which mainly expose subthrust pre-Tertiary rocks. Such domes in the Himalaya have been commonly inferred as fold interference structures. In recent years the subthrust rocks exposed in the cores of some major window structures e.g. Kuru and east Bhutan, Rangit in Sikkim and Siang in eastern Arunachal are inferred to represent hinterland dipping duplex structures (Ray et al., 1989; Acharyya, 1994; Acharyya & Sengupta, 1997).

Mineral Deposits :

Coal limestone, Dolomite, Oil and Gas are the principal natural resources of North East States. Oil and Gas are being exploited by public sector enterprises viz. Oil and Natural Gas Corporation and Oil India Limited. Besides, deposits of granite, China clay, Glass sands, Marbles, Quartzites and mineral/brine springs are worth mentioning.

A recent inventory of the known mineral deposits/occurrences and the status of exploration at each is presented in Table – II.

HYDROPOWER PROJECTS

North Eastern Region of India is gifted with abundant hydro potentials. Power is an essential component of the progressive growth. In this sector 37% of National Hydro power potential lies along on NE Region, through the vast river potentials of Brahmaputra and Barak river system (Fig.1). In order to tap this enormous hydel potential numerous major and minor civil structures are to be constructed with proper geotechnical in-built inputs. These geotechnical components are not only essential but the ultimate decision also for where and how these civil structures should be built in the ecofriendly sustainable geoenvironment as these multipurpose projects provide assured water for irrigation, industry, domestic supply, development of power and flood mitigation.

The distribution of some of the major projects is given where geotechnical studies for the feasibility of the scheme has been carried out by Geological Survey of India.

BRAHMAPUTRA STUDIES

The Brahmaputra basin is one of the most thickly populated river basins in India and faces serious problems because of heavy floods for which the economic development is always retarded. The problems of lean flow in the Ganga-Bhagirathi downstream of Farakka with consequent situation of threatening the Calcutta port had prompted the consideration of ways to augment this flow. One of the option was to make a canal to transfer the excess flow of Brahmaputra to the Ganga. As a part of the technical feasibility assessment Brahmaputra basin was studied in aspects of geomorphology, geotechnics, geohydrology and environmental impact.

The Brahmaputra valley has a physical structure comparable to a winnowing fan, abutted on the north by the lofty Eastern Himalayan ranges, on the south by the Meghalaya plateau and the Mikir Hills, on the east by the Naga Hills, the western side being open and contiguous with the Gangetic valley.

Physiographically the Brahmaputra valley may be divided near Guwahati into an Upper Assam valley and a Lower Assam valley. The Upper Assam valley trends ENE-WSW and the Lower Assam valley trends east-west.

The Upper Assam valley is a "Rift valley", bordered on the north by the easterly continuation of the Himalayan thrust-sheets and on the south by the Schuppen belt of the Naga Hills. The Upper Assam valley is a monotonously plain area, being filled up by a thick pile (-5,000 m) of Cretaceous, Tertiary and Recent sediments. The Lower Assam valley is a "Ramp valley" of sag in the crust formed tectonically during the Miocene period, along with the Gangetic depression, in front of the rising Himalayas. North of the Shillong plateau, in the Goalpara and Kamrup plains, there are some Archaean hills as remnants of the northerly sag of the plateau, only 30-40 km from the Himalayan foot-hills. These Archaean inselburgs form forest-clad steep hills amidst the surrounding rice fields, and many of these hills are over 500 m higher than the flood-plains of the Brahmaputra. The similarity of the strike of foliations in the crystallines of these isolated Archaean hills with those of the northerly sloping Shillong plateau and the geomorphology of the region suggest a recently drowned landscape (Gansser, 1964).

In the Lower Assam the highest and oldest terraces form the Chapar surface. It is deeply dissected into discontinuous patches, often associated with inselbergs, a spectacular deep red Latosol profile is evident in intense weathering, and in conjunction with the intricate drainage patterns, produces a landscape of a great beauty.

The next terrace is the Sarbhog surface, occurring in isolated higher remnants preserved within the younger plains. The sediments are coarse sand and the typical soil is a chocolate coloured sandy or silty loam. The Sarbhog surface too is free from flood.

The Hauli surface, intermediate between the Sarbhog and the present flood plain (Barpeta surface), is extensively developed. Present stream courses are generally incised, but gradation between the Hauli and Barpeta surfaces are seen at some places. The characteristic features are meander scars, cut off loops, and remnants of old levees. Fossil stream courses determine the pattern of settlements.

Traditional land use distribution is conformable with the geomorphology reflecting the adaptive style of earlier times. Settlements were built on levees and higher terraces, and seasonal crops grown in the lower areas. The pressures of population have impelled settlement in hazardous zones and put large numbers at risk. Even the adaptive traditions, however, could not provide full protection. The unstable river system, with changing courses and large scale erosion, often changed these patterns, and flooding has been a historical fact of life.

The area has a high seismic incidence and many geomorphic changes and instabilities have been attributed to seismotectonic activity. Very few specific correlations can be made, however, through the regional frame has been shaped by recent movements.

Sequential morphometric analysis from maps have revealed that erosion dominated from 1893 to 1927, but was balanced by matching deposition between 1927 to 1971 to produce a dynamic equilibrium state. Erosion along the north bank was more than on the south, possibly due to the basement being shallow towards the south. The period of high erosion was probably triggered by the instability following the Dhubri earthquake of 1897. In contrast the Great Assam earthquake of 1950 caused instability in the Upper Valley and the reach downstream of Guwahati was apparently unaffected.

COMMUNICATION

The road communication or the "Life line" is for the survival of the human population in the remote parts. The role of engineering geology is in the construction of the bridges and roads. The slope stability problems are associated with the road alignments. Number of places along NH-40 were examined where landslides have occurred in the past causing road blockages. The rail link between Kumarghat–Agartala passing through fragile terrain is demarcated on the basis of geotechnical inputs. The section between Dharmanagar–Kumarghat is already under operation whereas survey work between Kumarghat–Nalkata for geotechnical appraisal is already completed.

URBAN DEVELOPMENT

The population is on the rise in all seven sister states which is exercising excessive stresses on land in form of concrete jungle. For example in Aizawl such unsystematic over growth imparts imbalances in the fragile ecosystem translating into slope failures causing heavy loss to the lives and material. The township of Kohima is also reeling under the heavy demographic pressure culminating in major construction activities and around Kohima warranting systematic development and planned growth in accordance to the geotechnical considerations. GSI has been actively involved in geological, geomorphological and geoenvironment studies of different townships. In view of rapid developmental activity adequate safeguards have suggested by the geoscientists for preservation of the overall ecosystem.

LANDSLIDE HAZARD STUDIES

The North Eastern Region with its vast potential of natural resources, is poised for an all round accelerated development. The important developmental activities in the region are the establishment of road/rail communications joining the remote and difficult places to the main communication network, construction of a number of hydroelectric projects in the area. The high rainfall coupled with the mighty drainage system of the major rivers like Brahmaputra and Barak impart not only weakening of rock mass but also are responsible for large scale erosion and toe cutting of the valley slopes, triggering landslides and are a part of the ongoing geodynamic processes. Therefore the mitigation of the adverse defects of the processes of landslide and mass wastage by geotechnical studies has remained on the Geological Survey of India's agenda for almost last three decades (fig.2).

Landslide events studied in the region are mostly located along the road cuts, besides some in rural and urban areas because the construction of roads has followed the major drainage lines. Large number of landslides have been studied over the years and have been categorised in six types, viz. (i) Mud flow (ii) Debris slides (iii) Subsidence (iv) Slump slides (v) Rock fall/Rock slides and (vi) Earthquake induced slides. The landslides in Assam, Mizoram, Nagaland and Tripura are located in relatively soft sediments whereas landslides in Arunachal Pradesh and Meghalaya are located in metamorphic and igneous rocks. However, in

all the cases the prevalent excessive rainfall infiltrates into the ground and leads to increase in the pore pressure and decrease in shear parameters which in turn promote landslides.

The foregoing description is an illustration of the constraints for the developmental activities as prompted by the landslides hazards in context to the North Eastern Region. In this regard N. Mazumdar of GSI presented a Regional Zonation Map in 1980 (fig.2) on the basis of susceptibility to landslides in terms of physico, mechanical properties of rocks underlying the slope and intensity of rainfall. This may help the planners to make an assessment of the ground conditions for taking up the site specific geotechnical investigation as essential basic premise to the ground friendly developmental activities.

DEVELOPMENT OF VILLAGE ECONOMY THROUGH RESOURCE APPRAISAL PROGRAMME (DOVEMAP)

The GSI in its IX Plan proposals envisages to undertake a Project "Development of Village Economy through Resource Appraisal Programme" (DOVEMAP), to help the economic development of rural Meghalaya through geoscientific inputs of minor minerals and other terrain resources. The exploitation and utilisation of these resources being labour intensive, would generate employment opportunities for the weaker sections of the rural society. The mineral raw materials being looked for, such as hard rock, sands and clays are of low unit value and high volume. These may be utilised for direct consumption in the building and construction industry and also value addition by small scale industries, such as pottery, brick and tile manufacturing etc. In addition to the mineral search, this exercise would also simultaneously assess ground water potential for providing safe drinking water, mapping of landuse pattern, assessment of terrain conditions favourable for water storage structures, drainage improvement, construction sites and evaluation of feasibility for micro hydel projects. Thus the programme aims at rapid integrated resource survey at village level from a holistic view encompassing minerals, water and terrain itself, for planned exploitation of mineral land water resources and value addition to the terrain potential. The exploration would be based on rapid coverage on large scale mapbase, for locating resources within shallow, easily quarriable depths. Shallow drilling will be resorted to for reserve estimation and sampling where necessary. The activity will be aimed at generation of thematic maps on the large scale (1 : 10,000 scale or more) utilising IRS 1C geocoded sheets in the absence of cadastral maps.

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TABLE — I

RESOURCES OF MAJOR MINERALS ESTIMATED BY GEOLOGICAL SURVEY OF INDIA (RESOURCE IN MILLION TONNES UNLESS OTHERWISE STATED)

Sl. No.	Ore/Mineral	Resource position 1956	Resource position 1966	Resource position 1976	Resource position 1986	Resource position 1996
1.	Coal	25,000	1,11,000	1,25,827	1,86,044.24	2,00,028.90
2.	Lignite	42	2,855	4,290	5,687	5,857
3.	Tin (Metal)		1,752 (tonnes metal)	2,2234 (tonnes metal)	65,699 (tonnes metal)	65,699
4.	Tungsten		38.9	45.5	53.68	53.68
5.	Copper Ore	3.4	455	464.77	509.54	511.51
6.	Lead-Zm. Ore	4.8	241	360	466.28	498.2
7.	Gold Ore	4	9.8	16.1 (20.364 tonnes metal)	22.018	27.014
8.	Iron Ore Haematite)	5,000	11,470	13,066	13,651	13,651
9.	Manganese Ore	20	95	135	150.2	151.36
10.	Chromite	3.4	17	132*	134.073	145.823
11.	Bauxite	254	2,489	2,599	2,630.79	2,630.79
12.	Limestone	44,718	72,229	73,199	74,413	74,443
13.	Dolomite		3,738	3,958	3,958	4,086
14.	Rock Phosphate	61	139	177	195.51	199.01
15.	Potash Ore				78	404.19
16.	Molybdenum Ore					2,544

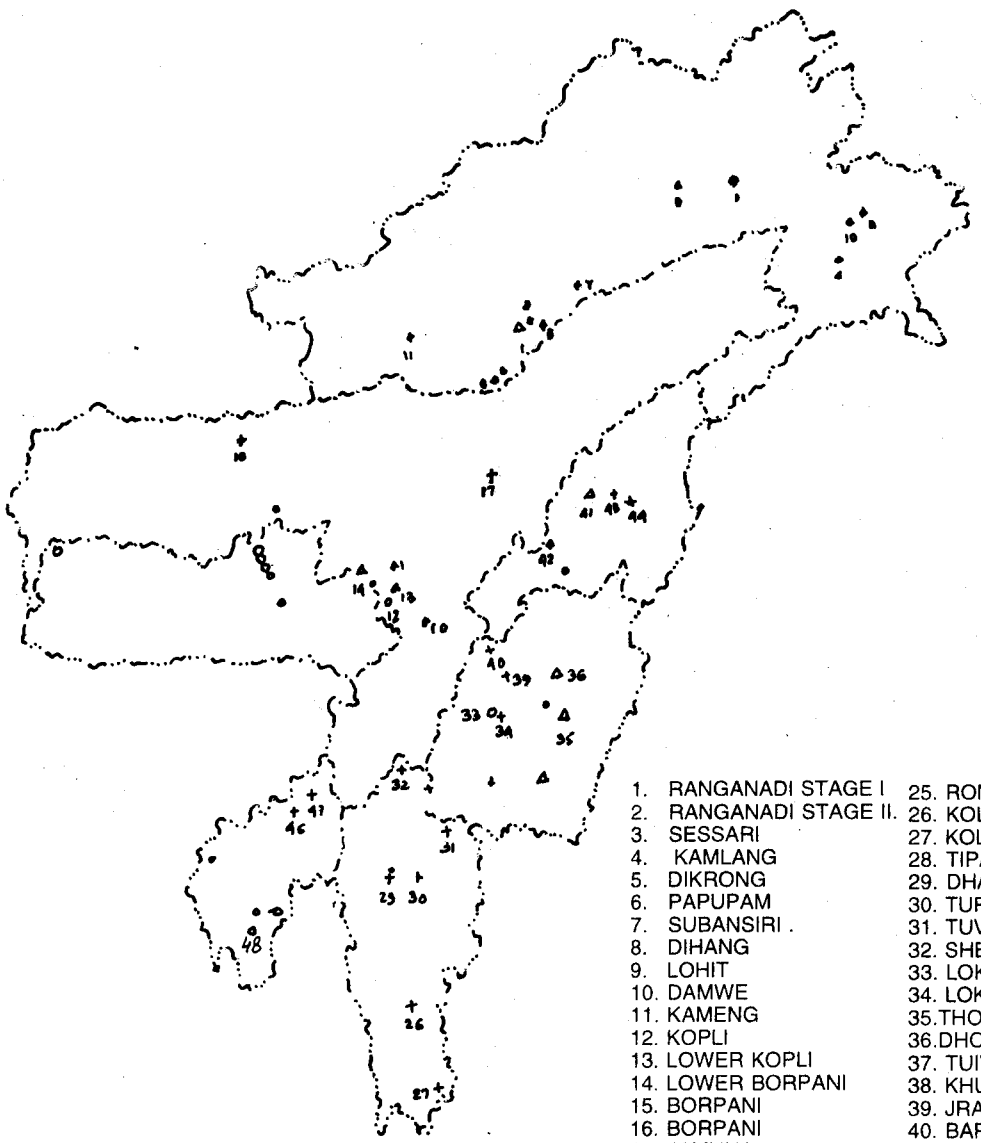
TABLE — II

KNOWN MINERAL RESOURCE NORTH EASTERN REGION (EXPLORATION STATUS)

STATE	NAME OF	DISTRICT	RESERVES		REMARKS
ARUNACHAL PRADESH	COAL	Changland	93.00	m.t.	Can be used for-Coking blend, Synthetic petroleum, power generation
	LIMESTONE	Lohit	91.00	m.t.	Being explored by M/s Parsuram Cement Works Suitable for Cement / Lime burning.
		Siang	225.00	m.t.	Suitable for cement and lime burning
		Lohit	---	----	'Do'
	DOLOMITE	Kameng	185.00	m.t.	SMS & Refractory
		Kameng	3.75	m.t.	– Do –
		Kameng	58.00	m.t.	– Do –
	GRAPHITE	Subansiri	0.30	m.t.	
		Lohit-Subansiri-Siang	84.673	m.t.	
	QUARTZITE	Kameng	3.13	m.t.	Ferrosilicon grade
ASSAM	COAL	Dibrugarh	235.00	m.t.	High sulphur, low ash, high caking, index high calonfic value
		Karbi Anglong			High moisture, high ash, high sulphur coal
		Dibrugarh	55.36	m.t.	Low ash, high sulphur coal
	LIMESTONE	N. C. Hills	103.00	m.t.	Cement grade blendable, high R-O, limestone
		Karbi Anglong	124.00	m.t.	May be used for Cement Lime burning
		Karbi Anglong	2.00	m.t.	Ferro-portland Cement
		N. C. Hills	36.00	m.t.	Cement grade, high R-O, limestone
	FIRECLAY	Karbi Anglong	0.71	m.t.	May be used for pottery and Fire bricks
		Dibrugarh	0.05	m.t.	May be used for Fire bricks
	KAOLIN	Karbi Anglong	0.06	m.t.	Suitable for Ceramic & refractory purposes
	CLAYS	Karbi Anglong	0.61	m.t.	Gr.I (SI) type
	FULLER'S EARTH	Nalbari	0.24	m.t.	Suitable for petroleum refining and fertilizer manufacture
	IRON ORE (BMQ)	Goalpara	30.00	m.t.	Suitable for sponge iron
	SILLIMANITE	Karbi Anglong	50.00	m.t.	Mostly of more than 10% sillimanite concentration - refractory
MANIPUR	LIMESTONE	Ukhrul	4.60	m.t.	Cement grade/being utilised by mini cement plant. 50 t.p.d. of Deptt. of industries, Manipur
		Ukhrul	1.80	m.t.	
	CLAYS	Churachandpur	2.52	m.t.	
MEGHALAYA	COAL	Garo Hills	127.00	m.t.	
		Garo Hills	133.00	m.t.	
		Garo Hills	125.00	m.t.	
		West Khasi Hills	97.61	m.t.	
		Jaintia Hills	33.66	m.t.	Explore by DMR, Meghalaya .
	LIMESTONE	East Khasi Hills	71.00	m.t.	Cement / being utilised by Mawmluh-Cherra Cement factory
		East Khasi Hills	900	m.t.	Cement/flux/Chemical grade.
		Jaintia Hills	2800.00	m.t.	Cement/SMS/Chemical grade
	KAOLIN	Khasi Hills	1.21	m.t.	
		East Garo Hills	8.40	m.t.	Explored by DGM-Assam, and DMR-Meghalaya
	CLAYS	Garo Hills	68.00	m.t.	Lithomargic clay
	SILLIMANITE	West Khasi Hills	0.45	m.t.	Refractory (mostly mined out). Used by Hindustan Steel Ltd.
	BAUXITE	East Khasi Hills	0.12	m.t.	Titaniferrous
	BASEMETALS	East Khasi Hills	0.12	m.t.	Pb-Zn-Cu
	APATITE	East Khasi Hills & Jaintia Hills	1.30	m.t.	Fertilizers
MIZORAM	DIMENSION-AL STONE	Aizwal	0.03	m.t.	Decorative stone (Explored by Deptt. of Industries)
NAGALAND	COAL	Mon	10.00	m.t.	
	LIMESTONE	Tuensang	375.00	m.t.	May be used in Cement / Paper / Chemical Industries. Nagaland Govt. has proposed to set up a cement plant.
		Phek	0.90	m.t.	Mini Cement plant has been commissioned by NSMDC. Reserve proved by DGM. Nagaland.
	DIMENSION-AL STONE	Phek	0.05	m.t.	Limestone used as decorative stone (explored by DGM, Nagaland)
TRIPURA	CLAYS		0.009	m.t.	Earthen wares and electrical insularors
			1.085	m.t.	Whitewares
			5.20	m.t.	Whitewares & stonewares
			9.31	m.t.	Earthenwares
	GLASS SAND		0.234	m.t.	Manufacture of glass

N. B. # Minerals for which industries could be set up.

LOCATION OF IMPORTANT HYDRO ELECTRIC PROJECTS NORTH EASTERN REGION



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PROJECT - UNDERCONSTRUCTION △
PROJECT - IDENTIFIED FOR INVESTIGATION +
•

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39. JRANG
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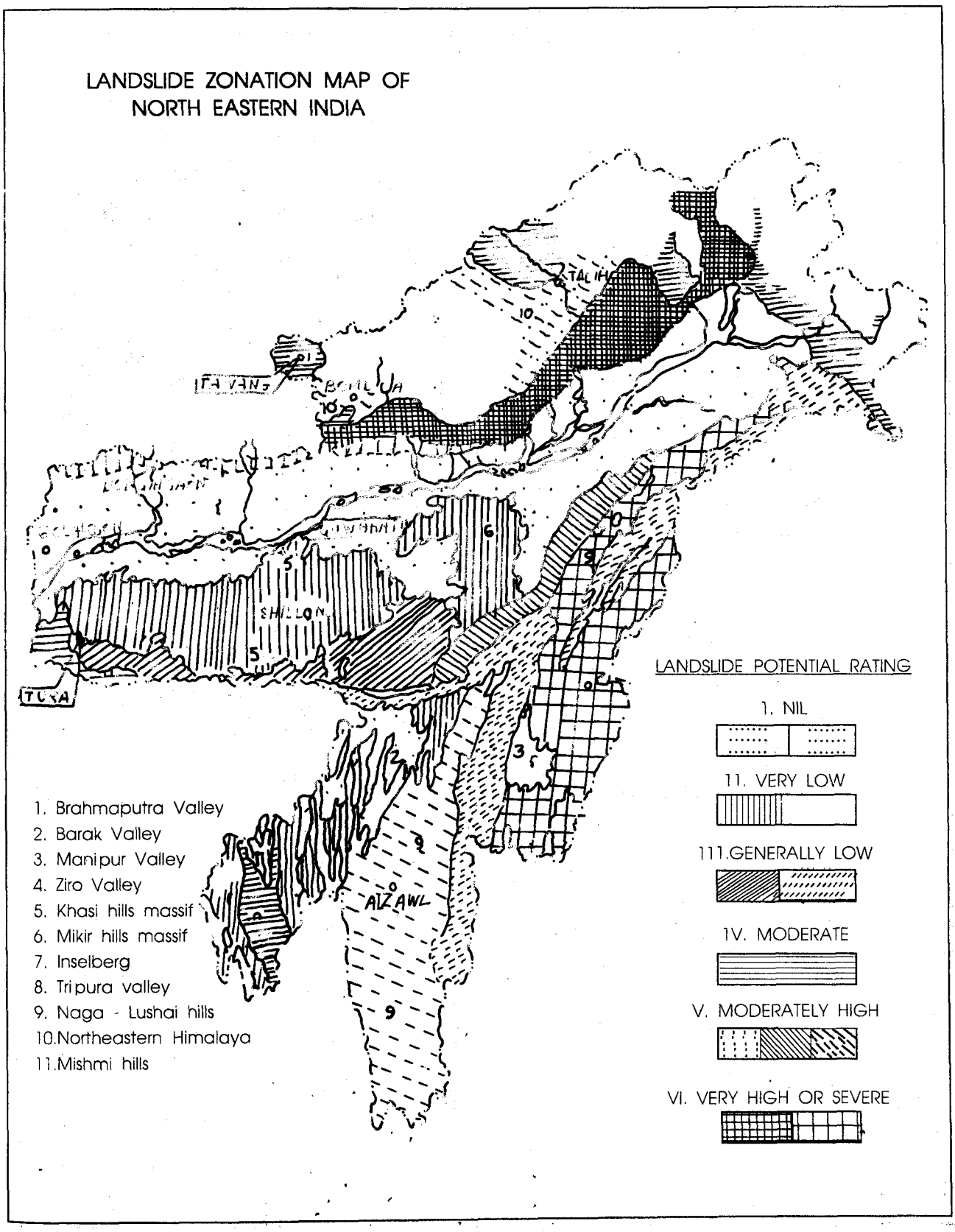
42. DZUZA
43. DIKHU
44. LIKIMRO
45. GUMTI
46. MAHARANI
47. LONGAI
48. MANU-DEO-JURI

FIGURE–1


LANDSLIDE ZONATION MAP OF
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1. Brahmaputra Valley
2. Barak Valley
3. Manipur Valley
4. Ziro Valley
5. Khasi hills massif
6. Mikir hills massif
7. Inselberg
8. Tripura valley
9. Naga - Lushai hills
10.Northeastern Himalaya
11.Mishmi hills
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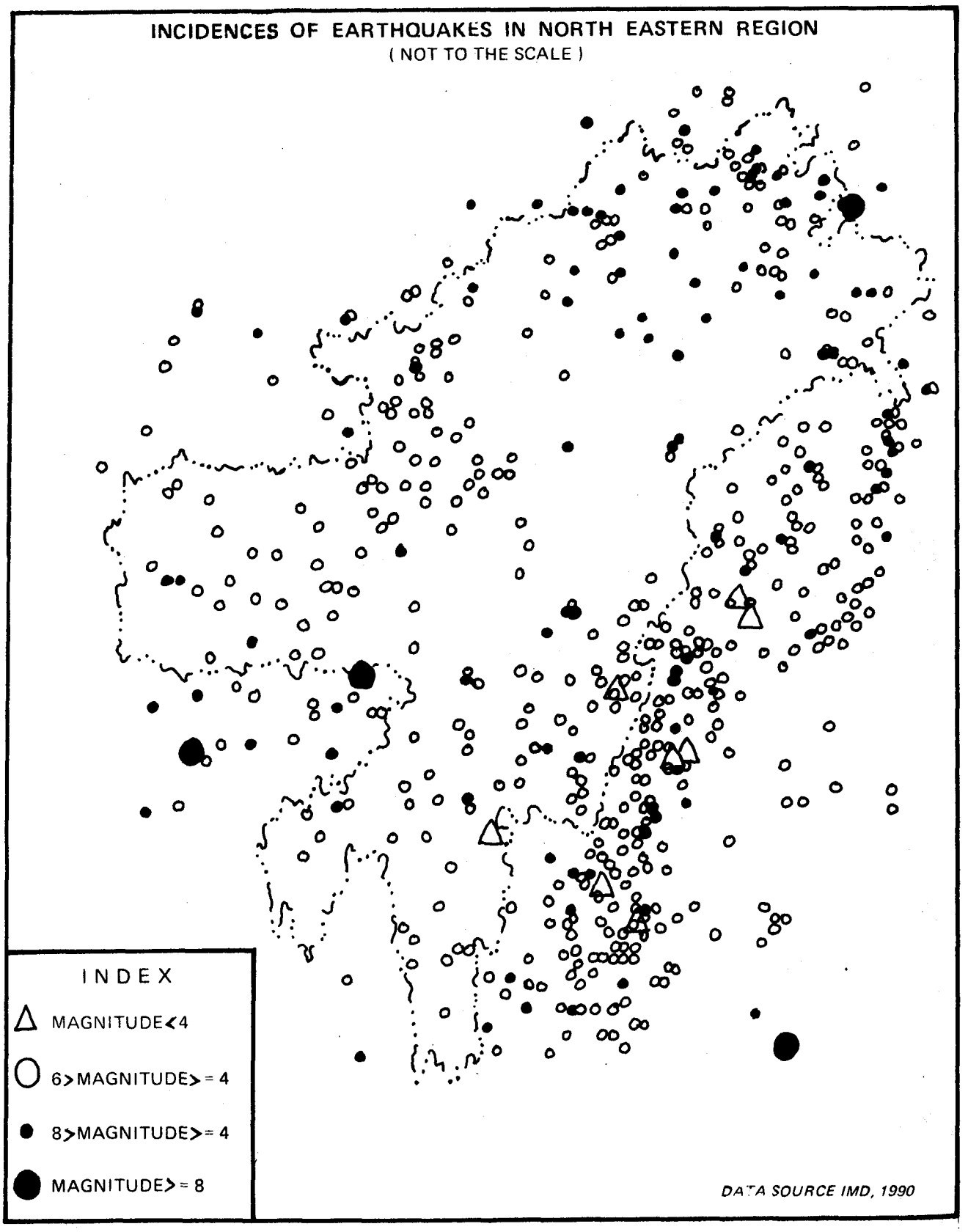
11. VERY LOW
111.GENERALLY LOW
1V. MODERATE
V. MODERATELY HIGH
VI. VERY HIGH OR SEVERE
SHILLONG
AIZAWL
TURA

FIGURE-2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(NOT TO THE SCALE)
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MAGNITUDE<4
6>MAGNITUDE>=4
8>MAGNITUDE>=4
MAGNITUDE>=8
DATA SOURCE IMD, 1990

FIGURE–3

ROLE OF DEPARTMENT OF ATOMIC ENERGY IN THE DEVELOPMENT OF SCIENCE AND TECHNOLOGY IN THE LAST 50 YEARS IN INDIA WITH SPECIAL REFERENCE TO NORTH EAST INDIA

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ABSTRACT

The genesis of Department of Atomic Energy (DAE) can be traced to the establishment of Tata Institute of Fundamental Research by Dr H.J. Bhabha in 1945 who like Pandit Nehru visualised Science & Technology and Nuclear Energy for peaceful purposes as sole route to growth in developing countries. The nuclear energy programme received necessary impetus after independence and the Atomic Energy Commission was set up in 1948, followed by Atomic Energy Establishment Trombay, (AEET) in 1954 which was renamed as BARC in January, 1967. The Indian nuclear power programme gained momentum in August, 1956 with the commissioning of Apsara, the first nuclear reactor in Asia. Apsara was followed by the commissioning of a series of research reactors Cirus, Zerlina, Purnima and Dhruva.

One of the primary objectives of Atomic Energy – to achieve self sufficiency in the technology of harnessing the power of atom to meet the country's exponentially growing energy demand is being realised by Nuclear Power Corporation India Ltd. (NPCIL) establishment in the year 1987. The Atomic Energy Regulatory Board's Industrial Safety Award AERB-ISA, 1994 and green site award 1993 for planting 6.5 lakh trees won by KAPS, AERB-ISA 1996 award by nu Kaiga Atomic Power Project etc. show the safe and eco-friendly power generation by the units. Safety records of the plants producing heavy water for the nuclear power programme has also been very good. Besides the power stations, other public units under DAE such as Electronic Corporation of India Ltd., Indian Rare Earth Ltd. and Uranium Corporation of India Ltd. are also engaged in meeting the multifaceted requirements of the various on going programmes of the department. The achievements of the department are numerous in wide variety of fields such as radioisotope production and application in Industry, medicine and agriculture; development of 5 KW carbon-di-oxide laser for industrial and surgical applications, special purpose PTFE powders as substitutes for special lubricating oils and compounds, biological insecticides, tissue culture based plants like groundnut, rice, jute, pulses etc. and many others.

Collaboration between DAE units and universities through Inter university consortium called IUC-DAE established by UGC started in May, 1990. Dhruva reactor at Mumbai. VECC at Calcutta and Synchrotron at Indore were opened to university researchers at national level.

The department has been supporting the growth of Science & Technology in North East India directly through Atomic Minerals Division (AMD) one of its constituent units. The unit with headquarters at Hyderabad is engaged in the augmentation of mineral resources for the nuclear power programme through its exploration efforts all over the country. AMD has been carrying exploration in the North Eastern part of the country for over three decades initially from Calcutta and subsequently for around two decades from North Eastern Regional headquarters at Shillong. The exploration programme achieved tremendous success in the North Eastern Region by identifying a commercially viable near surface uranium deposit of 9 Million ton of ore of 0.104% U_3O_8 at Domiasiat. West Khasi Hills Distt. Meghalaya.

Besides the exploration programme, AMD has been extending analytical support to various organisations in the region such as ICAR, Deptt. of Earth Sciences in Manipur University; DMR Meghalaya, Forensic Science Laboratory, Meghalaya; Department of Mining & Geology Assam and Nagaland etc. The Chemistry Group is collaborating with NEHU in several scientific activities including a project under Board of Research in Nuclear Science. Recently, a regional chapter of Indian Society of Analytical Scientists encompassing the entire NER with headquarters at Chemical Laboratory, AMD, Shillong with nucleus at BARC Mumbai has been inaugurated to bridge the cummunication gap in the scientific community in the region.

INTRODUCTION

The resemblance in thoughts of two great personalities, Dr Homi Jahangir Bhabha, the great scientist with remarkable vision and Pt. Jawaharlal Nehru, the politician with scientific dynamism sowed the idea of nuclear energy programme in India.

Dr Bhaba like Pt. Nehru visualised Science and Technology as the lone route to growth in developing countries and harnessing the energy within the atom for peaceful purposes as the ultimate course to achieve an overall growth and economic development of the country in the pre and post independence scenario. The superb combination of vision and action, in Dr Bhabha and his firmly rooted feet in the soil of the land led to the inception of Indian Nuclear Power Programme with the establishment of Tata Institute of Fundamental Research (TIFR) in 1945. India's independence in 1947 and total support from Pt. Nehru provided the necessary impetus and freedom to pursue the nationalistic goals in the nuclear energy domain.

The Atomic Energy Commission was set up in 1948 and Department of Atomic Energy in 1954. The Atomic Energy Establishment, Trombay (AEET) located in the picturesque surrounding between Trombay hills

and sea on a stretch of land, 2,000 acres in area, about 25 km from the centre of Mumbai was formally inaugurated by the Prime Minister on 20th January, 1957. The total set up of direct relevance to Nuclear Power Programme including the scientists was shifted from TIFR and became a part of AEET which started functioning as separate unit from April, 1957. The establishment was renamed as Bhabha Atomic Research Centre (BARC) in January 1967 in the memory of its prime architect after his tragic death in January 1966 in an air crash.

The Department of Atomic Energy has been engaged in a wide spectrum of activities, starting from pioneering role in harnessing the power of the atom, taking lead in frontline researches in nuclear sciences, engineering and allied high-tech areas to active participation in various nation building activities with significant achievements in non power applications of atomic energy in the fields of agriculture, medicine and industry besides power. The activities are broadly grouped under Public Sector Undertakings, Research & Development and industrial Service organisations besides support to institutions involved in nation building activities.

Safety and Regulatory aspects are looked after by Atomic Energy Regulatory Board (AERB). Table I shows the organisational structure of DAE and its units and Table II shows location of various units in the map of India.

PUBLIC SECTOR

The Public Sector undertakings of the department include Nuclear Power Corporation of India Ltd. (NPCIL). Electronics Corporation of India Ltd. (ECIL) and Uranium Corporation of India Ltd. (UCIL).

Nuclear Power Corporation of India Ltd.(NPCIL) :

NPCIL was constituted in the year 1987 to meet the country's exponentially growing demand by harnessing the power of atom, one of the primary objectives of the department. The mission of NPCIL is to produce nuclear power as a safe, eco-friendly and economically viable source of electrical energy and achieve self sufficiency in nuclear power technology. The corporation has been steering the power generation programme through the construction and operation of pressurised Heavy Water Reactors besides operation of Boiling Water Reactors. There are two boiling water reactors (BWRs) and eight pressurised heavy water reactors (PHWRs) under operation with a total installed capacity of 1940 MW, in the country, which have contributed over 100,000 million units by now to the national grid. Besides, eight pressurized heavy water reactors with a total capacity of 3880 MW are under construction. The complete and subsequent commercial operation the units are under construction would take us one step ahead towards the realisation of the gigantic task of achieving a capacity of 20,000 MW by the year 2020.

NUCLEAR POWER PLANTS UNDER OPERATION

Tarapur Atomic Power Station (2x160MW BWRs) :

Prior to achieving self reliance in nuclear power technology. It was decided to construct a boiling water reactor to gain experience of operating a nuclear power station in the Indian electrical grid. The nuclear power was introduced to the country through Tarapur Atomic Power Station, comprising of two 210 MW boiling water reactors using enriched uranium built by an US firm on turn key basis. Both the reactors became critical in 1969 and have been supplying the cheapest non hydel electric power at the capacity of over 50 per cent with 70 per cent availability. Though the reactors were originally rated 210 MW each, the present capacity of these is reduced to 160 MW each due to fuel availability problems and downgrading of some equipments. The electricity generated by the station is supplied to Maharashtra and Gujarat.

Rajasthan Atomic Power Station(RAPs) (100MW and 200MW PHWRs) :

RAPS, India's second nuclear power station with pressurised heavy water reactors using heavy water as moderator and coolant and natural uranium as fuel was built by Indian scientists and engineers with Canadian design and assistance from Canadian consulting engineers. The station has two units of 220 MW each. The first unit was commissioned in 1972 and started commercial operation from December 1973 while the second unit commissioned in October 1980 commenced commercial operation in April 1981. The originally rated capacity of 220 MW is presently reduced to 100 MW for Unit-1 and 200 MW for Unit-2. The station supplies electricity to Rajasthan.

Madras Atomic Power Stations (2x170 MW PHWRs) :

Commissioning and subsequent beginning of the commercial operation of the 235 MW unit at Kalpakkam in January 1984 marked the culmination of all the efforts to achieve self reliance in the field of nuclear power. The second unit, also of 235 MW capacity became commercial in March 1986. Presently, the capacity of both units has reduced to 170 MW capacity became commercial in March 1986. The units supply power to the southern grid and have generated over 20,711 million units since the beginning of commercial operation.

Narora Atomic Power Station (2x220 MW PHWRs) :

The tow units, each with original capacity of 235 MW, rated as 220 MW each attained criticality in March 1989 and October 1991, respectively. The station supplied 5982 million units till the end of January 1996 since commencement of commercial operation in January 1991 and July 1992 respectively to the northern grid.

Kakrapar Atomic Power Station (2x220 MW PHWRs) :

The station became fully commercial with the commencement of operation of its unit-2 from 1st September, 1995. Unit-1 had attained criticality on 3rd September 1992 and was synchronised with western grid of 24th November 1992. The station situated in Surat distt. of Gujarat has generated 2524 million units till end of January 1996.

NUCLEAR POWER PROJECTS UNDER CONSTRUCTION

Kaiga Atomic Power Project - 1&2 (2x220 MW PHWRs) :

The projects located at Kaiga, near Karwar in Karnataka are under construction. The progress in construction was hampered due to delamination of concrete in Kaiga-1 dome. The units – 1&2 are expected to achieve criticality during 1998-99.

Rajasthan Atomic Power Project - 3&4 (2x220 MW PHWRs) :

The project located at Rawatbhata in Rajasthan is under construction. The units - 3&4 are expected to achieve criticality during financial year 1998-99.

Tarapur Atomic Power Project - 3&4 (2x500 MW PHWRs) :

The financial sanction was accorded to the project in January 1991 but due to paucity of funds, main plant civil works could not be taken up.

Kudankulam Atomic Power Project (2x1000MW) :

Discussion with Government of Russia are underway to materialize Inter-Government Agreement. The possibility of equity participation in the project by southern states is being explored.

Electronics Corporation of India Ltd.(ECIL) :

ECIL based at Hyderabad started functioning since April 1967 to meet primarily the requirements of DAE in the area of nuclear electronic instrumentation but has diversified its activities. At present, its activities encompass controls and instrumentation, computer systems, communication components and special products and consumer electronics products.

As pioneer in the information technology industry, the corporation has developed a total branch automation software for bank front office automation in India to provide the state of the art banking. The comprehensive package with user friendly single window, on-line transaction processing system take care of all the accounting and servicing functions of a branch. Cockpit voice recorder. Air Traffic Control system of IAF, X-ray Baggage Inspection System being utilised by major air ports in India. Tantalum Capacitor for defence communications, instrumentation, computers, space applications and automobile electronics, TV, mobile TV relay stations, missile check out systems and mobile common post for Trishul Missile systems, Electronic Automation Systems for steam turbines for thermal plants etc are a few contributions of ECIL.

The total production of equipment in ECIL in 1996-97 was estimated at Rs. 401 crores.

Indian Rare Earth Ltd. (IREL) :

IREL was established in August 1950. The company has Rare Earth Plant at Alwaye, set up in 1952, to process monzite from beach sands; two Mineral Sand Separation plants at Manavalakurchi in Tamil Nadu and Chavara in Kerala and one Thorium plant at Trombay were commissioned.

The thorium plant set up in 1955 was operative till 1990. A new thorium plant was set up at Orissa Sand Complex (OSCOM) at an estimated cost of Rs. 3 crores. The company has also set up the Orissa Sand Complex at Chattarpur in Orissa for processing the beach sand in Orissa coast and a synthetic Rutile Plant.

The company has been earning foreign exchange from export of beach sand minerals and value added products (Rare Earth Chlorides) besides providing mineral feed stocks for high tech industrial production in the country. During 1996-97, turn over of the company was Rs. 147.8 crores with a profit of Rs. 5.8 crores.

Uranium Corporation of India Ltd.(UCIL) :

Mining and Milling of uranium ores, recovery of copper and molybdenum concentrates and production of magnetites as by products are carried out by Uranium Corporation of India Ltd, set up on 4th October, 1967 at Juduguda. Besides, uranium (70-100ppm), present in copper ore of Singhbhum is recovered by Uranium recovery plants at Surda and Rakha.

RESEARCH & DEVELOPMENT SECTOR

Bhabha Atomic Research Centre (BARC) :

BARC has been the mother institution to all other units of the Department of Atomic Energy. The R&D activities started in BARC in basic and applied science and technology resulted in the present state of expertise in all operations of nuclear fuel cycle.

Research Reactors :

The Indian Nuclear Programme gained momentum with the commissioning of Apsara, the first nuclear reactor in Asia on August 4, 1956. The 1MW(th) swimming pool reactor with enriched uranium as fuel, designed and built entirely by Indian Scientists and Engineers completed 40 years of successful operation in 1996. Apsara was followed by the commissioning of series of research reactors – Cirus, Zarline, Purnima and Dhruva. Zarlina, the zero energy reactor for lattice investigations, attained criticality in January 1961. Reactor physics experiments carried out in the reactor until its decommissioning in May 1983, perfected the nutronics design capability of Indian Scientists.

The 40 MW (th) Cirus reactor built in collaboration with Canada provided the insight into the engineering of a large size nuclear reactor. The neutron beams available from Cirus helped in carrying out a large number of experiments in basic physics and chemistry besides training to the first batch of reactor operators. Dhruva 100 MW (th), commissioned in 1985, provides much higher flux and serves as a powerful tool for carrying out experiments in physics, chemistry and engineering besides producing several valuable radio isotopes.

Fabrication of nuclear fuel is a highly complex operation requiring expertise in metallurgy and chemistry. The fuel fabrication facility created at Trombay made partly fuel for Cirus and part of the first core for RAPS unit-1.

Decommissioning of Zerlina provided valuable experience in that technology. BARC has recently completed the design and development of multipurpose research reactor with power in the range of 5-10 MW (th), useful in fundamental and applied researches, material development studies, isotope and in high technology nuclear research.

The latest research reactor, to be commissioned was Kamini, a 30 KW uranium-233 fuelled reactor went critical on October 29, 1996. At present, this is the only operating reactor in the world using man made fuel obtained from thorium.

Development of Advanced Heavy Water Reactor (AHWR), utilising plutonium – uranium mixed oxide fuel (MOX) in the seed zone and thorium – uranium 233 in the surrounding zone has been taken up in view keeping long term perspective in view. The surrounding zone will operate in self sustaining mode and produce U-233 from thorium as much as consumed; 75 percent of the reactor power will come from this zone. The reactor will use light water as coolant rather than heavy water and would also have advanced.

India's second stage reactors are plutonium fuelled Fast Breeder Reactors (FBRS) producing more fissile material than they consume and thus made efficient use of the available uranium. Work on Fast Breeder Reactor Technology, initially started at Trombay were shifted to Kalpakkam near Chennai by setting up Indira Gandhi Centre for Atomic Research.

The fast reactors utilise combination of fast neutrons to sustain the chain reaction and usually mixture of plutonium and uranium oxides as fuel. BARC has developed and used for the first time in the world a new type of fuel for FBTR which is mixed uranium, plutonium carbide. Fabrication of plutonium containing fuel is a complex task involving remotely operated nucleus and hot cells or glove boxes.

Reprocessing of spent fuel to recover the residual uranium and the plutonium produced during the reactor operation was started with the commissioning of a 30 tonnes per annum plant at Trombay in 1964. India was the fifth country in the world to start spent fuel reprocessing. Fuel reprocessing is carried in a closed fuel cycle with minimum amount of radioactive waste and maximum utilisation of fuel inventory. BARC commissioned two more spent fuel reprocessing plants one at Tarapur and another at Kalpakkam to reprocess spent fuel discharged from power reactors. The importance of radio active waste management was recognised very early and R&D work was initiated at Trombay much ahead of the power programme. This resulted in commissioning of a waste mobilisation plant after converting the waste into glass by verification.

Indira Gandhi Centre for Atomic Research(IGCAR) :

The principal activity of IGCAR at Kalpakkam, Tamil Nadu originally started as Reactor Reasearch Centre in 1971 is to conduct broad based multidisciplinary programme of scientific research and advanced engineering development for establishing the technology of sodium cooled FBTR. The FBTR utilising indigenously developed mixed 30% U-70% Pu Carbide as fuel, attained criticality in October 1985. Since then the reactor was operated at various power levels upto 12 MW (thermal) and was synchronised for the first time on July 11, 1997 to the regional electricity grid. The reactor generated about 1MW power which is being supplied to the Tamil Nadu grid. The centre got its present name in December 1985.

Centre for Advanced Technology (CAT) :

The CAT has been set up at Indore in Madhya Pradesh in February 1984 to undertake work on a variety of advanced and frontier technologies such as accelerators, lasers, fusion and related technologies. Lasers such as Copper Vapour Laser, CO_2 Laser and N_2 Laser were developed and supplied for application in medical science, industry and basic sciences. Under the accelerator programme – Microtron – the first indigenously developed electron accelerator (15.3 Mev) – designed and constructed at CAT has reached final stage of commissioning. India's first Synchrotron Radiation Facility consisting of two Synchrotron Radiation Sources (SRS) – INDUS-1 (450 Mev) and INDUS-2 (2 GeV) is under construction. Development of technologies relating to ultra high vacuum, cryogenics (super conducting magnets), non linear optics have also been taken up. CAT has developed and delivered to AMD an integrated Laser fluorimeter for quantitative measurements of U and rare earth elements (upto 0.1 ppb) which AMD has been so far imported from Scintrex of Canada. A microtron to accelerate electron to 12 Mev energy was developed and commissioned by CAT at the Mangalore University for training of students and research. A closed cycle helium cryo-refrigerator was developed at CAT and tested. Development of a 10 MeV proton cyclotron accelerator for producing radioisotopes used in Positron Emission Tromgraphy (PET) is underway. Main magnet of this weighing 26 tons is under fabrication at CAT.

Variable Energy Cyclotron, Calcutta (VECC) :

VECC has been set up at Bidhan Nagar, Calcutta by Bhabha Atomic Research Centre. It is a national facility for advanced work in Nuclear physics and for the controlled direct irradiation of biological and agricultural products. The cyclotrons delivers proton and deutron beams besides alpha particles to various user groups from universities and research institutions. There is a Regional Radiation Medicine Centre (RRMC) to provide diagnostic and radioimmunoassay (RIA) facilities to the people in Eastern Region. Some of the other systems available are isotope Separator On Line (ISOL) for separation of shortlived exotic nucleii, Pneumatic Carrier Facility (PCF) etc. A nodal centre for the Electronic Mail (E-Mail) facility will be set up at VEC Centre shortly for all the E-Mail users in and around Calcutta.

Atomic Minerals Division :

The exploration for uranium was started over four decades. It is the basic pre-requisite for any self sufficient nuclear power programme. The Atomic Minerals Division, since its inception in 29th July, 1949 as Rare Minerals Survey Unit is engaged in the augmentation of mineral requirement for the nuclear power programme. Initially, the exploration was mostly confined to the Singhbhum district of Bihar, but soon spread all over the country. As a sustained effort over the period, the division has established various ore reserves totalling to over 78,000 tonnes of U_3O_8 in grades ranging from 0.015 to 0.1% of U_3O_8. These comprise of both inferred and indicated reserves, though all of them are not commercially exploitable.

INDUSTRIAL SECTOR

Nuclear Fuel Complex (NFC) :

NFC was set up at Hyderabad to utilise the indigenous capabilities established in the early stages of nuclear programme in the crucial area of fuel fabrication, through R&D activities carried at BARC. NFC has been meeting the demand of fabricated fuel and zircaloy components of all the operating nuclear power stations over 25 years. NFC is set for expanding its manufacturing capacities of nuclear fuels and zircaloy to meet the future needs of the Indian Power programme. The erection phase in connection with expansion of fuel production was completed in 1996. Other facilities at NFC include Stainless Steel Tube Plant and Ball-bearing Tube Plant. NFC successfully entered the market in 1995-96, with the execution of orders worth Rs. 2.5 crores comprising 1000 tonnes of seamless tubes of alloy steels, titanium, titanium alloys etc.

Heavy Water Plants (HWPs) :

A multi-pronged approach was adopted for heavy water production in the early sixties utilising basic research and development of the hydrogen sulfide water exchange process and available knowhow for the ammonia-hydrogen exchange process. The first plant was set up at Nangal in Punjab in 1960 and was based on hydrogen distillation process with a capacity of 14 tonnes per year. It is no longer operational on account of high cost of power. The other plants and the process used are listed below their production capacity.

Based on H_2S-H_2O exchange process :

Kota - 100 te Manugru -185 te

Based on Ammonia-Hydrogen exchange

Mono thermal Process :

Single Stream :	Double Stream :
Baroda - 67.2 te	Thal - 110 te (Maharashtra)
Tuticorin - 70.3 te	Hazira - 110 te (Gujarat)

Bithermal Process :

Talcher - 62.7 te

Based on Ammonia-Hydrogen exchange

Mono Thermal Process :

Single Stream :	Double Stream :
Baroda - 67.2 te	Thal - 110 te (Maharashtra)
Tuticorin - 71.3 te	Hazira - 110 te (Gujarat)

Bithermal Process :

Talcher - 62.7 te

Besides the production from the above, heavy water is also obtained from plants for upgrading diluted heavy water from research reactors. One such plant has been operational at Trombay since 1962 and more

SHILLONG

are being installed at Nuclear Power stations. R&D efforts to develop attractive processes such as based on H_2-H_2O exchange are also going on.

BOARD OF RADIATION AND ISOTOPE TECHNOLOGY (BRIT)

BRIT was constituted by DAE in 1988 to produce and supply various radioisotope products for applications in the fields of industry, agriculture and health care. BRIT produces and supplies various radioisotopes and related products such as labelled biomolecules like P-32, S-35, labelled agro chemicals. Pm-140; radiation sources such as Co-60, Cs-137 for treatment of cancer and Ir-192 for industrial radiography; radiopharmaceuticals like Tc-99 for brain imaging; labelled compounds (C14 and tritium) etc.

During the year 1995-96, BRIT supplied over 70,000 consignments valued at Rs.12.75 crores to user institutions. The consignments include 67 numbers of remotely operated radiography cameras (ROLI - 1). Under order from IAEA, the first unit of newly designed Gamma Chamber - 5000 loaded with 12,000 units (444 TBq) of Co-60 and irradiation volume of five litres was exported to Siriraj Hospital, Bangkok. The second unit was supplied to Institute of Nuclear Medicine and Allied Sciences and BRIT's order book is full for such units from various institutions of country and abroad.

The consignments also include over 60,000 radiopharmaceuticals for diagnostic investigations of about seven lakh patients. BRIT also operates the regional centres for radiopharmaceuticals located at Bangalore and Delhi. RIA centre at Dibrugarh and Irradiated Sterilization of Medical Products (ISOMED) plant at Trombay.

Non power Applications of atomic energy in the fields of agriculture, medicine and industry has grown significantly.

Agriculture :

One of the most successful applications of nuclear energy in agriculture has been the development of improved varieties of crop plants by using radiation induced genetic variability in cross breeding. Eighteen improved varieties of pulses, oilseeds, rice and jute were developed by nuclear agriculture division of BARC released for general cultivation are being grown in many parts of India. These include two varieties each of green gram and red gram, three varieties of black gram, seven varieties of ground nut, two varieties of mustard and one each of jute and rice. The important varieties are obtained by exposing the seeds to gamma rays which cause genetic changes in them, mutations generally appear in the second generation. The mutant with desirable characters are further bred and tested over 4 to 5 generations with elite check varieties and are finally released after completely nullifying the harmful effects. The mutation results in higher yields or greater resistance to diseases and posts or improvement in the nutritive value etc. Besides, large scale multiplications of twelve commercially important varieties of banana by tissue have been obtained.

In the area of pest control, large scale sterilization of insects using gamma radiation and using these insects to reduce or eradicate insect population have been quite effective in reducing havoc caused by pests such as potato tubermoth and many others. Radiation preservation to disinfect export quality Basmati rice, considerable increase in shelf life of potatoes, onions, spices and many other products, extraction of pectin from lemon peel etc. without any adverse effect are also being realised. A new improved bionutrient phosphate fertilizer, ammonium polyphosphate has also been developed. The Nitrogen-15 enrichment plant of the Rashtriya Chemicals and Fertilizers Ltd. (RCF) utilising the process developed by BARC (Chemical Energy Division) is producing N-15 being used as tracer in agriculture research for studying uptake of nitrogen by plants from nitrogenous fertilizers. The product is also exported to IAEA, Vienna and other countries.

Other Applications :

Significant improvements have been made in tumor therapy using radiation and drugs in combination with hyper thermia and DNA end labelling technique to predict the radio response of tumors. Recently, a sewage treatment programme by the development of Sludge Hygienisation Irradiator at Baroda has been vitalised. The technique will help in eradication of micro organism causing several infectious diseases.

A super computer system "Anupam" based on Parallel Processing System has also been developed by BARC which has the fastest computing system available in the country.

CAT has developed of 5KW CO_2 laser for welding and cutting applications. Another laser developed for general surgery has been supplied to hospitals for trials.

Large scale synthesis of $Bi_2Sr_2Ca_2Cu_3O_x$ phase has been evolved. Tunnel Junctions of superconductor-insulator superconductor have been developed using Bi-2212 phase crystals.

BARC has developed technology of production of special purpose PTFE power by radiation processing for use as substitutes for special lubricating oils and compounds, which have wide industrial applications. These achievements place India along with select countries such as USA, UK, Japan and Germany.

BARC has developed a superior process, for production of different types and shapes of cross-linked polymers by radiation from industrial electron beam accelerators, based on which products with high temperature resistance and improved strength could be manufactured.

Gamma Irradiation Pilot Plant at Kottayam has been set up by DAE for Rubber Board of India, Kerala. Since this new technique eliminates use of external chemical, it is widely useful for vulcanisation of rubber to be used for applications in areas of surgery, family planning, etc.

Computerised Laser Printing Systems for printing Identity Cards based on image processing techniques developed by BARC facilities production of durable, inexpensive and reliable identity cards.

Synthetic diamond films used widely in electronic and optical industries can be deposited by vapour depositing technique using facility developed by BARC.

A monitor to detect tritium in air in high radiation background has been developed by BARC. The monitor is not available even in international market.

Against stiff international competition the Centre for Advanced Technology has got an order for supplying ultra-high vacuum manifolds and pump to CERN, Geneva.

COLLABORATIVE ACTIVITIES

Collaboration between DAE units and universities through Inter-University Consortium called IUC-DAE established by UGC started in May, 1990. Dhruva reactor at Mumbai, VECC at Calcutta and Synchrotron at Indore were opened to university researchers at national level. Board of Research in Nuclear Science funded NEHU, Shillong for the establishment of various laboratory facilities which resulted in formation of a group in the area of trace element analysis. The close interaction with IITs and IISc, Bangalore specially in areas of immediate interest to the department such as tele-operated vehicles at IIT Kanpur and Jadavpur University are under progress. The collaborative research programme with organisations abroad CERN, Germany, a 25 Million dollar agreement to participate in building the world's biggest atom smasher called Large Hadron Collider (LHC) and many more have been taken up.

SUPPORT TO THE GROWTH OF SCIENCE & TECHNOLOGY IN NORTH EAST INDIA

The department has been supporting the growth of science and technology in the North East India directly through establishment of Dr B. Barua Cancer Institute at Guwahati, establishment of Radio Immuno Assay (RIA) at Dibrugarh and Atomic Minerals Division (AMD), one of its constituent units. The unit with headquarters at Hyderabad is engaged in the augmentation of mineral resources for the nuclear power programme through its exploration efforts all over the country. AMD has been carrying exploration in the north eastern part of the country for over three decades initially from Calcutta and subsequently for around two decades from its North Eastern Regional headquarters at Shillong.

The exploration programme achieved tremendous success in the North Eastern Region by identifying a commercially viable near surface uranium deposit of 9 million te of ore of 0.104 % U_3O_8 at Domiasiat, West Khasi Hills Distt, Meghalaya.

The success contrary to jubilations, met with lot of apprehension by the local populace. The apprehension was caused by the fear of suspected radiation hazards due to their lack of awareness regarding tolerance radiation level, existence and functions of Atomic Energy Regulatory Board etc. especially in view of the accidents at Chernobyl NPP USSR (now in UKRAINE) in 1986 and Three Mile Island, USA in 1979. The department to educate them conducted seminars, exhibitions, etc. where the professors from NEHU and local scientists besides the scientists from AMD, BARC, UCIL etc. made aware the local populace and journalists, to carry the message to wider cross section, of the exposure to radiation from natural backgrounds, tolerance level of radiations, useful applications of radioisotopes in nuclear engineering, medicine, industry etc. through the papers presented by them. Teams of local leaders were also taken to visit UCIL etc. so that after believing by seeing can educate the public in Meghalaya regarding the actual radiational hazards.

In 1992-93, Uranium Corporation of India Ltd. entrusted the job of preparing a technoeconomic feasibility report on Domiasiat Uranium Deposit in Meghalaya to DCPL, Calcutta, a Consulting Engineering Firm. The expected cost of this new project is Rs.450 crores and the implementation of the project will be taken up in the 9^{th} Five Year Plan.

Besides the exploration programme, AMD has been extending analytical support to various organisations in the region such as ICAR, Department of Earth Science in Manipur University; DMR Meghalaya, Forensic Science Laboratory, Meghalaya; Department of Mining and Geology Assam and Nagaland etc. the Chemistry Group is collaborating with NEHU in several scientific activities including a project under Board in Nuclear Sciences. Recently, a regional chapter of Indian Society of Analytical Scientists encompassing the entire NER with headquarters at Chemical Laboratory, AMD, Shillong with nucleus at BARC Mumbai has been inaugurated to bridge the communication gap in the scientific cummunity in the region. The society provides a common forum for the analytical scientists, expertise etc. to benefit mutually and enter into collaborative activities for the growth of science and technology.

CONCLUSION

Use of atomic energy for peaceful purposes is still not viewed with all is well attitude by the masses and still atomic energy for power generation is under debate in wide cross section. Although as per the statistics issued by the Power Reactor Information System of the International Atomic Energy Agency indicate that 442 nuclear power plants in 30 countries around the world produced a total 2300 TWh of electricity in 1996 supplying 17% of the world's electricity, India's contribution was only 2.2% to its total electricity. The debate as already started is in view of the nuclear accidents and lack of awareness. The only solution is to be more open, more transparent to educate masses at greater levels. KAPs have won Atomic Energy Regulatory Boards green site award in 1993 for planting 6.5 lakh trees and Industrial Safety Aware (ISA) in 1994; Kaiga Atomic Power Project, Heavy Water Plants (Baroda and Tuticorin), Narwapahar Mines UCIL, BARC(R&D) etc. won Board's ISA in 1996. All this show the safe and eco-friendly operations by the units. Furthermore, one should not overlook the fact that by producing about one third of Europe's electricity, Nuclear energy helps avoid over 700 million tons of CO_2 per year. This is equivalent to removing all the cars in Western Europe (more than 200 millions) from the roads for same period. This convinces nuclear industry that a balanced mix of energy sources is the only credible policy to achieve the target of reduction in green house gases to limit the major environmental issue of global warming.

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TABLE – I

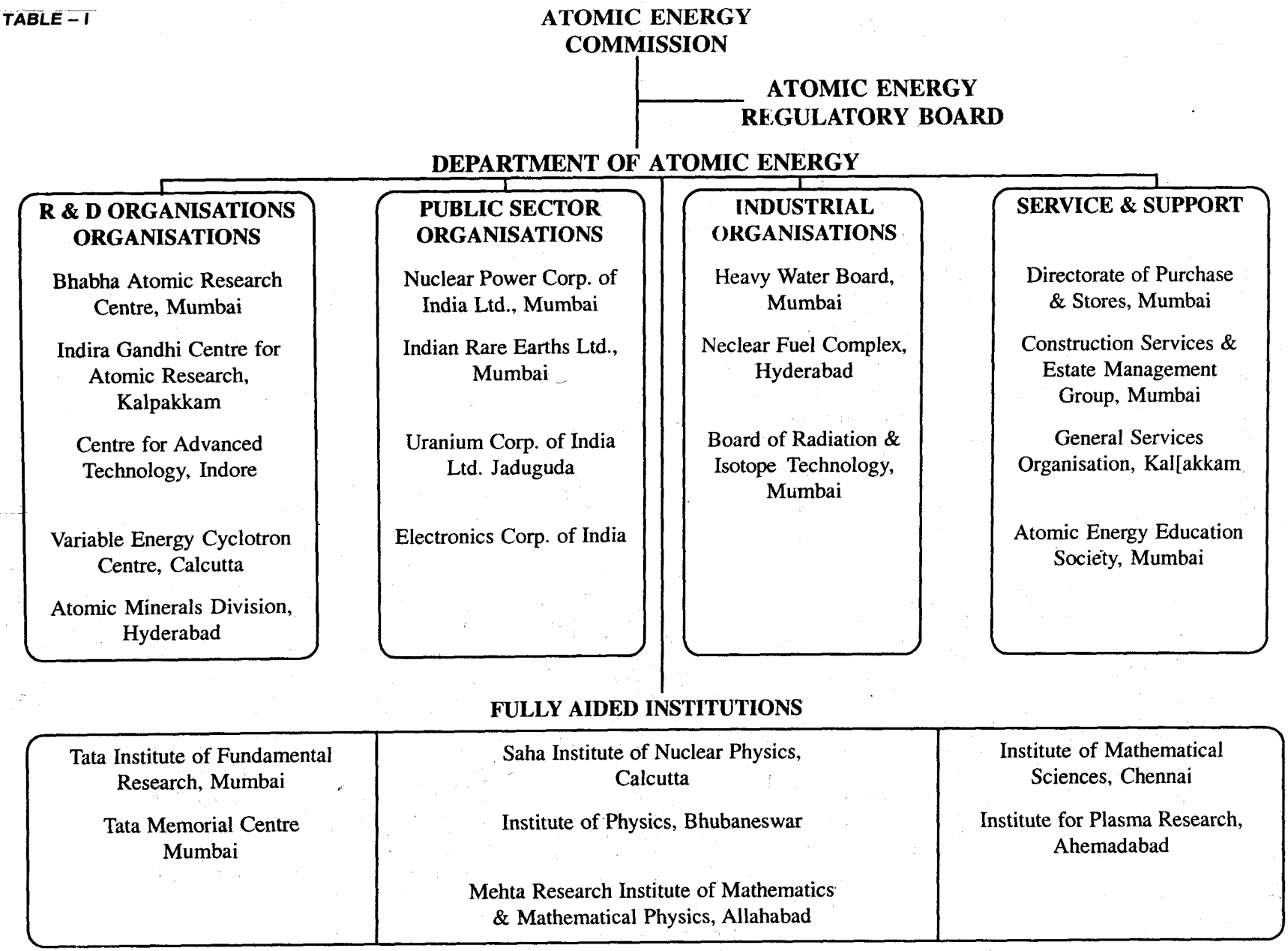
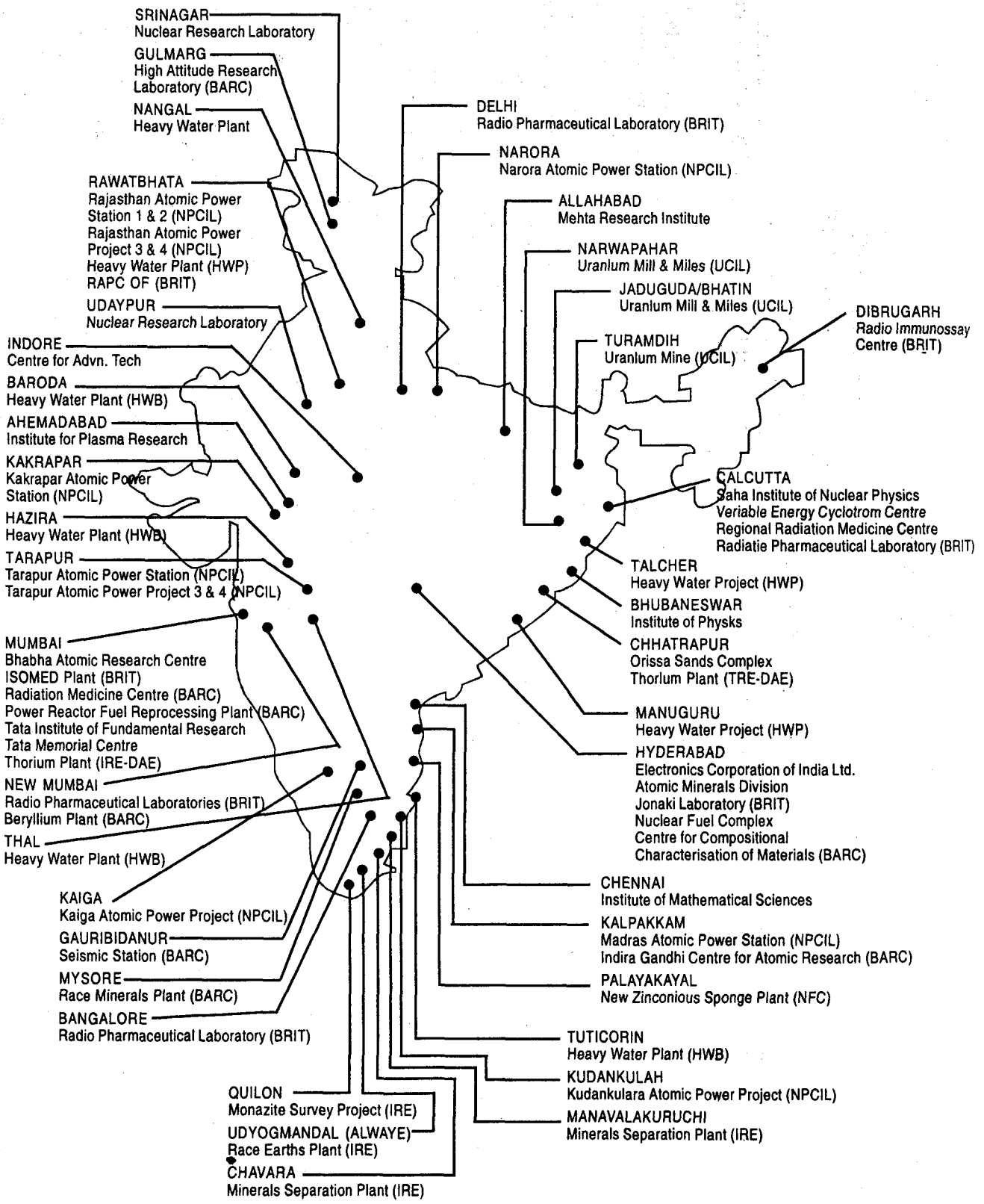

ATOMIC ENERGY COMMISSION
ATOMIC ENERGY REGULATORY BOARD
DEPARTMENT OF ATOMIC ENERGY
R & D ORGANISATIONS ORGANISATIONS
Bhabha Atomic Research Centre, Mumbai
Indira Gandhi Centre for Atomic Research, Kalpakkam
Centre for Advanced Technology, Indore
Variable Energy Cyclotron Centre, Calcutta
Atomic Minerals Division, Hyderabad
PUBLIC SECTOR ORGANISATIONS
Nuclear Power Corp. of India Ltd., Mumbai
Indian Rare Earths Ltd., Mumbai
Uranium Corp. of India Ltd. Jaduguda
Electronics Corp. of India
INDUSTRIAL ORGANISATIONS
Heavy Water Board, Mumbai
Neclear Fuel Complex, Hyderabad
Board of Radiation & Isotope Technology, Mumbai
SERVICE & SUPPORT
Directorate of Purchase & Stores, Mumbai
Construction Services & Estate Management Group, Mumbai
General Services Organisation, Kal[akkam
Atomic Energy Education Society, Mumbai
FULLY AIDED INSTITUTIONS
Tata Institute of Fundamental Research, Mumbai
Tata Memorial Centre Mumbai
Saha Institute of Nuclear Physics, Calcutta
Institute of Physics, Bhubaneswar
Mehta Research Institute of Mathematics & Mathematical Physics, Allahabad
Institute of Mathematical Sciences, Chennai
Institute for Plasma Research, Ahemadabad

TABLE – II

ATOMIC ENERGY INSTALLATIONS IN INDIA



MINERAL DEVELOPMENT IN MEGHALAYA

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ABSTRACT

The State Department of Meghalaya of Geology and Mining took up the mineral investigations after its inception in the last sixties due to its probable reserve of coal of the order of 560 million tonnes, limestone reserve of 4,500 million tonnes and 70 million tonnes of clays. A deposit of 4 million tonnes of kaolin and 3 million tonnes of glass sand are estimated by the department. Large deposits of multi-coloured granite in the state is there with a total probable reserve of 25 million cubic meters. Recently a granite cutting and polishing plant has been set up at Byrnihat in order to use raw materials available in the area. Meghalaya has also found uranium deposit of higher grade compared to the presently available in the country. The occurrence of traces of gold in the rocks round Tyrsad in the East Khasi Hills District has also been reported. Coal and limestone mining in Meghalaya is carried out both in the organised and unorganised sectors. Total production of coal and limestone during 1997-98 is of the tune of 34.90 million tonnes and 3.76 million tonnes respectively along with a total revenue of Rs. 39.21 lakh from mineral sector.

INTRODUCTION

The geological setting of the state of Meghalaya suggests that the state's mineral potential is very large indeed. Unlike the economically more advanced areas of the country, however, mineral investigations in the state in the past been rather sketchy and have ended only with "reported occurrences." The difficult mountainous terrain and inaccessibility have stood in the way of their detailed investigations so to speak of their exploitation. Hence most of the mineral deposits were not in a state ready to be considered for economic utilisation.

With the attainment of full statehood by the state of Meghalaya in 1972, the State Directorate of Mineral Resources was strengthened and some of the promising mineral deposits were taken up by it for detailed investigations with a view to preparing suitable mining schemes or mining plan for exploitation and utilisation of these mineral deposits. The number of field geological and drilling parties were increased and mineral investigation now spread all over the state. Besides, mineral investigations, the Directorate of Mineral Resources is now also conducting Ground Water Investigations and Geo-technical studies. The creation of the Regional Office of the Geological Survey of India at Shillong has also raised the tempo of activities in this sphere. The Atomic Mineral Division of the Department of Atomic Energy, Government of India has also been concentrating its field investigations in some of the promising areas of the state for radioactive minerals. Similarly the Central Ground Water Board has also taken Ground Water Investigations in the state and the Oil and Natural Gas Corporation Ltd. is also conducting exploration for oil and natural gas.

Of the many economic minerals reported in the state, Coal, Limestone, Granites, Clay and Silimanite are perhaps the most well-known and some of these minerals have been worked to a certain extent.

Coal :

The possible reserves of coal in the state have been estimated at about 560 million tonnes. Most of the coal-fields especially those isolated, small pocketed and inconsistent coal deposits have been extensively worked during the last two decades. But, there is no gain-saying of the fact that if Meghalaya is to progress industrially, its major coal-fields have to be exploited fully and that too judiciously. The tertiary coal of Meghalaya is sub-bituminous in character. The character of this coal is unique in many ways; its ash content (about 5%) is much lower than that of the best coal in the country and its heat value (5000 K.cal/Kg to 8000 K.cal/Kg) surpasses even some of the best graded coal in the country. But its comparatively higher sulphur content has so long provided a convenient excuse against its meaningful industrial utilisation because of the likely emission of corrosive oxides of sulphur.

The state is all out to undertake detailed investigations of approximately half of the West Darrangiri coal-fields of Garo Hills, where the total estimated reserves of 125 million tonnes in an area of about 48 sq kms. was earlier reported and investigated by the Geological Survey of India by wide spaced drilling. A proved reserves of about 60.00 million tonnes were established by the State Directorate over an area of 25 sq. kms. And a mining project known as the "Simsang Colliery Project" was prepared by the Central Mine Planning and Design Institute Ltd., Ranchi of M/S Coal India Limited for raising about 0.30 million tonnes of coal annually. This was done specifically in connection with the State Govt.'s. proposals to set up a pit-head Thermal Power

Station of suitable capacity using the above coal as well as to establish a coal-linkage to the proposed Garo Hills Cement Project at Siju. M/S Coal India Limited, the lessee ot Simsang Colliery Project is developing the mine at a very slow pace since both the proposed Thermal Power Station and the Garo Hills Cement Plant have yet to be cleared by the Govt. of India. The Simsang Colliery Project minus the Thermal Power Station and the Garo Hills Cement Project would be unviable especially in the context of marketing the production of coal from the said colliery considering the stiff competition that it would have to face from the production of coal mined in the unorganised sector with practically zero-investment.

The State Directorate had also took up detailed investigation of the Mawlong Coal-field under NFC Scheme with a view to augmenting supply of coal to meet the additional requirement by the Mawmluh-Cherra Cement Limited for the expansion of its Cement Factory at Mawmluh from 250 t.p.d. to 930 t.p.d. capacity. The scheme was found to be unviable even after conducting exploratory mining. A block of the Bapung Coal-field under NEC Scheme investigated in details for establishing a coal-linkage to the proposed Jaintia Hills Cement Project.

Thus, presently the production of coal in the state is only from the unorganised sector, that is, from small scale coal mines operated by the local tribals of Garo Hills, Khasi Hills and Jaintia Hills District. The production of coal from these small-scale coal mines is more than 30.00 lakh tonnes per year. After meeting the requirements of the state and the neighbouring state of Assam, coal produced from the state goes to other states of the country even up to Punjab and Haryana and is also exported to Bangladesh mainly for use in the brick-fields. The revenue earned by the state in the form of royalty on coal is more than Rs. 38.00 crores per year.

Limestone :

An extensive belt of limestone occurs along the southern border of the state of Meghalaya for a length of 200 kms. extending from Jaintia Hills in the east to Garo Hills in the west. At places, the deposit is usually represented by three different bands accounting for a total thickness of more than 200 metres. The total possible reserve of limestone in the state is of the order of 4500 million tonnes. The geographically location of the limestone deposits has stood in the way of its meaningful utilisation (because of the high cost of transportation involved) except for use in the cement units within the state and for export to the neighbouring country Bangladesh. The quality of limestone available in the state is of higher cement grade and runs even into metallurgical and chemical grades with huge reserves in some areas.

Limestone deposit of Komorrah area were operated by the erstwhile Assam Bengal Cement Company Ltd. from 1939 to 1965. The operation was stopped in 1965 consequent upon the Indo-Pak conflict in that year. However, with the liberation of Bangladesh in 1971 an Indo-Bangladesh Joint Group recommended resuming of supply of limestone from Komorrah to the Chhatak Cement Factory, Bangladesh by establishing a mining enterprise to operate the Komorrah Limestone Quarries. A quick geological appraisal of the limestone deposit of Komorrah was undertaken by the Directorate of Mineral Resources in 1972 which was followed-up by detailed investigations in the subsequent years. The operation of the Komorrah Limestone Quarries resumed in 1973 by a Joint Sector Company, the Komorrah Limestone Mining Company Ltd. and is exporting more than 1.00 lakh tonnes of limestone annually. Some amount of limestone is also being exported to Chhatak Cement Factory by the Private Limestone Quarry Owners from Mawlong-Ishamati, Shalla, Nongjri and Rorsora areas. These operations are earning valuable foreign exchange of more than 10.00 lakhs US $ per year and contribute revenue to the State Government of more than Rs.65.00 lakhs per year.

The limestone deposits of the Mawmluch-Cherrapunjee hills have been established by the Indian Bureau of Mines and the State Directorate of Geology and Mining of the erstwhile composite state of Assam as well as by the Mawmluh-Cherra Cement Company Ltd. to be more than sufficient to sustain the Mawmluch Cement Factory throughout its life against a production of 930 t.p.d.

The Directorate of Mineral Resources had also established sufficient resources of limestone at —

(i) Siju, Garo Hills to sustain a production of more than 1000 t.p.d. of cement of the proposed Garo Hills Cement Project.
(ii) Lumshnong Jaintia Hills for setting up a cement factory of more than 1000 t.p.d. capacity.
(iii) Lumshnong, Jaintia Hills for a 200 t.p.d. paper grade lime plant.
(iv) Shella, Khasi Hills setting up of a cement factory of more than 1000 t.p.d. capacity.

(v) Besides, the state-owned cement factory at Mawmluh, there are three mini cement plants in the state under private sector with production capacity ranging from 25 t.p.d. to 50 t.p.d. and located in Garo Hills, Khasi Hills and Jaintia Hills utilising the locally available limestone of Darang-Eraning/Chockpot of Garo Hills, Mawlong-Ishamati of Khasi Hills and Nongkhlieh, Jaintia Hills respectively. Feasibility Report of utilisation of some of the chemical-grade limestone deposits for production of Calcium Carbide and Hydrated Lime were prepared. However, suitable entrepreneurs could not be attracted so far to execute these projects primarily because of the proposed location of sites near to the raw materials and the consequent distance from the market.

The establishment of some of the plants based on limestone have again been taken up by the State Government in the Task Force set up by the Government of India for development of mineral-based industry of the North Eastern Region.

Sillimanite :

One of the best sillimanite deposits in the world was found around Sonapahar in West Khasi Hills. The high alumina content of these deposits make this mineral a refractory mineral of great commercial values. However, after an operation of these deposits for four and half decades, the reserves have depleted and mining was ceased w.e.f. December, 1992. More than 3.00 lakh tonnes of sillimanite were exploited.

Granite :

Commercially, the word "Granite" includes all granites, granitic rocks, geneisses, dark coloured hard rocks such as dolerite, basalt, amphibolite etc. and used in stone industry all over the world. These rocks are highly durable and can take good polish to display an impressive aesthetic look. Large areas of the state are covered by granite, dolerite, amphibolite and other rocks. However, important deposits of multi coloured granite occur around Nongpoh, Mylliem, and Mawktrwat-Mongstoin of Khasi Hills and Mednipathar-Songsak in Garo Hills. Workable deposits of dolerite have been located at and around Jenjal and Hallidayganj in Garo Hills. A probable reserve of granite at Nongpoh has been estimated at 20 million cubic metres. The probable reserve of dolerite at Jenjal is about 1.00 lakh cubic metres.

The physico-mechanical properties of the Nongpoh granite are as follows:

1. Dry density(gm/cc) – 2.51 to 2.82
2. Specific gravity – 2.60 to 2.90
3. Water of absorption – 0.01 to 0.02
4. Compressive strength – 689 to 736 (kg/cm^2)
5. Tensile Strength(kg/cm^2) – 30 to 62
6. Shearing strength(kg/cm^2) – 32 to 70
7. Impact hammer testing(kg/cm^2) – 306 to 394

Granite and Granitic rocks of the state are suitable for use as dimensional and decorative stones. The quality of polished blocks and slabs produced from these rocks are almost similar to that of some of the well-known rocks of South India. A granite cutting and polishing unit has been set up at the Export and Industrial Promotion Centre, Burnihat, Ri-Bhoi District which utilised the granitic rocks of the areas around Sonapahar and Nongpoh. The production capacity of this unit is 7,200 sq. metres per annum.

Kaolin :

Kaolin or China-clay is a product of chemical alteration of feldspars of granite and granite-gneiss due to changes of physico-chemical conditions.

Kaolin deposits have been located around Mawkriah, Mawphlang, Smit, Laitlyngkot in Khasi Hills, Thadlaskein, Shangpung, Mulieh and Mynsngat in Jaintia Hills and Darugiri in Garo Hills. The total probable reserve of Kaolin in Meghalaya has been estimated at 4.4 million tonnes. This Kaolin could be used in the manufacture of good quality china-ware and porcelain ware. It could also be used as filler in paper and rubber industry. So far no Kaolin deposit has been commercially exploited.

Clay :

Good quality sedimentary white clay or lithomargic clay is found in the Tertiary formations in the state in different places such as at Rongrenggiri, Khera Sengsak, Khobal, Nangwalbibra, Nangkhra and Dobu in Garo Hills Districts. The total probable reserve of sedimentary clay in the state is in between 70 and 90 million tonnes. The clay deposits could be fruitfully used in the setting up of refractory brick industry.

Glass-sand :

Glass-sand is found to occur at Laitryngew, Umstew and Kreit in Khasi Hills and Tura in Garo Hills. The silica content of these sands varies between 95.0 and 99.4%. The percentage of Fe_2O_3 varies from 0.12 to 0.49 in glass-sand of Umstew area and from 0.04 to 1.65 in that of Tura area. The reserve of glass-sand in the state is about 3 million tonnes.

Some quantity of glass-sand is at present being mined and transported to the plains of Assam for making inferior grade glass wares and for manufactures of sodium silicate.

Uranium :

Uranium and some other radio-active minerals are found in different parts of the state. The Uranium deposit located at Domiasiat in West Khasi Hills District is of higher grade compared to a deposit presently exploited in the country.

Other Minerals :

Other minerals listed below have been also located in the state but their economic viability has yet to be ascertained.

(i) Iron-ore at Aradonga in West Khasi Hills and Nishangram in East Garo Hills.
(ii) Gold at Tyrsad in East Khasi Hills.
(iii) Copper, lead and zinc at Umpyrtha and Barapani-Tyrsad area of East Khasi Hills and Sung Valley in Jaintia Hills.
(iv) Quartz-feldspar at Hahim, Mairang and Nongkhlaw in West Khasi Hills and Bonsomgiri, Rombhagiri in East Garo Hills and Tura in West Garo Hills.
(v) Rock phosphate at Sung Valley in Jaintia Hills and Phosphatic noddle at Siju in South Garo Hills and Sonapur in Jaintia Hills.
(vi) Gypsum at Harigaon and Mahendraganj in West Garo Hills.

CONCLUSION

Meghalaya coal is mainly used as a fossil fuel in brick fields, tea gardens, lime kilns and for domestic work. The ash content of Meghalaya coal is much lower than that of the best quality deposit in the country. Its calorific value is at par with some of the best grade coal in the world. But presence of high percentage of sulphur restricts its use in major industries. However, it may be blended with low sulphur gondwana coal of the country to obtain an intermediate product which could be used as a fuel in cement, steel and thermal plants. Beehive coke and coal briquette can be produced using this coal. More than ten thousand tonnes of coal is despatched from the state to other parts of the country every day. Coal is also exported from Meghalaya to Bangladesh. The total annual production of coal in the state during 1997-98 was 31.90 lakh tonnes and revenue earned on this production is Rs. 38.28 crores.

The quality of limestone in Meghalaya ranges from cement grade to chemical grade. The Mawmluh-Cherra Cement Factory located at Cherrapunji is the major cement plant in the state which has a production capacity of 550 tonnes per day. There are three mini cement plants in the state at present. The production capacity of these cement plants ranges from 25 to 50 tonnes per day. All these cement plants utilise locally available limestone deposit as the main raw material. A factory, located at Barapani, uses limestone to produce hydrated lime. There are a number of lime kilns in Khasi and Jaintia Hills Districts of the state which utilise limestone to produce quick lime. The metallurgical and chemical grade limestone of Meghalaya can be used in foundry, in the manufacture of steel, paper and sugar and for production of calcium carbide. A bulk quantity of limestone is exported to Bangladesh. The state has produced 3.76 lakh tonnes of limestone during 1997-98 and earned a handsome revenue of Rs. 79.43 lakhs on this mineral.

Granite and granite rocks of Meghalaya are suitable for use as dimensional and decorative stones. The quality of polished blocks and slabs produced from these rocks are almost similar to that of some of the well-known rocks of South India. Very recently, a granite cutting and polishing plant has been set up at Byrnihat in the Ri-Bhol District which is using the granitic rocks of the areas around Sonapahar and Nongpoh. The production capacity of the plant is 72,000 sq. ft. per annum. The products of the plant have found market in north eastern states and North Bengal.

Apart from exploitation of three principal minerals as mentioned in the foregoing paragraphs, deposits of glass and sedimentary clay have also been worked on a small scale in a few captive mines in the state. It is learnt that these minerals are sold outside the state and are utilised in glass and ceramic industries.

Exploitation of coal in the state on a commercial basis was started in the last century when in 1894 above 8,500 tonnes of coal were mined by the then political agent from a coal-field at Cherrapunji, now in East Khasi Hills District and were sent down to Calcutta. The operations were apparently not economic and coal mining operations were left to the Khasi miners to mine coal on a cottage industry type, initially for their own domestic consumption. However, with the opening up of road communications to these coal-fields, coal exploitation started for commercial purpose. The main market for these coals is Guwahati. Most of the coal-fields of the state are small, isolated and coal seams are inconsistent and as such are not amendable to systematic and scientific mining to be conducted in the organised sector. This being the case, the govt. did not disturb the coal mining activities conducted by the Khasi miners. With the passage of time the tribal miners had accepted that coal mining is their traditional and customary right. These activities spread out to other parts of the state namely, Jaintia Hills and Garo Hills in the beginning and the latter part of the year, 1970 respectively.

The state government is also anxious to exploit the vast reserve of 125 million tonnes of coal in the West Darranggiri Coal-field, Garo Hills in the organised sector with the intention to utilise this coal for setting up a thermal power station of 60 MW capacity at Nongwalbibra and in the proposed cement plant nearby. Accordingly, a mining lease was granted to M/S Coal India Ltd., and construction work including driving of mine entries of this colliery, namely, Simsang Colliery had been started. Certain doubts have arisen regarding the Garo Hills Thermal Power Project and as such neither the Planning Commission nor the Central Electricity Authority were supporting the power plant proposal. Even the proposed Garo Hills Cement Project has yet to come up.

The geographical location of the limestone deposits of the state has come on the way of their meaningful utilisation, since these deposits occur in the southern part of the state adjacent to the Bangladesh border and would involve high cost of transportation. The limestone deposits of Mawmluh Cherrapunji Hills has been utilised in cement manufacturing at the state owned Mawmluh Cherra Cement Ltd. This deposit is considered to be more than sufficient to sustain the plant of 930 T.P.D. throughout its life. The state has been a traditional supplier of limestone to the cement plant across the border located at Chhatak, Bangladesh. The supply is being made from the Komorrah quarry operated by a joint sector company namely, M/s. K.L.M.C. Ltd, and also from the limestone quarries operated by private parties.

The exploitation of sillimanite has come to a standstill with the expiry of the mining leases held by M/s. Bharat Refractories Ltd, a Govt. of India undertaking. The operation on clay is not worth mentioning and other minerals found in the state are yet to be exploited.

Development of mineral deposits in the state had not picked up on account of the fact of insufficient development of infrastructure, the major one being communication. In the past two decades a number of roads has been opened up to the interior of the state but much still remains to be done, road communication, however, is an expensive mode of communication and the delivered cost of either the raw materials or the finished product is considerably increased by the road freight involved, thus, making it highly uncompetitive. In order to develop the mining industry in the state, it is imperative that a cheap mode of transportation be made available to this industry. One of such means of transport is rail transport. In case the rail link from Guwahati to Jogighopa/Goalpara is extended at the western part of Garo Hills to the southern border of the state upto Shella, the metallurgical grade limestone could be economically exploited for utilisation in the Steel Plants of Eastern India, namely Bokaro, Durgapur, Jamshedpur and Rourkela. The earlier proposal for construction of aerial ropeway and rail-link upto Byrnihat may also be revived for providing a cheaper mode of transport as well as a ready outlet of any material brought upto Assam-Meghalaya border. Similar proposals of construction of aerial ropeways and/or rail-link which have been under the consideration of the State Government for Garo Hills and Jaintia Hills may also be concretised.

It can thus be seen that although the frame work, that is, investigation/exploration of the mineral deposits has by now been established, much remains to be done by way of mineral development of the state. The geographical location of the state as well as the areas of concentration of minerals away from main linkage with the rest of India, is likely to make any mineral development unviable and uneconomic if measured by all Indian standard. If the state is to claim any position in the mineral development map of the country at all, the first and foremost requirement is the development of infrastructure extending rail links/lines from the neighbouring state of Assam and constructing aerial rope-ways.

APPLICATION OF REMOTE SENSING TECHNIQUES IN HYDROGEOMORPHOLOGICAL MAPPING OF ASSAM

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ABSTRACT

Search for ground water potentiality, particularly in areas with consolidated and semi-consolidated rock formations, considered more difficult from the point of view of exploration, is considerably aided by the use of hydrogeomorphological maps prepared from satellite imagery. Districtwise hydrogeomorphological map based on visual interpretation of IRS-LISS-II and LANDSAT-TM data have been prepared on 1:250,000 scale. These including structural lineaments having different groundwater prospects. As these units control the groundwater occurrences and movements in the area, their delineation from satellite imagery indicate that different hydrogeomorphological units indicates different groundwater potential zone. The major hydrogeomorphological units identified are flood plain, younger alluvial plain, older alluvial plain, upper piedmont plain, lower piedment plain, valley fill, structural hills of Tertiary and Shillong Groups, denodational hills of Tertiary Group, Shillong Group, Gneissic complex inselbergs, pediment and burried pediment.

INTRODUCTION

Groundwater is one of the most important natural resources. Fortunately, groundwater is a widely distributed renewable natural resource which gets replenished almost regularly by precipitation (Sahai, Bhattacharya and Hedge, 1991). But groundwater investigation in an area by conventional method is a costly, time consuming and difficult task. Groundwater distribution in the ground is not uniform and is subject to wide spatio-temporal variations depending on the underlying rock formations, their structures, surface expressions etc. Hence, to understand the movement and occurrence of groundwater below the ground, the geology geomorphology, structural setup and recharge conditions have to be well understood (Reddi, Kumar and Seshadri, 1996).

In different hydrogeomorphological units groundwater potentiality is different. Due to synoptic coverage of the satellite imagery help to identify geological, geomorphological, structural elements which are generally considered as controlling factors for the occurrence and movement of groundwater. About 12% of the total geographical area of the state is covered by Precambrain rocks, 10% area by Tertiary, 61% by alluviam, 7.63% by river bed and 1.4% area by beels and swamps.

OBJECTIVE

The prime objective of this study was to delineate the groundwater potential zones of each districts of Assam depending upon the landforms lithological character and structural behaviour of the rock formation and finally to draw the overall view of each hydrogeomorphological units of the entire state of Assam with the help of Remote Sensing technique. This will help further to put bore well locations as per requirement of groundwater for drinking water as well as for irrigation and other industrial uses in different localities.

STUDY AREA

The state of Assam occupy an area of 78,523 sq. km. with 23 districts which includes both hills and plains. The state is bounded by latitude 24° 98' 00" N to 27° 58' 22"N and Longitude 89° 45' 00"E and 96° 00' 00"E. The state is bounded by the foot hills of the Eastern Himalayas to the north, the Patkai Range to the south east, Meghalaya to the south and part of North Bengal and Bangladesh to the west. The great Brahmaputra river flows through the state from east to west. The river is fed by 35 tributaries from north and south. Another river the Barak debouches from the Barail Range and passes through the Surma Valley for a length of 565 km. The topographic height of the region varies from 30m in Dhubri area to 1713m Barail Range in N.C. Hills district.

The climate of Assam is characterised by coolness and high humidity. Annual rainfall varies from 166cm. to 292cm. The winter temperature varies from 8°C to 12°C and the highest temperature varies from 27.8°C to 36°C. The total population of the state is 22.41 million as per 1991 census.

METHODOLOGY AND DATA BASE

The study was mainly based on visual interpretation of IRS-IA (LISS-II) imagery and LANDSAT-5 [TM] data on 1 : 250,000 scale using standard image interpretation technique like tone, texture, pattern, size, shape, drainage, vegetation etc. and transferred the interpreted details like different landform features, structural elements etc. onto the base map which were already prepared from Survey of India toposheets on 1 : 250,000 scale. Geomorphic features and associated landforms having groundwater potentiality can be recognised on the basis of their spectral reflectance characteristics and spatial feature present in the satellite imagery (Shah & Mohan, 1992). Field verification of interpreted data, geomorphological observations, well inventory, water level and pumping test data collection were also carried out before finalisation of the interpreted maps.

OBSERVATIONS AND RESULTS

The mapping on 1 : 250,000 scale for the entire state of Assam comprising 23 districts reveal that there are three broad geomorphological divisions viz. i) depositional, ii) denudational and iii) denudo-structural. Each of the broad divisions is again sub-divided into several hydrogeomorphological units depending upon their nature and lithological character. The hydrogeomorphological characteristics of different geomorphic units have been studied by remote sensing techniques in addition with field observations, collection of collateral data, hydrogeological characteristics of each geomorphic units have been taken into consideration.

The present day landforms in the districts are essentially the products of different geomorphic, geotectonic as well as environmental processes, such as erosion, deposition, crustal movement and climatic changes which are operating on the surface since remote past (Goswami & Goswami, Duarah & Deka, 1990). The various hydrogeomorphological units identified in different districts under depositional categories are flood plain, younger alluvial plain, older alluvial plain, piedmont plain, valley fill areas; under denudational categories depending upon the rock formations the following units like denudational hills of Precambrain rocks, denudational hills of Tertiary group of rocks, pediment and burried pediment surface of Precambrain rocks and Tertiary group of rocks and under denudo-structural divisions structural hills of Tertiary rocks, inselbergs on the alluvial plains (fig-1) are described.

From the study it appears that the different landforms have their own hydrogeological characteristics with reference to their groundwater storage. The hydrologic characteristics of different landforms are summarised as follows :

i) Flood Plain Deposit :

Flood plain occur on both sides of the river Brahmaputra, Barak and its major tributaries when the river overflow their banks and deposited the unconsolidated mobile sediments like gravel, sand, silt and clay all over there. Old meanders, abandoned channels, ox-bow lakes, natural levees and back swamps are present. It is a recharge zone with shallow groundwater table. Old meanders, natural levees and channel bars are good locations for shallow groundwater occurrences. It occupies an area of 11,293 sq. km. for the entire districts of Assam. Development of groundwater may be possible by both hand-tubewell as well as deep tube-well for good quantity of water.

ii) Younger Alluvial Plain :

Younger alluvial plain occur just adjacent to the flood plain on both the Brahmaputra and Barak Valley (Fig 2, 3 & 4) and the areas are slightly higher in elevation than the present day flood plain. The areas are formed due to the later cycle of fluvial deposits consisting of unconsolidated material like gravel, pebble, sand, silt and clay. Abandoned channels and natural levees are good locations for shallow groundwater occurrence. In other areas groundwater is available at shallow to moderate depth i.e. within 100m. Younger alluvial plain occupies the maximum area of the state i.e. 25,787 sq. km. for the entire districts.

iii) Older Alluvial Plain :

Older alluvial plain mostly occur near the foot hills of the southern bank of the Brahmaputra river and as isolated patches in upper Assam and north bank of the Brahmaputra river having slightly higher in elevation occasionally up to 4m. then the younger alluvial plain and formed by the earlier cycle of fluvial deposits. The material consists mainly of unconsolidated to semi-consolidated weathered limonitic clay and unsorted pebbles, gravels and sands. It is a recharge zone. Groundwater may be developed from aquifer zones found within 100-125m. Older alluvial plain occupies an area of 5120 sq. km. for the entire districts of Assam.

iv) Lower Piedmont Plain :

Lower piedmont plain occurs in the districts of Barpeta, Darrang, Kamrup, Kokrajhar, Lakhimpur, Nalbari, Sonitpur, Dibrugarh, Jorhat, Nagaon and Sibsagar. The area is built up by lower reaches of the fanning streams from the foot hills. The transition zone between lower piedmont plain and younger alluvial plain is marked by a zone of seepage and springs in the northern bank of the Brahmaputra river (ARSAC Report '90). Material consists mainly of gravels, pebbles, sands and silts. It is a high recharge zone, Groundwater may be developed at deeper aquifer i.e. within 100-150m.

v) Upper Piedmont Plain :

Upper piedmont plain occurs along the Bhutan and Arunachal foot hills. The area is built up by streams originating from the Himalaya flowing southwards and deposited the coarser materials consisting of boulders, gravels and sands with clay in the intercone areas. Coarse textured, braided seasonal streams signify high infiltration due to permeable deposits. Very good area for groundwater recharge. Water level is deep and ranges from 7m to 21m. Groundwater may be developed with the help of percussion drilling rig as the area consist mainly of big boulders and gravels.

vi) Structural Valley/Valley-fill Areas :

These occur within narrow linear valleys mostly in the hilly areas. The material consist of unconsolidated to semi-consolidated boulders, angular fragments of rocks, gravels, pebbles, sand, silt and clays. Development of ground water in these areas are controlled by the thickness of sediments. It is a recharge zone. Good yield along the fracture line in low level areas. It occupies an area of 69 sq. km. for the entire districts of Assam.

vii) Pediment Surface of Tertiary Group :

Pediment surface of Tertiary Group occurs in the foot hills of the districts of Dibrugarh, Golaghat, Cachar, Hailakandi and Karimganj. These are nearly a plain surface, consist mainly of sandstone shale & clay. It is partially a recharge zone. Development of groundwater in these areas are poor. However, development of moderate quantity of groundwater through deep tubewell may be possible only on the friable sandstone areas. It occupies an area of 204 sq. km. in the districts mentioned above.

viii) Burried Pediment :

Burried pediment of Tertiary group of rocks occur in the southern part of Singla valley and in the central western part of Longai Valley just beyond the younger alluvial plain. The pediment is overlain by thin alluvium cover and the underlying rocks are mainly of alternate bands of fine to medium grained sandstone, siltstone, shales and clays forming synclinal structures. Due to argillaceous nature runoff is high. Development of groundwater may be possible at shallow to moderate depth within 100m with poor to moderate quantity of water. It occupies an area of 166 sq. km. in the district of Karimganj.

ix) Denudational Hills of Tertiary Group :

Denudational hills of Tertiary group of rocks mostly occur in the districts of Cachar, Karimganj, Hailakandi, Dibrugarh, Karbi Anglong, Nagoan and N.C. Hills of Assam. It occupies an area of 9357 sq. km. These are highly dissected hills and representing an undulating surface consisting of alternating beds of sandstone, shale, limestone, clay, siltstone, mudstone, boulder bed etc. It is a runoff to partially a recharge zone. Recharge may take place along joints, fractures, faults, weathered friable sandstone and also along the bedding plan. Groundwater development may be possible along the fracture zones, and highly weathered zones by dugwell and hand tube well. In the major valley areas moderate quantity of water may be possible with the help of hand tube well and deep tube well.

x) Structural Hills of Tertiary Group :

Structural hills of Tertiary group of rocks mostly occur in the districts of Cachar, Karimganj, Hailakandi, Dibrugarh, Sibsagar, Jorhat, Nagaon, N.C. Hills, Lakhimpur, Sonitpur and Darrang of Assam. It occupies an area of 4583 sq. km. and consist of medium hard to hard sandstone, shale, clay, coal seams etc. The areas are moderate to highly dissected by sub-parallel to trellis type of drainage. It is a runoff zone. Partial recharge may take place along joints, fractures, faults and weathered sandstone. Development of groundwater through deep tube well is very limited except in the weathered friable sandstone areas.

xi) Pediment Surface of Precambrian Rocks :

Pediment surface of Precambrain rocks mostly occur in the districts of Goalpara, Kamrup, Nagaon and Darrang districts of Assam and occupies an area of about 115 sq. km. The area is a slightly undulating one on the gneissic complex. It is a runoff zone. Feasibility of groundwater through deep tube well is quite low due to lack of primary porosity. Dug wells may be possible in the weathered zone for limited quantity of water.

xii) Denudational Hills of Precambrain Rocks :

Denudational hills of Precambrain rocks mostly occur in the districts of Dhubri, Goalpara, Kamrup, Nagaon, Karbi Anglong N.C. Hills, Golaghat and Darrang. It occupies an area of about 7,188 sq. km. and consisting mainly of gneisses, granite and quartzitic rocks. The area is moderate to highly dissected by joints, fractures and faults followed by dendritic to rectangular and sub-rectangular drainage. The area shows moderate to high relief with very compact to moderately compact rocks. Prospects of groundwater development through deep tube well is very limited. Groundwater may occur in pockets under water table conditions only in weathered mentle and along joints and fractures (Goswami and Goswami, 1992).

xiii) Structural Hills of Precambrain Rocks :

Structural hills of Precambrain rocks mostly occur in the northern part of Nagaon and Karbi Anglong districts of Assam and it occupies an area of 1,590 sq. km. in both the districts. The area is moderately dissected consisting mainly of hard to moderately hard quartzite, phyllite and conglomerate which are intruded by both acid and basic rocks. It represents high runoff zone. Minor recharge may take place along joints and weathered friable quartzite. Only dug wells may be constructed along the weak zones. In the low lying depressed weathered zone, hand tube wells may be executed for limited quantity of water.

xiv) Inselbergs :

Inselbergs occur in the districts of Barpeta, Dhubri, Goalpara, Golaghat, Kamrup, Karbi Anglong, Kokrajhar, Sonitpur and Darrang of Assam and occupies an area of about 244 sq. km. It consists mainly of granite, gneisses and quartzite rocks. It is highly a run off zone, partial recharge may take place along the fractures and joints. In this unit groundwater prospect is very negligible.

CONCLUSION

The synoptic view obtained through IRS and LANDSAT data help in deciphering the major structures and hydrogeomorphological features in a regional way either for accessible or inaccessible areas. Conventional ground data is necessary for interpretation of remote sensing data properly. Areas of younger alluvial plain where thickness is gradually higher towards the main river course are suitable for development of groundwater through deep tube wells. In the northern belt of piedmont plain although groundwater is available, due to bouldery horizon the development of groundwater will be more expensive. In the Tertiary rocks, the areas of weathered, medium to coarse grained sandstone may be promising for groundwater development. The Precambrian rocks are hard and compact and primary porosities are very negligible. Here, partially weathered with joints, fractures and faults are having limited water holding capacity. Groundwater may be developed in weathered pockets under water table conditions. Only dugwells, hand pumps may be possible along joints, weathered zones in the area for limited quantity of water.

It is evident from the study that an integrated approach using both remote sensing and ground data can help in groundwater exploration in large areas under difficult terrain and complex geological conditions within a relatively short span of time.

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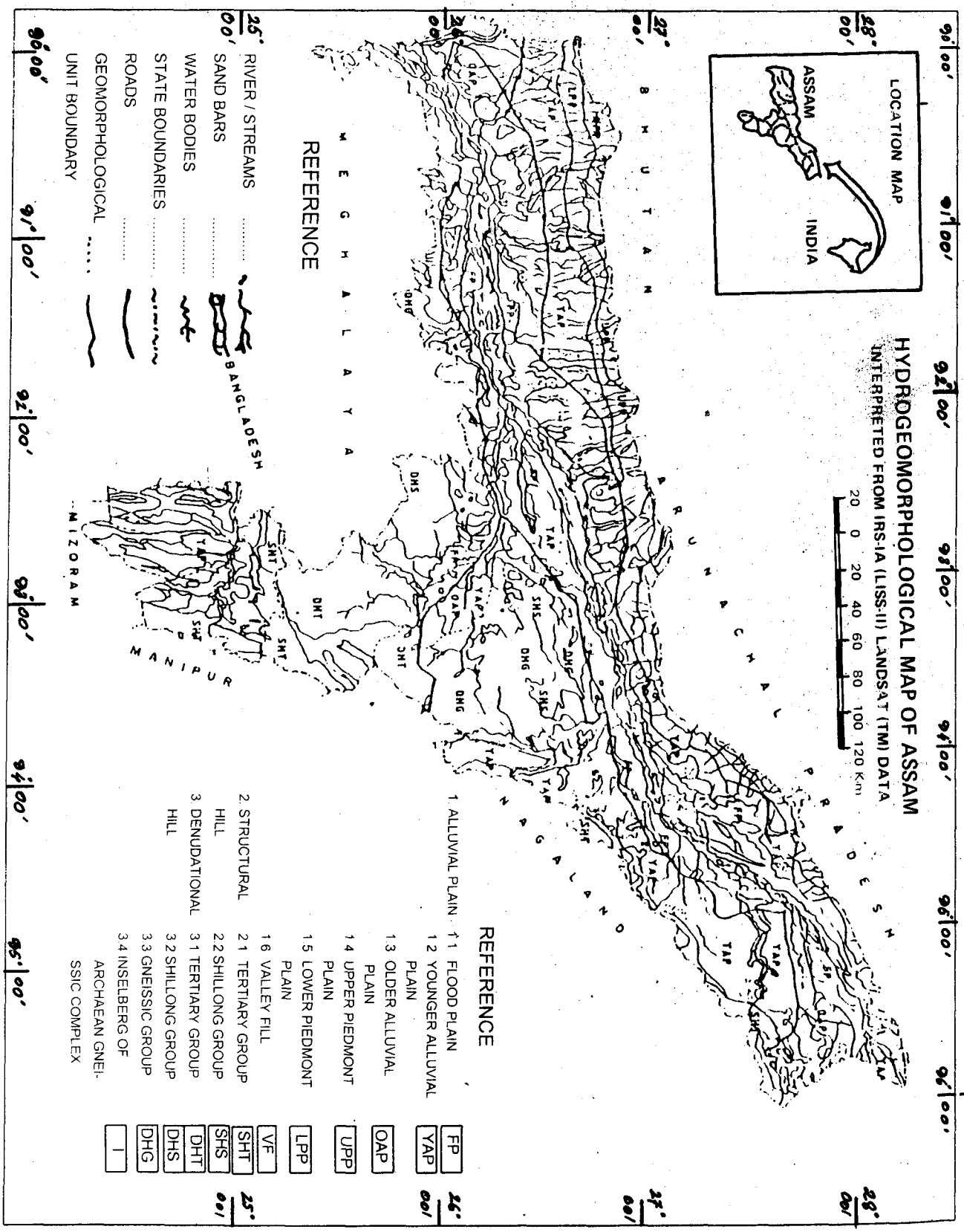
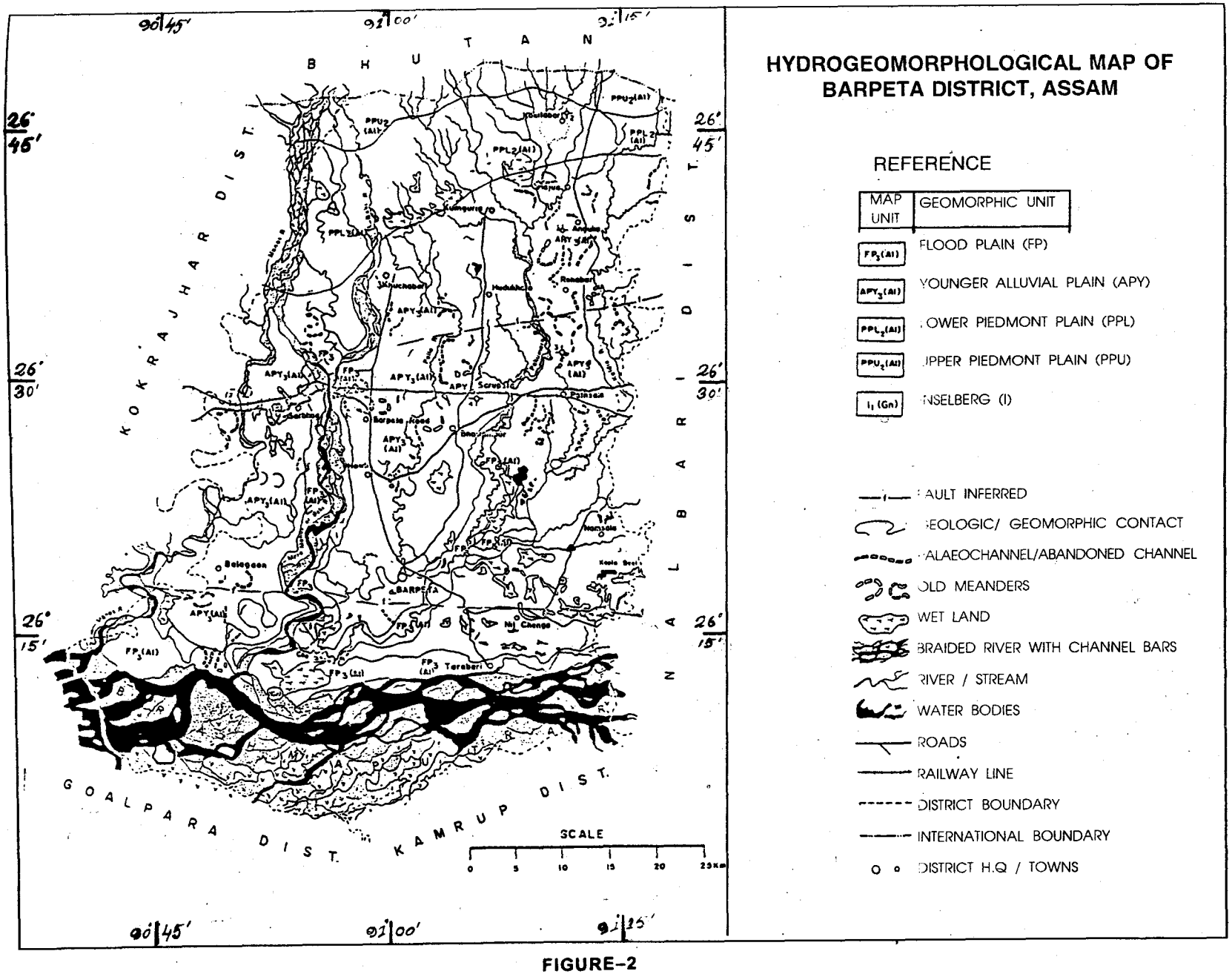
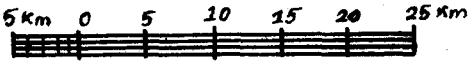
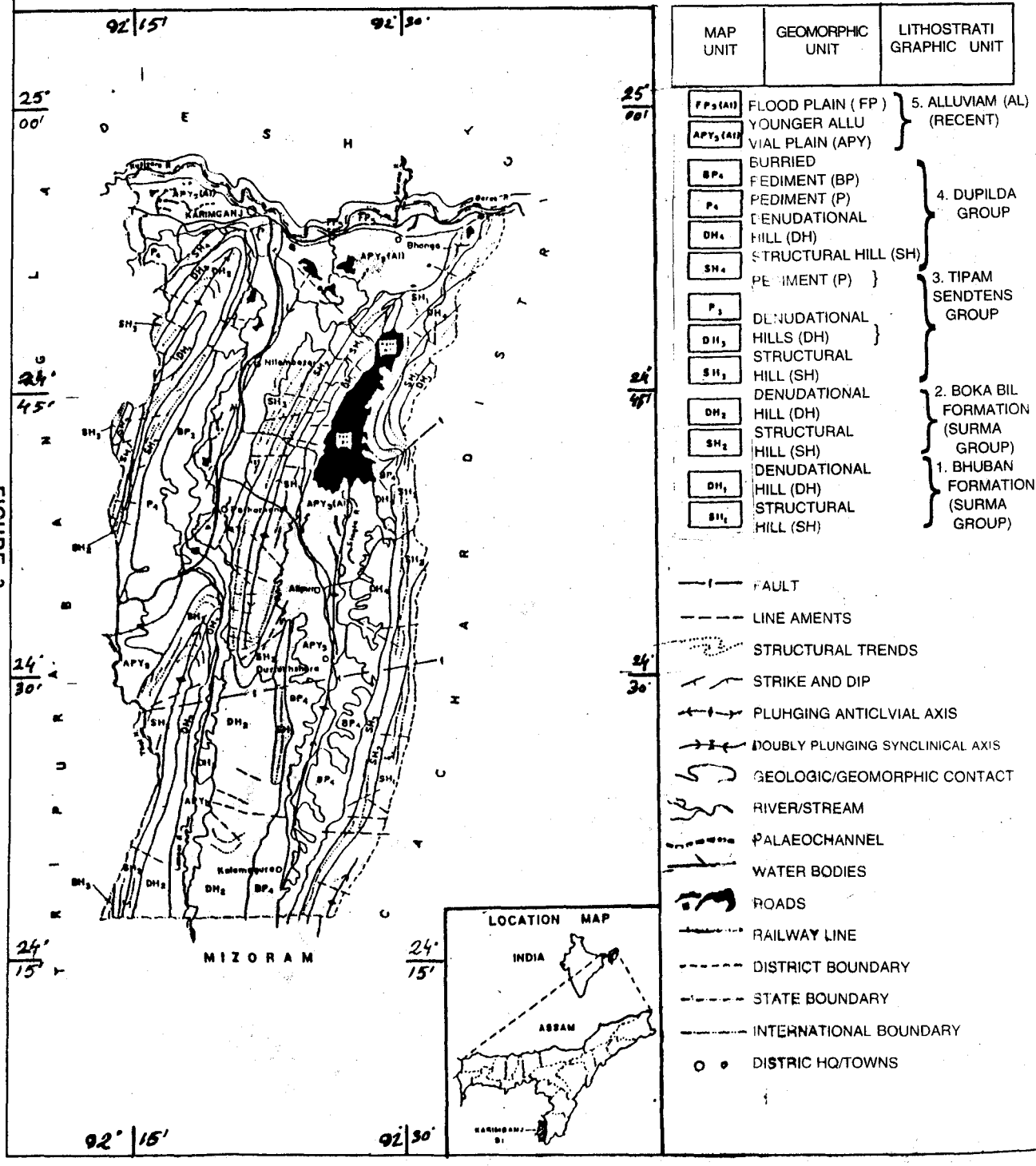

HYDROGEOMORPHOLOGICAL MAP OF ASSAM
INTERPRETED FROM IRS-1A (LISS-II) LANDSAT (TM) DATA
20 0 20 40 60 80 100 120 Km
LOCATION MAP
ASSAM
INDIA
BHUTAN
ARUNACHAL PRADESH
NAGALAND
MEGHALAYA
MIZORAM
MANIPUR
BANGLADESH
REFERENCE
RIVER / STREAMS
SAND BARS
WATER BODIES
STATE BOUNDARIES
ROADS
GEOMORPHOLOGICAL UNIT BOUNDARY
1 ALLUVIAL PLAIN
11 FLOOD PLAIN
12 YOUNGER ALLUVIAL PLAIN
13 OLDER ALLUVIAL PLAIN
14 UPPER PIEDMONT PLAIN
15 LOWER PIEDMONT PLAIN
16 VALLEY FILL
2 STRUCTURAL HILL
21 TERTIARY GROUP
22 SHILLONG GROUP
3 DENUDATIONAL HILL
31 TERTIARY GROUP
32 SHILLONG GROUP
33 GNEISSIC GROUP
34 INSELBERG OF ARCHAEAN GNEISSIC COMPLEX
FP
YAP
OAP
UPP
LPP
VF
SHT
SHS
DHT
DHS
DHG
I

FIGURE–1

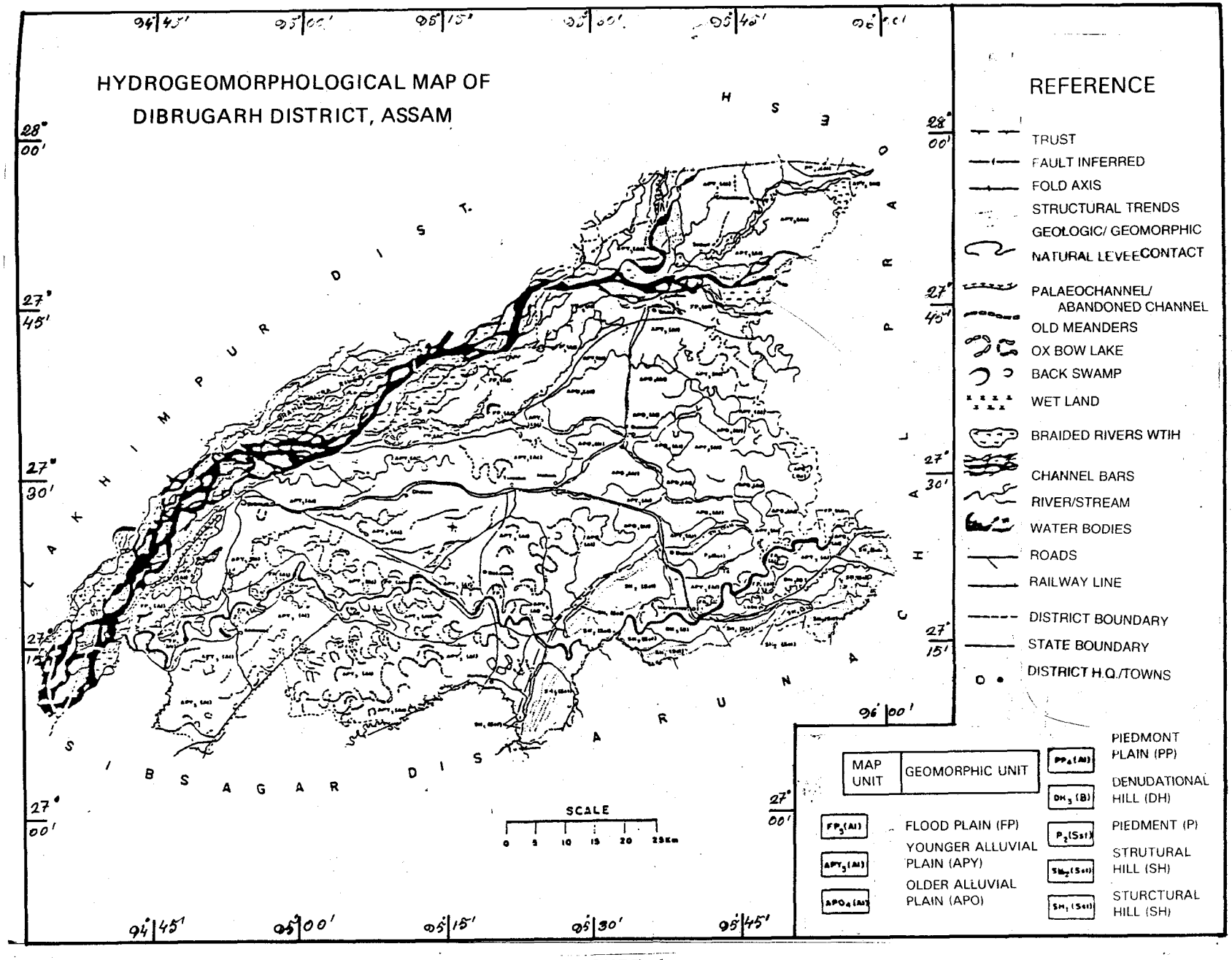

HYDROGEOMORPHOLOGICAL MAP OF
BARPETA DISTRICT, ASSAM
REFERENCE
MAP UNIT
GEOMORPHIC UNIT
FLOOD PLAIN (FP)
YOUNGER ALLUVIAL PLAIN (APY)
LOWER PIEDMONT PLAIN (PPL)
UPPER PIEDMONT PLAIN (PPU)
INSELBERG (I)
FAULT INFERRED
GEOLOGIC/ GEOMORPHIC CONTACT
PALAEOCHANNEL/ABANDONED CHANNEL
OLD MEANDERS
WET LAND
BRAIDED RIVER WITH CHANNEL BARS
RIVER / STREAM
WATER BODIES
ROADS
RAILWAY LINE
DISTRICT BOUNDARY
INTERNATIONAL BOUNDARY
DISTRICT H.Q / TOWNS
BHUTAN
KOKRAJHAR DIST.
NALBARI DIST.
GOALPARA DIST.
KAMRUP DIST.
BARPETA
SCALE
0 5 10 15 20 25Km
90°45'
91°00'
91°15'
26°45'
26°30'
26°15'

FIGURE–2

HYDROGEOMORPHOLOGICAL MAP OF KARIMGUNJ DISTRICT, ASSAM

BASED ON INTERPRETATION OF IRS LISS II & LANDSAT TM IMAGERY WITH LIMITED FIELD CHECKS



FIGURE–3


HYDROGEOMORPHOLOGICAL MAP OF
DIBRUGARH DISTRICT, ASSAM
LAKHIMPUR DIST.
SIBSAGAR DIST.
HSE
PRADESH
ARUNACHAL
SCALE
0 5 10 15 20 25Km
REFERENCE
TRUST
FAULT INFERRED
FOLD AXIS
STRUCTURAL TRENDS
GEOLOGIC/ GEOMORPHIC
NATURAL LEVEE CONTACT
PALAEOCHANNEL/ ABANDONED CHANNEL
OLD MEANDERS
OX BOW LAKE
BACK SWAMP
WET LAND
BRAIDED RIVERS WTIH
CHANNEL BARS
RIVER/STREAM
WATER BODIES
ROADS
RAILWAY LINE
DISTRICT BOUNDARY
STATE BOUNDARY
DISTRICT H.Q./TOWNS
MAP UNIT
GEOMORPHIC UNIT
FLOOD PLAIN (FP)
YOUNGER ALLUVIAL PLAIN (APY)
OLDER ALLUVIAL PLAIN (APO)
PIEDMONT PLAIN (PP)
DENUDATIONAL HILL (DH)
PIEDMENT (P)
STRUTURAL HILL (SH)
STURCTURAL HILL (SH)

FIGURE–4

TECHNICAL SESSION – III

AGRICULTURAL SCIENCES & LIFE SCIENCES

SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT OF AGRICULTURE IN MEGHALAYA.

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ABSTRACT

In Meghalaya, 80% of its population living in the rural area depends upon agriculture for their livelihood. At the time of inception of the state, agricultural productivity was much less due to traditional method of cultivation. Due to the advent of new crop production technology such as high yielding varieties, non-traditional crops, potentiality for mushroom, inter-cropping, rainfed farming, micro-irrigation devices, soil testing, plasticulture technology, agro-bio-diversity, pest management and post-harvest techniques adopted by farmers, the productivity has increased manifold, however it seems only a marginal increase in the net cropped area.

INTRODUCTION

Meghalaya is basically an agricultural state with eighty per cent of its population living in rural areas and depend on agriculture for their livelihood. It has a monsoon type of climate but with wide variations depending upon altitude and physiographic difference of land mass. At the time of the inception of the state agriculture was predominantly in its traditional form of cultivation with much less productivity per unit area. Nevertheless, with the acceptance of the new crop production technology by the farmers over the years, the productivity has increased remarkably although there seems to be only a marginal increase in the net cropped area as indicated below :

Particulars	1993-94 (Ha)	1994-95 (Ha)	1995-96 (Ha)
A. Net area shown	201221	201292	206477
B. Area shown more than once	37267	37389	40936
Total cropped area	23488	238881	247413

Source : Directorate of Economics & Statistics, Meghalaya [1]

The development of agriculture in Meghalaya during the period before its inception and in the last twenty five years are outlined in the following pages with reference to the notable scientific and technological introductions.

1.0 VARIETAL DEVELOPMENT

Crop variety is the most important component of improved technology which contributes up to 40 per cent towards production.

1.1 Rice variety performance is according to specific altitude ranges due to the effect of temperature. Varieties which perform well at low altitudes (800m above msl) do not do well at mid (800-1300m above msl) and high (1300m above msl) altitudes. In high altitude region, the low temperature (15-16^{0}C) during September-October coinciding with the flowering of rice, results into high percentage of chaffy grains at maturity[2]. Though some local traditional rice varieties are tolerant to low temperature at the flowering stage, yet they are low yielding and are susceptible to lodging. Therefore, at mid and higher altitudes, varieties should invariably possess cold tolerance. The development of such varieties is achieved through screening of rice varieties, selection, hybridisation and utilising innovative breeding methods[2]. However, introduction of rice varieties developed and released in a different agro-climatic condition is of limited success because of biotic and abiotic stresses. Consequently, rice improvement in the target environments has enable the ICAR Research Complex to identify many promising lines of which Megha Rice 1 and Megha Rice 2 were released for Meghalaya by the State Seed Committee. The comparative

performances of these released varieties against the popular traditional one as shown below has been preferred for commercial cultivation.

Varieties	Grain yield (Kg/Ha) during 1989 location wise				
	Upper Shillong	Mylliem	Sohiong	Mairang	Mean
Megha Rice 1	2360	2140	2380	2410	2322.50
Megha Rice 2	2415	2850	2290	1990	2386.25
Khonorullo	1890	1660	1980	1830	1840.00
% increase of Megha Rice 1 over Khonorullo	20	29	20	32	25.25
% increase of Megha Rice 2 over Khonorullo	28	72	16	09	31.25

Source : ICAR Research Complex for NEH Region [2]

1.2 Of all the commercial crops grown, potato is the most important as the agro-climatic condition of the high altitude region is very suitable for its cultivation and there are specific areas which are best suited for seed purposes. Two high yielding varieties viz. Kufri, Jyoti and Kufri Megha developed through the Central Potato Research Station have been successfully introduced with the production increase to 208.63 thousand MT (1995-96) from 109.70 thousand MT (1989-90) [3].

1.3 The introduction of True Potato Seeds (TPS) is another development which is yet to be popularised for general cultivation in large scale. The success of this technology will go a long way to reduce bulk requirement of potato tubes as planting materials since 100gms TPS is enough for one hectare area of potato cultivation. This will ease transportation and consequently reduce cost of cultivation.

1.4 Nadia variety of ginger with less fibre content (4.1%) is doing well and very popular among the ginger growers.

1.5 Other varieties of common grown crops and vegetables have been introduced and accepted for cultivation by the farmers of the state. New varieties for Turmeric, Soyabean and Maize have been evolved and are under observation for release.

2.0 NON-TRADITIONAL CROPS AND OFF-SEASON VEGETABLES

The introduction of non-traditional crops notably tea and cashew nut is another development in the last twenty five years.

2.1 Trial plantation of tea was started during 1976-77 with seeds of recommended varieties from Assam and Darjeeling [4]. The good performances of the tea bushes and the yield of green tea leaves encouraged expansion of tea cultivation at a commercial scale. Farmers were assisted to take up plantation un small units and a total of 289 growers have undertaken tea cultivation up to 1996-97 [3]. Even Jhumias are now willing to opt for settled and permanent cultivation from the traditional shifting cultivation practices. The trend of area and production of tea is given below :

Items	Unit	1989-90	1995-96	1996-97
A. Area under Tea Plantation	Ha.	64.5	267.2	303.2
B. Production of Tea	MT	28.1	470.0	670.0

Source : Directorate of Agriculture, Meghalaya. [3]

2.2 Cashew nut cultivation has been introduced for control of jhuming or shifting cultivation. The warm climate of low and mid altitude regions in the state is suitable for its cultivation which would enhance the cause of changing the economy of the farming community in the near future.

2.3 Meghalaya has the potential of producing off-season crops notably tomato and French beans. At high and mid altitudes these crops are produced in May-June and ready market is available as this period of production coincides with the lean period in the plains.

3.0 MUSHROOM PRODUCTION

Meghalaya offers great potential for mushrooms production. Two varieties viz. *Agaricus* sp. commonly known as White-button mushroom and *Pleurotus* sp. commonly known as Oyster mushrooms have greater market potential among the cultivated mushrooms. The climate suitability with a temperature range of 18-28^{0}C and relative humidity of 75-85 per cent from March to October allows cultivation of oyster mushrooms under various altitude conditions while button mushroom grows successfully in temperature range of 12-18^{0}C that prevails in the winter months of the year[5]. Good quality spawn (seeds) are produced in the state and are available to cultivators during the growing period.

4.0 INTERCROPPING AND CROP ROTATION

4.1 In the state, farmers have the practice of growing two crops in the same plot of land without supplementing adequate nutrients in the soil. This results in crop competition for nutrition and space. Planting the same crop year after year also depletes the plant nutrients in the soil in an unbalanced manner. Therefore, a proper rotation of crops is essential to preserve productivity and to enrich soil fertility.

4.2 Introduction of leguminous crops like soya bean in between rows of maize crop has practised by the cultivators which fixes free nitrogen from the air and convert it into nitrogenous compounds for the use of the crop plants.

4.3 The proper utilization of the inter-spaces in between rows of the main crop also provide additional income and minimizes weed growth to some extent.

5.0 AGRICULTURAL MECHANISATION

The scope for mechanised farming is not very encouraging due to the hilly terrain but there is awareness among the farmers to avail the minimum facilities in this regard. The stage of mechanisation is mostly for assured and timely completion of land preparation.

5.1 The introduction of medium size power tillers and the concept of low HP tractor fits into the topography of the hilly terrain which can be easily operated upon by the farmers themselves. Such mechanisation is selective and eco-friendly to rainfed farming.

5.2 ICAR has also developed certain tools and implements according to the different soil and weather conditions.

6.0 IRRIGATION POTENTIAL AND MULTIPLE CROPPING

6.1 The irrigation potentiality created through the irrigation projects and the utilisation of the command areas within their scope, opened avenues for multiple cropping wherever feasible. These areas retain enough moisture to sustain a second or a third crop within the same plot of land in a year. Thus the land may utilise up to 200 or even 300 per cent cropping intensity.

6.2 The availability of water for crops like Betel vine and Black pepper that require proper quantum and constant moisture because of the water holding capacity of the soil has been made possible through modernised drip irrigation system.

6.3 In flash-flood prone areas the excess water is retained through the eco-friendly and technological approach of shallow tubes to ease the crop during moisture stress period.

6.4 The concept of sprinkler irrigation is another innovative technology introduced in rain shadow areas.

6.5 In high altitude region, the cropping pattern of spring potato followed by rice in low lying areas has been found as a common practice by farmers. In low altitude and warmer areas, short duration high yielding varieties could be grown with even three crops for more production to attain food security.

7.0 SOIL TESTING AND SOIL SURVEY

7.1 For satisfactory crop yields, the presence of essential plant nutrients in the soil in adequate quantities and in readily utilisable form is necessary. Thus, a knowledge of the fertility status and physical properties of the soil is possible through soil testing. Soil testing facilities have been provided through the State Soil Laboratories to analyse the surface soils of the cultivator's fields by rapid chemical test and on this basis for fertilizer use recommendations. These soil test results have also been of great value in assessing the nutrient status of different soils in the country.

7.2 Soil survey facilities have also been introduced to chart soil resources for a detailed planning of proper land use. The broad objectives are to classify soils into units of a uniform system of classifications with uniform nomenclature in order to correlate them with those in other areas, to show on maps their distribution in the field and to define their adaptability for crops, grasses and trees, their management requirements and yields of individual crop under different systems of land use and management.

8.0 PLASTICULTURE TECHNOLOGY

Plasticulture technology has helped to raise high-valued crops and for efficient utilisation of water resources.

8.1 Growing of off-season vegetables has been introduced through poly-houses which provide green house effect-cum-rain shelter during heavy rainy season. Tomato crop grown in these houses effectively resist late-blight diseases with only 3 to 4 spraying of fungicide at 15-21 days interval while the same crop grown in normal condition is badly affected by the disease. Similarly, off-season cucumbers are conveniently harvested in cold winter months.

8.2 The use of plastics on the soil surface helps to conserve moisture and acts as mulching material. This also has smothering effect on weeds as well.

9.0 WATERSHED DEVELOPMENT

9.1 The National Watershed Development Project for Rainfed Areas (NWDPRA) was launched by the Ministry of Agriculture for its implementation during the seven Five-year Plan period and eight projects have been implemented in the state during the eight plan. However, each community Development Block have been earmarked with one project in the ninth plan. Such projects are on-going activities until the objectives are stabilized for a sustainable agriculture.

9.2 This approach and strategy for rainfed farming is based on the concept of conservation of rainwater for holistic and integrated development of potential watersheds and promotion of farming systems approach, management of common property resources and augmenting family incomes and nutritional levels through house-hold production systems. Some of the programme measures that are being promoted under NWDPRA which stabilize and increase productivity in rainfed areas include soil and water conservation, bio-mass production, integrated nutrient and pest management, mixed cropping, rainfed horticulture, animal husbandry, pisciculture, agro-forestry, silvicultue, house-hold production systems and management of common property resources. The goal of the watershed-based management approach is to evolve methods of sustainable agriculture in rainfed areas which can be replicated on a larger scale in the country in a phased manner in the future [6].

10.0 PEST MANAGEMENT

With intensive cropping systems there is the emergence of pests and diseases and weed problems. Their control measures are often carried out through pesticides application. However, the non-judicial and indiscriminate use of these pesticides adversely affect the environment and the eco-system as a whole. The restricted use of these harmful pesticides has been substituted to a large extent by adopting and popularising Integrated Pest Management strategies through all the available methods of control in addition to needbased application of pesticides. Though this approach is still considered a new concept in the state, efforts have been taken to create awareness among the farmers of the state.

11.0 POST HARVEST TECHNOLOGY

Most crops, particularly vegetables and fruits are highly perishable and as a result there is the challenge for proper development of post harvest technology which include food processing.

11.1 Disposal of the entire perishable produce in raw form is not always possible and the fruit processing units available in the state are not adequate but there is prospect with expansion.

11.2 The cold storage facilities and de-humidifiers have been introduced for storage purposes so also standard storage bind of different capacities.

11.3 Marketing of marketable surplus with a view to reducing post harvest losses has to some extent facilitate with the opening of regulated markets in the state through the facilities being provided and to be improved in the future.

11.4 There are enough scope for setting up of agro-based industries in Meghalaya for the products like potato-chips, ginger candy, ginger cube, tapioca and banana slices, canned mushroom, jack fruit products, pineapple leaf fibre extraction etc. Cashew nut processing has taken off and with further expansion and modernization will provide incentives for extensive cashew nut cultivation.

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IMPACT OF RESEARCH AND EXTENSION ON AGRICULTURAL PRODUCTION OF NORTH EAST INDIA

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ABSTRACT

Analysis of agricultural production data of north eastern India for a period of 22 years from 1972-73 to 1993-94 indicates that there has been substantial increase of area, production and productivity of foodgrains and other crops in the region. The increase in production of foodgrains, pulses and oilseeds was to the tune of 49.58%, 45.21% and 171.97% in 1988-89 to 1992-93 over1972-73 respectively. In most of the crops, a progressive increase was evident from 1972-73. The annual compound growth rate of production for the period was 2.33% for rice, 3.21% in pulses 1.05 in total foodgrains and 5.85% oilseeds. This shows that the improved technology packages evolved by research and extension institutions of the region had a vital role in enhancing agricultural production of north east India. Although agriculture includes animal husbandry and fishery also, this paper restricts to discussion of only agricultural crops of the region.

THE NORTH EASTERN REGION

The north eastern region (NER) of India comprising the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura occupies a geographical area of 2.74 lakh square kilometers. Northeast India is a land locked region with only one narrow outlet to the rest of the country. It is surrounded by China, Myanmar, Bangladesh and Bhutan. The region is characterized by diverse geological, physiographic and agroclimatic features which make the region unique in many ways. Physiographically, the region is divided into 4 units : i) Eastern Himalayas, ii) Eastern Mountains, iii) Meghalaya-Mikir Tablelands and iv) the Brahmmaputra Valley. This, in turn, has given rise to six agroclimatic sub-zones which form the primary basis for planned development of agriculture and livestock farming. The broad parameters governing the varied pattern of agroclimates comprise rainfall (2200mm – 5.4 – 7.0), altitude (50-1800 m msl) etc. The predominant systems of cultivation are : shifting cultivation and settled cultivation.

ROLE OF RESEARCH AND EXTENSION

Development activities of creating agricultural growth remain incomplete without proper role of research and extension programmes. In the absence of a research and extension approach, usually a gap between the declared potential and actual utilisation exists. This has been the country wide experience. Since agriculture and allied sectors constitute the primary occupation of the people of NER, agricultural growth is conceived as a prerequisite and therefore research and extension is a must for accelerating the development of agriculture in the entire NER. There are several factors inhibiting in the agricultural production in the region. Most of the problems have originated due to the lack of proper technologies for economic exploitation of the land and water resources. This has now been taken care of with the establishment of Assam Agricultural University and ICAR Research Complex for tackling location-specific and production oriented problems. The research and extension efforts put by these and other related institutions so far have yielded far-reaching importance in the agricultural scenario of the region. However, the results of research to the farmers have not been fully exploited owing to the lack of trained manpower. Manpower management in the region is a problem of high magnitude and, therefore, a proper system and network for Transfer of Technology (TOT) to the farmers coupled with a strong supply of inputs becomes imperative.

The existing Research and Development (R&D) institutions in the NER related to agriculture are : Assam Agricultural University (AAU), Jorhat and its 7 Regional Research Stations, ICAR Research Complex for NEH Region, Umiam and its 6 Regional Stations at Arunachal Pradesh, Manipur, Mizoram, Nagaland, Sikkim and Tripura, sub-station of Central Potato Research Institute, Shillong, sub-station of Central Plantation Crops Research Institute, Guwahati, Ramie Research Station of CRIJAF, Sorbhog, Regional Research Station of National Soil Survey and Land Use Planning, Jorhat, Agro-Economic Research Station, Jorhat, Central Agricultural University, Manipur, Agricultural Colleges of Nagaland and Manipur, Directorate of Extension Education, AAU, Jorhat and Krishi Vigyan Kendras (KVK) of AAU, ICAR Complex and NGOs. ICAR Research Complex (established in 1975) along with its KVKs caters to the research and extension needs of the entire hill states of the region including Sikkim. The AAU set up in 1969 provides training, research and extension

facilities besides having faculties in UG, PG and Ph.D. programme of different agricultural disciplines. The AAU primarily caters to the R&D needs of state of Assam only. The two agricultural colleges of Nagaland and Manipur have not yet developed research facilities and offer UG programme in agriculture. The Central Agricultural University has been stated recently and it has stated PG programme in a few disciplines. Research works done at substations of CPRI, CPCRI, CRIJAF and NBSS and LUP have benefited a lot in production of potato, fibre crops, plantation crops and soil management in NER. The AAU and ICAR Complex have developed/identified suitable varieties and production practices for cereals, pulses, oilseeds, fibre crops, sugarcane, fruits, spices, vegetables etc. Management of acid soils, cropping systems research, integrated nutrient management, soil and water conservation, water management, farming system research, plant protection, designing and testing of farm power and machineries, soil survey and soil mapping, on farm research, training, demonstrations, publication of research and extension literatures are some of the important research activities of these R&D organisations of the region. These R&D organizations have definitely played a vital role in the enhancement of agricultural production of NER.

PRODUCTION AND PRODUCTIVITY TREND OF AGRICULTURAL CROPS (1972-73 TO 1993-94)

An analysis of area, production and productivity trend in NER for the period 1972-73 to 1993-94 indicates that the region produced a total of 5068.9 thousand tonnes of food during 1993-94 from an area of 3747 thousand ha, i.e. 2.78% of total food grains production in the country from 3.06% of total area under food grains, which lies in the region. The productivity of foodgrains of the region during 1993-94 was 1353 kg/ha which was 9% below than national average of 1487 kg/ha (table-I).

On analysis of percent population and percent production of all India basis (table-II), it is evident that NER is not self sufficient in total foodgrain production. It has been observed from the analysis of the trend of area, production and productivity from 1972-73 to 1993-94 that except fibre crops (jute, mesta and cotton), area has been increased in all the four periods (table-III). Area under oilseeds registered an increase of 110.48% during 1988-89 to 1992-93 (base year 1972-73) followed by 100.10% during 1983-84 to 1987-88. Area under total foodgrains increased to 49.58% in 1988-89 to 1992-93 from 5.48% in 1973-74 to 1977-78. However, area under fibre crops showed a progressive decline which may be attributed to the more and more use of synthetic fibres rather than vegetable fibres. Coming to production; rice, foodgrains and oilseeds registered a progressive increase, the increase of oilseeds being spectacular, i.e. from 10.98%(1973-74 to 1977-78) to 171.97% in 1988-89 to 1992-93. However, the growth scenario in pulses and fibre crops is a mixed one. Although pulse showed an increasing trend from 1978-79, it had gone down to 9% during 1973-74 to 1977-78 whereas production of fibre crops was decreased in all the years. In case of productivity, there was appreciable increase in rice, foodgrains and oilseeds, the highest being 29.01% in oilseeds followed by 28.89% in rice (1988-89 to 1992-93). In pulses except during 1988-89 to 1992-93, the productivity was decreased while surprisingly it was increased in fibre crops even though there was decrease in area and production. Percent change in area, production and productivity in some crops during 1972-73 to 1993-94 indicates that except fibre crops and pulses, there was appreciable increase in most of the crops, the maximum being in ginger.

On analysis of growth rate it could be seen (table-V) that the growth rate of area and production of rice, pulses, total foodgrains and oilseeds was positive while it was negative for fibre crops. This implies that the area and production of rice, pulses, total foodgrains and oilseeds were increasing but the same was declining for fibre crops. Growth rate of productivity of all the crops was found positive. The highest growth rate in productivity was found in fibre crops (3.04%) followed by pulses. Though the growth rate of productivity of fibre crops was to the tune of 3.04%, the decline in the growth rate of area brought down the growth rate of production of fibres to (–)0.10%. In case of rice, pulses, total foodgrains and oilseeds growth in both area and productivity contributed towards the growth rate of production in positive trend. In case of rice and total food grains, productivity contributed more towards the growth of production while in pulses and oilseeds growth in area subscribed a higher proportion towards the growth of production.

During 1977-78 net cultivated area to total area was 15.9% and percentage of net irrigated area to net cultivated area was 22.1 in NER whereas it was 71.7% in 1990-91 but percentage of net irrigated to net cultivated area unchanged (table-VI). The consumption of plant nutrients (NPK) in 1974-75 was 11.29 thousand tonnes and consumption of plant nutrients per unit gross cropped area was 5.04 kg/ha whereas it

was 17.78 thousand tonnes and 16.07 kg/ha respectively in 1992-93 (table-VII) – an increase of 57.48% and 218.85% respectively. Area under High Yielding Varieties (HYV) reveals that area under HYVs in paddy and maize increased to 1740 thousand ha and 72 thousand ha in 1993-94 from 354.7 thousand ha and 19.8 thousand ha in 1973-74, the increase being 3.6 and 2.6% respectively. However, there was decline in HYV wheat area (table-VI). Increase in area, production, productivity, consumption of fertiliser etc. points to the fact that with the recommendation and use of improved production technology, the agriculture scenario of NER is also changed, even though the change is not at a faster rate.

IMPACT OF TECHNOLOGY AND EXTENSION

Adoption of improved technology was limited in early seventies which affected yield rate and farmers decided their crop patterns broadly in relation to a set of traditionally accepted rotation, viz. physical settings of the individual fields. The overall deciding factors were rainfall, irrigation facilities, quality of soil and need of the household for different crops for home consumption. With the development of **TOT** through adoption of package of practices, the production and productivity of agriculture crop have been increased. The agriculture scientists and extension personnel had a major role in developing location specific suitable crop planning and crop varieties through conduction of adoptive trails and research (on farm testing and demonstrations). The extension persons KVKs demonstrable the technologies developed by the scientists in research stations with needed interpretation adjustment with local condition in order to obtain maximum returns.

The training and demonstration programme conducted by the KVKs have undoubtedly created a zeal for scientific cultivation among the practicing farmers towards the increased crop production practices, adoption of soil conservation measures maximum utilisation of land, raising of orchard and farm forestry and diversified farming. These practices provided at least assured gainful employment throughout the year. The process of compact extension activities adopted by KBKs through regular follow-up, farmers meeting, evaluation camps, audio-visual education, field trips etc. have caused more consciousness among farmers about the recent advancement in agriculture and allied fields showing thereby a good impact on **TOT**. Adoption of double cropping in place of monocropping in Assam and Manipur, scientific farming of composite fish culture in Tripura, groundnut cultivation in Assam, Nagaland and Tripura, raising of 'Amarpali' mango in Tripura, rabbit rearing in Manipur, mushroom production in most of the states etc. are some of the achievements of R&D programme of agriculture in NER.

Recommended and newly developed varieties have the farmers of the region in adopting improved technology for increasing food grains, horticulture crops and livestock production. Suitable inter-cropping systems have benefited the farmers to increase productivity per unit area. Weed control measures contributed maximum for increasing grain yield of rice and other crops under ecosystem while fertiliser contributed maximum in production of rice under low land condition. The farmers are now used to manage acidic soils by quantifying the requirement and frequency of lime application for correction of soil acidity. Evaluation of agro-forestry systems has facilitated the development of suitable land management practice of sloping land of hills. The agro-forestry interventions were found to be sound, economically viable and sustainable for hilly ecosystem. Research conducted during 1976-1982 helped to understand the potential of micro-watershed land use system as an alternative to shifting cultivation. Technologies in terms of farm tools and implements, soil and water conservation and water harvesting enhance by way of achieving timely operation and use of soil and water resources. The use of contour bunds, bench terrace, half moon terraces and grass water ways on steep slopes (32.5%) effectively checks soil erosion and retains 80-100% of annual rainfall in situ with various land uses. With adoption of technology standardised by ICAR Comples, farmers have rejuvenated their declined Citrusal Orchards. Mushroom production technology has popularised cultivation mushroom among small and medium farmers. This has helped in expanding production leading to additional source of income and employment generation. Plant protection technologies including rodent management have minimised yield loss due to disease and pests in crops.

The region characterised by a wide spectrum of agro-climates ranging from tropical to humid alpine and rich plant genetic resources is congineal for multiferous agriculture development. For instance, managing the current level of technology, the region's present production of foodgrains estimated over 5 million tonnes from 4 million ha could be raised to 7.8 million arable land to feed about 50 million people by 2000 AD by resorting to improved packages of scientific technology.

TABLE–I
AREA PRODUCTION AND PRODUCTIVITY OF MAJOR CROPS OF NORTH EAST INDIA (1993-94)

Crop	Area ('000 ha)	Production ('000 tonnes)	Productivity (kg/ha)
Rice	3351.9	4680.5	1396
Maize	109.4	196.2	1793
Wheat	92.8	125.6	1358
Small millets	46.1	38.4	833
Pulses	146.8	92.7	627
Total food Grains	3747.0	5068.9	1353
Oilseeds	391.8	215.6	550
Sugarcane	42.0	1700.0	40467
Cotton	12.3	10.1*	821
Jute	82.9	75.9*	949
Potato	96.5	688.9	7131
Turmeric	11.5	12.0	1043
Ginger	11.6	63.4	5473
Soybean	8.2	11.3	1378
Chillies	25.0	17.7	708
Tapioca	7.0	40.9	5843
Sweet potato	16.5	65.9	3994
Arecanut	80.4	66.2	823
Banana	56.2	680.9	12116

Source: Basic Statistics of North East India, NEC, Shillong
*production in thousand bales (1 bale = 180 kg)

TABLE–II
COMPOSITION OF REGIONAL SHARE OF FOOD GRAINS PRODUCTION (1972-73 TO 1993-94)

Year	Population ('000)	% of all India	Share of food grains (000t)	% of all India production	% of all India production Rice	Coarse Cereals	Wheat	Pulses
1972-73	19592	3.57	3055.4	3.15	7.07	0.80	0.66	0.52
1982-83	24752	3.62	3906.6	3.01	7.64	1.23	0,32	0.51
1993-94	31551	3.72	5068.9	2.78	5.92	10.23	0.21	0.70

TABLE–III
PERCENT CHANGE IN AREA, PRODUCTION AND PRODUCTIVITY OF FIVE CROPS IN FOUR PERIODS IN NER

Crop		1973-74 to 1977-78	1978-79 to 1982-83	1983-84 to 1987-88	1988-89 to 1992-93
Rice	A	6.19	8.29	13.81	17.80
	P	10.32	15.97	31.78	51.82
	Y	3.91	7.02	15.75	28.89
Pulses	A	6.48	23.45	47.28	35.65
	P	(–)9.00	7.63	36.79	45.21
	Y	(–)14.58	(–)12.73	(–)6.98	6.98
Total	A	5.48	8.77	15.93	18.99

Foodgrains	P	7.65	14.13	31.24	49.58
	Y	2.12	5.16	13.25	25.78
Oilseeds	A	10.05	44.81	100.78	110.48
	P	10.12	61.74	133.84	171.97
	Y	0.71	11.56	16.27	29.01
Fibre Crops	A	(–)11.80	(–)12.64	(–)18.17	(–)30.33
	P	(–)19.42	(–)5.54	(–)5.50	(–)15.09
	Y	(–)8.74	8.11	15.54	21.84

A : Area; P : Production; Y: Productivity

TABLE–IV

ANNUAL COMPOUND GROWTH RATE(%) OF AREA, PRODUCTION AND PRODUCTIVITY OF MAJOR CROPS (1972-73 TO 1993-94) OF NORTH EAST INDIA

Crop	Area	Production	Productivity
Rice	0.81	2.33	1.53
Pulses	1.77	3.21	1.73
Total Foodgrains	1.13	1.05	1.45
Oilseeds	4.34	5.85	1.25
Fibre Crops	(–)2.25	(–)0.10	3.04

Pulses : green gram, black gram, pigeon pea, gram, pea, lentil, beans.
Foodgrains : rice, maize, wheat, small millets and pulses.
Oilseeds : Rapeseed-mustard, sesamum, castor, linseed, groundnut.
Fibre Crops : cotton, jute, mesta.

TABLE–V

CULTIVATED AND IRRIGATED AREA ('000 HA) NER

Year	Total reporting area	Cultivated area Net	Gross	% of net cultivated area to total area	Irrigated area	% of irrigated area to net cultivated area
1977-78	22,758	3617	4530	15.9	798	22.1
1990-91	22,529	3722	196	16.5	835	22.4

Source: Basic Statistics of North East India, NEC, Shillong, 1987 and 1996.

TABLE–VI

CONSUMPTION OF PLANT NUTRIENTS (NPK) IN NER

Year	Total consumption ('000 tonnes)	Consumption of per unit gross cropped area (kg/ha)
1974-75	11.29	5.04
	(2573.30)	(15.90)
1985-86	40.57	12.11
	(8474.10)	(48.40)
1992-93	49.43	16.07
	(12152.39)	(67.10)

Source : Fertilizer Statistics, 1993.
Figures in parenthesis indicate all India estimates.

TABLE–VII
AREA UNDER HIGH YIELDING VARIETIES IN NER ('000 HA)

Crop	1973-74	1983-84	1993-94
Paddy	354.7	1260.0	1764.0(5.91)
Wheat	128.0	128.0	119.0(0.52)
Maize	19.8	34.0	72.0(2.43)

Figures in parenthesis indicate % share against all India.

FAUNAL EXPLORATIONS IN NORTH EASTERN INDIA WITH SPECIAL REFERENCE TO MEGHALAYA

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ABSTRACT

North Eastern India comprises the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. The area comes under the Indo-Chinese sub-region which is a centre of differentiation and radiation for various groups of animals. With the establishment of Eastern Regional Station, Zoological Survey of India, at Shillong, altogether 210 faunistic surveys covering 46 districts (Table I) were conducted in addition to earlier ones undertaken by the Headquarters, Calcutta.

A summary of faunal composition of various states is given under Table II, providing number of genera and species known from various states. Altogether 2545 genera and 5538 species are reported from Meghalaya the faunal picture from other states is far from complete since the studies are in progress. A list of vertebrate species restricted to N.E. part of India along with their current status is provided in Table III. The most notable feature amongst the invertebrate fauna is the occurrence of Typhloperipatus williamsoni kemp (Onychophora) in Arunachal Pradesh.

INTRODUCTION

North-Eastern India comprises the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. The whole area commands an important position geographically in having common boundaries with countries i.e. China, Bangladesh, Myanmar and Bhutan. It forms the northern part of the Assam-Arakan geological province. The area includes parts of eastern Himalayas, Patkoi, Lushai, Arakan Yoma, Garo, Khasi, Jaintia, Naga Hill ranges besides hills ranges of Tripura and broken chain of hills in Assam. The alluvial plains of Brahmaputra and Surma or Barak Valleys form part of it.

The Himalayan system which lies north of Brahmaputra valley has the same characteristic formations as distinguished in the sub-Himalayan rocks throughout their whole length from Indus to the eastern limits. The outermost hills consist of soft massive sandstones of upper tertiary age, known as the Siwalik series spreading all along the Himalayas (Anonymus, 1984).

The annual rainfall in whole area varies between 200 cm and a little over 400 cm especially in Arunachal Pradesh, Meghalaya and North Cachar Hills in Assam. Most of the hill slopes are covered with North Tropical Forest or Assam Valley Tropical Wet Evergreen; North Indian Tropical Moist deciduous Forests and Miscellaneous Forests according to forest survey records based on the manual of Champion & Seth (Ghosh, 1985).

FAUNISTIC SURVEYS

The convention on bio-diversity at the United Nations Conference on Environment and Development held at Rio in June, 1992 was signed by India along with other countries. The article 7 of the said convention makes it obligatory for the contracting parties to identify and monitor the components of bio-diversity. In order to meet this requirement a renewed effort is made in this direction.

However, since the establishment of the Zoological Survey of India during 1916 the process of faunal exploration in India, including North Eastern India was on. To explore extensively and intensively the fauna of this part of India, the Eastern Regional Station, Shillong was established in 1959. As a result, 210 faunistic surveys covering 46 districts were conducted by this station, in addition to several survey conducted in the area by the headquarters of the survey before the establishment of this station, a wealth of material was collected. It is being studied by various experts of the survey to provide clear picture of various faunal components. The details of such surveys are summarised in table-I.

ZOOGEOGRAPHY AND FAUNAL COMPOSITION

In view of the varied topography, heavy precipitation and thick vegetation cover the whole area provides favourable habitat and breeding grounds for the faunal elements. An idea of the faunal composition of various states can be had from table-II providing the number of genera and species for different groups of animals recorded.

The faunal picture of Meghalaya is quite clear since the studies have been completed and the results of the same would be published soon in ten parts by the Zoological Survey of India. Altogether 2545 genera and 5538 species are reported in the said volumes (Alfred, 1995). As regards other states it is far from complete,

because it is based on the information and identified specimens available at the Eastern Regional Station, Zoological Survey of India, Shillong. Further studies are in progress and it hoped that results would be published soon.

A list of vertebrate species restricted to NE part of India along with their present status is given under table-III. Some of the species are endemic to the area whereas others are distributed in South East Asian countries as well. Altogether 46 species are listed, which include 10 of Mammals, 10 of Aves, 6 of Reptilia, 11 of Amphibia and 9 of Pisces. All the Mammal and Aves species are threatened, of which one of the species of former and three of latter group are facing extremely high probability of extinction in the wild in the immediate future and have been defined as 'Critical'. Status of Amphibia and Pisces is at present insufficiently known. The area comes under the Indo-Chinese sub-region and is the centre of differentiation and radiation of a very large number of recent and phylogenitically young group of animals (Mani, 1968). The fauna occurring in this region has differentiated, and are typically humid tropical forest forms. They are able to spread westwards all along the wooded slopes of Himalayas and could even penetrate through Peninsular India into Sri Lanka.

The most notable and unique feature amongst the invertebrate fauna is the occurrence of *Typhloperipatus williamsoni* Kemp, (Onychophora) from Arunachal Pradesh. It may be considered as the most important discovery of the century in the field of taxonomy in India. Among the vertebrate fauna, the *Cervus eldi eldi* McCleeland (Manipur Brow-antlered Deer or Sangai) which is restricted to the Keibul Lamjao National Park in Manipur deserves mention. Its status is critical as per the categorization of IUCN (1993). In, 1951 it was regarded as extinct, but it was located in 1952-53 in the floating swamps of Keibul Lamjao area in Manipur. Although certain measures have been adopted to establish it, more efforts are required to save it from extinction.

TABLE–I

AREAS SURVEYED IN N.E. STATES

Arunachal Pradesh :

22 surveys covering 9 districts, *viz.* Tirap, Lohit, Upper Subansiri, Lower Subansiri, East Siang, West Siang, East Kameng, West Kameng and Changlong.

Assam :

38 surveys covering 11 districts, *viz.* Barpeta, Dibrugarh, Dhubri, North Cachar Hills, Darrang, Goalpara, Sibsagar, Kamrup, Kokrajhar, Nalbari and Nowgong.

Manipur :

14 surveys covering 5 districts, *viz.* Manipur Central, Manipur North, Kongpokpi, Keibul and Tipaimukh.

Meghalaya :

97 surveys covering 7 districts, *viz.* West Garo Hills, East Garo Hills, South Garo Hills, East Khasi Hills, West Khasi Hills, Ri Bhoi and Jaintia Hills.

Mizoram :

15 surveys covering 3 districts, *viz.* Aizawl, Lungleh and Chimtuipui.

Nagaland :

11 surveys covering 8 districts, *viz.* Phek, Nagaland, Mokokchung, Wokha, Kohima, Tuensang, Mon and Zunheboto.

Tripura :

13 surveys covering 3 districts, *viz.* North Tripura, South Tripura and West Tripura.

TABLE–II

FAUNAL COMPONENTS OF VARIOUS STATES OF N.E. INDIA (PARTLY MODIFIED AFTER ALFRED, 1995)

MEGHALAYA	**No. of Genera**	**No. of Species**
Vertebrate		
Mammals	83	139
Aves	232	540
Reptilia	51	94
Amphibia	11	33
Pisces	74	132

Invertebrate		
Bryozoa	3	5
Arthopoda		
Arachnida	104	217
Insecta	1662	3624
Crustacea	39	60
Annelida	25	49
Mollusca	67	223
Nematoda	49	77
Rotifera	30	111
Platyhelminthes	56	83
Madusae	2	2
Porifera	1	1
Protozoa	56	128
Total	2545	5538

ARUNACHAL PRADESH

	No. of Genera	No. of Species
Vertebrate		
Mammalia	15	20
Aves	46	64
Reptilia	15	17
Pisces	23	45
Invertebrate		
Arthopoda		
Arachnida	1	3
Insecta	65	97
Crustacea	6	9
Annelida	10	14
Mollusca	6	9
Total	187	278

ASSAM

	No. of Genera	No. of Species
Vertebrate		
Reptilia	9	9
Amphibia	5	13
Pisces	32	50
Invertebrate		
Arthopoda		
Arachnida	5	8
Insecta	85	175
Annelida	3	4
Rotifera	7	12
Total	146	271

MANIPUR

	No. of Genera	No. of Species
Vertebrate		
Reptilia	6	9
Amphibia	2	5
Pisces	38	65
Invertebrate		
Arthopoda		
Arachnida	1	2
Insecta	47	80
Crustacea	9	18
Mollusca	11	16
Rotifera	3	4
Total	119	199

MIZORAM

	No. of Genera	No. of Species
Vertebrate		
Reptilia	6	11
Amphibia	5	9
Pisces	3	21
Invertebrate		
Arthopoda	2	3
Insecta	31	42
Crustacea	4	6
Total	51	92

NAGALAND

	No. of Genera	No. of Species
Vertebrate		
Reptilia	8	9
Invertebrate		
Arthopoda		
Insecta	71	85
Crustacea	5	7
Rotifera	6	15
Total	90	116

TRIPURA

	No. of Genera	No. of Species
Vertebrate		
Reptilia	3	3
Amphibia	1	2
Pisces	31	47

Invertebrate		
Arthopoda		
Insecta	20	32
Mollusca	1	1
Rotifera	8	19
Total	64	104

TABLE–III

A LIST OF VERTEBRATE SPECIES RESTRICTED TO NORTH EASTERN INDIA WITHIN INDIAN LIMITS (ABBREVIATIONS USED : CR = CRITICAL; EN = ENDANGERED; VU = VULNERABLE AND IK = INSUFFICIENTLY KNOWN)

MAMMALIA

Lorisidae	**Status**
Nycticebus caucang(Boddaert) (Slow Loris)	IK
CERCOPITHECIDAE	
Presbytis geei Khajuria (Golden Langur)	VU
Presbytis phayrei Blyth (Phayre's Leaf Monkey)	VU
Presbytis pileatus (Blyth) (Capped Langur)	VU
Mecaca nemestrina (Linnaeus) (Pig-tailed Macaque)	VU
Macaca arctoides Geoffroy (Stump-tailed Macaque)	VU
HYLOBATIDAE	
Hylobates hoolock (Harlan) (Hoolock Gibbon)	EN
PROCYONIDAE	
Arctonyx collaris Cuvier (Hog Badger)	IK
CERVIDAE	
Cervus eldi eldi McClelland (Manipur Brow-antlered Deer or Sangai)	CR
MANIDAE	
Manis pentadactyla Linnaeus (Chinese Pangolin)	IK

AVES

ANATIDAE	
Cairina scutulata (Muller) (Whitewinged Wood Duck)	VU
PHASIANIDAE	
Tragopan temmincki (J.E. Gray) (Temminck's Tragopan)	EN

Tragopan blythii (Jerdon) (Blyth's Tragopan)	VU
Crossoptilon crossoptilon harmani Elwes (Elwes's Eared Pheasant)	EN
Lophophorus sclateri Jerdon (Sclater's or Mishmi Monal Pheasant)	EN
Syrmaticus humei (Hume) (Mrs Hume's Bar-tailed Pheasant)	CR
Bambusicolafytchii Anderson (Bamboo Partridge)	VU
GRUIDAE	
Grus monacha Temminck (Hooded Crane)	CR
HELIORNITHIDAE	
Heliopais pesonata (Gray) (Masked Finfoot)	CR
BUCEROTIDAE	
Ptilolaemus tickelli austeni (Jerson) (Brownbacked Hornbill)	VU

RETILIA

LACERTIDAE	
Takydromus sexlineatus khasiensis (Boulenger)	IK
EMYDIDAE	
Cyclemys mouhoti Gray (Assam Freshwater Tortoise)	IK
Cyclemus dentata Gray (Garo and Khasi Hills Tortoise)	IK
Kachuga sylhetensis (Jerdon) (Assam Sawback Turtle)	IK
TESTUDINIDAE	
Geochelone elongata (Blyth) (Yellow Tortoise)	IK
Geochelone emys (Schlegel and Mueller) (Assam Land Tortoise)	IK

AMPHIBIA

RANIDAE	
Rana garoensis (Boulenger)	IK
Rana danieli Pillai & Chanda	IK
Rana mawphlangensis Pillai & Chanda	IK
Micrixalus borealis (Annandale)	IK
RHACOPHORIDAE	
Philautus shillongensis Pillai & Chanda	IK
Philautus garo Boulenger	IK
Philautus cherrapunjiae Roonwal & Kripalani	IK
MICROHYLIDAE	
Microhyla berdmorei (Blyth)	IK

BUFONIDAE

Bufoides meghalayana (Yazdani & Chanda)	IK
Pedostibes kempi (Boulenger)	IK

HYLIDAE

Hyla annectens (Jerdon)	IK

PISCES

CYPRINIDAE

Barilius tileo (Hamilton-Buchanan)	IK
Garra naganensis Hora	IK
Garra rupecula (McClleland)	IK
Puntius shalynius (Yazdani & Talukdar)	IK

PSILORHYNCHIDAE

Psilorynchus homaloptera (Hora & Mukherjee)	IK

SISORIDAE

Glyptothorax striatus (McClleland)	IK
Laguvia shawi Hora	IK

CHAUDHURIIDAE

Chaudhuria indica (Yazdani)	IK
Chaudhuria khajuriai (Talwar, Yazdani & Kundu)	IK

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FRUIT GERMPLASM DIVERSITY AND ITS DEVELOPMENT IN NORTH EAST INDIA

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ABSTRACT

The tropical to temperate zone of N.E. India is endowed with varied fruit plants. Diversities among these fruit plants are distinct, which ranges from cultivated, semi-wild to wild form. The paper will highlight the occurrence of such species, the area of concentration and their respective economic potentiality as a native germplasm resources. Importance of indigenous fruit germplasms vs. Introduction of exotic fruit germplasm and their acclaimatisation have been discussed.

INTRODUCTION

North Eastern India is a meeting ground for the Indo-Malayan and Indo-Chinese bio-geographical realms (Rodgers, 1985), covering the biotic province of Brahmaputra Valley and Assam Hills where many Himalayan and Peninsular Indian elements are available. The various natural biomes are – tropical evergreen forest; very moist Sal forests, Tropical moist deciduous forests, subtropical forests, mountain temperate forests and wetlands. The topography, climate, soil factors etc. have resulted the region a rich source of plant genetic diversity. The percentage of forest cover in seven north-eastern states is also one of the reason for the occurrence of various wild fruit trees.

According to Zeven and de Witt (1982), India is one of the important centres of diversity where at least 167 species of plants were originated land diversified. The north eastern region of the country has contributed the fruit genera like – *Citrus, Musa, Mangifera, Docynia, Elaeocarpus, Myrica, Morus, Vitis* (Chadha, 1995). Besides these, a large number of minor fruits are also grown in the region. These include mainly Guava *(Osidium)*, Litchi *(Nephelium)*, Jujube *(Zizyphus)*, Pomegranate *(Punica)*, Bael *(Aegle)*, Passion fruit *(Passiflora)*, Custard apple *(Annona)*, Sapota *(Achras zapota L.)* and Carambola *(Averrhoa)*. The north eastern region named (Vavilov 1949-50), as the 'Hindusthani Centre of Origin of cultivated plants is very important for Tropical and Subtropical fruits like Mango, Banana, Orange, *Citrus*, Jack fruit, Bael etc. Many of these tropical fruits have been introduced since long from other regions also but have now a wide range of variability developed on account of diverse eco-climatic conditions. Area and production of major fruits in the region are presented in table–I, which shows that the major cultivated fruits of the region are banana, orange and pineapple.

DIVERSITIES OF MAJOR CULTIVATED FRUITS

Tropical Belt :

Mango : The cultivated mango species is known botanically as *Mangifera indica* L. Four species of mango are believed to be native of India. *Mangifera sylvatica* Rozb., a tall evergreen tree and a wild form with small fruits is found in the state of Mizoram. Diversities of mango in Manipur is noteworthy where many Myanmarese elements are migrated and naturalised. The subtropical region of Tripura, Manipur, Mizoram and southern Assam is the major area of occurrence of Mango Diversities (Mukherjee, 1975). The dwarf-mango of Manipur is an interesting species which yields fruits within 3-4 years after planting. As many as 6 cultivators and at least 2 wild species are existing in the region.

Jack Fruit : The coccon jack fruit is known as *Artocarpus heterophyllus.* The species is available in cultivated forms in the states of Assam, Tripura and hotter parts of Meghalaya, Manipur and Mizoram. Abundant variability with respect of shape, size, pulp colour, sweetness of the fruit is available within the species. The region has got the potentiality to do extensive cultivation and research on this fruit which can be commercially rewarding. The other two relatively semi-wild species are – *A. chama* Buch-Ham. and *A. lakoocha* Roxb. The fruits of these two species are also edible.

Banana : The region is rich in banana both in terms of cultivated as well as wild forms. The species is found growing from sea level to 1500m elevation. All the species of banana are the progenitor of *Musa acuminata* (A-genome) and *Musa balbisiana* (B-genome). The wild banana has got the intrinsic value and helps in understanding the evolution of cultivated types or forms. This also provide the desired traits in breeding purpose which is not available in the improved cultivars. The genomic analysis of various species of *Musa* has

really helped to understand the classification of species and varieties. The region is represented by the two genera i.e. *Ensete* and *Musa*. The former genus does not produce any sucker and purely propagated through seeds while the latter produce sucker and thus vegetatively propagated.

There are two species of *Ensete* and thirteen species of *Musa* that occurred in this region (Hore et.al., 1992). Many of the wild species of *Musa* are less studied and this warrants to establish a research centre under the banner of NRC, Banana. The major area of concentration of banana diversities are as follows :

State	District(s)	Habitat
1. Meghalaya	East Khasi, Jaintia, East and West Garo Hills.	Hilly slopes in sub-montane region. Rambhagiri area of East Garo Hills.
2. Assam	North Cachar.	Hill slopes at lower altitude.
3. Nagaland	Phek, Tuensang, Wokha and Mon.	Sub-montane hill regions along the water courses.
4. Arunachal	Lower Subansiri, Upper Subansiri, West Siang, Tirap, Lohit and Dibang Valley.	Plains to mid-hills, between 300-1200m altitudes.
5. Mizoram	Aizawl, Champhai and Lunglei.	Lower hills, river valley, Hill slopes of mixed vegetation of banana and bamboos.

The major cultivars of banana in the region are – Jahaji (AAA); Dwarf Cavendish; Borjahaji (AAA, *Robusta*); Malbhog (AAB); China (AAB); Manohar (ABB); Kanchkol (AAB); Chinichampa (AB); Bhimkol (BB); Amrita Sagar (AAA) and Martoman (AAB).

Subtropical Belt :

Citrus : The species of *Citrus* are the major fruit in the subtropical belt of the region. A few of these species are believed to have originated in India and the major centre of diversity is north-eastern India. This statement can be derived from the exemplary collection of various *Citrus* species from the Mizoram and Tripura hills of the region (Hore et.al., 1997). According to Kaul (1981), about 17 species with 52 varieties of *Citrus* occurring in this are –

1) *Citrus reticulata* Blance – Mandarin Orange
2) C. sinensis Pers – Sweet Orange (Valencia)
3) C. macroptera Montr – Satkara
4) C. Jambhiri Lush – Rough Lemon
5) C. indica Tanaka – Indian wild (Mimang Narang)
6) C. limetta (Risso) Lush – Sarbati Lime
7) C. limon (L.) Burm. – Assam lemon (Batabi/Patilebu)
8) C. medica L. – Citron
9) C. aurantifolia (Christm.) Swingle – Kagzi Lime
10) C. karna Rafin. – Karna khatta
11) C. aurantium L. – Sour Orange
12) C. megaloxycafrpa Lush. – Sishuphal (Bar-tenga)
13) C. grandis (L) Osbeck – Pumello
14) C. ichengensis Swingle – Ichang
15) C. assamensis Dutta & Bhatt. – Ada jamir
16) C. latipes (Swing.) Tan. – Khasi
17) *limonia* Osb. – Rangpur lime

The concentration of the various species is location specific. The population of *C. ichengensis, C. megaloxycarpa, C. limonia* is very limited. The Indian wild orange *Citrus indica* is found in Nokrek hill range of Garo Hills, Naga Hills near Dimapur and a few pockets in Mizoram. For necessary conservation of wild population of *C. indica*, the Nokrek range of West Garo Hills has been declared as Citrus gene sanctuary.

Similar attempt can be made on wild population of *C. jambhiri* (Rough Lemon) around Shimmong, Pugging, Ramshing and Gossang villages in Yinkiong district, along the course of Siang river in Arunachal Pradesh.

Other subtropical fruits cultivation, mainly the rosaceous species of *Pyrus, Prunus, Malus, Sorbus, Rubus, Docynia* and *Fragaria* are sporadic. There are good numbers of cultivars and their wild relatives of these Rosaceous taxa which are potential to evolve some hybrid cultivars. The occurrence of species enumeration under each genus is given below :

1) *Pyrus communis* L.
2) *Pyrus pashia* Buch-Ham. ex D. Don
3) *Prunus cerasoides* D. Don
4) *Prunus cornuta* Steud.
5) *Prunus persica* Stokes
6) *Prunus* jenkinsii Hook.f.
7) *Prunus domestica* L. ssp. *Instita* (L.) Schneid.
8) *Prunus na[ai;emsos* (Ser.) Steud.
9) *Prunus wallichii* Steud.
10) *Malus baccata* (L.) Borkh.
11) *Sorbus aucuparia* L.
12) *Sorbus cuspidata* (Spech) Hedlund
13) *Rubus assamendis* Focke
14) *Rubus ellipticus* Sm.
15) *Rubus leucens* Focke
16) *Rubus lineatus* Reinw.
17) *Rubus moluccanus* L.
18) *Rubus niveus* Thumb.
19) *Rubus paniculatus* Sm.
20) *Rubus rosaefolius* Sm.
21) *Rubus rugosus* Sm.
22) *Rubus saxatilis* L.
23) *Docynia indica* (Wall.) Decne.
24) *Docynia hookeriana* Decne.
25) *Fragaria vesca* L.

Pineapple (Ananas comoosus Merr.), Papaya (*Carica papaya* L.) and Passion fruit (*Passiflora edulis* Sims.) are the introduced species in the region that are well adapted and naturalised. Many hybrids selection has given excellent yield in the region and the superior genetypes were identified. Exotic passion fruit accession received from USA has been found very well adapted in the climatic condition of Meghalaya.

Minor Fruits : The percentage of forest cover ranges from 14.73 to 65.13 depending upon the states of the region (table-II). Many minor fruits occur within these forests or forest edges. The semi-wild population is less than its wild population. Minor fruits are not less important in the region. A few species are marketed during their ripening season and fetches a reasonable price (Pandey et.al., 1993). Species like *Citrus macroptera* and *Prunus napaulensis* are being exploited commercially for processing industry in Mizoram and Meghalaya respectively. There are at least two dozen wild edible fruit species existing in the region (table–III) which has got the potentiality to bring them in large scale cultivation, if the market is assured. Cashew nut (*Anacardium occidentale*) is another probable fruit which may be cultivated in the foot hill region. The jujube (*Zizyphus*) is under cultivation for more than 4000 years and 23 species of Indian jujube alone occur in NE India (Mehra, 1967). The state of Tripura is rich in diversities of *Zizyphus*. The wild guava (*Psidium guyanensis*) is a novelty species of this state. *Cornus capitata*, a less explored and exploited species occur at higher elevations in Arunachal Pradesh which can be brought under cultivation after necessary improvement. The natural population of Embelic/Aonla (*Emblica officinalis* Gaertn.) of West Khasi Hills (Nongkhyllum, Rajaju, Khonjoy area) warrants in-situ conservation which may even be declared as gene sanctuary for the species.

TABLE-I

AREA UNDER CULTIVATION OF IMPORTANT FRUIT OROPS IN N.E. REGION (IN 000' ha)

State	Pine-apple	Orange	Other Citrus	Banana	Apple	Pear	Stone fruits	Papaya	Mango	Guava	Coconut	Total
Arunachal Pradesh	0.256	1.667	–	0.335	–2.312	0.125	0.305	–	–	–	–	5.000
Assam	3.400	2.000	1.100	20.000	–	–	–	2.480	–	–	5.000	33.980
Manipur	6.020	4.000	2.000	8.500	–	1.600	0.400	0.200	0.100	1.000	–	23.820
Meghalaya	7.300	4.800	1.600	2.875	–	0.300	0.310	0.260	–	0.460	–	17.851
Mizoram	0.210	0.380	–	0.900	–	–	–	0.690	–	–	–	2.180
Nagaland	0.110	0.364	–	–	–	–	–	–	–	–	–	0.474
Tripura	2.830	1.210	–	2.800	–	–	–	0.300	–	–	0.800	7.940
Total	**20.126**	**14.421**	**4.700**	**35.410**	**2.312**	**2.025**	**1.015**	**3.930**	**0.100**	**1.406**	**5.800**	**91.245**

TABLE – II
FOREST COVER IN NORTH-EASTERN STATES

State	Geographic Area	Dense Forest Cover (40%)	Percentage
Assam	78438	15.842	20.1g
Arunachal Pradesh	83743	54.542	65.13
Nagaland	16579	3,531	21.29
Meghalaya	22429	3,305	14.73
Manipur	22327	5,309	23.77
Tripura	10486	1,825	17.40
Mizoram	21081	4,279	20.29

Source : Anonymous (1993)

TABLE – III
AN INVENTORY OF MINOR FRUITS OF NORTH EASTERN REGION

1. *Elaegnus latifolia* L. (Elaeagnaceae)
2. *Elaegnus pyriformis* Hook.f. (")
3. *Rubus ellipticus* Sm. (Rosaceae)
4. *Rubus moluccanus* L. (")
5. *Myrica esculenta* Buch.-Ham (Myricaceae)
6. *Sorbus cuspidata* (Spech) Hedlund (Rosaceae)
7. *Pyrus pashia* Buch.-Ham. ex D. Don (")
8. *Prunus napaulensis* (Ser.) Steud. (")
9. *Baccaurea sapida* (Roxb.) Muell.-Arg. (Euphorbiaceae)
10. *Castanopsis indica* (Roxb.) A. Dc. (Fagaceae)
11. *Viburnum corylifolium* Hook.f. & Thoms. (Caprifoliaceae)
12. *Calamus erectus* Roxb. (Arecaceae)
13. *Gynocordia odorata* R. Br. (Flacourtiaceae)
14. *Emblica officinalis* Gaertn. (Euphorbiaceae)
15. *Artocarpus lakoocha* Roxb. (Meraceae)
16. *Garcinia lanceafolia* Roxb. (Clusiaceae)
17. *Mangifera sylvatica* Roxb. (Anacardiaceae)

18. *Phoenix humilis* Royle (Arecaceae)
19. *Elaeocarpus floribundus* Bl. (Elaeocarpaceae)
20. *Cornus capitata* Wall. (Cornaceae)
21. *Annona squamosa* L. (Annonaceae)
22. *Morus acidosa* Griff. (Moraceae)
23. *Docynia hookeriana* Decne. (Rosaceae)
24. *Punica granatum* L. (Rosaceae)
25. *Vangueria spinosa* Roxb. (Rubiaceae)
26. *Syzygium aqueum* (Burm.f.) Alston (Myrtaceae).

ROLE OF NBPGR, SHILLONG IN THE REGION

Since the re-establishment and independent functioning of the station from 1986, the NBPGR Regional Station, Shillong is engaged in exploration and collection of various fruit crop germplasms from the region. Emphasis is laid on the collection of various wild species and cultivars of *Musa* and *Citrus*. The station has collected about 13 species of *Citrus* and about 100 accessions of *Musa* (cultivated + wild). All these accessions have been introduced in station's field gene bank, Barapani, Meghalaya, for maintenance, exchange land research purposes. It is a well accepted fact that most of the wild relatives of cultivated species or cultivars has the capacity to tolerate and resist under the various stress factors. Traits or genes which are holding such capacity can utilised in desired breeding programme as a donor. About 8 species of minor fruit accessions have also been introduced but due to various ecological and stress factors, most of the accessions are not performing well. The station has a mandate to introduce the exotic species/varieties which are suitable to Barapani environment. Exchange of such germplasms are usually made with the crop based institutes of ICAR for their research need.

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DEPARTMENT OF ZOOLOGY : North Eastern Hill University – CONTRIBUTIONS AND PERSPECTIVES

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ABSTRACT

The Department of Zoology, established in 1974, aims to promote higher education and research in the field of Zoology and develop trained human resources to cater the needs of the N.E. region. It offers post-graduate courses based on UGC National curriculum with thrust area in Environmental Biology and specialisations in the field of Genetics, Cell & Molecular Biology, Entomology, Parasitology, Limnology, Endocrinology, Developmental Biology and Biochemical Adaptation. This department has been awarded DRS-I and DRS-II by the University Grants Commission, has so far produced 374 M.Sc., 62 Ph.D. and 22 M.Phil. students and has published about 550 research papers in journals of national and international repute. Further, it has conducted 21 Refresher courses during the last decade and trained about 380 college and university teachers from different states of North-Eastern India.

This article presents an account of major contributions and activities of the Department of Zoology since its inception, outlines its future perspectives and suggests new frontiers which deserve regional as well as national attention.

INTRODUCTION

The Department of Zoology, one of the oldest departments of the North-Eastern Hill University, was established in 1974 under the School of Life Sciences. It began its activities with limited infrastructure and staff. Freshwater ecology remained the focal area of attention during the first decade of its inception, but with the addition of more disciplines, Environmental Biology was selected as the thrust area. This department has now emerged as one of the premier academic institutions of India committed to impart higher quality post-graduate education in Zoology with special reference to the needs of the North-Eastern region.

This paper, a status report, gives an explicit account of activities and contributions of the Department of Zoology as well as its role in strengthening higher studies, research and human resource development. Besides, it indicates future perspectives of teaching and research in relation to rich faunal diversity of the N.E. India.

MAJOR ACTIVITIES OF THE DEPARTMENT

1. ***Academic Programmes :***

The department offers M.Sc. and M.Phil./Ph.D. programmes and the courses are based on the UGC National curriculum with special reference to the regional requirements. The syllabi are regularly updated to incorporate recent advances in various disciplines and to maintain academic standard at par with other Central Universities of India. Our ongoing M.Sc. syllabus is well equipped to cover latest trends in Zoology. Further, in conformity with the recent directives of the Government of India, adequate attention has been paid to include aspects of Environmental Biology in the offered programmes.

M.Sc. Courses : These include theory and practical courses as mentioned below :

First Semester – Cell Biology & Immunology, Molecular Biology, Animal Physiology.

Second Semester – Biological Chemistry, Genetics & Developmental Biology, Parasitology & Entomology.

Third Semester – Animal Ecology & Behaviour, Endocrinology & Reproductive Biology, Aquatic Biology & Fisheries.

Fourth Semester – Biosystematics & Evolution, Techniques in Biology & Biometrics, Special Papers.

Special Papers Offered – Biochemical Adaptations, Cell Biology & Immunology, Developmental Biology, Endocrinology & Reproductive Physiology, Entomology, Genetics, Limnology, Parasitic Helminthology.

M.Phil./Ph.D. courses : These include the following one semester courses :

Departmental Papers – Animal Cytogenetics, Parasitic Helminthology, Fresh Water Biology, Plankton Ecology, Advanced Endocrinology, Adaptational Physiology, Entomology, Cell Biology & Immunology, Developmental Biology.

School Level Paper – Basic Techniques in Biological Research.

M.Sc. degrees awarded : The first batch of M.Sc. students in Zoology passed out in 1976 and till now a total of 374 students have been awarded M.Sc. degrees. The departmental intake capacity was limited to

15 seats initially, but the number of seats was subsequently increased to the present capacity of 20 to meet the regional demands. However, it has not been possible to do so due to infrastructural limitations.

A careful analysis of the results declared so far (1976–1998) indicates that about 186 (49.7%) SC/ST students and 188 (50.3%) general category students have been awarded M.Sc. degree in Zoology. A further break-up of the results presents an interesting feature and indicates that the ratio of SC/ST vs. General category was 91 : 126 (41.9% : 58.1%) during the period 1976–1989. However, the ratio of SC/ST vs. General category has registered a significant increase to 95 : 62 (60.5% : 39.5%) during the current decade (1990–1998). The available trends, hence, indicate that the department has played an important role in the promotion of higher education among SC/ST students.

The gender-wise analysis of our results shows that a total of 188 male (50.3%) and 186 female students (49.7%) have received M.Sc. degree during 1976–1998. A further break-up indicates that the sex ratio of male vs. female was 129 : 88 (59.3% : 40.7%) during 1976–1989. However, the sex ratio exhibited an inverse trend i.e. 59 males : 98 females (37.6% : 62.4%) during 1990–1998. Therefore, this department has depicted an equally important role for promotion of higher education among females students of this region.

Awards for M.Sc. students : This department offers the following awards to M.Sc. students to encourage academic activities :

Late Prof. M.K. Khare Memorial Gold Medal : Awarded for securing highest marks in Developmental Biology.

R.K. Jain Memorial Charitable Trust Book-grant : Book-grants are given to two 1st Semester (one : SC/ST and one : General category) students based on their merit in U.G. examinations.

Faculty Prize : Awarded to the best Students's seminar for M.Sc (final).

2. Research Programmes :

The department has developed infrastructure for higher research of international standard and its faculty members are trained in modern research techniques. Our completed and present research activities focus attention on various aspects of the rich faunal diversity of North-Eastern India, a global hot-spot for its bio-diversity and contribute in totality to the departmental thrust area of Environmental Biology.

Cytogenetics Group : This group has contributed significantly to the cytotaxonomy of spiders and collembollans of North-Eastern India and has studied phylogenetic relationships in the murrels and genetic variations in indigenous chocolate mahseer, *Neolissocheilus hexagonolepis*. However, their main area of research interest is biochemical genetic studies on local fish and amphibians with emphasis on identification of genetic variations at individual genetic loci in these animals. This group is also studying the role of intracellular factors in defining cellular radio- and chemosensitivity and has inferred the role of endogenous glutathione (GSH) in decreasing the cellular radio- and chemosensitivity together with its important role in DNA repair, radical scavenging and hydrogen donation. Now work is in progress on gene duplication and gene sequencing in the chocolate mahseer, influence of GSH on arcoline (an alkaloid of betel-nut)-induced DNA damage, p 53 expression in irradiated cells and cytogenetic toxicology of a new organotin antitumor compound.

Parasitology Group : This group has investigated spectrum of helminthic parasites in vertebrates of food value, e.g., freshwater fishes, chelonians, amphibians, poultry birds, sheep, goat, cattle and pigs. They have also studied the transmission dynamics of geohelminthic infections of human hosts and aspects of ascariasis and hookworm infections in human population in different climatic regions of Meghalaya. At present, they are investigating species composition of the prevalent infections, the role of the climatic factors and socio-cultural practices in transmission and dissemination of infections, and anthelmintic efficacy of an indigenous plant *Flemingia vestita*.

Entomology Group : This group has focused attention on various aspects of insect morphology and physiology, methods of pest control, physiology of vision in arthropods, insect integument and related pigmentation, biology of the Indian honey bee and biology and ecology of the Anophiline mosquitoes in Meghalaya and Assam. At present, they are investigating ecophysiology and neuroendocrinology of differentiation of the rose aphid, *Macrosiphum rosaeformis* and histochemical, physiological and biochemical aspects of vision in fish and birds.

Freshwater Biology Group : This group has undertaken studies on the biodiversity of Zooplankton and freshwater prawns with special reference to North-Eastern India. The studies have so far been completed in the states of Meghalaya and Tripura and flood-plain lakes of Assam. They have also undertaken limnological investigations in freshwater ponds and lakes, reservoirs, rice-fields and fish ponds of Meghalaya and in certain floodplain lakes of the Brahmaputra basin. In addition, they have published a

monograph on Indian *Cladocera* under the prestigious Fauna of India Series and yet another Fauna volume on freshwater Rotifera is in preparation. At present, the studies are being conducted on biodiversity, distribution and ecology of aquatic invertebrates in different states of the N.E. Region, evaluation of regional bioindicator species, Zooplankton diversity in the flood-plain lakes of Assam, limnology of ephemeral aquatic biotopes, lacustrine limnology and on biology of indigenous fishes of N.E. Region.

Endocrinology Group : This group has studied the hormonal regulation of the oxidative metabolism, intermediary metabolism and reproductive biology of local species of fish, amphibians (both hibernating and non-hibernating species), reptiles and birds. They have also studied physiology and signal transduction in rat pineal and prevalence of hypothyroidism in women of reproductive age in the state of Meghalaya. At present they are investigating the breeding biology and endocrinology of indigenous fishes and rare amphibian species, role of G-proteins in signal transduction in avian and mammalian pineal and prevalence of hypothyroidisn in human population of Meghalaya.

Cell Biology Group : This group has studied the mechanism of action of cisplatin separately and in combination with ascorbic acid against cancer in murine system and examined significant changes in various biochemical parameters (e.g. proteins, carbohydrates etc.) and enzymes (arginase, glocose-6-phosphatase, cathepsins lactate dehydrogenase etc.) in malignant cells as well as in other tissues. At prersent, this group is investigating relationship of cellular glutathione (GSH) with cisplatin's anticancer activity, effects of GSH on mitochondria and other cell organelles, significance of macrophages in tumour regression and comparative aspects of other cisplatin analogues.

Developmental Biology Group : This group has undertaken ultrastructural studies on development of chick embryo during the early stages, distribution and types of the sensory structures in the larvae and adults of indigenous butterflies as well as on reproductive and integumentary system and photoreceptor cell of tadpoles and adult amphibians. Now they are investigating ultrastructure of respiratory and circulatory systems in relation to development of tadpoles.

Biochemical Adaptation and Physiology Group : This group is engaged in the field of physiological and biochemical adaptations in relation to nitrogen metabolism and glucose during cell volume changes in air-breathing teleosts. Further, they have studied differences in physiology of hibernating and non-hibernating amphibians. At present, this group is investigating regulatory mechanisms involving enzymes related to nitrogen metabolism during hyper-ammonia and aniso-osmotic stresses at the transcriptional level and attempts are being made to explore adaptational physiology of indigenous amphibians in relation to climatic conditions.

SPECIAL ATTAINMENTS / AWARDS / HONOURS

Departmental recognition – Based on overall academic and research contributions, this department was awarded DRS scheme by the UGC under its Special Assistance Programme. We have already completed the first phase (DRS-I) of this scheme (1990–1995) and the second phase (DRS-II) is in progress (1995–2000).

Faculty recognition : The faculty members of this department has several attainments as detailed below :

International Fellowships :

1. Alexander von Humboldt Fellowship	Prof. K. Chatterjee Prof. A. Raghuvarman
2. Senior Fullbright Fellowship	Prof. R.G. Michael (Rtd.)
3. University of California Fellowship	Prof. (Mrs) V. Tandon
4. Austrian Academy of Sci. Fellowship	Prof. B.K. Sharma
5. Senior DAAD Fellowship	Dr B.B.P. Gupta Dr N. Saha
6. German Academic Exchange Fellowship (DAAD Fellowship)	Dr B.B.P. Gupta Dr N. Saha
7. BOYSCAST Fellowship	Dr S.B. Prasad
8. Mount Vernon Hospital Trust Fellow	Dr A. Chatterjee
9. UICC Fellowship (U.K.)	Dr A. Chatterjee

National Awards / Recognitions :

1.	Prof. R.G. Michael (Rtd.)	F.N.A.Sc.
2.	Late Prof. M.K. Khare	F.N.A.Sc. F.R.M.S. (London)
3.	Prof. K. Chatterjee	FZS
4.	Prof. (Mrs) V. Tandon	FZSI, FHSI
5.	Prof. B.K. Sharma	FZS, FNIE, UGC National Associateship
6.	Dr S.B. Prasad	UGC National Associateship
7.	Dr N. Saha	ISCA Young Scientist Award

Research projects : The Department of Zoology has already completed about 25 research projects (Total cost : 1.15 crore approx.) sponsored by UGC, CSIR, ICAR, DST, DoEn, DAE, NEC, GTZ (Germany), Ecodevelopment, State DST and Meghalaya Pollution Control Board.

Research degrees awarded : M.Phil / Ph.D degrees awarded are as follows :

	M.Phil (1986–1998)	**Ph.D** (1980–1998)
Total (awarded) :	22	62
SC/ST	5 (22.7%)	16 (25.8%)
General	17 (77.3%)	46 (74.2%)
Presently working :		
SC/ST	6 (100.0%)	19 (67.9%)
General	–	9 (32.1%)

The available trends of total degrees awarded vs. research students presently working indicate that more SC/ST students are now opting for research degrees.

Research publications :

The faculty members of this department have so far published a total of 550 research papers; it includes 248 paper published in reputed international journal and 302 papers in national journals. Besides, we have three books to our credit; these include one monograph under the prestigious Fauna of India series and two edited books while one more monograph is in preparation under the stated series.

Research collaborations :

The Department of Zoology has research collaborations with following international and national research institutions/laboratories.

National collaborations :

National Bureau of Fish Genetic Resources, Zoological Survey of India, Gauhati University (Assam), Dibrugarh University (Assam), Patna University (Bihar), Central Drugs Research Institute (CDRI), Lucknow.

International collaborations :

Department of Anatomy, Main University (Germany), Department of Biochemistry of Molecular Biology, University of Minnesota (USA), Department of Internal Medicine, University Clinic, Dusseldorf, Germany, Gray Laboratory, Cancer Research Trust, Northwood (UK).

Research equipments :

The department has acquired following major equipments – HPLC (2), Spectrophotometer (2), Gas Chromatograph, Optical Systems (with camera and Photoautomat) (6), Liquid Scintillation Analyser (Packard 1600 TR), Automatic Gamma Counter (Packard Cobra 5002), Ultra-Microtome, Ultra-Sonicators (2), Ultra-Deep Freezer (-80 C), Polytron homogenizer, Refrigerated High Speed Centrifuge (3), Cryostat (2), Deep

Freezers (3), Portable Cold Room, Personal Computers (8), CO2-Incubator, Knife-Maker (For Ultra-microtome), Ion Analyser, Gel Scanner, Sartorius Monopan Electronic Balance (3), Laminar Flow (2).

Other facilities :

This department has Fish farm-cum-Hatchery complex which is being made operational for research, extension and teaching activities.

3. Extension Programmes :

Refresher courses :

We have so far conducted 21 UGC sponsored Refresher courses since 1987 and trained nearly 380 college and university teachers from N.E. India. The trained personnel have played valuable role in improving teaching in Zoology at the under-graduate level.

National Identification Advisory Service :

This service is being extended, since 1980's, to research workers from different Indian universities/institutions for identification of freshwater Zooplankton.

IGNOU and PETC :

Our faculty members have acted as Councillor, IGNOU Shillong study centre and have invariably acted as resource persons at All India Pre-Examinations Training Centre, Shillong.

Others :

The faculty member of this department often participate in panel discussions over All India Radio and Doordarshan Kendra, Shillong on current issues related to our activities.

EPILOGUE

Although the Department of Zoology, NEHU is still fairly young yet it has carved a unique niche of its own in India through valuable academic and research achievements and its role in the trained human resources development. In spite of our attainments, we are well aware of our limitations and lacunae which deserve priority attention. An endeavour is on to make more fruitful contributions in our already established disciplines and to strengthen certain juvenile disciplines as well as to initiate newer areas of activity with special reference to vocational regional requirements and also in view of the new frontiers in Zoology in the 21st century. We proudly rededicate ourselves to NEHU motto "Rise up and Build" and resolve to contribute our share for overall development of the North-Eastern Region more effectively and to emerge as a nodal post-graduate Department of Zoology in India.

SOIL AND WATER CONSERVATION IN MEGHALAYA

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ABSTRACT

The Soil Conservation Department, Meghalaya originated as the Jhum Control Wing under the Forest Department in the erstwhile composite state of Assam. It was subsequently created as an independent department during 1959-60. As one of the major development departments of the state, it has been substantially contributing towards the vital cause for the conservation of soil and water, the two vital natural resources that are essential for the survival of all living organisms on the earth.

The paper attempts to focus the different programmes of the department like controlling of the depleting natural resources of soil, water and vegetation and programmes with the objective of conserving the vital resources and gearing them up towards achieving sustained food production and generating employment and adoption of improved techniques for ensuring food security.

INTRODUCTION

The Soil Conservation Department, Meghalaya originated as the Jhum Control Wing under the Forest Department in the erstwhile composite state of Assam. It was subsequently created as an independent department during 1959-60. As one of the major development departments of the state, it has been substantially contributing towards the noble cause for the conservation of soil and water, the two vital natural resources that are essential for the survival of all living organism on earth. Accordingly, the department has taken up the following as its main functions :

1. Conservation of natural resources like soil, water and vegetation for sustained development and continuing economic progress and improved way of life of the people.
2. To combat destructive agricultural practices of shifting cultivation or jhumming to preserve, maintain and improve balance of ecology and environment.
3. Maximum utilisation and conservation of soil, water and vegetation in the catchment areas by making judicious use of land according to its capability.

The Soil Conservation Department, Meghalaya has taken up the challenging task of controlling the depleting natural resources like soil, water and vegetation through various efforts and programmes with the objective of conserving the vital resources and gearing them up towards achieving sustained food production and generating employment and adoption of improved techniques for insuring food security. Thus, the necessity to control accelerated erosion along with judicious use of our valuable land resources cannot be over emphasized. As a consequence, increasing emphasis is being laid on scientific management of land resources in a manner that ensures optimal utilisation, keeping in view conservation and environmental needs. The whole set of programmes of the department are focussed on the perspective of providing soil cover to mitigate accumulated soil erosion, to provide basic amenities to the farmer communities, to create basic infrastructure to the village; to provide package of incentives to the rural communities and to create a sustainable alternative farming system as a whole for providing additional income with a view of weaning the jhummias from the traditional methods of cultivation and to uplift their socio-economic status at large.

MEGHALAYA – BASIC INFORMATION

Climate :

Meghalaya lies between $20^0$1'N and $26^0$5'N Latitude and $89^0$49'E and $92^0$52'E Longitude with an altitude ranging from 50-1961 MSL. The state is directly influenced by the South West monsoon and North East winter winds. The region experiences tropical monsoon climate which varies from western to eastern part of the plateau. Garo Hills District has tropical climate characterised by high rainfall and humidity, generally warm summer and moderately cold winter. Khasi & Jaintia Hills have high rainfall, moderately warm summer and severe winter periodic depression to below freezing point marked by appearance of ground frost at night and morning over higher elevated areas. The lower elevated areas experience fairly high temperatures for most part of the year having a mean maximum of 23-26^0C and a mean minimum of 12-17^0C. For the entire state, the mean summer temperature is 26^0C and the mean winter temperature is 9^0C. The mean annual rainfall

varies from 2000-4000mm with most rains concentrated from May to September. A maximum rainfall of 12,000mm has been recorded in the southern slopes of Khasi Hills along the Cherrapunjee-Mawsynram belt.

Natural Vegetation :

The state is rich in species of flora and varies from open scrub (Grassland) to pine forest in the central plateau region. The rest is covered by mostly moist deciduous to evergreen forest and transitional tropical moist deciduous pine forest.

Geology :

The state of Meghalaya is occupied by – a) Archean Gneissic Complex with Acid and basic intrusive b) Shillong Group of Rocks (mostly Quartzite) usually friable, Schists, Conglomerates) c) Granite rocks d) Lower Gondwana rocks e) Sylhet Traps f) Cretacious-tertiary sediments viz. Khasi Group (Jadugata and Mahadek formation), Garo Group (Simsang Baghmara, Chengapara formation).

These sediments consist of dominantly sandstone, limestone, silt stone, shale and pebbles, clays, conglomerates. These sedimentary rocks are in a complex form.

Soil :

This region has three prominent Soil Types. Its hilly uplands are covered with red loam with occasional clayey soils on the less steeper slopes on lower altitudes. This soil is rich in organic matter and nitrogen though low in phosphate and potash, it's acidic in nature and quite suitable for the cultivation of potato and various citrus fruits. Laterite Soil form a narrow strip running in a west to east direction along the northern border of the plateau. It is extremely leached and due to its low water retention capacity dries up as soon as the rainy season is over. Old Alluvium Soils can be traced along the northern fringes of the state. Sandy loam to clayey soil is used for cultivating cereals, fruits and vegetables.

Drainage Pattern :

The drainage pattern of the state represents a most spectacular feature revealing extraordinary straight courses of the rivers and streams evidently along the joints and faults. The magnificent gorges scooped out by the rivers in the southern Khasi and Jaintia Hills are the result of massive headward erosion by antecedant streams along joints of the sedimentary rocks over the block, experiences relatively great uplift. Westward in the Garo Hills, the consequent streams are mostly controlled by the structures, faults and monoclines in the sedimentary rock. The northern part of the plateau devoid of any sedimentary cover is marked by long incisive valley formed due to headward erosion along joints in the gneissic rocks and granites. The limestones covered country over southern Garo, Khasi and Jaintia Hills represents a typical karst topography. The present physiographic configuration of the plateau was attained through different geological events since Melozonic to present day as indicated by polycyclic surface at various levels. The state is drained by eight main rivers in the north and five main rivers in the south. Rivers of north and south are tributaries of Brahmaputra and Meghna respectively.

Land Degradation :

The state with its undulating topography and high intensity rainfall suffers from acute soil erosion problems and eco-system degradation. In addition, the primitive and destructive cultivation practices such as Jhumming, unscientific mining, grazing, quarrying etc., has adversely affected the overall ecological condition of the state. The loss of fertile top soil, soil fertility, flora and fauna, drying up of springs, rivers and streams cannot be sufficiently evaluated in monetary terms.

Shifting Cultivation :

Almost the entire state has been or is being influenced under shifting cultivation, except for some pockets of valley bottom lands and reserve forests. Shifting cultivation destroys the protective and productive vegetation in preference to a very brief period of immediate crop production and this results in Soil Loss and other consequential damages. Commonly known as "Jhum," this practice was valid only during those days where human population was sparse and pressure on land was negligible. The "Jhumming Cycle' then varied from 50 to 60 years; but due to increase in population, the jhum cycle has now been reduced from 3 – 5 years in Western Meghalaya to 1 – 3 years in the central and eastern parts. The rationale behind the persistency of the system greatly lies in its compatibility with the physical environment. This has made the land highly

unproductive and is alarmingly leading to extensive land degradation and imbalance in the socio-economic setup of village communities.

It has been reported that soil erosion from hills slopes of 60–70% is as follows :

First year of Jhum	146.6 tonnes/ha/yr.
Second year of Jhum	170.2 tonnes/ha/yr.
Abandoned Jhum (1st Yr)	30.2 tonnes/ha/yr.
Bamboo forest	8.2 tonnes/ha/yr.

(Source : Agriculture in NER – D.N. Borthakur)

Thus, from the point of view of soil erosion, the second year of jhumming cycle is more hazardous than first year. Mixed cropping is the system of cultivation and the important crops are chillies, sesamum, tobacco, tapioca, etc. In the "Bun" cultivation, the main crops are potato, sweet potato, millet, hill paddy, cole crops etc. Crop rotation is followed during first, second and third year and left follow from the fourth year onward.

SCHEMES IMPLEMENTED BY THE SOIL CONSERVATION DEPARTMENT – JHUM CONTROL SCHEME

This is one of the major schemes aiming to combat the further deterioration of fertile top soil due to jhum/bun cultivation. The main thrust of the scheme is to provide an effective supporting base for permanent settlement of jhummia families. Initiated in 1974-75, the scheme consist of the following components : (Achievements in table – I).

i) To provide developed permanent cultivation lands with assured irrigation facilities.
ii) To provide follow-up programme by way of free supply of inputs like seeds and plants; manures and fertilizers, including cultivation cost for 3 (three) years at a gradual sliding scale.
iii) To provide cash/horticultural crop plantation.
iv) To provide water supply to village settlements.
v) To provide link roads to work areas.

In addition to the above State Plan Scheme, the Jhum Control Programme is also being taken up through central assistance :

1. The Central Sector Scheme for control of Shifting Cultivation was started in Meghalaya in 1987-88. The original proposal was to settle 2200 families within an outlay of Rs. 650 lakhs. A total of 50 villages spreading across all the districts of Meghalaya covering 2573 nos. of families was covered from 1987-88 to 1992-93. The total amount of expenditure here was Rs. 527.96 lakhs.
2. Central Sector Scheme in the name of Watershed Development Programme in Shifting Cultivation areas (WDPSCA) was started in 1995-96 with a total outlay of Rs. 600 lakhs. This WDPSCA is being taken up in 12 centres covering 67 villages and affecting 3692 families. The financial achievement for 1995-96 and 1996-97 is Rs. 236 lakhs.

WATERSHED MANAGEMENT PROGRAMME

The term "Watershed" strictly refers to the divide separating one drainage basin from another and may be defined as "The land area from which water drains to a given point". Wherever one lives, one lives in a watershed and the people and animals are all part of the watershed community. All depend on the watershed and they in turn, influence what happens there – whether good or bad. The sustained production of food, fuel, forage, fibre, fruit and water by the management of vital resources of water, soil and vegetation are determined by the nature of watershed functioning, hence the need for watershed management.

The concept of watershed management lies in –

i) Managing water, land and vegetation for increased production of agricultural crops, grasses and trees on a sustained basis;
ii) Conserving soil and water and reducing runoff; and
iii) Decreasing sediment in runoff.

This is a package scheme aimed at integrating various soil and water conservation measures to be taken up in selected micro-watershed basis. The main objective of the programme is to bring about a continued utilisation of land, vegetation resources for optimum production. The work taken up under this programme include Terracing and Land Reclamation, Follow-up Programme, Water Harvesting and Irrigation, Drinking Water facility, construction of Link Roads to work areas, Afforestation, Cash and Horticultutral Crop Plantations, Fodder and Pasture Development and Erosion Control Works, table – I.

SOIL CONSERVATION SCHEMES IN GENERAL AREAS

This scheme covers the general areas outside those not specifically covered by the Jhum Control Programme or Watershed Management Programme. Its main objective is to reduce the erosion hazards and land degradation where faulty cultivation practices are adopted by individual farmers. Works taken up under this scheme include Terracing and Reclamation, Erosion Control Works, Water Conservation and Distribution, Afforestation, Water Harvesting Farms Ponds and Conservation Work in Urban Areas, Table – II.

EDUCATION AND TRAINING

To enhance manpower development to cope with the ever expanding works of the Department, Training Programmes of 11 months duration for Soil Conservation Demonstrators and Foresters and a 5½ months course for middle level (Technician) is conducted at Conservation Training Institute, Byrnihat.

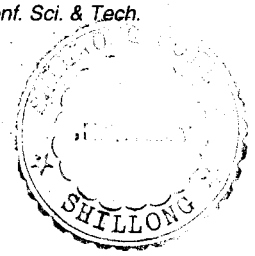
TABLE – I
ACHIEVEMENT OF SOIL CONSERVATION, MEGHALAYA, (STATE-PLAN)

JHUM CONTROL SCHEME

Items	Achievement upto 1996-97 Physical	Financial Rs. (in lakhs)
i) Land Development (Terracing & Reclamation)	8608.21 ha	533.15
ii) Follow-up Programmes	5742.52 ha	80.97
iii) Afforestation	3524.56 ha	99.89
iv) Irrigation	6727.01 ha	361.73
v) Camps & Camp Equipments	443 nos	42.70
vi) Dwelling Houses	1665 nos	33.31
vii) Drinking Water	301 nos	24.53
viii) Link Roads	664.69 km	119.48
ix) Cash/Horticultural Crop DEVELOPMENT		
a) Rubber	3139.13 ha I	
b) Coffee	1083.22 ha I	
c) Cashew nut	989.83 ha I	1287.17
d) Horticulture	1461.28 ha I	
e) Black Pepper	6.00 ha I	

WATERSHED MANAGEMENT

Items	Achievement upto 1996-97 Physical	Financial Rs. (in lakhs)
i) Terracing & Land Reclamation	3652.59 ha	190.58
ii) Follow-up programme: Seeds, Manures Fertilizers & Cultivation cost	2728.93 ha	54.69



iii)	Irrigation	3624.59 ha	249.08
iv)	Drinking Water	78 nos	9.43
v)	Link Roads	167.22 km	59.44
vi)	Afforestation	6092.01 ha	290.68
vii)	Cash Crop/Horticulture Plantation		
	a) Horticulture	955.55 ha l	
	b) Cashew nut	607.85 ha l	468.98
	c) Rubber	260.00 ha l	
viii)	Fodder & Pasture Dev. Works	22 ha	1.34
ix)	Erosion Control Works	1272.93 ha	111.30

SOIL CONSERVATION SCHEME
(In general areas)

Items	Achievement upto 1996-97 Physical	Financial Rs. (in lakhs)
i) Land Developments (Terracing) and Reclamation	10452.97 ha	140.86
ii) Erosion Control Works	5683.78 ha	356.53
iii) Water Conservation & Distribution	6027.81 ha	335.14
iv) Afforestation	19515.96 ha	673.68
v) Pasture Development Works	1035.00 ha	16.63
vi) Water Harvesting	394 nos	100.83
vii) Cash Crop Dev. Works		
a) Hortilculture	224.73 ha l	
b) Cashew nut	219.45 ha l	43.57
c) Rubber	37.00 ha l	

LAW LYNGDOH (SACRED GROVE) AT MAWPHLANG, MEGHALAYA

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ABSTRACT

The **MAWPHLANG Sacred** Grove, like all sacred groves in Ri Hynniewtrep (Khasi & Jaintia) has existed since time immemorial. There is no greater gift of nature to humanity, than the forest wealth, the flora and fauna, their richness and pristine glory which is still being preserved in these sacred groves. The **Mawphlang** sacred grove, near Shillong, had existed since the time when the administrative state of Hima Mawphlang was formed, by the twelve clans (Khadar Kur), who were the descendants of **Ka Mei Kmah**, the ancesstress, who is still revered till today in the annual religious ceremony of the twelve clans, usually held atop a hillock called Lum Ryngkew Mawiong. The stone relics commemorating the memory of **Ka Mei Kmah**, are to be found near the sacred grove. Similarly, the ancient nature of the sacred grove in other parts of Khasi Hills is emphasised by the outlaying numerous tall **monoliths** erected in memory of the departed Khasi elders. The sacred groves of the Khasi Hills are a typical example of ecosystem conservation comparable with the **UNESCO's (MAB) Biosphere Reserve Programme.** The Khasis maintain sacred groves in many places. They believe that their **Sylvan deities** live inside the sacred groves and they offer sacrifices to please these deities. It is a sang or taboo for a Khasi to cut any plant or kill animals inside the forests. They believe that the Sylvan deities would be offended if any one causes any damage to the plants and animals. Even the fallen branches and fruits are not collected from the forests for firewood or for consumption. In Mawphlang sacred grove, the **Kur lang Blah** clan have been vested with the duties of performing religious rites called **Knia Kynthong**. Such forests are protected by religious sanctions and are guarded by spiritual guardians known as **Ki Ryngkew ki Basa**.

The **Mawphlang** sacred grove has an amazing life form and it is an island of **Bio-diversity**. The grove can serve as a gene bank to the ecosystem and it is a natural living laboratory. The grove can also generate eco-tourism and environmental education. It is above all a temple of nature to instill the present generation to preserve the rich heritage for posterity. More than a century ago the celebrated English Botanist **Sir J.D. Hooker** who visited the grove had commented on the unusual wealth of species present here. Much later another English Botanist (and a forest officer) **Dr N.L. Bor** studied this and two other sacred groves including that of Shillong peak, and had pleaded for the preservation of these groves in an undisturbed condition, for all to enjoy the beauty and grandeur of the primeval forest.

INTRODUCTION

Mawphlang with its nearby sacred grove lies about 25 km south-east of Shillong and is easily approached by a black-topped road which winds its way through a picturesque landscape of scattered little hamlets and paddy fields in the narrow valleys. The sacred grove occupies the basin of a saucer-shaped depression with the hills slopping all around. A bird's eye view of the entire grove, can be obtained from the approach point along the footpath leading from the village, down to the meandering stream that winds its way into the forest. The vegetation composing this sacred grove is very different from that of the surrounding areas, which are marked by the dominating Khasi pine or **Pinus kesiya**. The dominant trees inside the forests are **Rhododendron arboreum, Pyrus pashia, Schima khasiana, Camellia caduca, Myrica esculenta, Quercus griffithii, Castanopsis kurzii,** etc. The shrub layer is represented by **Berberis wallichiana, Mahonia pycnophylla, Lyonia ovalifolia, Agapetes obovata, Sarcandra glabra, Daphne bhalua, Sarcococca saligna, Osbeckia stellata** etc. The trunks and branches of the trees and shrubs are loaded with many ferns, orchids, lichens and mosses and other epiphytes. The common ferns are **Dicranopteris linearis, Mecodium javanicum, Dryopteris paleacea, Lindsaea cultrata, Polypodium** spp., **Lycopodium** spp. etc.

The panorama keeps changing with the seasons, and has its attractive features during each season. During spring, in the months of March, April and early May, the entire area is gay with sprinkled bushes of **Rhododendron formosum** all densely covered with large white blooms, and the more flamboyant tree species **Rhododendron arboreum**, many individuals dwarfish and gnarled, and all with globose trusses of fiery red flowers standing out amidst the dark green foliage. Another outstanding tree is **Pyrus pashia** fully enveloped in white blossoms, the young leaves slowly sprouting after the shedding of the flowers. In the fields, amidst grass and scattered little tufts of the tiny herb **Gentiana quadrifaria**, which with their star-like azure-blue flowers attract the eye. More prominent due to their long stalks and golden yellow flower heads are the dandelion like **Hypochaeris radicata**. The sloping ground is rocky and lateritic with short, much-grazed grass and patches of darker green herbaceous growth of **Swertia** with star-like flowers, **Anemone** with white flowers and smaller herbs of interest like the bladderwort **Utricularia bifida** with yellow flowers and the sundew or **Drosera peltata** with interspersed clumps of sedges and short grass. **Osbeckia crinita** a low undershrub is also prominent due to its foliage marked with 3 equally emphatic nerves and the deep pink-

violet flowers with the contrasting yellow sickle-shaped anthers on short stalks. Here and there can be seen patches of the prostrate Rosaceae plant **Potentilla polyphylla** with yellow flowers.

The Sacred grove is also in sharp contrast to the surrounding low grassland. It is rimmed by a dense growth of **Castanopsis kurzii** trees as if forming a protective hedge, halting the intrusion of the pine, which is present here and there at the edge of the slope. Amongst these trees, with their somewhat glaucous foliage, are scattered trees of **Quercus griffithii**. Only after getting into the forest and walking about on the soft cushion of accumulated humus and looking around, one can see that what appeared at first sight to be a somewhat uniform greenery only, is really composed of many species with much varied foliage and floral display. There are some very ancient, large **Rhododendron arborea** ablaze with their scarlet bouquets of large flowers. Scattered and more modest are the white-flowered shrubs of **Rhododendron formosum**. There are gregarious shrubs of **Daphne cannabina** with sweet smelling white to pinkish flowers. Again white flowered, shrubs to trees of **Symplocos chinensis** easily recognised by their toothed, rough leaves and the much-twisted and grooved branches and trunks. Amongst other trees that can be easily spotted are **Exbucklandia populnea** with heart-shaped leaves and large ovate hoodlike stipules, **Engelhardtia spicata** with bunches of pendant 3-winged fruits and **Elaeocarpus lancifolius** with very young and very old leaves scarlet amidst a generally glossy green foliage of lanceolate leaves. The trees are heavily loaded with epiphytic growth of aroids, pipers, ferns, fern-allies and Orchids. Some of the branches are bent under the pressure of this accumulated epiphytic growth, and often parts of these fallen on the forest floor, and there itself forming a small colony of their own. The most conspicuous of these are the variedly fancy-leaved ferns, and the easily recognised and quite ornamental orchids. In October, the pink coloured large flowers of **Pleione praecox**, solitary or in clumps attract attention, as also the large dangling clumps of semiopen white to cream-coloured flowers of **Cymbidium elegans** from clumps of dense strap shaped leaves and stout rhizomes, tantalizingly perched on top branches of trees. There are also numerous other 'botanical' orchids with small flowers like species of **Oberonia, Otochilus,** and **Eria**. Sometimes the long pendant spikes of medium sized white flowers of a **Pholidota** may also catch the eye. On the ground itself, in some shady moist places, one may find the rare jewel orchids **Anoectochilus** with intricate variegated patterns on the leaf (the leaves being ornamental and not the flower) and the close relations of the jewel orchids - **Zeuxine** and **Goodyera**. Occasionally the saprophytic orchid - **Epipogium roseum** can also be seen, in groups of 4 to 8 white sickly looking stems producing white to pink flowers on a long stalk. These are short-lived and sprout up on decaying humus. It is also possible to occasionally discover here another rare flowering plant **Monotropa uniflora** growing in dark moist habitats, very much like that of the orchid **Epipogium**. While one is looking around on the forest floor, depending upon the season, one may stumble upon different kinds of fleshy fungi like **Scleroderma** and **Geaster** or the Earth-star, **Lycoperdon** or the puff balls, **Clavaria** or the coral-fungus, **Dictyophora** or the lacefungus, **Clathrus** or the cage-fungus, **Morchella** or the edible morel or rarely on pieces of decaying wood **Nidularia** or the bird's nest fungus. The most common of the fleshy fungi are **Polyporus** or the braket fungi responsible for the death of old trees, **Agaricus** or the mushroom forming fairy rings on the forest floor. A touch of beauty can also be seen in the overhanging or sometimes clasping grey-green to ash-brown layers of lichens often a very neglected element in any flora but certainly attention not only as a hardy element in the flora but also for their picturesqueness. It can be appreciated after a second look by the density and pattern of their covering on long neglected rocks or tree-stems or even old stems and branches they add an atmosphere to the ancient nature of these woods. Some of them, which could be recognised even by layman with a little efforts, are fruticose lichens like **Usnea** with long creeping string like thallus freely branching and often ending in flat disc like fertile tips-foliose lichens with leaf-like, lobed to deeply incised thallus, like **Parmelia** with variously sized patches each dotted with large pin-head like fertile points. Another attractive group of plants that would strike the eye, notwithstanding their perpetual greenness is the ferns. The ferns compensate their lack of different colours by the grateful beauty of their young fronds, in various stages of uncoiling and by their infinite variety of lobes of the mature fern leaves and often with the various coloured and textured silky covering of the rhizome and other parts. The pattern of the fertile spots or sori, on the back surface is also greatly varied as also their protective flaps or indusia and helps in distinguishing the different kinds. The most common one is the scented fern used by the Khasi for keeping their wardrobe fresh - **Lindsaea odorata**. Another conspicuous fern is the silver-fern with its back full of silvery scales. The frond leaving a fine pattern of itself, if pressed on the back of one's hand. Other conspicuous ferns are **Botrychium, Peranema, Dryopteris, Polypodium** etc.

The **Mawphlang** sacred grove is saved from biotic factors like fire, grazing, lopping, felling etc., because of the customs connected with the worship of Sylvan deities. It helps in the preservation of many rare plants

like **Taxus baccata** with its two ranked flat leaves and solitary seed, borne in cup-like fleshy aril; **Botrychium lanuginosum** with grape-like globose sori; **Helicia nilagirica,** the only wild species of the family Proteaceae available in India; **Gnetum scandens**, climbing gymnospesrm with broad leaves and pendant fruits; **Rauvolfia densiflora** with white flowers; and the endangered plant like **Anoectochilus sikkimensis**, a ground orchid with variegated leaves. The primitive plants like **Exbucklandia populnea** with heart-shaped leaves and large ovate hood-like stipules; **Corylopsis himalayana** with golden yellow drooping catkinlike spikes and **Manglietia insignis** with large white flowers are common in the sacred groves. Saprophytic plants like **Epipogeum roseum** with pinkish white flowers; parasitic plants like **Balanophora dioica** with cone-like inflorescence; **Monotropa uniflora** with bluish-white solitary nodding flowers, **Mitrastemon yamamonti** with cup-shaped capsules are also preserved in these natural habitats.

The Khasis (Khasi Hills) and Pnars (Jaintia Hills) tribes of the state of Meghalaya have a tradition that they are the descendants of **Ki Hynniew Trep** (The Seven Huts or Families) sent down by God in the beginning of Time to settle on these hills which have become their homeland since then, and have been called Khasi and Jaintia Hills after their occupation by the British, but which they themselves, call **Ka Bri U Hynniew Trep** (*The Home of Hynniew Trep*) and also **Ka Ri Laiphew Syiem Ka Ri Khadar Dalois** (*The Country of Thirty Syiems and Twelve Dalois*). The political system of the Khasi-Pnar is purely democratic. The Syiems and Dalois are nominal heads over their respective jurisdiction. The land, being God-given, belongs to the people. The Chieftains act as instruments to carry out the common will of the people expressed in councils or **dorbars** of elders presided over by the Chieftain for running the day to day administration. The ultimate authority is vested with the General Council or Dorbar Hima which every adult male member of the territorial unit under the headship of a chieftain has a right to attend and be heard, but the decision is invariably by consensus, not by counting of votes. The principle on which our ancestors, **Ki Hynniew Trep**, based our land tenure system was that no descendants of theirs should be landless in their own homeland. And so they formulated a system comprising of two main classes of land known generally as (1) **Ri Kynti** and (2) **Ri Raij** (also spelt Raid).

1. **Ri Kynti** lands are those reserved from the time of the founding of a Hima (an independent territorial unit of the country) for certain clans upon whom the proprietory, heritable and transferable rights were vested. They are known by different names as **Ri Kur, Ri Nongtymmen, Ri Seng, Ri Khurid** etc.

2. **Ri Raij** lands are community lands comprising of the rest of the territory for the growing population and new settlers. Each family can occupy only so much of this land as it can itself put to use for house and home and cultivation. No one can occupy more than what one can oneself put to use for one's need. A **Ri Raij** property, occupied by any one, if abandoned or left unused for three consecutive years, reverts back to the community for any other family within the **Raij**, a part of the **Hima** having the management and control of the land by customary **chief-in-durbar**. Persons or family occupying **Ri Raij** lands have no rights over them excepting upon the improvements made upon them of which they could not be deprived without due compensation for the same. Such improvements are in the nature of permanent buildings, cultivations like wet paddy fields, permanent plantations like orange orchards, forests like pine groves etc., **Ri Raij** lands are also known by different names, like **Ri Shnong, Ri Bamlang, Ri Lynter,** etc. with the passage of time, proprietory, heritable and transferable rights have accrued upon **Ri Raij** lands where occupiers have made permanent improvements.

In the light of the foregoing outline of our tradition let us take a close look at the different classes of forests constituted by our ancestors from time immemorial. They had the vision to foresee that with the march of time population would grow and so would proportionately increase the essential need of men for timber and fuel. There must, therefore, be always sufficient green cover of trees for mother earth to maintain the balance of nature in order to provide man with his vital necessities for maintaining life - not only wood for building and domestic use but also for pure air and water. Accordingly they constituted forests known to this day as **Law Kyntang, Law Lyngdoh, Law Niam, Law Adong, Law Sang, Law Shnong, Law Ri Sumar,** and **Law Kynti**.

Law Kyntang (Sacred Forests), **Law Lyngdoh** (Priestly Forests) and **Law Niam** (Religious Forests) are forests constituted in **Ri Raij** lands set apart for certain uses connected with religious ceremonies of **Hima** (State), a **Raij** (a group of villages forming a district unit of the Hima) or Shnong (Village) forming a distinct part of the **Raij** within their respective jurisdiction assigned when they were originally constituted. These forests are in the nature of the Government Reserve Forests and Game Sanctuaries we know today. The power over these forests and responsibilities for their maintenance vest in the **Syiem, Lyngdoh, Daloi** or **Sordar** acting in **dorbar** (Council) within whose jurisdiction they situate according to the distribution of such

powers and responsibilities made when they were originally constituted. The felling of any tree or cutting of any branch of it is strictly prohibited; so also is the killing of any bird or beast. The felling of any tree or cutting of any branch of it and its removal from the forest is permissible only with the previous order of the **Syiem, Lyngdoh, Daloi** or **Sordar** or **Rangbah Shnong** acting in **dorbar** as is customary when the dorbar is satisfied that the tree is needed for certain religious functions connected with the **Hima, Raij** or **Shnong** as the case may be. In the old days the orders of the **Syiem, Lyngdoh, Daloi, Sordar** or **Rangbah Shnong** as instruments to carry out the common will of the people based on their democratic system of Government were religiously obeyed. People were also God-fearing and were by natural disposition dismayed to displeasing God by any violation of the sanctity of those orders. And so these forests have been standing sentinel of the land for ages.

Law Adong (Protected Forests) **Law Sang** (Prohibited Forests) and **Law Shnong** (Village Forests) are forests constituted in **Ri Raij** lands for the use of the community within the **Hima, Raij** or **Shnong** as may be permitted by the **Syiem, Lyngdoh, Daloi, Sordar** or **Rangbah Shnong** upon whom powers and responsibilities for their control and maintenance were vested from the beginning. Permission to fell and/or remove trees or their branches from **Law Adong** and **Law Sang** is given only in cases where a family falls on evil days deserving the help of the community to rebuild their house or meet some other calamity. The felling and removal of trees from **Law Shnong** is given to every family in the village occasionally for fire wood, and to individual families should a necessary arise. But permission is given only under orders of the Headman acting in dorbar. The orders are obeyed by virtue of the common will of the people for the common good of the community. The democratic system of governance of a **Hima, Raij** or **Shnong** depends solely on the will of the people as the system does not provide for the establishment of a law enforcing machinery, like soldiers or policemen.

Law Sumar or privately owned forests in **Ri Raij** lands. They belong to an individual, family, clan or community constituting and maintaining them; and accordingly have proprietory, heritable and transferable rights over them similar to those over the **Ri Raij** lands occupied for homesteads etc. **Law Kynti** are privately owned forests of the clan owning the **Ri Kynti** land where the forest stands. They are also owned by individual families or members of the clan in cases where the heads of the clan have allotted different lots to the separate families or members of the clan.

Till fifty years or so ago, it could very well be said that people in general had profound regard for old values, great respect for law and order, deep reverence for customs and usages. Of course the influence of the administrators and, regrettably enough, that of the missionaries too, had eroded or warped such of the admirale customs and usages of the people as made them a strong and virile nation, and simple believers in their faith in the mysterious power of divine commands that evil would befall him or her, or their beloved ones, kith and kin, the community itself if they violate such commands; for example, the sanctity of Sacred forests, Sacred pools, etc. wherever the lie of the land is such that a mountain range is the source of streams and rivulets near which they could settle or there were already settlements, Sacred or Religious Forests were constituted to be sources for supply of good, clean, pure drinking water and pure air for the people.

The world's limited natural resources are undergoing certain changes due to man's tendency to exploit them to meet his ever-expanding necessities, and if proper measures are not taken to stabilise human population, the ecological balance will be lost. Hence the great danger staring us in the face now in this connection is that unless we turn to that wisdom, vision and foresight of our ancestors about the preservation of ecology and environment, it will not take long for our beautiful land to become a desert. Our Khasi ancestors were divinely inspired to know that no trees can be without land nor life can remain without trees. And so they began with laying down the system of their land tenure, our wonderful heritage the height and depth of its meaning we seem presently to have ignored.

Our Khasi ancestors were unlettered people and so had we remained till the advent of the Missionaries of the Welsh Methodists' Foreign Mission to our Khasi land in the 1840 when **Rev. Thomas Jones** and his young wife was the first Welsh Missionary to come. He sailed from Liverpool on 25.11.1840 and landed in Sohra (Cherrapunjii) on 22.6.1841. Rev. Thomas Jones mastered Sohra dialect within six months and adapted the Roman script for use as Khasi alphabets to enable the Khasi people to write and read and for Christianising them by establishing schools adapting the Roman alphabets. It was the devotion of the missionaries to their avowed calling to Christianise what they called the pagan world supplemented admirably by their dedication to the work of spreading literacy among the people as a means towards that end which accounted for the fact that barely within a span of one hundred fifty years Christianity has become the major

religion among the hill people of North East India. And this, as they say is because the field is favourable since the hill people are by nature well-disposed and friendly, and their religion is one of tolerance, especially among us the Khasi-Pnars whose very social custom is one where there is no prejudice whatsover against any creed, caste or sex. Nevertheless the British who completed the conquest and occupation of our land were pleased to describe the Khasi people as savages and blood-thirsty barbarians and they looked down upon as inferior in every respect. This was the impression they had and which guided them in their dealings with the people in the earlier days. It was also in pursuit of their imperialist policy to strengthen their rule, religion and reign over the conquered people by making them lose faith in themselves and in their belief in the beauty, truth and strength of their own culture, customs and traditions.

Not long after independence, with so many concessions and all sorts of preferential treatment as Tribals extended to the people by the Government of India to promote and accelerate their progress and religion having been left severely alone by the British, the spread of education, not only of the elementary and secondary but also of their higher type in the universities, not of humanities only but of science and technology also to broaden their outlook, a change began to enter into their attitude towards life, from the even tenor they were used to from generation to generation, but still bred into them growing disrespect for the sanctity of Sacred forests, etc. as mere superstitions of the benighted, unlettered people and also instilled a kind of disregard for the powers of the traditional and customary Heads acting in council or **dorbar** as ordained by their ancient institutions of indigenous democratic form of government because of certain laxity in Government control itself. This results in what we see today right before our eyes the fast vanishing of forests in other adjoining areas of Mawphlang sacred grove.

There are many sacred groves in the Khasi and Jaintia Hills, Meghalaya. The sacred groves at Mawphlang (**Law Lyngdoh**) and that near the Sohra rim village, are still preserved in a comparatively undisturbed condition. The groves near Shillong peak and Mawsmai village are quite disturbed due to biotic factors. These groves are situated in the folds on the hill-slopes and are surrounded by grasslands or pines, while in Mawphlang the vegetation of the **Law Lyngdoh** Sacred grove till date is subjected only to climatic factors. The biotic factors are excluded. Similarly is the case with biotically undisturbed Raliang sacred grove, Jaintia hills, Meghalaya.

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View of "Law Lyngdoh" sacred grove at Mawphlang

FIGURE–1

A Group of Monolithes in front of the sacred grove

FIGURE–2

BIOREMEDIATION OF OIL SPILLED SOIL : CURRENT SCENARIO

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ABSTRACT

Detrimental effects of oil pollution on flora and fauna had been a matter of serious concern to environmentalists. There are many sites throughout exploration & production operations at which soils have been negatively impacted by hydrocarbon spills or leakages from well heads and surface facilities. Often, the shallow aquifers (prevalent in Assam) too are affected by leaching of soluble fractions of oil. Normally, these sites are small, scattered and remote. Consequently, a low cost, in-situ remediation methodology is needed. Bioremediation is an emerging technology, utilised to degrade and detoxify hydrocrbon contaminants in soils by utilizing the biodegradative capability of the indigenous soil microbes. Present scenario in India is predominantly directed towards development of microbial consortia of potent hydrocarbon degraders. Oil & Natural Gas Corporation Ltd., in North Eastern region, had taken the lead and besides developing sound inhouse capabilities, sponsored various collaborative projects to different institutes/universities on the subject. The concerted efforts have resulted in development of infrastructure, expertise and the technology at laboratory scale.

A field study of bioremediation of oil polluted soil has been conducted in Rudrasagar Oil Field on a site near to well RDS#109, where large amount of oil was spilled as a consequence of blow out. The soil has 6.8 pH, 13% moisture content and 24200 ppm total petroleum hydrocarbon contents. 2.2 X 10^7/g of hydrocarbon utilising bacteria are present as indigenous microflora in soil. Under optimised conditions of moisture content, 120:10:1 ratio of C:N:P, at 6.8-pH, within 25-38^{0}C temperature and aeration by tilling, the indigenous mixed microflora could degrade upto 62% of crude oil. However, bioaugmentation with microbial consortium of mixed culture of *Rhodococcus* sp., *Pseudomonas aeruginosa and Bacillus licheniformis* helped to achieve as much as 72% oil bioremediation in two months' time. The study indicated that bioremediation methodology could be applied to scattered and remote exploration and production sites for bioreclamation of petroleum contaminated soils in a cost effective manner, with minimum threat to environment.

INTRODUCTION

Growing dependence on petroleum for energy has resulted in introduction of large amount of crude oil into biosphere. The contribution of crude oil pollutant to the biosphere is due to natural seeps, spillage during petroleum production, transportation and refining. With the growing awareness of environmental protection and strict enforcement of Governmental regulations, the scientists all over the world have refocused their attention for the combatment of oil pollution. Most attention has been focussed on aquatic environment because large body of water whether river or ocean are the ultimate receiving body. Nevertheless, onshore oil spills during various exploration, production operations is also a problem of increasing magnitude. Soils have been negatively impacted by hydrocarbon spills or accidental releases from well heads and surface facilities. Often, the shallow aquifers (prevalent in Assam) too are affected by leaching of soluble fractions of oil. Several authors have studied biodegradation of crude and its components in different ecosystems (Atlas & Bartha, 1992; Lee, 1995).

The application of microbes for the clean up of oil pollution gained popularity because of the advantages of biotechnological processes over other technologies for environmental clean up i.e. reduced cost and minimum environmental impact. Many hydrocarbon degrading seed cultures of *Pseudomonas, Rhodococcus, Mycobacterium, Aeromonas* sp. etc. have been developed, patented and are being marketed by many companies. Though, the genetic engineering advances have led to the development of a multiplasmid 'Super bug' hydrocarbon degrading *Pseudominas* strain for rapid degradation of fuel hydrocarbons (Friello & Chakrabarty, 1976). It hasn't been used in the bioremediation of oil spills owing to risks and regulations (Stewart Tull et.al., 1992). However, such organisms, could be useful in closed oil waste treatment systems, thereby helping in effluent treatment programs.

BIOREMEDIATION OF OIL SPILL

Bioremediation is an emerging technology, utilized to degrade and detoxify the hydrocarbon contaminants. Bio-remediation is a biotechnological method in which the biodegradative capacity of indigenous micro organisms is accelerated by adjusting the critical environmental factors and by overcoming the rate limiting factors (Atlas, 1991, Basseree, 1993). Indigenous microbes, well adapted for survival and growth in their environment through infinite generation of evolutions, are best adapted to degrading petroleum hydrocarbon contaminants. It has been observed that in ecosystem, not previously exposed to hydrocarbons, hydrocarbon degraders are typically less than 0.1% of microbial community. However, when the environment

is exposed to hydrocarbons selective enrichment of hydrocarbon degraders occur. The real challenge in bioremediation is therefore to adjust the critical environmental factors to accelerate the rate of natural biodegradation by indigenous microbes. Critical environmental factors include nutrients (especially Nitrogen and Phosphorous), temperature, oxygen, pH, moisture (in soils) and salinity (Lee, 1995). After the success of the bioremediation process in Prince William Sound, Alaska, at least 100 more sites, throughout Europe and US are being treated by this methodology (Bragg, 1992; Croft, 1995).

Oil & Natural Gas Corporation Ltd. operates several hundred production wells in Assam. The production wells are quite scattered and remote. The growing awareness about environmental protection and stringent regulations have focussed the need for developing the suitable remedial measures for bioreclamation of affected soils. Bioremediation is an emerging technology of 1990s, utilised to degrade and detoxify the hydrocarbon contaminants in soils (Sim, 1989). Since, hydrocarbon degrading bacteria are ubiquitous, the land treatment of petroleum spills by utilising indigenous soil microbes, has been recognised as a viable treatment technology (Kosteckki, 1989; Atlas, 1991; Riser & Robert, 1992).

The present study is the first in-house application of bioremediation methodology in Rudrasagar Oilfield of ERBC. The objective of this study is to assess the capability of indigenous soil microbes to degrade the spilled oil and the potential for enhancing their biodegradation rate by adjusting the critical environmental factors and/or through microbial seeding (Bioaugmentation).

EXPERIMENTAL DETAILS

Sample Collection :

Crude oil contaminated soil sample were collected from the area near a production well # 109 of Rudrasagar oil field where large quantity of oil was spilled following a blowout. Surface soil of 6m x 4m oil spilled area was excavated upto 30cm. depth and 8 samples were collected from different places. The samples were mixed homogeneously to form a composite representative sample.

Isolation land Enumeration of Soil Microflora :

The mixed culture was isolated by inoculating 5% contaminated soil in BYP medium of composition : K_2HPO_4 - 0.5g; Na_2SO_4 - 2.0g; NH_4Cl - 1.0g; KNO_3 - 2.0g; $MgSO_4.7H_2O$ - 0.2g; $FeSO_4$ $7H_2O$ - traces; Yeast extract-1.0g; Peptone-1.0g; D / W-11. Hydrocarbon degraders were enumerated on mineral salt medium agarose plate (Whittenburry et al. 1970), evenly spread with one drop of crude oil.

In-Situ Bioremediation Studies on Oil Spilled Soil :

Four small test plots of 2m x 1m were prepared on the spilled site. Total petroleum hydrocarbon in soil was estimated and pH was recorded. One plot was left as such. In the second, only weekly tiling was done. In the third, nutrients in the form of diammonium phosphate (DAP) was added to have a C:N:P ratio of 120:10:1 as per Gibb's formula and weekly tiling was done. While in the fourth, a mixed culture consortium of hydrocarbon degraders (*Rhodococcus sp.* + *Pseudomonas aeruginosa* + *Bacillus licheniformis*) developed by the authors in another study from North Gujarat oil field, was also added in addition to nutrients and weekly tiling. The extent of biodegradation was observed after 60 days by measuring the percent decrease in TPH (total petroleum hydrocarbons).

Chromatographic Studies :

The bioremediated (maximum degraded) crude oil after 60 days was fractionated into saturates, aromatics and NSOs (nitrogen, sulphur and oxygen containing compounds) fractions on a silica-alumina column. These were successively eluted by petroleum ether (40-60^{0}C), benzene and methanol respectively. Percent degradation of each fraction was estimated quantitatively. Gas chromatograms of control and bioremediated oils (Saturate fraction) were also recorded on a gas chromatograph on OV-101 capillary column.

RESULTS & DISCUSSION

Soil Microflora :

The soil sample collected from oil contaminated site of Rudrasagar oil well # 109 contain 2.2 x 10 /g hydrocarbon degraders. The high population of hydrocarbon utilisers in comparison to that normally observed in unpolluted soil is because of selective enrichment of hydrocarbon degraders in response to release of hydrocarbon to soil.

In-Situ Bioremediation :

In-situ bioremediation in field conditions was carried out, after optimizing the factors under laboratory conditions. The effect of adjusted critical factors in soil eco-system was studied by making four test plots at the oil spilled site. The results are given in table-1. The initial TPH estimated in composite soil sample was 24200 ppm. pH of the soil was 6.8, which is well within the range of optimal degradation. Therefore, no treatment for pH control is needed. The temperature recorded during the study varied from 25^0C – 33^0C. Since, maintenance of temperature in open soil system is not feasible, the bioremediation efforts should be concentrated during summer months of the year, when temperature varies between 30^0 – 38^0C. Brady (1990), suggested that covering of soil with transparent plastic sheet can increase soil temperature by approx. 5^0C. Moisture content of soil is critical for microbial activities, since nutrients, organic constituents and metabolic wastes are transferred to and from microbial cells in water. The optimum level of soil water for microbial activity is 10 – 13% (i.e. 65 – 80% of water holding capacity). As the soil in Rudrasagar field contain moisture always more than 10%, no additional moisture is required. On the contrary, during rainy season, the soil get saturated and therefore frequent tilling will reduce the problem of excess moisture, compaction and leaching.

The results (table-I) indicated 28% reduction in TPH in undisturbed contaminated soil, which was increased to 36% by simple weekly tiling of the upper 15 cm. soil. The availability of nitrogen and phosphorous can be maintained by application of various fertilisers. An oleophillic fertiliser, Inipol EAP-22 produced by Elf Equitaine, which has been designed to concentrate the nutrients at the oil water interface and has been used by Bragg et.al. (1992) successfully. The addition of diammonium phosphate as nutrients (biostimulation) in the third test plot along with tilling gave encouraging results and 62% oil was degraded in two months time. However, microbial seeding (bioaugmentation) with a mixed culture consortium of potent hydrocarbon degraders *(Rhodococcus sp. + Pseudomonas aeruginosa + Bacillus licheniformis)* increased the degradation to 72% i.e. by another 10%.

To ascertain, the losses due to evaporation in open soil system, a soil sample collected from adjacent unspilled soil was sterilized in laboratory in an autoclave at 121^0C to kill all the indigenous microflora and then 24200 ppm of RDS # 109 oil was mixed with it. This was also kept in the field environment as sterilised control for the same duration of 2 months. The oil content estimated after 60 days indicated 13% loss of oil, which was attributed to evaporation/weathering effect.

Effect on Fractions of Crude Oil :

Gravimetric estimation of different fractions i.e. alkanes, aromatics and NSOs, after column chromatography indicated a predominant degradation of alkanes i.e. upto 76%, followed by aromatics. The NSOs remain unattacked and their relative concentration is increased by 435% (table-II). Gas chromatograms of Saturate fractions of crude oil collected initially and after 60 days of bioremediation from different plots (fig.1) revealed the extent of biodegradation. In two months time not only n-alkanes, but iso-prenoids i.e. pristane and phytane, which were considered recalcitrant at one time, too have been removed completely and the nC17/pristane and nC18/phytane ratios (one of the biodegradation indices) could not be calculated. It is seen that straight chain alkane compounds are more readily attacked than the iso-prenoidal and cycloalkanes.

CONCLUSIONS

Surface soil, spilled with crude oil contain anomalous population of hydrocarbon degraders. The biodegradative capability of indigenous microbes can be greatly increased by addition of nutrients (diammonium phosphate) with regular tiling of the soil. Bioaugmentation with the developed consortium of mixed culture of *Rhodococcus* sp., *Pseudomonas aeruginosa and Bacillus licheniformis* helped to achieve as much as 72% oil bioremediation in two months time. Thus Bioremediation methodology could be applied to scattered and remote exploration and production sites for bioreclamation of petroleum contaminated soils in a cost effective manner.

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TABLE–I
IN-SITU BIOREMEDIATION OF RDS#109 SPILLED OIL

Initial TPH	–	24200 ppm.
pH of soil	–	6.8
Temperature variation	–	25–33^{0}C
Moisture content	–	13%

Test Plot	Treatment Option	Remaining TPH Content (ppm) after 60 days	Degradation (%)
A	No Treatment	17424	28.0
B	Only Tilling	15488	36.0
C	Nutrient + Tilling	9196	62.0
D	Nutrient + Tilling + Seeding	6776	72.0
	WEATHERING EFFECT		
0	Sterilized Soil Control	21054	13.0*

* Evaporation Losses

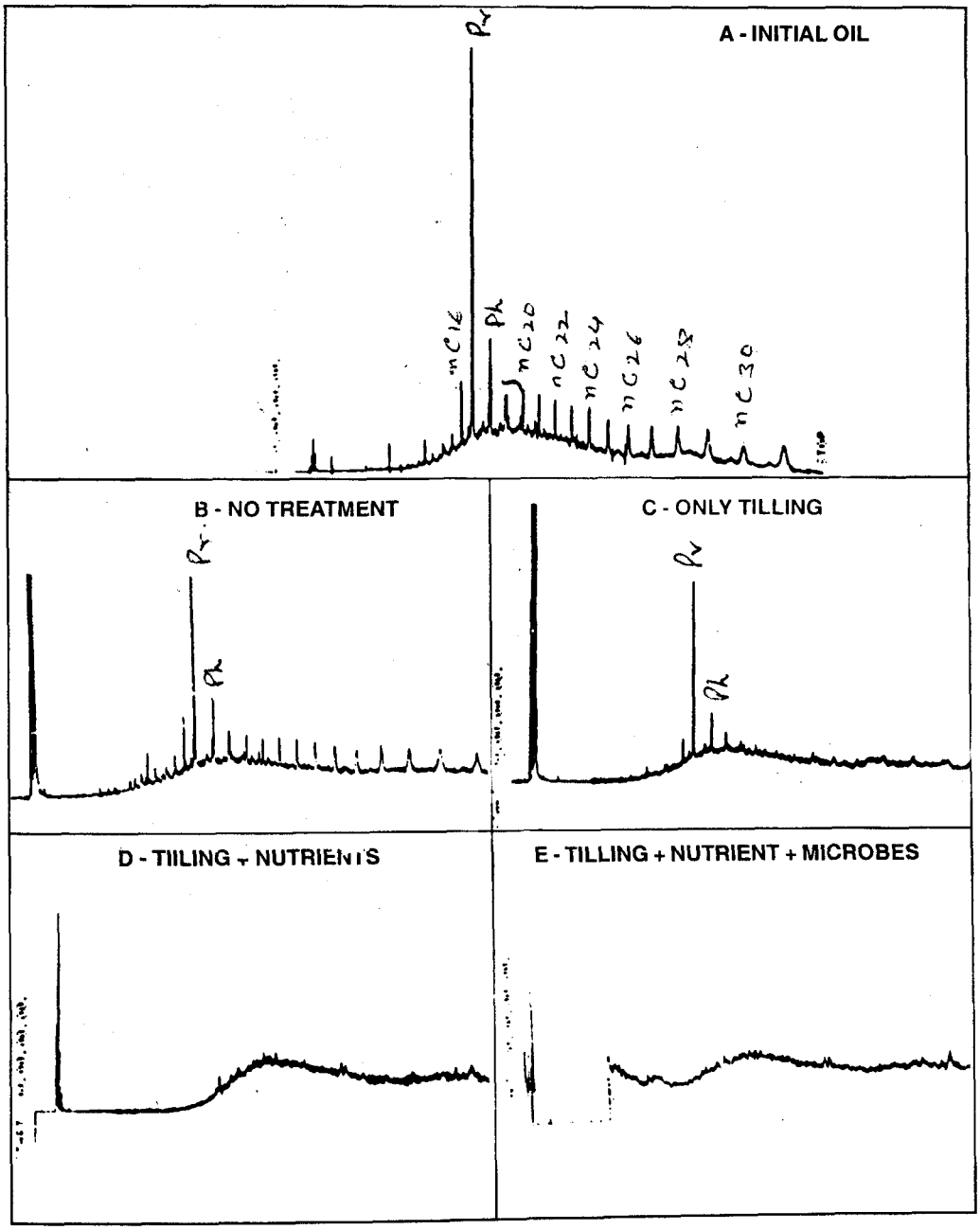
TABLE–II

CHANGES IN GROSS COMPOSITION OF IN-SITU BIOREMEDIATED RDS#109 SPILLED OIL

Fraction	Initial %	Final %	Degradation %
Saturates	46.00	11.04	76.00
Aromatics	45.00	40.77	09.40
NSOs *	09.00	48.19	(–)435.50

*Nitrogen, Sulphur and Oxygen containing Compounds

GAS CHROMATOGRAMS OF SATURATE FRACTIONS OF BIOREMEDIATED RDS#109 OIL



FIGURE–1

CYANOBACTERIAL NITROGEN METABOLISM : RELEVANCE IN AGRICULTURAL BIOTECHNOLOGY WITH REFERENCE TO NORTH EAST INDIA

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ABSTRACT

Studies on certain aspects of N_2, NO_3^- and ammonium metabolism in free-living and symbiotic cyanobacteria, during the past decade, have identified new strategies for modification of diazotrophic cyanobacteria for their use in agricultural biotechnology in general and biofertilizer in particular. These findings include :

1. Heterocysts are the exclusive sites of N_2–fixation in heterocystous cyanobacteria. In symbiosis, the cyanobionts fix N_2 at a much higher rate due to higher heterocyst frequency. The increased heterocyst frequency is correlated to the carbon nutrition of the cyanobiont.
2. In free-living cyanobacteria, heterocyst formation is accompanied by increased levels of glutamine synthetase. The latter is linked to the expression of nitrogenase in heterocysts. In symbiosis the glutamine synthetase is repressed in heterocysts leading to the liberation of N_2–derived ammonia.
3. Nitrate uptake and reductase systems are absent in heterocysts. Ammonia causes repression of heterocyst development as well as nitrogenase synthesis. Nitrate represses heterocyst development but does not affect nitrogenase in preexisting heterocysts.
4. Nonheterocystous cycanobacteria contain 10-20 fold higher nitrogenase protein than that in heterocystous forms but much of it is not functional due to insufficient oxygen scavenging. There is great possibility to enhance nitrogen fixation using such strains if additional oxygen scavenging mechanisms are introduced in them.

The above findings shall be discussed in relation to the modification of free-living cyanobacterial strains for maximizing N_2 fixation, release of fixed nitrogen and their use as biofertilizers with or without chemical nitrogen supplements.

INTRODUCTION

Cyanobacteria are structurally diverse assemblage of aerobic gram-negative eubacteria (prokaryotes) characterized by their ability to perform oxygenic photosynthesis. Many are obligate photoautotrophs. Some, which can grow chemotrophically, have limited range of utilisable substrates due to absence of a functional TCA cycle (lack of 1-ketoglutarate dehydrogenase) and specific permeases necessary for uptake of exogenous sugars by the cell [4,5].

Many cyanobacteria are diazotrophic; combining two seemingly incompatible processes : the O_2-evolving photosynthesis and the O_2-sensitive N_2-fixation. While the two processes are spatially separated in heterocystous cyanobacteria (N_2-fixation in heterocysts; photosynthesis in vegetative cells), in nonheterocystous forms the two processes show temporal separation (alternating cycles of N_2-fixation and photosynthesis); thus, protecting nitrogenase from photosynthetically evolved O_2 [6].

Though capable of independent existence, cyanobacteria also enter into symbiotic associations with various plants and animals (table I), and symbiosis as a habitat exerts considerable influence on the cyanobionts' metabolism (table II). Among cyanobacterial - plant symbioses, the cyanobiont is almost always a diazotroph and the transfer of fixed-N from the cyanobiont to the eukaryotic partner (host) a common feature [11, 21, 26].

In this paper, certain aspects of nitrogen metabolism in free-living and symbiotic cyanobacteria, undertaken by us are reviewed and discussed with regard to their relevance in agricultural biotechnology in general and biofertilizer in particular.

NITROGEN FIXATION, HETEROCYSTS AND NONHETEROCYSTOUS FORMS

N_2-fixing cyanobacteria are listed in table III. Under N-limiting conditions, heterocystous cyanobacteria differentiate specialized cells called heterocysts which form 5-10% of the total cell population in a filament. Heterocyst differentiation from vegetative cells is accompanied by structural, biochemical and genetic changes [30]. In such strains heterocysts are exclusive sites of nitrogenase synthesis and N_2-fixation [2].

Among nonheterocystous forms, nitrogenase synthesis and activity occurs in all the cells. A comparison of heterocystous and nonheterocystous forms in terms of nitrogenase levels and activity (table IV) shows that while nonheterocystous forms possess nearly 15-fold higher nitrogenase protein, the activities are similar.

This clearly shows that much of the nitrogenase in nonheterocystous cyanobacteria is not functioning for N_2-reduction [20, 24]. Whether some of the nitrogenase in these strains is involved in O_2-reduction, as in *Azotobacter* [28], is as yet uncertain but possible.

For biotechnological application of cyanobacteria, it is desirable to have strains with higher nitrogenase levels and activity. To achieve this goal, one strategy would be to study non-heterocystous forms, which already have very high levels of nitrogenase, with an aim to make such strains use all their nitrogenase for N_2-reduction. A second strategy, involving heterocystous forms, would be to increase heterocyst frequency and thereby increase nitrogenase levels and activity. Studies on symbiotic cyanobacteria provide valuable insight into increased heterocyst differentiation, N_2-fixation and release of fixed-N; all of which are desirable in strains for biofertilizer use [12]. In symbiosis, demand for fixed-N is much higher and the cyanobiont is entirely responsible for the total fixed-N requirements of the whole symbiosis. Hence, cyanobionts in symbiosis possess much higher heterocyst frequency (upto 80%). Heterocyst frequency beyond 30% leads to occurrence of double and multiple heterocysts in a row. N_2-fixation rates show a linear correlation with increasing frequency of single heterocysts instead to the total heterocyst frequency. Immunogold labelling studies show nitrogenase protein to be present in all heterocysts including multiple heterocysts but in the latter case nitrogenase is unable to function due to non-availability/restricted availability of fixed-C from the vegetative cells; heterocysts in the middle of a chain of heterocysts have no contact with vegetative cells and those at the end of the chain have contact with only one vegetative cell as against single heterocysts which are connected to two vegetative cells, one on each side [2]. Thus, while it is desirable to have strains with high heterocyst frequency, such heterocysts should occur singly, since double/multiple heterocysts are not efficient.

A comparison of heterocyst frequencies of cyanobionts in various symbioses shows an interesting pattern (table V). Increase in heterocyst frequency of cyanobiont varies with its role in the symbiosis. Symbioses, where the cyanobionts transfer fixed-N to and in return receive fixed-C from the eukaryotic partner, have the highest heterocyst frequency, followed by those where cyanobionts transfer fixed-N but receive little or no fixed carbon (i.e. are self sufficient with regard to fixed-C). Cyanobionts which transfer fixed-C as well as fixed-N have heterocyst frequency and N_2-fixation rate which are no higher than those in free-living cyanobacteria. Thus, the availability of fixed-C/carbon nutrition plays an important role in frequency of heterocyst differentiation in cyanobacteria. This is logical because already much of the N_2-derived N is liberated by the cyanobiont, reducing its carbon skeleton requiremtns for ammonia assimilation. High heterocyst frequency and N_2-fixation rates in symbiosis create a much higher demand for fixed-C as a source of energy and reductant for N_2-fixation. While much work has been done on studying heterocyst differentiation from nitrogen nutrition point of view, there is a need to study regulation of heterocyst differentiation from the carbon nutrition point of view. Indeed our recent studies show considerable increase in heterocyst frequency and N_2-fixation rate during photoheterotrophic/heterotrophic mode of nutrition in a symbiotic *Nostoc* strain grown in free-living state (table VI).

NITRATE TRANSPORT AND ASSIMILATION

Diazotrophic cyanobacteria prefer nitrate to N_2. Exogenous nitrate is first transported in to the cell where it is reduced to ammonia by the combined action of nitrate reductase (NR) and nitrite reductase (NIR).

In heterocystous filamentous cyanobacteria, nitrate uptake and reductase systems show spatial separation since both these systems have been found to be associated with vegetative cells only and have been shown to be absent in heterocysts [10, 13]. The lack of NR activity in heterocysts was found to be due to the absence of NR-apoprotein synthesis and not due to the absence of Mo-cofactor (table VII). This was indicated by the fact that while heterocyst extracts showed no NR activity, complementation of heterocyst extracts with NR- apoprotein preparations from whole filament extracts gave reconstituted NR activity similar to that in whole filament extracts (table VII). This also showed that Mo-cofactor was present in heterocysts. Such a strategy (i.e. the repression of NR in heterocysts) prevents competition for Mo and reductant between the two molybdoenzymes, NR and nitrogenase, both of which use reduced Fd as reductant. Further more, heterocysts lack the ability to take up nitrate, although they take up and assimilate ammomium and show NIR and GS activity indicating that the heterocyst preparations used were metabolically active (table VII). Further studies on isolated and intact heterocyst have established that this loss of nitrate uptake and reductase during heterocyst differentiation is irreversible and that it is probably related to the genomic reorganisation in heterocysts resulting in *nif* gene cotranscription [13].

AMMONIUM TRANSPORT AND ASSIMILATION

Ammonia is a preferred source of inorganic-N for cyanobacteria. When available in excess, it represses nitrogen-fixation as well as nitrate uptake and reduction. This is understandable since both N_2 and nitrate are first converted to ammonia through energy-dependent processes in the cell before further metabolism. Thus, direct availability of ammonia is preferable in terms of the energy economy of the cell. At physiological pH ammonia occurs predominantly as NH_4^+ which can permeate through biological membranes without a transport mechanism. Studies on diazotrophic cyanobacteria (both free-living and symbiotic) have shown that cyanobacteria possess energy-dependent ammonium transport systems (ATS) which actively transport ammonium into the cells and probably play a role in cyclic retention of intracellular ammonia [9, 17, 18, 23]. Recent studies on *Anabaena* 7120 suggest that ATS in cyanobacteria may regulate ammomium entry into the cells by undergoing affinity modulation in response to external ammomium concentrations [14]. ATS-deficient strains of diazotrophic cyanobacteria may be desirable for use as biofertilizer, photobiological production of ammonia and establishment of artificial symbioses [15]. Such strains shall leak N_2-derived ammonia, shall not be able to use exogenous fixed-N and shall have permanantly derepressed nitrogenase. Although ATS, as such, has not been characterized in isolated heterocysts, they do take up and assimilate ammonia (table VII). Furthermore, on exposure to 13N-ammonium isolated heterocysts take up and convert it to glutamine via GS [27]. However, since glutamate synthase (GOGAT) is absent in heterocysts [16, 27] the glutamine thus produced accumulates. In intact filaments, the glutamine produced in heterocysts is transferred to the vegetative cells where it is converted to glutamate by GOGAT [16, 27]. Thus, while heterocysts lack the ability to take up and metabolise nitrate, they have the ability to take up and metabolise ammonium at least upto the level of glutamine.

EFFECT OF NITRATE AND AMMONIA ON HETEROCYST DIFFERENTIATION AND NITROGENASE EXPRESSION

Nitrate and ammonia are known to adversely affect heterocyst differentiation and nitrogenase synthesis / activity in heterocystous cyanobacteria [25]. However, in contrast to the ammonium effect, the effect of nitrate on heterocyst differentiation and nitrogenase activity has been found to be variable and generally less potent. A recent study om *Anabaena cylindrica* [22] showed that nitrate inhibited heterocyst differentiation by 35% and the nitrogenase activity decreased correspondingly. However, ammonia caused a much greater decrease in heterocyst differentiation (80%) and an even greater decrease in nitrogenase activity (98%) (table VIII).

The relatively weaker effect of nitrate on inhibition of heterocyst differentiation may be explained by the fact that it took 72 h to induce nitrate uptake and assimilation in A. *cylindrica* while ammomium uptake and assimilation started immediately. Secondly, nitrate uptake rate was considerably lower than the ammomium uptake rate. Therefore higher heterocyst frequency in nitrate - grown cultures was a reflection of the fact that for the first three days heterocyst differentiation occurred normally since nitrate was not metabolized during this period. The small number of heterocysts present in the ammonium-medium may be mostly accounted by the heterocysts present in the N_2-grown inoculum rather than new heterocyst formation. The fact that in ammonium-medium nitrogenase activity decreased more drastically than heterocyst frequency indicated that even those heterocysts which were present in the ammonium medium were either lacking nitrogenase protein or its activity. We have investigated nitrogenase protein levels in heterocysts of nitrate and ammonium-grown filaments of *A. cylindrica* using immunogold labelling (table VIII). In heterocysts of N_2- and nitrate-grown cultures, nitrogenase antigen level was similar indicating that nitrate did not affect nitrogenase synthesis in differentiated heterocysts. This is readily explained by the fact that heterocysts lack nitrate uptake and reductase systems. However, there was little or no nitrogenase protein in heterocysts of ammonium-grown cultures as indicated by the fact that labelling of nitrogenase in heterocysts of ammonium-grown cultures was extremely low and comparable to the background label found in the vegetative cells.

From the above, it can be concluded that nitrate represses heterocyst differentiation thereby causing decrease in nitrogenase activity, when N_2-fixing cultures are transferred to nitrate-medium, but nitrate does not csuse repression of nitrogenase in differentiated heterocysts. In contrast, ammonia represses heterocysts differentiation as well as nitrogenase synthesis in differentiated heterocysts thereby causing a relatively much greater decrease in nitrogenase activity when N_2-fixing cultures are transferred to ammonium-medium.

Where chemical nitrogen fertilizers are used as supplement to diazotrophic cyanobacteria (being used as biofertilizer), the choice of the chemical fertilizer is crucial because it represses N_2-fixation by cyanobacteria. As shown above, nitrate fertilizers would be less inhibitory to N_2-fixation than the ammoniacal fertilizers. Such

studies, if extended to other chemical fertilizers, would help choose the most suitable chemical nitrogen fertilizer (which has least adverse effect on N_2-fixation) for use as supplement.

CORRELATION BETWEEN NITROGENASE AND GLUTAMINE SYNTHETASE EXPRESSION IN HETEROCYSTS

Glutamine Synthetse is the primary ammonia assimilating enzyme in heterocystous cyanobacteria [25]. This enzyme is present in both heterocyst and vegetative cells. As seen in Table 8, in N_2-grown cultures, heterocysts had GS antigen level two-fold higher than that in vegetative cells as noted earlier [3, 19]. Heterocysts in nitrate-grown cultures showed a similar GS level and distribution pattern. Heterocyst in nitrate-grown cultures showed a similar GS level and distribution. In contrast, heterocysts in ammonium-grown cultures had a GS level similar to that in vegetative cells. In other words, the GS level in heterocysts of ammonium-grown cultures was half of that in heterocysts of N_2- and nitrate-grown cultures. Thus, heterocysts containing nitrogenase (N_2- and CO_3-medium) had two-fold higher level of GS than that in vegetative cells while in heterocysts lacking nitrogenase (ammonium-medium) GS level were down to the same level as that in vegetative cells.Therefore, it is obvious that expression of high level of GS in heterocysts is correlated to expression of nitrogenase. It follows therefore, that probably this additional GS in heterocysts is involved in assimilation of N_2-derived ammonia. This is further substantiate from our studies on symbiotic systems.

Symbioses where fixed-N is transferred from the cyanobiont to the host plant in the form of ammonia (e.g. *Rhizosolenia,* lichens, liverworts and hornworts, and *Azolla*), the GS level, activity and the relative distribution pattern between heterocysts and vegetative cells undergo change [1, 7, 8, 19]. A common feature in all these symbioses is the partial repression of GS in heterocysts with the result that heterocyst GS level becomes identical to that in vegetative cells (table IX for *Nostoc - Anthoceros* symbiosis). This contrasts with the situation in free-living cyanobacteria where heterocysts possess a two-fold higher GS level than that found in vegetative cells. The precise mechanism for enhancement of GS level in heterocysts is not clear. However, heterocystous cyanobacteria possess two promoters for *gln* A gene, one of which is a *nif*-like promoter responsible for elevated levels of *gln* A transcription under N_2-fixing conditions [29]. If the transcription through this promoter is located in heterocysts, it would explain the high levels of GS in heterocysts. Ammonia, while repressing *nif* gene expression, will also repress the *nif*-like promoter of *gln* A. The result is a total inhibition of nitrogenase synthesis by ammonia while the *gln* A transcription can still occur through the second promoter thereby synthesizing GS in heterocysts but at a level similar to that in vegetative cells. The two processes, *nif* and *gln* A transcription by the *nif*-like promoter, therefore seem to be coregulated. However, in heterocysts of the cyanobionts, the *nif* gene expression is not accompanied by enhanced level of *gln* A transcription / GS synthesis as indicated by the fact that GS level in such heterocysts remains at a level similar to that in vegetative cells. In such a situation the cyanobiont heterocyst is unable to assimilate the N_2-derived ammonia which is liberated out of the cell and assimilated by the host. Thus, the enhanced level of GS in heterocysts seems to be essential for assimilation of N_2-derived ammonia. This finding is relevant to the current efforts regarding generating ammonia releasing strains of cyanobacteria for photobiological production of ammonia or for their application as biofertilizers.

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TABLE–I
CYANOBACTERIAL SYMBIOTIC ASSOCIATIONS

In Association with	Cyanobiont	Remarks
Algae		
Marine diatoms (*Rhizosolenia, Hemiaulus*)	Richelia, Calothrix	Cyanobiont resides in periplasmic space.
Fresh water diatoms	Unicellular cyanobacteria	Cyanobiont appears as bluish-green Intracellular Inclusion bodies.
Fungi		
Lichens	*Nostoc, Scytonema*	Intercellular symbioses called cyanolichens; *Fischerella, Calothrix,* consist of two membered associations between unicellular cyanobacteria fungi and cyanobacteria or three membered associations containing a green alga as well. About 8% of nearly 18,000 species of lichens are cyanolichens.
Bryophytes		
Anthoceros	*Nostoc*	Cyanobionts occupy mucilage-filled cavities on the *Notothylus Nostoc* undersurface of the gametophyte. Symbiosis Intercellular.
Blasia	*Nostoc*	
Cavicularia	*Nostoc*	
Sphagnum	*Nostoc*	Cyanobionts occupy the hyaline cells.
Pteridophytes		
Azolla	*Nostoc*	Cyanobionts occupy the leaf cavities on ventral surface of dorsal lobes of *Azolla* fronds.
Gymnosperms		
Cycads	*Nostoc*	Intercellular symbiosis Cyanobionts occupy cortical zone of the coralloid root nodules. Intercellular symbiosis.
Angiosperms		
Gunnera	*Nostoc*	Cyanobionts reside inside the host cells in stem glands. Intracellular symbiosis.

Marine sponges		
38 genera belonging to the groups Calcarea and Desmospongia	*Aphanocapsa, Phormidium*	Cyanobionts occur intracellularly and/or intercellularly throughout the sponge tissue and/or in superficial tissues only. Symbioses mainly restricted to photic zone.
Nonphotosynthetic protists		
Amoeba (*Paulinella*) Glaucophyta (Cyanophora)	Cynelles	Intra cellular inclusions resembling unicellular thin-walled cyanobacteria referred as 'cyanelles.'
Bacteria		
Various nonphotosynthetic bacteria	Various heterocystous	Cyanobacteria act as host; bacteria generally reside in and non-heterocystous mucilage sheath; in heterocystous forms bacteria are cyanobacteria generally clustered around heterocysts or heterocyst-vegetative cell junctions. In *Pleurocapsa minor* the symbiont occurs intracellularly.

TABLE–II
SOME CHARACTERISTICS OF CYANOBACTERIAL SYMBIOSES

Symbioses	N_2-fixation	Heterocyst frequency in cyanobiont	Transfer of Fixed Nitrogen	GS level	CO_2– fixation & transfer of fixed-C
Diatom	Yes	One heterocyst per trichome in *Richelia*; cyanobiont in *Rhopalodia* is non-heterocystous	Yes	less than 5% of the normal level; repression of the enzyme synthesis	Both symbionts fix CO_2
Lichens	Yes	4-8% in bipartite and 15-25% in tripartite lichens	Yes, as ammonia	5-10% of the normal level; repression of the enzyme synthesis	Cyanobiont fixes CO_2 in all cyanolichens but transfers fixed-C (as glucose) in bipartite lichens only
Bryophytes	Yes	up to 43%	Yes, as Ammonia	30% of the normal level; enzyme synthesis reduced by 50%	Both symbionts fix CO_2; CO_2 fixation by cyanobiont inadequate for high NO_2-fixation.

				in heterocysts	Fixed-C moves from bryophyte to cyanobiont
Azolla	Yes	25-30%	Yes, as Ammonia	20% of the normal level, regulation at transcription level	Both symbionts fix CO_2 but in old fronds fixed-C moves from *Azolla* to cyanobiont for high N_2-fixation
Cycads	Yes	up to 46%	Yes	Normal	No CO_2 fixation in the cyanobiont; fixed-C moves from cycad to cyanobiont
Gunnera	Yes	up to 65%	Yes, as Ammonia	70% of the normal level; activity affected Synthesis reduced by 50% in heterosysts	No CO_2 fixation in the cyanobiont; fixed-C moves from *Gunnera* to the cyanobiont.

TABLE–III
N_2-FIXING CYANOBACTERIA

Category	Representative Species
I. Unicellular species dividing by binary fission or budding.	
a. Anaerobic or microaerobic N_2-fixation only	*Gloeocapsa*
b. Some strains capable of aerobic N_2-fixation	*Synechococcus, Cyanothece*
c. All strains Aerobic N_2-fixers	*Gloeothece, Synechocystis*
II. Unicellular species dividing by multiple fission; All strains fix N_2 anaerobically/microaerobically.	*Dermocarpa, Xenococcus, Myxosarcina, Chroococcidiopsis, Pleurocapsa*
III. Filamentous nonheterocystous species.	
a. N_2-fixation microaerobic/anaerobic	*Lyngbya, Plectonema, Phormidium, Psedanabaena*
b. Some strains capable of aerobic N_2-fixation	*Oscillatoria, Trichodesmium, Microcoleus*
IV. Filamentous heterocystus species dividing in only one plane. All are aerobic N_2 fixers.	*Anabaena, Calothrix, Cylindrospermum Nodularia, Nostoc, Scystonema*
V. Filamentous heterocystous species dividing in more than one plane. All are aerobic N_2-fixers.	*Chlorogleopsis, Fischerella*

TABLE–IV
RELATIVE NITROGENASE ACTIVITIES AND PROTEIN LEVELS IN HETEROCYSTS AND IN NON-HETEROCYSTOUS CYANOBACTERIA

Values for protein levels represent labelling densities (number of gold particles per μm^2 area) obtained in immunogold labelling experiments using rabbit anti-*Rhodosporillum rubrum* nitrohenase Fe-protein (1:100 dilution) as primary antibody and goat anti-rabbit IgG conjugated to size 10 nm colloidal gold as secondary antibodies.

	Nitrogenase antigen	Nitrogenase activity [a]
Heterocysts	54 (3-4) [b]	10-12 [c]
Oscillatoria limosa	57	12-15
Plectonema boryanum	50	10-15
Gloeothece PCC 6909	45	6-8

[a] nmol C_2H_2 reduced h^{-1} (ug Chl a)$^{-1}$

[b] Figures in brackets represent values obtained when heterocyst labelling is expressed as per unit cell area taking into account heterocysts as well as vegetative cells.

[c] Nitrogenase activity relates to whole filaments.

TABLE–V
HETEROCYST FREQUENCIES IN CYANOBIONTS OF CYANOBACTERIAL-PLANT SYMBIOSES

Category	Symbiosis	Heterocyst frequency (%)
I. Symbioses wherein the cyanobiont provides fixed-C as well as fixed N to the eukaryotic partner	Bipartite lichens	2-5 %
II. Symbioses wherein the cyanobiont provides only fixed-N to the eukaryotic partner	Tripartite lichens, *Azolla*	15-30 %
III. Symbioses wherein the cyanobiont provides fixed-N to and receives fixed-C from the eukaryotic partner	Liverwords, hornworts, Cycads, *Gunnera*	45-80 %

TABLE–VI
EFFECT OF SUGARS ON HETEROCYST FREQUENCY AND NITROGENASE ACTIVITY IN *NOSTOC* ANTH

Growth Condition	Heterocyst frequency (%)	N_2 ase activity (nmol C_2H_2 reduced/μg Chl a/h)
N_2-medium	13.95	3.09
N_2-medium + 50 mM Glucose	21.64	12.85
N_2-medium + 50 mM Fructose	19.02	9.05
N_2-medium + 15mM Sucrose	17.50	8.65
N_2-medium + 50 mM Lactose	18.77	4.79
N_2-medium + 50 mM Maltose	21.02	4.19

TABLE–VII
NITRATE, NITRITE AND AMMONIUM UPTAKE RATES AND THE ACTIVITIES OF NITRATE REDUCTASE, NITRITE REDUCTASE AND GLUTAMINE SYNTHETASE IN ISOLATED HETEROCYSTS AND WHOLE FILAMENTS OF ANABAENA 7120

Experimental material	Uptake rates (nmol min^{-1} mg^{-1} protein) Nitrate	Nitrite	Ammonium
Isolated heterocysts	not detectable	not detectable	20
Whole filaments	3.0	2.7	15
	Enzyme activity (nmol product formed min^{-1} mg^{-1} protein)		
	Nitrate reductase	**Nitrite reductase**	**GS**
Isolated heterocysts	not detectable	23.5	125
Isolated heterocysts extract supplemented with apoprotein preparation from whole filaments	6.25 [a]		
Whole filaments	3.4	25.6	70

[a] The amount of apoprotein used was 2 mg per ml.

TABLE–VIII
HETEROCYST FREQUENCY, NITROGENASE ACTIVITY, NITROGENASE PROTEIN LEVELS AND GS PROTEIN LEVELS IN HETEROCYSTS AND VEGETATIVE CELLS OF N_2, NO_3^- AND NH_4^+ — GROWN CULTURES OF *ANABAENA CYLINDRICA*

(The cultures were harvested after 7 days of growth. H, heterocyst; V, vegetative cell)

Material	Heterocyst frequency (%)	Nitrogenase activity [a]	Nitrogenase protein level [b]		GS protein level [b]	
			H	V	H	V
N_2-grown	3.9	27	200	11	72	32
NO_3^- – grown	2.7	18	212	12	67	33
NH_4^+ – grown	0.8	0.3	11	7	37	33

[a] nmol C_2H_2 reduced $h^{-1}\mu g^{-1}$ Chl a
[b] gold particles μm cell area

TABLE–IX
GS PROTEIN LEVELS IN HETEROCYSTS AND VEGETATIVE CELLS OF THE CYANOBIONT AND THE FREE-LIVING CULTURED ISOLATE *NOSTOC* ANTH FROM *ANTHOCEROS PUNCTATUS*

Sample	Number of gold particles cm^{-2}
Nostoc ANTH	
Vegetative cells	9 [a]
Heterocysts	19
Cyanobiont	
Vegetative cells	7
Heterocysts	8

[a]GS (glutamine synthetase) antigen was quantitated using immunogold labelling and by counting gold particles per unit cell area on TEM photomicrographs (15,000 magnification).

TECHNICAL SESSION – IV

ENVIRONMENTAL SCIENCES

WATER INJECTION FOR PRESSURE MAINTENANCE IN THE OIL FIELDS OF UPPER ASSAM – AN OVERVIEW

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ABSTRACT

Continuous production of oil and gas from the reservoir leads to pressure decline as the time progresses. This pressure has to be replenished for optimum recovery from the reservoir. Various methods like water injection, gas injection and polymer flooding are adopted for this purpose. Water injection is a dominant method among these most, the world over, because of its easy availability and better oil sweep efficiency. In Upper Assam the main oil producing sands are Tipam and Barail which are operating under depletion drive and observed gradual pressure decline. Water injection was initiated in 1982 to arrest further pressure decline in these sands first in Geleki. Subsequently all the fields were brought under this scheme. At present approximately 5000 M^3/D water is injected through 81 injectors from seven water injection plants. For the success of water injection the quality of water plays a significant role. The present paper deals with the various techniques adopted for improving the quality of injection waters as the quality of water plays a significant role in the success of any injection scheme.

INTRODUCTION

Upper Assam basin is one of the major oil producing fields of ONGC with the annual production rate of approximately 2.0 MMT. The main producing sands are Tipam and Barail. The initial reservoir pressures were around 245-320 Kg/cm^2 in Tipam and 270-408 Kg/cm^2 in Barails. The oil production commenced in the early 60's from these reservoirs. Both the sands are operating depletion drive and observed gradual pressure decline. Water injection plan was envisaged during 1982 to arrest further pressure decline in these sands. It was first initiated in Geleki field and subsequently all the fields were brought under injection scheme. Water injection plants (WIP-I,II,III) were commissioned in Lakwa on 17-08-85, Rudrasagar on 19-09-85, Lakhmani on 19-08-91 and Demulgoan on 12-01-93. At present approximately 5000 M^3/D of treated water is injected through 81 injector wells under different flood patterns. Water quality requirement for water injection is very stringent in the sense that the injection water should not adversely affect the permeability of the reservoir. Suspended solids, oil, corrosion and scaling products often plug the formation there by reducing the injectivity. Hence water should be treated thoroughly before injection into the reservoir.

TREATMENT SYSTEM

Different sources (produced, river and tube well water) are used for injection purposes at different plants depending upon the availability. Produced waters after separation from oil contains free and emulsified oil and other solid contaminants which acts as a plugging agent and reduce the injectivity drastically. The produced waters are treated at effluent treatment plants (ETP) to make it free from oil/grease and suspended solids. Earlier lime and alum were used as flocculent at ETP. In 1996 a polymer acrylamide hydrolysate-PHPA has successfully been introduced as a coagulant aid. The addition of 1 PPM of this polymer along with lime and alum has greatly increased the settling rate of flocks (ref-1). From ETP the treated water is pumped to various water injection plants where water is treated with different water flood chemicals like oxygen scavengers, bactericides, corrosion inhibitors and scaling inhibitors. In water injection plants where river or tube well water is used the source water is treated with lime, alum, clay stabilizers, oxygen scavengers, bactericides, corrosion inhibitors and scaling inhibitors. Oxygen scavenger removes the dissolved oxygen from the water which is the main cause of corrosion in injection waters. Clay stabilizers prevent formation damage due to clay swelling. To check the growth of detrimental bacteria like SRB and GAB batch treatment of bactericide is given. Aldehyde and Amine type of bactericides are used alternatively to prevent bacteria becoming immune to bactericide. In addition to that continuous chlorination is being done. Corrosion and scaling inhibitors prevents formation of corrosion and scaling products in the injection waters. Traditional chromate based corrosion inhibitors have been phased out and organic inhibitors are introduced in place which require only smaller concentrations and are non polluting.

In ERBC the quality of water is adversely affected by the presence of iron. Targets of water injection could not be achieved due to poor quality of the water. Recently a study has been conducted by Regional Chemical Laboratory, Sibsagar which shows that the treatment of alkaline KmnO4 remarkably improves the quality of injection water when used along with other flood chemicals. The source water contains dissolved iron and/or organic matter in the form of fine suspended particles. KmnO4 in the alkaline media oxidizes these

to form the insoluble flocks which are removed by the filters. The treatment could bring down the iron content to zero level, total suspended solids to less than 2.5mg/1, turbidity to 0.4 NTU and corrosion rate to less than 1 mpy without the use of corrosion inhibitor. The filterability characteristics has increased to three to five times (ref-2). In most of the water injection plants the other parameters like pH, bacterial counts (SRB & GAB), dissolved oxygen and residual chlorine are also maintained within the operating limits.

Water properties are liable to change frequently. Close monitoring of various critical parameters like filterability, turbidity, total suspended solids, corrosion and scaling tendencies, bacterial activity is being carried out to assess the quality of injection waters both at the plants as well as in the laboratory. The details of water injection scheme and the operating limits of various parameters monitored are given in Tables I & II.

CONCLUSION

Various innovative methods adopted in the treatment has remarkably improved the quality of injection waters which ultimately helped to achieve injection targets for enhanced oil recovery. These techniques are very much cost effective and environmental friendly.

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TABLE – I
DETAILS OF WATER INJECTION SCHEME

Sl. No.	Details	WIP Geleki	WIP Rudrasagar	WIP (I,II,III) Lakwa	WIP Lakhmani	WIP Demulgoan
1	Date of inception	16-09-82	19-09-85	17-08-85	19-08-91	12-0193
2	Injection sand	TS5A, TS3A TS4B, BMS & TS2A	BMS	TS1, TS2 TS6, TS4B LBS-2 & LBS-6	TS-II TS-IV	BMS
3	Source of water	River/Tube well	Tube well/ Effluent	Effluent	Tube well	Tube well
4	Initial Reservoir Pressure (Kg/cm^2)	300 TSVA 248 TSIIIA 408 BMS	270 BMS	234 TSI 245 TSII 320 TSVI	250 TSII 245 TSIV	—
5	No. of injectors	48	3	24	5	1
6	Cum.(m^3) vol. Injected	3781767	1353861	3236078	642107	254151

TABLE – II
OPERATING LIMITS OF VARIOUS PARAMETERS

Sl. No.	Parameter	Operating Limit
1	pH	7.0 – 7.5
2	Turbidity (NTU)	<0.5
3	Filterability (lit/30 min)	6 – 10
4	Total Suspended Solids (mg/L)	<2.5
5	Dissolved Oxygen (ppm)	Nil
6	Residual Chlorine (ppm)	0.4 – 0.6
7	Iron content (ppm)	<0.2
8	GAB (No./ml)	1000 – 10000
9	SRB (No./ml)	Nil
10	Corrosion rate (mpy)	<1.0

DEVELOPMENT OF FLORISTIC BOTANY IN NORTH-EASTERN INDIA DURING POST INDEPENDENT PERIOD

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ABSTRACT

The north-east of India comprising the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura lies between 22-30^0 N latitude and 80-97^0 longitudes. It covers an area of 254961 sq. km. which represents 7.8% of the country's geographical area (3287263 sq. km.). The region distinguishable into tropical, sub-tropical, sub-temperate, temperate, sub-alpine and alpine regions is rich in forest resource germplasm and represents approximately 50% of the Indian flora. It contains numerous endemic, rare, threatened, economic, medicinal, horticultural, interesting, edible fruits, resins, dyes, tannins, fibre, timbers yielding and wild relatives of cultivated plant species. The presence of large number of primitive Angiosperms makes this region important and term as the "cradle of flowering plants", where angiosperms have diversified because of active speciation.

The worldwide awareness for use and conservation of plant diversity has necessitated intensive survey and critical floristic research not only in the N.E. India but throughout the country and the world. Being botanically very rich, north-east India has attracted innumerable botanists, plant explorers, researchers, naturalists to carry out various studies concerning with floristic botany in the past 50 years. During this period Government of India, has also established research organisations like, Botanical Survey of India at Shillong and Arunachal Pradesh, Botany Departments under many Universities, National Bureau of Plant Genetic Resources, Regional Research Laboratories and other institutes under Council of Scientific and Industrial Research, Indian Council of Agricultural Research and Department of Science & Technology for expanding and expediting the floristic studies.

In recent past efforts have also been made to survey and study the Cryptogamic flora of the region. Besides sporadic articles on algae, fungi, bryophytes, pteridophytes and lichens of the region, few significant contributions like ferns and fern allies of Meghalaya, Nagaland and lichen flora of Nagaland were published. Hence, the progress achieved during the last 50 years on Floristic Botany is quite satisfactory and commendable. An attempt is made to present all these details in the paper.

1. INTRODUCTION

The North-East India comprising the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura, lies between 22–33"N latitude and 80–97"E longitude, is bordered by China in the north, the Himalayan Kingdoms – Bhutan and Nepal in the west, Bangladesh in the south and Myanmar in the east. It covers an area of 2,54,961 sq. km. The region is inhabited by more than 150 tribes of different ethnic groups and cultural entities. Agriculture is the main occupation and many of these people practice 'jhum' or 'shifting' cultivation to grow cereals vegetables and fruits. The region consists of mountains, plateau and valleys of various dimensions.

On account of its unique geographical, topographical, altitudinal and ecological gradient, this region forms the richest reservoir of floristic diversity. The major forest types as classified by Rao and Hajra (1986) are — (i) Tropical semi-ever-green to evergreen forests (upto 800m), (ii) tropical deciduous forests (upto 1000m) (iii) Sub-tropical broad-leaved forests (1000-2000m), (iv) Subtropical pine forests (1500-1800m), (v) temperate forests (1800-3500m), (vi) sub alpine forests (3500-4000m) and (vii) alpine forests (4500-5000m). The varied forest types exhibit innumerable varieties and kinds of orchids, medicinal, horticultural, interesting plants, bamboos, canes, timber, dye, fibre, resin yielding, wild relatives of cultivated plant species, etc. The presence of large number of primitive plants makes N.E. India the 'cradle of flowering plants' where angiosperms have diversified on account of active speciation. The region also possesses numerous endemic, rare and endangered plant species.

The world wide awareness for use and conservation of bio-diversity on this planet has necessitated intensive and critical floristic research not only in the north eastern India but throughout the country and the world. Being botanically very rich and interesting, north-east India has attracted innumerable botanists, plant explorers, researchers, naturalists to carry out various studies concerning with floristic botany in the past 50 years. During this period research organisations like, Botanical Survey of India (BSI) at Shillong in Meghalaya and at Itanagar in Arunachal Pradesh, National Bureau of Plant Gangetic Resources (NBPGR), some Regional Research Laboratories and other institutions and laboratories under Council of Scientific and Industrial Research and Botany Department under Universities were established to promote the floristic studies in north eastern region.

2. FLORISTIC STUDIES

2 : 1 *Phanerogamic Flora :*

Phanerogamic flora is rich and interesting. It has been given more attention as compared to other disciplines of botany. Efforts were made to explore the area extensively. In this context regional offices of BSI located in this region have played an important role in surveying the area and in the past have conducted many important botanical explorations lying more emphasis on the unexplored and under explored areas, which were inaccessible to the earlier collectors for better knowledge of the flora and vegetation. As a result, significant progress has been achieved in the field of floristic botany during the last 50 years. The continuous research has led to the publication of various research papers on vegetation, floristic accounts of smaller areas and of states, enumeration of families, revisionary studies of many genera, description of new taxa, new records, endemic, rare, endangered taxa etc.

In order to conserve space, only major and important contributions are taken into account for presenting the development of floristic botany, while details of others have been omitted as they are published elsewhere (Shukla 1993). The progress made in different states and some other aspects of floristic botany are as follows.

2 : 1 : 1 : 1 ARUNACHAL PRADESH :

The state formerly known as NEFA (North East Frontier Agency) covers a total geographical area of 83,743 sq. km., of which 68,602, sq. km. area is covered by forests. In general it has rugged terrain characterised by hill ridges and valleys. The vegetation broadly is divisible in to tropical evergreen forests, tropical semi-evergreen forests and tropical forests, pine forests, temperate forests, sub-alpine and alpine forests.

Scientists from BSI, state forest departments, NBPGR etc. have intensively explored the area and contributed many important publications. These include the botanical tours to Subansiri frontier division (Panigrahi & Naik 1961, Panigrahi & Joseph 1966), contributions to the flora of Tirap frontier division (Deb & Dutta 1971, 1972, 1973, 1974), the flora of Siang frontier division (Rao & Joseph 1965) and contributions to the flora of Kameng and Subansiri districts (Sahni 1969). More recently the flora of Namdapha National Park (Chauhan et al 1996) and Materials for the flora of Arunachal Pradesh – Vol. I (Chowdhury et al 1996) have been published dealing with 1119 and 4055 species respectively.

Scientists of Van Vigyan Kendra of state forest department have also contributed significantly to the knowledge of the flora and vegetation and published some valuable accounts (Hedge 1986, Haridasan et. al. 1987, 1993; Beniwal & Haridasan 1992).

Orchidaceae a family of most showy, variable and long lasting flowers is very well studied. Many contributions dealing with new taxa, new records, conspectus, etc, have been brought out (Rao & Deori 1973, Hegde & Rao 1983, 1984; Rao 1986). Comprehensive account dealing with about 450 species of orchids have also been published by Hedge (1980) and more recently by Chowdhury & Pal (1996). To get more precise information about the flora more explorations need to be carried out in remote and unexplored areas of the state.

2 : 1 : 1 : 2 ASSAM :

The state covers a total geographical area of 78,438 sq. km., of which about 23,824 sq. km. area is covered by forests. Topographically the state comprises of low lying alluvial land with occasional low hilly terrains. The vegetation can broadly be classified into tropical forests (tropical wet evergreen forests, tropical semi-evergreen forests, tropical moist deciduous forests, grassland, riparian forests, swamps) and sub-tropical forests (sub-tropical broad-leaved forests, subtropical pine forests, bamboo and cane brakes).

Here again the scientists of the BSI explored the area and published many papers during sixties and seventies (Kar & Panigrahi 1963, Kataki & Panigrahi 1964, Panigrahi & Kar 1966, Rao & Rabha 1966, Rao & Verma 1969, Rao 1974, Jain & Hajra 1975) etc. and thus enriching the knowledge of the area. Besides, researchers from various Colleges and Universities and other research organisations have also contributed valuable publications (Barua et al 1988, Islam 1990, Sas Biswas et al 1990, etc.). Few doctoral thesis on the floristic studies of the state and different districts have also been completed (Bordoloi 1973, Chongkakati

1989, Devi 1981, Gogoi 1976, Baruah 1978, Hajra 1978, Sarmah 1989, Barua 1992, Sarkar 1993, Singh 1993, etc.) during post independent period.

Studies on the monocot flora of Assam published as materials towards monocot flora of Assam viz. Hydrocharitaceae and Marantaceae (Rao & Verma 1970), Zingiberaceae and Marantaceae (Rao & Verma 1972), Taccaceae, Discoreaceae and Stemoniaceae, Rao & Verma 1973, 1974, 1976), orchids in some habitats in Assam (Jain & Hajra 1976) and notes on the distribution of some grasses in Assam (Neogi & Jain 1979) are some major achievements in the field of floristic.

Based on the above publications and information available from ASSAM Herbarium, Baishya (1997) has made an effort to present the floristic diversity of the state where he dealt c 3017 species distributed within 1115 genera and 211 families of Angiosperms.

2 : 1 : 1 : 3 MANIPUR :

Manipur lies in the extreme of north-east India with a total geographical area of 22,327 sq. km. including 17,418 sq. km. areas as forest cover. The vegetation is composed of tropical, temperate and pine forests.

The major contributions made from this area are the enumeration of monocotyledonous and dicotyledonous plants by Deb (1957, 1961). Shukla & Baishya (1979), Jain & Shukla (1979) and Malick & Safui (1987) have also made further additions. Recently Chauhan (in press) from BSI explored the area and compiled all the available information known so far, from the area in the form of a detailed floristic account dealing with about 2376 species under 1052 genera.

2 : 1: 1: 4 MEGHALAYA :

Meghalaya commonly known as 'Abode of Clouds' with lust evergreen forests and waterfalls covers a total estimated forest area of 15,657 sq. km. against the total geographical area of 22,429 sq. km.

The flora of Meghalaya is diverse. Hooker (1906) had already remarked once that the vegetation of Khasi Hills in Meghalaya is 'richest in India and probably in all Asia'. This is true for the whole north-east India, as also remarked by Murti and Joseph (1984). The progress of Angiosperm floristic in Meghalaya in terms of publications was much more than other states, probably because of easier approachability of the area and Shillong being a capital of undivided Assam. Researchers from abroad and all over the country visited Shillong and its neighbouring places in Khasi and Jaintia Hills for their studies. Garo Hills being far away was poorly studied. Further, the regional office of the BSI initially, was also established at Shillong, during 1956, that helped in promoting the studies.

Initially scientists of BSI explored the area extensively in Khasi and Jaintia Hills and partly in Garo Hills and published numerous papers. Enumeration of plants of some of the sacred groves in Meghalaya was made by Raju (1964) and Hajra (1975), Orchids of Khasi and Jaintia Hills were studied by A.S. Rao (1960). Plants of Garo Hills (Ghose et al 1978, Raju & Banerjee 1978), floristic composition of vegetation of pine forests of Shillong (Rao & Kharkongor 1979), non-indigenous plants in the flora of Shillong and its neighbourhood (Rao & Dam 1979), orchids of Garo Hills (Dutta & Kataki 1988), new species of orchids (Deori & Malhotra 1977), etc. are some other publications.

Besides, some detailed taxonomic accounts published from the area are – Flora of Jowai in two volumes by Balakrishna (1981 & 1983), dealing with 1517 species within 749 genera and 165 families, Flora of Nongpoh and vicinity (now Ri Bhoi district) by Joseph (1982) with 1036 species under 639 genera and 159 families of Angiosperms, Forest Flora of Meghalaya in two volumes by Haridasan and Rao (1985, 1987), dealing with 1151 woody species distributed under 532 genera and 119 families of Angiosperms, orchids of Meghalaya by Kataki (1986) dealing 350 species and insectivorous plants of Khasi and Jaintia Hills of Meghalaya (Joseph & Joseph 1986) with 13 species.

Botany department under Guwahati and North-Eastern Hill Universities have also played an important role in the development of systematic in this area. Some of the Ph.D. thesis submitted in these universities are the Monocot flora of Meghalaya (Myrthong 1980), Flora of Shillong peak (Bordoloi 1980), Flora of Balphakgram (Kumar 1984) and Flora of Cherrapunjee sub-division, East Khasi Hills district, Meghalaya (Namita Dam 1996). Recently Haridasan (1997) based on above studies accounted the floristic diversity of the state.

2 : 1 : 1 : 5 MIZORAM :

The state covers a total geographical area of about 21,081 sq. km. of which 18,775 sq. km. area is forest cover. The entire state presents a mountainous terrain with more or less parallel hill ranges running in the north-south direction with deep river valleys, averaging 700 to 1000m in altitude. In general the forests of Mizoram can broadly be divided into tropical wet evergreen and semi-evergreen forests, montane subtropical forests, temperate forests and bamboo forests.

The progress of floristic studies in Mizoram was quite poor, probably it was due to the insurgency prevailed for a longer period which effected the comprehensive studies to be taken up there. However, few significant contributions made so far, on the flora of Mizoram are by Deb and Dutta (1973). Deb et al (1987), Shukla (1978) and D.K. Singh et al (1990). At present the Flora of Mizoram is under investigation by the scientists of BSI, Shillong. Recently, K.P. Singh (1977c) has published the floristic diversity of the state where about 2141 species of Angiosperms under 905 genera are accounted.

2 : 1 : 1 : 6 NAGALAND :

Nagaland comprises a total geographical area of 16,527 sq. km. of which 14,221 sq. km. area is under forest cover. The vegetation of the state can broadly be classified into tropical evergreen and semi-evergreen forests, tropical deciduous forests, sub-tropical pine forests and mixed bamboo forests and sub-alpine meadows.

The progress of floristic studies in Nagaland was also inadequate. Family orchidaceae has been worked out in detail. Devrani and Naithani (1995) published a taxonomic account of orchids of Nagaland, while Hynniewta et al. (In press) dealt orchidaceae of Nagaland, accounting 380 species from the area. State flora of Nagaland is also being worked by the scientists of BSI, where 2447 species, 981 genera and 186 families are described and planned to be published in 3 volumes. Plants of smaller area like Dzuko valley (Mao & Kataki 1994), Saramati peak (Hynniewta 1994), etc. have also been published in recent past.

2 : 1 : 1 : 7 TRIPURA :

Tripura a small state with a total geographical area of 10,477 sq. km., of which 5,546 sq. km. area is covered by forests. The vegetation of the state can broadly divided into climatic types (evergreen forests, moist deciduous forests – sal forests, moist deciduous mixed forests), several types (swamp vegetation) and subsidiary edaphic types (bamboo forests, cane brakes, garjan forests, savannah and grassland vegetation).

Floristic studies of the state have been carried out by the scientists of BSI. Initially Deb (1963) worked out the flora and subsequently published a bibliographical review on the floristic studies in Tripura. Deb (1981-82) also published the Flora of Tripura, in two volumes, giving an account of 1600 species and 867 genera of vascular plants which is a major contribution today.

2 : 1 : 2 **Aquatic Flora :**

Aquatic weeds of North-East India were studied by Islam (1989). He described 113 species distributed within 77 genera and 43 families of Angiosperms and Pteridophytes.

2 : 1 : 3 **Studies On Families :**

With the objective of completing the flora of this region, more emphasis has been laid on the study of families. The major contribution on the monocot families is the 'Flowering plants of Eastern India', vol – 1 Monocotyledons by Mitra (1958). This publication describes 10 orders and 35 families of this region. Cyperaceae of North-East India by Rao and Verma (1982) deals with 14 genera and 173 species, representing about 50% of the total estimated Indian taxa (ca. 350 species). Grasses of North-Eastern India by Shukla (1995) describes 475 species. Detail studies on several other families include Burmanaceae (Panigrahi 1966), Bromeliaceae (Panigrahi 1966), Haemadoraceae (Panigrahi 1966), iridaceae (Panigrahi 1966), Amaryllidaceae (Panigrahi 1966), Ponederiaceae (Rao & Verma 1973), Xyridaceae (Rao & Verma 1974), Commelinaceae (Rao & Verma 1974) and Juncaceae, Typhaceae, Sparaginaceae, Flagellariaceae, Alliismataceae, Butomaceae, Aponogetonaceae and Eriocaulaceae (Rao & Verma 1976), orchids of north eastern region and Sikkim (Kataki et al 1984) and tribe Garnotieae (Prakash & Jain 1989).

Among the Dicot families some important publications made are Rubiaceae (Kar & Panigrahi 1963), Ranunculaceae (Kataki & Panigrahi 1964), Asteraceae (Panigrahi & Kar 1966), Campanulaceae (Malhotra & Bhowmik 1979) etc. Some additions to the Apiaceae of north eastern India (Deb & Dutta 1968) were also made.

2 : 1 : 5 **Studies Of Genera :**

Comprehensive studies on individual genera of this region were also undertaken. Some of these include *Arthraxon* (Naik & Panigrahi 1961, Rao & Verma 1969), *Crotalaria* sericea (Subha Rao 1963), *Rhododendron* (Sastry & Kataki 1967), *Cynodon* (Jain 1967), *Rubia* (Deb & Malick 1968), *Panicum* (Majumdar 1973), Porpax (Deori 1975), *Coelogyne* (Das (nee Phukan) Sandhyjyoti 1975, 1976, 1978), Das (nee Phukan) Sandhyajyoti & Jain (1980), *Eupotorium* (Rao & Rao 1980), *Primula* (Ghosh 1980), *Sonchu* (Rao & Rao 1976, *Styxis* (Dutta & Dam 1989), etc. These studies have greatly enhanced the knowledge of the flora of this region.

2 : 1 : 6 **New Taxa And New Records :**

Intensive explorations particularly by the BSI, have brought out over 95 new taxa over 75 new records either for India or for north eastern region. These have been dealt separately in various volumes of Bulletin Botanical Survey of India and other leading journals of the taxonomy by various authors. Their listing is omitted here as most of them are already enumerated by Shukla (1993).

2 : 1 : 7 **Endemic Plants :**

The region also contains very high number of endemic plants. There is no comprehensive work available on endemism from this area. However, some studies such as endemism and outside influence on the flora of Manipur (Deb 1958), endemic plants of Meghalaya (Hajra 1974), endemic orchids of north eastern India (Das & Deori 1983), endemism in the grasses flora of north eastern India (Shukla 1983) and on the status of endemism of some grasses in this region (Jain 1986) have been brought out in the past 50 years.

2 : 1 : 8 **Rare, Endangered And Threatened Plants :**

Detailed studies on the flora of this region have also revealed many of the plants species which have become rare, threatened and endangered in their natural habitats. In order to evolve conservation strategies of these plants BSI has brought out 3 volumes of Red data book of India, where 114 species from this region are also listed. A list of such species is provided to create awareness amongst the people and necessary measures for their conservation.

Name	Family	Status
Acer oblongum Wall. Ex Dc. var, microcarpum Hiern	Aceraceae	Endangered
A. sikkimense Miquel var. serrulatum Pax	Aceraceae	Endangered
Acranthera tomentosa R. Br. ex Hook.f.	Rubiaceae	Vulnerable
Adiandra griffithii Dyer	Ternstroemiaceae	Endangered
Adiantum sobiliferum Wall. ex Hook.f.	Adiantaceae	Possibly extinct in India
Albertisia mecistophylla (Miers) Forman	Menispermaceal	Indeterminate or possibly, extinct
Alniphyllum fortunei (Hems 1.) Makino	Styracaceae	Rare
Aneilema glanduliferum Joseph et Rolla Rao	Commelinaceae	Vulnerable
Anoectochilus tetrapterus Hook .f.	Orchidaceae	Vulnerable
Argostemma khasianum Clarke	Rubiaceae	Indeterminate
Aspidopterys oxyphylla (Wall.) Juss.	Malpighiaceae	Indeterminate
Athyrium atratum Bedd.	Athyriaceae	Endangered
Begonia arborensis Dunn.	Begoniaceae	Rare
B. brevicaulis DC.	Begoniaceae	Endangered
B. brukillii Dunn.	Begoniaceae	Rare

B. lushaiensis C.E.C. Fischer	Begoniaceae	Rare
B. Rubrovenia var. meisneri Clarke	Begoniaceae	Rare
B. scintillans Dunn.	Begoniaceae	Indeterminate
B. tessaricarpa Clarke	Begoniaceae	Indeterminate
B. watti Clarke	Begoniacear	Endangered or possibly, extinct
B. Wengeri C.E.C. Fischer	Bengoniaceae	Inteterminate
Bulleyia yunnanesis Schltr.	Orchidaceae	Rare
Calanthe anthropophora Ridely	Orchidaceae	Endangered in India
C. mannll Hook.f.	Orchidaceae	Rare
Capparis cenerea Jacobs	Capparaceae	Indeterminate
C. pachyphylla Jacobs	Capparaceae	Indeterminate
Coelogyne rossiana Reichb.f.	Orchidaceae	Vulnerable
Corybas purpureus Joseph et. Yog.	Orchidadeae	Rare
Crotalaria meeboldii Dunn.	Fabaceae	Indeterminate
C. nove oides	Febaceae	Indeterminate
Carex fuscifructus Clarke	Cyperaceae	Indeterminate
C. repanda Clarks	Cyperaceae	Presumed extinct
Ceropegia angustifolia Weight	Asclepiadaceae	Vulnerable
C. arnottiana Weight	Asclepiadaceae	Endangered
C. lucida Wall	Asclepiadaceae	Endangered or possibly, extinct
Chaerophyllum orientalis (Clarke) Kukh.	Apiaceae	Indeterminate
Chirstensenia assamica (Griffith) Ching	Chistensenanceae	Vulnerable (in India)
Cleyera japonica Thumb Var. grandiflora (wall. ex Choisy) Kobuski)	Theaceae	Rare
Climatis apiculata Hook.f. et Thoms.	Ranunculaceae	Endangered
Coptis teeta Wall.	Ranunculaceae	Vulnerable
Coryphopteris didymochlaenoides (Clarke) Holtt.	Thelypteridaceae	Rare
Cyclea debiflora Miers	Menispermaceae	Indeterminate or possibly, extinct
C. watti Diels	Menispermaceae	Indeterminate or possibly, extinct
Cymbidium eburneum Lindl.	Orchidaceae	Vulnerable
C. hookerianum reichb.f.	Orchidaceae	Vulnerable
C. tigrinum Parish	Orchidaceae	Rare and Vulnerable
Dendrobium aurantiacum Reichb.f.	Orchidaceae	Endangered, probably extinct in natural habitat
Dendroglossa minutula (Fee) Copel.	Polypodiaceae	Endangered
Dioscorea deltoidea Wall. ex. Kunth	Dioscoreaceae	Vulnerable
Diplomeris pulchella D.Don	Orchidaceae	Vulnerable
Drynaria meeboldii Rosenst.	Polypodiaceae	Vulnerable
Elaeagnus conferta ssp. dendroidea Servettaz	Elaeagnaceae	Endangered
Elaeocarpus acuminatus Wall. ex. Mast.	Elaeocarpaceae	Rare
E. prunifolius (C. Muell.) Mast.	Elaeocarpaceae	Rare
Euonymus assamicus Blakelock	Celastraceae	Endangered
Fimbristylis stolonifera Clarke	Cyperaceae	Presumed extinct
Gieditsia assamica Bor	Fabaceae	Indeterminate

Hedyotis brunonis Merr.	Rubicaceae	Vulnerable
H. scarbra Wall. ex Kruz	Rubiaceae	Rare
Huodendron biaristatum (W.W.Sm.) Rehder	Styracaceae	Rare in India
Indopolsolenia wallichii (Hook.f.) Bennet.	Rubiaceae	Rare
Inula kalapani Clarke	Asteraceae	Endangered
Ixonanthes khasiana Hook.f.	Ixonanthaceae	Vulnerable
Kalanchoe roseus Clarke	Crassulaceae	Endangered
Lagerstroemia minuticarpa Dobberm. Ex. p.c. Kanjilal	Lythraceae	Rare
Lastreopsis wattii (Bedd.) Tagawa	Aspidiaceae	Presumed extinct
Lilium macklinae Sealy	Liliaceae	Endangered
Lindsaea himalaica Kraner	Lindsaeaceae	Rare
Metathelypteris decipiens (Clarke) Ching	Thelypteridaceae	Rare
Michelia punduana Hook.f.	Magnoliaceae	Rare
Mitrastemon yamamotoi (Makino)	Mitrastemonaceae	Endangered
Neanotia oxyphylla (G.Don) Lewis	Rubiaceae	Rare
Nemocharis synaptica Sealy	Liliaceae	Rare
Ophiorrhiza gracilis Kurz.	Rubiaceae	Indeterminate
O. griffithii Hook.f.	Rubiaceae	Indeterminate
O. hispida Hook.f.	Rubiaceae	Endangered
O. lurida Hook.f.	Rubiaceae	Rare in India
O. subcapita Wall. ex. Hook.f.	Rubiaceae	Endangered
O. tingens Clarke ex. Fisher	Rubiaceae	Vulnerable
O. wattii Fisher	Rubiaceae	Endangered
Pauia belladonna Deb et Dutta	Solanaceae	Rare
Paphiopedilum fairrieanum (Lindl.) Stein	Orchidaceae	Endangered
P. hirsutissimum (Lindl. Ex. Hook)	Orchidaceae	Rare
P. insigne (Wall. ex. Lindl.) Pfitz	Orchidaceae	Vulnerable
P. spicerianum (Reichb.f.) Pfitz	Orchidaceae	Vulnerable
P. villesum (Lindl.) Stein	Orchidaceae	Vulnerable
P. venustum (wall. ex. Sims.) Pfitz.	Orchidaceae	Vulnerable
Phoenix rupicota T. Anders	Arecaceae	Rare
Pholidota wattii King et. Pautl.	Orchidaceae	Rare
Pleione lagenaria Lindl.	Orchidaceae	Presumed extinct
Pimpinella evolula (Clarke) Mukh.	Apiaceae	Possibly
P. flaccida Clarke	Apiaceae	Indeterminate
Pollia pentasperma Clarke	Commelinaceae	Indeterminate
Polypodiodes wattii (Bedd.) Ching.	Polypodaceae	Rare
Psychotria aborensis Dunn.	Rubiaceae	Endangered
Pternopetalum senii Deb et Dutta	Apiaceae	Rare
Pueraria bella Prain	Febaceae	Rare
Renanthera imschootiana Rolfe	Orchidaceae	Endangered
Rhopalocnemis phalloides Jungh.	Balanophoraceae	Rare
Rhychglossum lazulinum Rao & Joseph	Gesneraceae	Rare
Salacia jenkinsii Kurz.	Celastraceae	Endangered
Sapria himalayana Griff.	Rafflesiaceae	Rare

Scleria alta Boeck	Cyperaceae	Indeterminate
Senecio mishmi Clarke	Asteraceae	Vulnerable or Indeterminate
S. rhabdos Clarke	Asteraceae	Rare
Silene khasiana Rohrb.	Coryophyllaceae	Indeterminate
S. vagans Clarke	Coryphyallaceae	Indeterminate
Synotis simonsii (Clarke) Jeffrey et Chen	Asteraceae	Indeterminate
Sterculia khasiana Debbarman	Sterculaceae	Presumed extinct
Trivalvaria kanjilalii D.Das	Annonaceae	Endangered
Vanda coerulea Griff. ex. Lindl.	Orchidaceae	Rare
Wallichia triandra (Joseph)	Areacaceae	Rare
Zeuxine pulchra King et Pantl.	Orchidaceae	Endangered

2 : 2 CRYPTOGAMIC FLORA

Though the Cryptogamic flora is rich in diversity but very poorly understood. A very little area has been surveyed for Cryptogamic plants. The most studied group is the Pteridophytes. Some of the significant contributions made on pteridophytes from this region are Baishya and Rao (1982), Jamir and Rao (1988), Barua et al (1989), Bhattacharya et al (1995), etc.

Similarly studies on lichens are also very meagre, Panigrahi and R.S. Rao from BSI made some collections from Arunachal Pradesh which were subsequently published by Awasthi (1961), enumerating their 74 species. To promote the studies on lichens, BSI established a lichen herbarium at Shillong. This herbarium comprises more than 13000 specimens from different states of north eastern region. K.P. Singh surveyed the Arunachal Pradesh, Nagaland, Meghalaya and published numerous papers (Singh & Sinha 1997a, 1997b). Various contributions made on lichens from this area are enumerated separately by Singh and Sinha (1997c) and may be consulted for details. The important contribution made so far from this region is the lichen flora of Nagaland, which deals with 346 species. The studies on Arunachal Pradesh lichens are being continued.

Other groups like Algae, Fungi, Bryophytes are very poorly studied except few sporadic publications. Some important contributions on algae from this region are by Alfred (1978), Bordoloi (1980), etc. On Bryophytes D.K. Singh (1982, 1983, 1987, 1997) has made some valuable studies. Very little work is done on the taxonomy of fungi. As a whole the region is intact for Cryptogamic studies. It needs immediate attention for its proper evaluation and study by the specialists.

3. ROLE OF BOTANICAL SURVEY OF INDIA

Botanical Survey of India being an apex organisation on the floristic and taxonomic studies has made valuable contributions during the last 50 years by surveying the remote areas and published numerous floristic accounts as mentioned earlier. It maintains a herbarium at Shillong and another at Itanagar on plants of north eastern region with historical collections of Fisher, Perry, Bor, Kingdon Ward, Kanjilal and recent collections made by the scientists of the survey. These herbaria help in promoting the floristic studies and conservation of the flora of this region. Currently the scientists of the survey are engaged on the Action Plan Projects viz. Flora of Manipur (in press), Flora of Nagaland (part in press), Flora of Mizoram (vol. 1 completed), Flora of Assam, and flora of Arunachal Pradesh (in press, partly published), besides numerous other studies concerning with lower group (Lichens & Pteridophytes) of plants and conservation of flora in general.

4. FUTURE STRATEGIES

As we have already mentioned, the region is rich in floristic diversity and is also considered as one of the world's 18th biological hot spots. In the past we have made significant progress in the field of floristic botany but still one has to go a long way to document complete diversity of the region. These are the areas which are still unexplored or under-explored. Therefore, efforts need to be made to explore such areas to record floristic wealth. Cyptogamic flora of this region have immense potential for the welfare of human being and need to be studied extensively. The rich floristic diversity of the region is under serious threat due to various biotic and natural causes. Hence, there is an urgent need to conserve the floristic wealth of the region for our posterity. It

can be possible by ex situ and in situ conservation techniques. Job opportunities, population pressure and awareness programme are some important issues, that need to be given priority by the concerned government agencies in order to save our precious floristic wealth.

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CONTRIBUTION AND INITIATIVES OF THE MINISTRY OF ENVIRONMENT AND FORESTS IN THE DEVELOPMENT OF ENVIRONMENT AND FORESTRY ACTIVITIES IN NORTH-EAST INDIA : AN OVERVIEW

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ABSTRACT

Created as a Department in 1980 and upgraded into a full-fledged Ministry in 1985, the Union Ministry of Environment and Forests is the nodal agency in the administrative structure of the Central Government for planning, promotion and co-ordination of environmental and forestry programmes in the country. To fulfil these mandates, the Ministry is organised into profiles of subordinate, associated or autonomous agencies spread across the country. Its Regional Office (NEZ) at Shillong is a subordinate organisation, established in 1987 as part of the secretariat of the Ministry to follow up the works of the Ministry in the field at regional level. The N.E. Regional Office has its geographical jurisdiction over the seven states of N.E. India.

Although the Ministry has been allocated with works relating and pertaining to environment, forests, wildlife, bio-diversity, climate change, pollution prevention and control, etc. and implementation of relevant acts and regulations, the Regional Offices has the primary mandates in the implementation of the provisions of the Forest (Conversation) Act, 1980 and the Environment (Protection) Act, 1986 at the regional level. Recent order of the Supreme Court has further widened the scope of the forestry functions of the Regional Office in particular.

This essay is an attempt to present an overview of the role and contribution of the Ministry of Environment & Forests vis-à-vis its Regional Office (NEZ) in the regulation and development of environment and forestry activities in N.E. India. Its contribution through participation in the activities of the North Eastern Council (by virtue of its Head of the Department being Ex-Officio Adviser to NEC on Forest & Environment) is however not included in the present essay.

INTRODUCTION

The year 1997 is a landmark in our history as it marks 50 years of our existence as an independent nation. Just 50 years, but the scale of transformation in our natural landscapes and resources – globally, regionally and locally – has led us to be concerned, more than ever, on issues relating to environment, forests, biodiversity, pollution and alike. Today, these are the themes being addressed by anybody and everybody almost anywhere and everywhere.

It is also an undeniable fact that the key to our progress as 'human and survival of the present and future generation with dignity is going to be on knowing how, when and where to reconcile development with the environment. Reconciling development with environment is precisely the reason why the Ministry of Environment & Forests is basically for. Therefore, it can be said that its core philosophy is development without destruction; its emphasis is on 'sustainability'. Its vision is sustainable use of natural resources for sustainable development to transform ourselves into sustainable society and nation.

The year 1997 makes Ministry of Environment & Forests (MoEF) just about 12 years as a full-fledged Ministry or 17 years as Department of Environment. Nevertheless, as Khare has remarked in his paper on 'Science in India : 1947-1997' that it is a good time to look back and see how we have done as a nation in various spheres of activities in the last half century. It is indeed a time for reflection and evaluation of performances.

In this context, the contribution and role of the Ministry of Environment & Forests in the development of science and technology in North-East India should not be seen merely in the ordinary sense of science and technology as is generally understood. Issues pertaining to environment and forests are indeed vital in the context of overall scope of science and technology. Over the past years of its existence, the MoEF, as well as its various subordinate/associated/autonomous organisations, have been making significant contribution in the development of the environment and forestry facets of science and technology in the region.

It may be mentioned here that besides its Regional Office (NEZ) at Shillong, other associated or autonomous organisations of the MoEF located in N.E. Region are the Botanical Survey of India, at Shillong and Itanagar (for survey, identification and documentation of flora), Zoological Survey of India at Shillong and Itanagar (for survey, identification and documentation of fauna). G.B. Pant Institute of Himalayan Environment & Development at Itanagar (for mountain areas research and development), Central Pollution Control Board

at Shillong (for prevention and control of pollution), Centre for Environment Education at Guwahati (for environment education), State Forest College at Byrnihat (for forestry education and training), Institute of Rain and Moist Deciduous Forest research at Jorhat (for forestry research).

While each of these organisations may be presenting their specific contributions in their specialised areas of functional mandates in the context of the development of science and technology, the present essay is as much to familiarise the readers of North-East on MoEF as is an attempt to briefly overview the role and contribution of the Ministry of Environment & Forests vis-à-vis its Regional Office (NEZ) in the development processes and activities in N.E. India.

HISTORICAL PERSPECTIVES

Since independence, India had been according sufficiently high priority, as part of national programmes, for the promotion of public health and hygiene, sanitation, nutrition, housing, forestry, wildlife protection, soil conservation etc. Yet a comprehensive, integrated view of environmental protection and improvement with emphasis on the sustainable use of natural resource for development has not received any significant attention in the planning processes of the country, both at the central and state government level, until the end of sixties or early seventies.

The 4th Five Year Plan (1968-73) gave explicit recognition to the fact that planning for harmonious development is possible only on the basis of a comprehensive appraisal of environmental issues and it was necessary, therefore, to introduce the environmental dimension into the planning and development processes of the country. At this stage, the Committee on Human Environment set up in 1970 by the Government of India under the Chairmanship of Shri Pitambar Pant, Planning Commission to prepare a Country Report the UN Conference on Human Environment went into this aspect and indicated the need for establishing a formal system for ensuring greater coordination and integration in environmental policies and programmes. A National Committee on Environmental Planning and Coordination (NCEPC) was accordingly set up in February 1972. The committee was serviced by a multi-disciplinary team of officers within the Department of Science and Technology. The major role of NCEPC was to advise the government on environmental problems and suggest solutions after consultation with the experts and the concerned Ministries/Departments.

The 5th Five Year Plan also stressed the need for a close association of the NCEPC with all major industrial development decisions so that environmental goals are fully taken into account. The underlying objective was that the pursuit of development goals need not cause a reduction in the quality of life through deterioration in environmental conditions. Rather, the attempt should be to maintain a link and balance between developmental planning and environmental management.

It was heartening to note that during the Sixth General Election in January 1980, the issue of environmental protection figured in the Election Manifestoes of almost all major national political parties. Consequently, immediately after government took office, a High Powered Committee was set up under the Chairmanship of Shri N.D. Tiwari, the then Deputy Chairman, measures and administrative machinery for ensuring environmental protection and recommending ways to strengthen them. On the basis of the recommendations of this committee, the Government of India constituted a separate Department of Environment with effect from November 1, 1980, which was eventually upgraded into a full-fledged Ministry of Environment & Forests since 1985.

ROLE AND THRUST AREAS OF ACTIVITIES OF MoEF

The Ministry of Environment and Forests is the nodal agency in the administrative structure of the Central Government for planning, promotion and co-ordination of environmental and forestry programmes. The main activities of the ministry are conservation and survey of flora, fauna, forests and wildlife, prevention and control of pollution, afforestation and regeneration of degraded areas, protection of ecological sensitive areas, environmental impact assessment, eco-regeneration, assistance to organisations implementing environmental and forestry programmes; promotion of environmental and forestry programmes; promotion of environmental and forestry research, extension, education and training to augment requisite manpower, dissemination of environmental information, regional/international cooperation in the areas of environment and forests, and creation of environmental awareness among all sectors of the country's population.

ORGANISATIONAL PROFILE

The Ministry of Environment & Forests is usually headed by a Cabinet Minister of the Union Government. In the past, either Minister of State or Minister of State with Independent Charge had also headed the Ministry. Functionally, it can be said to be organised into five broad divisions/set up, viz. the National River Conservation Directorate, National Afforestation and Eco-Development Board, Environment Division, Forest Conservation Division and the Wildlife Division. The ministry also has a number of associated and autonomous organisations within its set up. A profile of the organisational structure is given in Annexure A.2.

ALLOCATION OF WORKS / BUSINESS

The MoEF has been allocated with several works or business as its functional mandates: These include Environment and Ecology, including environment in coastal waters, mangroves, coral reefs but excluding marine environment on the high seas; Botanical Survey of India and Botanical Gardens; Zoological Survey of India; National Museum of Natural History; The Water (Prevention and Control of Pollution) Cess Act, 1977; The Air (Prevention and Control of Pollution) Act, 1981; The Indian Forest Act, 1927; The Prevention of cruelty to Animals Act, 1960; The Wildlife (Protection) Act, 1972; The Forest (Conservation) Act, 1980; The Environment (Protection) Act, 1986; The Public Liability Insurance Act, 1981; Biosphere Reserve Programme; National Forest Policy and Forestry Development including Social Forestry; Forest Policy and all matters relating to forests and forest administration in so far as Andaman and Nicobar Islands are concerned; Indian Forest Service; Wildlife Preservation and Preservation & Protection of Wild Birds & Animals; Prevention of cruelty to animals; Central Zoo Authority; Fundamental research, including coordination thereof and higher education in forestry; Padmaja Naidu Himalayan Zoological Park; National Assistance to Forestry Development Schemes; Central Ganga Authority; Indian Plywood Industries Research and Training Institute, Bangalore; Indian Institute of Forest Management, Bhopal; Forest Survey of India, Dehra Dun; National Afforestation and Eco-Development Board; Desert and Desertification; Wetland Conservation programmes; Paryavaran Vahinis etc.

THE REGIONAL OFFICES OF MoEF AND THEIR ROLES IN REGIONAL DEVELOPMENT

The Regional Offices of the Ministry of Environment & Forests at Bangalore, Bhopal, Bhubaneswar, Chandigarh, Lucknow and Shillong were set up as part of the Secretariat of the Ministry, ordinarily to look after all matters relating to functions of the ministry at the regional level. The Regional Offices were first set up vide GOI Resolution No. 37-3/85-FP dated April 7, 1986 primarily to deal with matters arising out of application and implementation of Forest (Conservation) Act. By 1988, however, in view of increasing work relating to all aspects of environmental management including pollution control and environmental management of developmental projects and activities in the country and in order to be able to follow up the works of the ministry in the field, the scope of the functionings of the Regional Offices were further expanded vide GOI Resolution No. 17-3/88-PC dated 12th May, 1988. Thus, the mandates of the Regional Offices, amongst others, primarily fall within the two broad Acts of the government, viz. the Forest (Conservation) Act, 1980 (FCA) and the Environment (Protection) Act, 1986 (EPA). These functions are nomenclatured as Forestry Functions and Environmental Management and Pollution Control Functions, each of which may be described as below :

FORESTRY FUNCTIONS OF THE REGIONAL OFFICES OF THE MoEF

The forestry functions of the Regional Offices include monitoring and evaluation of all ongoing forestry development projects and schemes with specific emphasis on conservation of forests; to assist states and UFs in preparation of proposals involving diversion of forest lands for non-forestry purposes under the provisions of the FCA for expeditious processing and disposal of such cases; to undertake physical inspection of sites in cases of diversion of forests involving an area of more than 40 ha; to monitor the implementation of conditions and safeguards stipulated by the Central Government in regard to diversions approved under the FCA; to assist the states and UFs in the preparation of management plans for working of forests under their control within framework of guidelines issued by the Central Government from time to time; to assist the states and UFs in streamlining collection, collation, storage and retrieval of data covering all the facets of forests and forestry activities and to transmit such data to the Central Government/Central Data Processing Centre. However, following the recent order of the Supreme Court and directives contained therein, the scope of the forestry functions of the Regional Office (NEZ) has further been widened.

ENVIRONMENT MANAGEMENT AND POLLUTION CONTROL FUNCTIONS

The mandates of the Regional Offices under the environment management and pollution control functions include follow up of implementation of stipulations and safeguards laid down for projects/activities accorded environmental clearance under the EPA; to follow up pollution control measures taken by industries, local bodies, government undertakings etc.; to collect and furnish information relating to environmental impact assessment (EIA) of projects, pollution control measures, methodology and status, legal and enforcement measures, environmental protection of special conservation areas like wetlands, mangroves, biosphere reserves etc.; to maintain liaison and provide linkage with the concerned State Government, Central Government Agencies, project authorities, CPCB, SPCBs, NGOs/VAs in implementation of programmes relating to environment. Facilitating implementation of Paryavaran Vahinis in the district levels is also a part of the environment functions of the Regional Offices.

FOREST (CONSERVATION) ACT, 1980 AND ITS SIGNIFICANCE IN THE REGULATION OF REGIONAL DEVELOPMENT

Regulations of diversion of forest lands for non-forestry purposes under the FCA is one of the major functions of the Regional Offices. This includes site inspections of the proposals received, careful evaluations of the sites/proposals, weighing of alternatives, assigning of stipulations/conditions while according clearance, monitoring of compliance of stipulations by the user agency and above all regular monitoring/evaluation of compensatory afforestations and its survival rate. It may be mentioned here that diversions up to 5 ha is accorded by the Regional Office; Diversions up to 20 ha is discussed and recommended through the State Advisory Committee constituted under the Act; and above this all cases are directly dealt by the ministry in New Delhi.

Through the enforcement of the Act, it is observed that although the forests need to continue to be diverted for non forestry purposes, this has helped in maintaining total area of forest lands through the mechanism of compensatory afforestation. The need is the timely execution of the compensatory afforestation and constant improvement of the quality of forests created through compensatory for ecological, economic and biodiversity services. Table 1 illustrates the total number of diversion/cases and total forest area diverted so far in the North-East under the Forest (Conservation) Act, 1980. The diversion of forests are for various activities such as oil drilling & exploration, setting up of small scale industries, construction of buildings, hydroelectric power projects, construction of roads/railways/bridges, transmission line, telecommunication, irrigation, water supply, stone quarrying, thermal power plants and other miscellaneous purpose including burial ground, laying of water pipes, conservation of a specific site for its historical importance etc.

ENVIRONMENT (PROTECTION) ACT, 1986 AND ITS SIGNIFICANCE IN THE REGIONAL DEVELOPMENT

The environment management and pollution control function is another major activity of the Regional Offices. Under this, the important mandates are monitoring of projects for implementation of environmental safeguards after clearance under EPA and follow up of pollution control measures being implemented by polluting industries. The Environment (Protection) Act, 1986 is an umbrella act for safeguarding the environment. It is perhaps the most important mechanism or tool for reconciling development with environmental protection. Ever since this ACT came into operation, it can be said that there has been greater awareness at all the levels of our society for sustainable reconciliation of our developmental needs with environmental protection. Table 2 shows the total number of projects cleared under the EPA in different states of the North-East, which are being monitored by this regional office. The projects cleared within the provisions of the EPA, fall under different categories, such as River Valley Projects (hydel, irrigation or multipurpose), gas based thermal power plants, industries (cement, paper, fertiliser), mining (coal and limestone), refinery, airports etc.

CENTRALLY SPONSORED SCHEMES FUNDED BY THE MINISTRY OF ENVIRONMENT & FORESTS

In order to off-set the state resources and facilitate the development of overall environment, forests and wildlife of the region, the Ministry of Environment & Forests has been extending financial support to the State Government under the 'Centrally Sponsored Schemes' of the Central Government. Major activities, for which funds are made available under the ministry include development of protected areas like wildlife sanctuaries, national parks, biosphere reserves, management of wetlands of national/international significance; eco-development/eco-restoration/ecological improvement; watershed and wasteland development; ex-situ

conservation and multiplication of threatened endemic plant species; area-oriented fuel and fodder improvement etc. Table 3 shows the funds made available to various states of the North-East for various items of works between 1991-92 to 1997-98.

NATIONAL ENVIRONMENTAL AWARNESS CAMPAIGN (NEAC), RESEARCH FUNDINGS ETC.

The Ministry of Environment & Forests has been conducting a National Environmental Awareness Campaign every year since 1986 with the aim of creating environmental awareness at the national level. Under these schemes, funds are made available to registered NGOs/Vas, educational institutes, State Government Departments working in the field of environment and development for conducting various activities like seminars/workshops, competitions, festivals, camp/padyatras/rallies etc. for creating environmental awareness among the general public. The funds for this purpose are channelised through Regional Agencies, which are identified for every states of the country, including N.E. India. So far sizable amount of funds has been made available for the purpose, of which, N.E. India too has been benefitted. The themes of the NEAC for 1997-98 or 50th year of India's independence are – (a) Pollution Prevention and Control and (b) Conservation and Plantation of Trees for Environmental Protection.

Besides these, the ministry provides funds for basic and applied research in science relating to environment and forests. This advantage has been enjoyed by universities and research institutes in N.E. India under the Man and Biosphere Programme, Environmental Research Programme, Climate Change, National Natural Resource Management System, Conservation of Biological Diversity and so on.

THE PARYAVARAN VAHINI (ENVIRONMENT BRIGADE)

The Union Ministry of Environment & Forests in its drive for creating environmental awareness and to involve people in the preservation of environment, forests and wildlife, started a scheme known as 'Paryavaran Vahini'. It is meant to be a people's programme wherein persons/NGOs dedicated to the cause of environmental protection are identified, encouraged and invited to be members. The objectives of the scheme are – (a) creation of environmental awareness and involvement of people through active participation; (b) reporting on illegal acts pertaining to forests, wildlife, pollution, environmental degradation and cruelty to animals; (c) feedback regarding afforestation and survival of plants; (d) monitoring, including collection of sample, analysis of ambient air and water quality, including vehicular pollution.

It may be mentioned here that the scheme is not employment generating scheme. Membership is voluntary and honorary; selected members are, however, partially reimbursed for the expenses made for attending meetings. Through the creation of large number of Paryavaran Vahinis at each district of each state, the ministry's vision is in the ultimate building up of environmentally concerned and active citizens across the country. the scheme is executed under the leadership of the Deputy Commissioner or Collector of the district. In North-East India, the Paryavaran Vahini has been constituted and/or in the processes of constitution in 22 districts (Table 4) across the seven states with varying degree of success.

CONCLUSION

Transformation of the North-East through appropriate reconciliation of environment and development is the constant dream and long-term goal of the Ministry of Environment and Forests. Being the nodal agency for the planning, promotion and co-ordination of environmental and forestry programmes in the country, the ministry vis-à-vis its Regional Offices have made modest contribution towards this mandate as reflected in the foregoing discussion. The environmental consideration in all the planning and execution processes of developmental activities are now increasing realities. The concept and concern on environment, forests, wildlife, bio-diversity, pollution control, global warming, sustainable development etc. are now more frequently discussed in the media, radio, TV, newspapers, magazines; in educational and technical institutions; in government/corporate/private offices; in religious places and political arena of the country, both nationally and regionally/locally. Yet, what needs to be done remained a much more daunting task than what has been achieved.

The North-East has been not only a latecomer to development, but also disadvantaged in many ways. Although rich in ethno-geographic and bio-geographic diversity, as well as in bio-diversity, partition has left the region geo-politically isolated with over 4500 km of external frontier with Bangladesh, Bhutan, China and Myanmar, and only about 22 km connection with the mainland India. The post-partition trauma for the region

has been in the disruption of market and communication facilities, socio-economic and socio-political transformation due to influx, geo-political reorganisation, insurgencies, agitations, socio-economic distancing resulting in retardation of economic growth which has not been adequately appreciated nor compensated.

The majority of the people of North-East India continue to depend heavily on forests and forest-based resources for their livelihood and economy. But recent spate of pressure on the forest and the rate of depletion of forests of the region has been indeed alarming, particularly after the nineties. It is thus observed that between 1991 and 1993, whereas the forest cover throughout the country registered an increase of 925 sq. km., that in the North-East declined by 635 sq. km. Again, between 1993 and 1995 the decline has been to the tune of 783 sq. km. Further decline of 316 sq. km took place between 1995 and 1997 assessment as per FSI[3] report. In this report, it is observed that decline in forest cover has taken place in the states of Arunachal Pradesh, Assam, Manipur, Meghalaya and Nagaland, whereas there was slight increase in forest cover in the states of Mizoram and Tripura (Table 5).

This alarming situation has led to further search for sustainable reconciliation of development with environment and forests, resulting in the outcome of landmark reports in the form of Shukla Commission[4] and Rajamani Commission[5] dealing on the North-East. While the former report deals on overall development needs of the region, including forest and environment, the latter report specifically deals on matters relating to conservation and management of forests in North-East India. Suffice it to mention here that with the acceptance of these reports, as well as following recent Supreme Court order relating to forests in the North-Eastern states, which is extraordinarily significant on the many counts[6], the role and scope of the functions of the Ministry of Environment & Forest vis-à-vis its Regional Offices, particularly that of the N.E. Regional Office at Shillong, have further been widened.

The order, amongst others, includes a series of directives and comprehensive plan(s) to deal with the preservation and sustainable exploitation of what is arguably, at once, the richest and most threatened forested region of the country. The order[7] further laid down a regulatory framework for sustainable exploitation of forest resources through approved working plans, notification of industrial estates for locating wood-based industries, restrictive movement of timber and so on. In a way, this could be the best opportunity to truly reconcile development with environment and forest. This Supreme Court Order, the aforementioned Commission' reports and many more regulatory frameworks planned, programmed and coordinated by the Ministry of Environment & Forests together with its Regional Offices, if strictly adhered to, should go a long way towards sustainable development of the country in general and North-East India in particular. And together with the people, for the people and by the people, we look the future with greater optimism and hope to realise this vision.

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TABLE–I
NUMBER OF FOREST DIVERSION CASES APPROVED AND FOREST LAND DIVERTED UNDER THE FCA IN N.E. INDIA UPTO MARCH 1998

States	Total No. of cases	Forest area diverted (ha)
Arunachal Pradesh	37	871.209
Assam	88	1519.6945
Manipur	7	246.231
Meghalaya	28	176.8712
Mizoram	2	55.16
Nagaland	–	–
Tripura	34	1854.1165
Total	196	4723.2822

TABLE– II
TOTAL NUMBER OF PROJECTS GIVEN ENVIRONMENTAL CLEARANCE UNDER THE EPA IN N.E. INDIA UPTO MARCH 1998

Projects	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Tripura
River Valley	2	6	6	3	3	2	2
Gas Industry	–	6	–	–	1	–	1
Thermal	1	4	–	–	–	–	–
Refinery	–	4	–	–	–	–	–
Mining	–	2	–	–	–	–	–
Airports	–	–	–	2	1	–	–

TABLE–III
CENTRALLY-SPONSORED SCHEMES SANCTIONED/FUNDED (IN LAKHS) BY THE MOEF BETWEEN 1991-92 TO 1997-98 IN N.E. INDIA (AMOUNT COMPUTED BASED ON AVAILABLE RECORDS IN REGIONAL OFFICE, SHILLONG)

States	Protected area development	Eco-development	Watershed/wasteland wasteland development	Fuel & fodder	Ex-situ conservation
Arunachal Pradesh	49.96	273.72	103.27	39.05	–
Assam	201.21	132.90	30.00	690.48	29.65
Manipur	11.75	778.00	49.60	1260.00	–
Meghalaya	114.53	205.03	159.38	190.10	–
Mizoram	94.74	82.44	–	1300.00	–
Nagaland	1.00	126.30	119.50	25.15	–
Tripura	56.22	143.35	28.55	151.25	–

TABLE–IV
DISTRICTS COVERED UNDER THE PARYAVARAN VAHINI IN N.E. INDIA

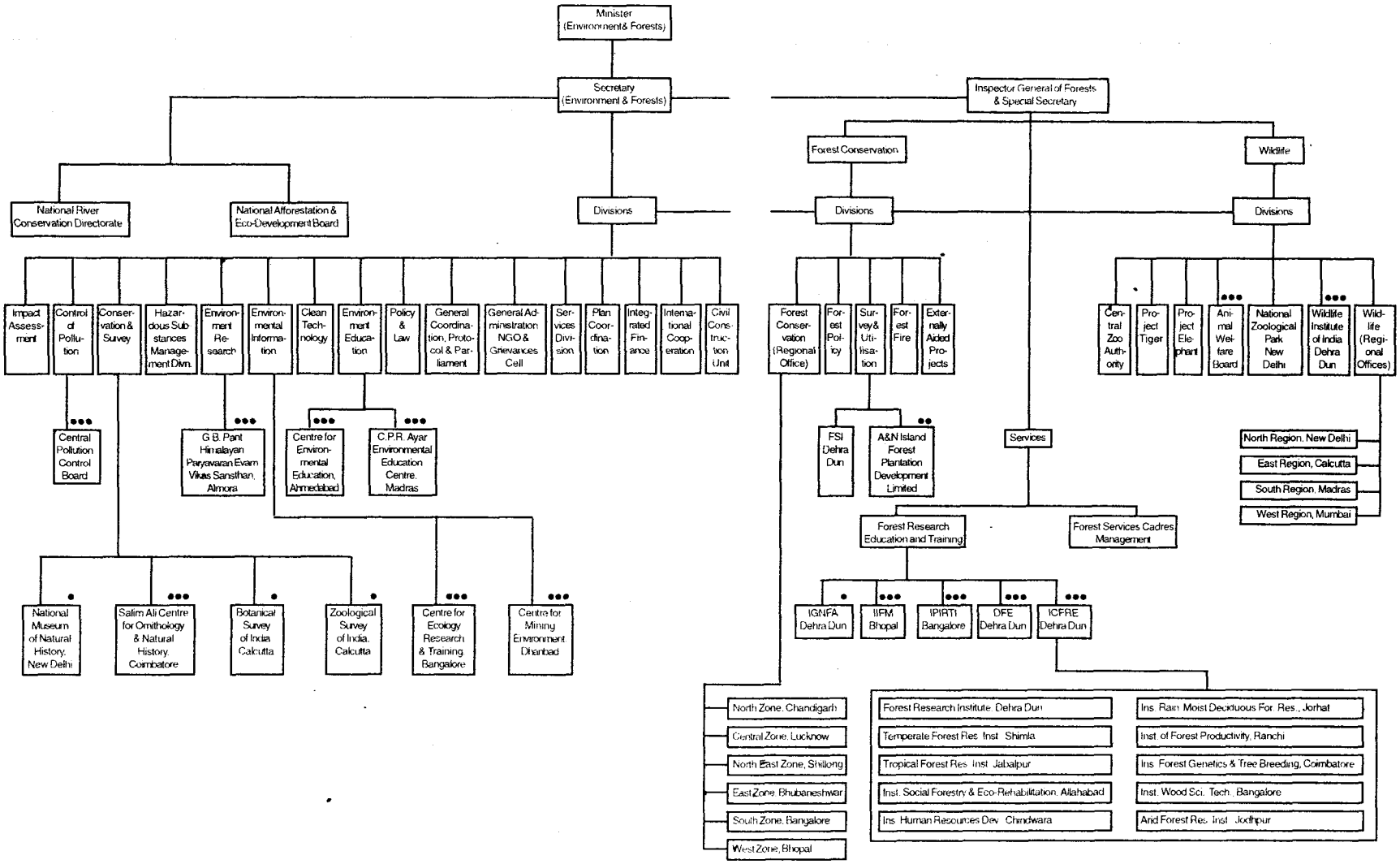
States	Districts
Arunachal Pradesh	Tawang
	West Kameng
	East Kameng
	Lower Subansiri
	Upper Subansiri
	Papumpare
	West Siang
	East Siang
	Dibang Valley
	Lohit
	Changlang
	Tirap
Assam	Dibrugarh
	Sibsagar
	Cachar
	Karbi Anglong
Manipur	Ukhrul
Meghalaya	East Khasi Hills
Mizoram	Aizawl
Nagaland	Kohima
	Mokokchung
Tripura	South Tripura

TABLE–V
COMPARATIVE ACCOUNT OF FOREST COVER N.E. INDIA IN 1995 AND 1997 ASSESSMENTS (Sq. Km.)

States	1995 Assessment	1997 Assessment	Change
Arunachal Pradesh	68,621	68,602	(–) 19
Assam	24,061	23,824	(–) 237
Manipur	17,558	17,418	(–) 140
Meghalaya	15,714	15,657	(–) 57
Mizoram	18,576	18,775	(+) 199
Nagaland	14,291	14,221	(–) 70
Tripura	5,538	5,546	(+) 8
Total	164,359	164,043	(–) 316

(Source: FSI, MoEF, 1997)

TABLE – VI
ORGANISATION CHART OF THE MINISTRY OF ENVIRONMENT AND FORESTS



- ● Subordinate Offices
- ●● Public Sector Undertakings
- ●●● Autonomous Bodies

DEVELOPMENT OF POLLUTION CONTROL ACTIVITIES IN NORTH EAST INDIA

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ABSTRACT

Air, water and soil pollution is mostly caused by the activities of man. In the north eastern states of India pollution is caused by vehicular emissions, industrial emissions and effluents, sewage and solid wastes, discharges of domestic and commercial activities, mining activities, agricultural activities etc.

To plan a comprehensive programme for air pollution prevention, control and abatement and to inspect air pollution equipment and give such directions as may be considered necessary for pollution controls. The Central Pollution Control Board, North Eastern Zonal Office Shillong, co-ordinates with the State Pollution Control Boards in north east India to check and control vehicular emissions by regular checking of different vehicles in the state capitals, to issue time bound consent letter with suitable conditions to hotel industries, bakeries, vehicle servicing centres, smoke emitting chimneys etc. and to make regular inspection and monitoring to different factories etc.

For water pollution control the CPCB inspect the Effluent Treatment Plants (ETP) of different industries, and monitor ground water and river water quality in and around the industrial areas, sponsored different projects to the State Boards for water quality monitoring. The Central Pollution Control Board in collaboration with the State Pollution Control Boards (SPCB) has established the Water Quality Monitoring (WQM) network.

For soil pollution control, the Central Pollution Control Board gives direction and guidelines to State Boards for proper disposal of domestic and commercial wastes, agricultural and industrial wastes etc.

The Central Pollution Control Board also sanction funds to different NGOs to organise Mass Awareness Programmes to make the people aware of the harmful effects of pollutions and the need for pollution control.

INTRODUCTION

Pollution can be defined as the undesirable change in physical, chemical or biological characteristics of air, water and land that harmfully affect health, survival or activities of human being or living organisms. This environment pollution is mainly caused by human activities like – urbanisation, industrialisation, agriculture, transport, mining etc.

Global environment pollution is increasing year by year due to the above mentioned factors and cumulative impact of human activities. India is also facing this pollution problem due to the development activities. So an Act to provide for the prevention and control of water pollution and the maintaining or restoring of wholesomeness of water called "The Water (Prevention and Control of Pollution) Act, 1974", was passed under clause (1) of article 252 of the Constitution. To implement this Water Act the Central Board for prevention and Control of Water Pollution was constituted in September 1974, under Ministry of Environment and Forest, Govt. of India. Subject to the provisions of this Act, the main function of the Central Board shall be:

1. To promote cleanliness of streams and wells in different areas of the states.
2. In particular and without prejudice to the generality of the foregoing function, the Central Board may perform all or any of the following functions :–
   a) advise the Central Government on any matter concerning the prevention and control of water pollution;
   b) co-ordinate the activities of the State Boards and resolve disputes among them;
   c) provide technical assistance and guidance to the State Boards;
   d) plan and organise training programmes;
   e) to organise mass awareness programmes;
   f) collect, compile and publish technical and statistical data relating to water pollution and its control;
   g) lay down, modify or annul the standards for a stream and well;
   h) plan and cause to be executed a nation-wide programme for the prevention, control or abatement of water pollution;
   i) perform such other functions as may be prescribed.

3. The Central Board also established or recognised laboratories to perform its functions efficiently.

To prevent, control and abate air pollution in the country, the Government of India enacted central legislation called the Air (Prevention and Control of Pollution) Act, 1981. Under this Act the Central Board is empowered to :

a) advise the Central Government on any matter concerning the improvement of the quality and prevention, control and abatement of air pollutants;
b) plan and cause to be executed a nation-wide programme for the prevention, control and abatement of air pollution;
c) co-ordinate the activities of the State Boards and resolve dispute among them;
d) provide technical assistance and guidance to the State Pollution Control Boards;
e) plan and organise the training of persons engaged or to be engaged in pollution control activities;
f) sponsor investigations and research relating to air pollution prevention, control and abatement of air pollutants;
g) collect, compile and publish technical and statistical data relating to air pollution;
h) lay down the standards for the quality of air and emission quantities.

Also, an Act to provide the protection, improvement and abatement of environment and for matters connected therewith called "The Environment (Protection) Act was passed on 23rd May 1986. It came into force in the whole of India on 19th November 1986. Under the Act the Central Government/Central Board is empowered to :

i. co-ordination of actions by State Boards;
ii. planning and executing a nation-wide programme for the prevention, control and abate environmental pollution;
iii. laying down standards for the quality of environment in its various aspects;
iv. laying down standards for emission or discharge of environmental pollutants from various sources whatsoever;
v. restriction of areas in which any industries, operation or process or class of industries, operation or process shall not be carried out or shall be carried out to certain safeguards;
vi. laying down procedures and safeguards for the prevention of accidents which may cause environment pollution and remedial measures for such accidents;
vii. laying down procedures and safeguards for the handling of hazardous substances;
viii. examination of such manufacturing process, materials and substances as are likely to cause environmental pollution;
ix. carrying out and sponsoring investigation and research relating to problems of environmental pollution;
x. inspection of any premises, plant, equipment, machinery, manufacturing or other processes, materials or substances and giving, by order, of such directions to such authorities, officers or persons as it may consider necessary to take steps for the prevention, control and abatement of environmental pollution;
xi. establishment or recognition of environmental laboratories and institutes to carry out the functions entrusted to such environmental laboratories and institutes under this Act;
xii. collection and dissemination of information in respect of matters relating to environmental pollution;
xiii. preparation of manuals, codes or guides relating to the prevention, control and abatement of environmental pollution;
xiv. such other matters as the Central Government deems necessary or expedient for the purpose of securing the effective implementation of the provisions of the Act.

For the avoidance of doubts, it is also declared that the power to issue directions under this section includes the power to direct –

(a) closure, prohibition or regulation of any industry, operation or process, or
(b) stoppage or regulation of the supply of electricity or water or any other service.

Exercising these provisions of Water Act 1974, Air Act 1981 and Environment (Protection) Act 1986, the Central Pollution Control Board, lay down ambient air quality standards for different notified areas and emission standards for various air polluting units, effluent discharge standards for water polluting units, noise level standards for specified areas etc. to provide a basis for protecting public health from adverse effects of air, water and other pollution, and for eliminating or reducing to a minimum, those contaminants of air, water, etc. that are known or likely to be hazardous to human beings, animals, vegetation, agriculture, historical monuments etc. For the convenience of pollution control in industrial areas, the CPCB categorised highly polluting industries in the country into 17 categories and stress to implement pollution control provisions to the following industries : (1) Aluminium Smelter (2) Caustic Soda (3) Cement (200 tpd and above) (4) Copper Smelter (5) Distillery (6) Dyes & D.I. (7) Fertilizer (8) INT. Iron & steel (9) Tanneries (10) Pesticide (11) Petrochemicals (12) Basic Drugs & Pharmaceuticals (13) Pulp & Paper (30 TPD & above) (14) Oil Refinery (15) Sugar (16) Thermal Power Plant and (17) Zinc Smelter. The CPCB is collecting detailed status from these industries.

To exercise the provisions of the Water, Air and Environment Acts in the North Eastern Region of India, the Central Pollution Control Board, North-Eastern Zonal Office had been established at Shillong in the year 1988. The jurisdiction of this Zonal Office covers the seven states of North East India. Most of the states have established Pollution Control Boards at the state levels under different departments (Meghalaya & Manipur Board under PHE, Assam & Tripura under Science & Technology and Mizoram, Nagaland & Arunachal Pradesh under Forest Dept.) to exercise the Air and Water Acts at state level. The CPCB NEZO give Technical/Scientific assistance to these State Boards whenever required. It also take follow-up actions to implement Pollution Control activities in various major polluting industries. Under the jurisdiction of CPCB NEZO there are 16 units of highly polluting industries (under 17 categories) 15 in Assam (10 with adequate facilities to comply with standards and 5 without adequate facility) and 1 in Meghalaya without adequate facility to comply with standard. There are 12 Grossly Polluting Industries all are located in Assam.

To prevent, control and abate air pollution in North East India the CPCB NEZO in collaboration with the State Pollution Control Boards (SPCB) implement the provisions of Air Act. The Pollution Control Board issue consent letters with definite terms & conditions, to pollution emitting industries and pursue the implementation of the consent terms & conditions by regular inspection of the plants and monitoring the ambient air quality of the surrounding and stacks. It also gives directions to highly air polluting industries to install pollution control equipments like : Electrostatic Precipitators (ESP), Dust Bag Filter, Cyclone, Scrubbers etc.

The CPCB, NEZO co-ordinates the SPCB to check and control vehicular emissions by regular checking of different vehicles in their respective capitals and issue cards with regard to their pollution emission giving directions to reduce pollution emissions (Hydrocarbons & Carbon Monoxide). Also the SPCB issue consent letters with definite terms & conditions to hotel industries, bakeries, vehicle servicing centres, smoke emitting chimneys etc. and make regular inspection and monitoring to different pollution emitting factories.

The CPCB sponsors 12 National Ambient Air Quality Monitoring Stations (NAAQMS) in N.E. Region through respective State Boards and the North East Zonal Office is supervising Technical & Scientific aspects of regular monitoring, to collect and compile the ambient air quality of the specified areas and also to store, prepare and formulate policies and action plans.

To prevent, control and abate water pollution in N.E. India the CPCB, NEZO in collaboration with the SPCBs implement the Water Act 1974, making regular inspection to the Effluent Treatment Plants (ETP) of water pollutant discharging industries and monitoring the water quality of river and streams receiving industrial effluents. The CPCB also sponsors different projects to the State Boards for Water Quality Monitoring. The CPCB in collaboration with SPCBs has established 17 stations of Water Quality Monitoring (WQM) network/Monitoring of Indian National Aquatic Resources Stations (MINARS) in 1977 and 480 stations in 1994 spread over 21 states and 4 Union Territories, in the country, with 26 stations in N.E. India (12 in Assam, 5 in Meghalaya, 5 in Manipur and 4 in Tripura). The CBCP NEZO is supervising Technical & Scientific aspects for regular monitoring of the water quality. One of the mandates of the CPCB for the MINARS is to make regular monitoring of river water quality in different states, collect, compile and publish Technical & Scientific data relating to water pollution and the measures desired for its effective prevention, control and abatement. The Pollution Boards also issue consent letters with specific terms & conditions to water pollutant discharging industries like : hotel industries, vehicle servicing centres etc. The SPCBs also monitored water quality in the mining areas in their respective states and submit their findings and advice to their State Government to take necessary actions for water pollution control. The CPCB is making regular monitoring of ground water quality

at problem areas around the Oil Refineries (like Digboi) to collect and compile data for different parameters like – heavy metals, oil & grease, pesticides etc.

For soil pollution control, the CPCB gives suggestions and guidelines to SPCBs for proper disposal of domestic & commercial wastes, agricultural & industrial wastes, medical wastes etc.

The CPCB sponsors Zoning Atlas Projects to State Boards extending technical, financial support and training to the SPCBs for efficient execution of different areas for sitting of industrial units and estates. Till date two districts (Goalpara and Kamrup) in Assam and three districts (Imphal, Thoubal and Bishnupur) in Manipur have been completed, while others are in progress.

The CPCB attends Public/VIP complaints for settlements of pollution related matters and the Central Board through its Technical & Scientific resources pursue the complaint matters and find out remedial measures/solution and recommend necessary action to the concerned departments/authorities. Also the CPCB attend parliamentary as well as Supreme Court directions on pollution control matters.

Legitimate control (Water and Air Acts) alone cannot solve the pollution problems unless the common people are conscious of the pollution problems, the Pollution Control Boards through mass awareness try to make the common people aware of pollution and its related subjects by organising mass awareness programmes like : workshop, seminar, exhibitions, painting competitions, debate competitions etc. through various recognised institutional organisations, NGO etc.

ENVIRONMENTAL IMPACTS OF COAL MINING ACTIVITIES IN JAINTIA HILLS OF MEGHALAYA

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Shillong - 793 014

ABSTRACT

Meghalaya is rich in minerals like coal, limestone, sillimanite, clay, gypsum, copper, phosphates and uranium. Coal is one of the most important and widespread mineral mainly in Jaintia Hills. Coal production in Meghalaya dates back to 19th century. The coal mining in Jaintia Hills is performed by individual mine owner in a most unplanned and unscientific manner. In coal mining areas, the surface water and ground water have become contaminated with untreated acid mine drains and coal dump run-offs. The air in the coal mining areas is polluted at different stages like coal mining, handling, storage and transportation. The unscientific coal mining activities in Jaintia Hills District have started showing significant environmental impacts and there is an urgent need for corrective measures.

INTRODUCTION

Man, in quest for better living standards, has started exploiting mineral resources since time immemorial. But since last few decades, tremendous stress has been put to exploit and utilise finite mineral resource due to fast increasing industrialisation, urbanisation, growth in agriculture and population explosion. This unprecedented upsurge in exploitation of minerals is resulting in massive ecological disturbances and impairment of the environment.

Meghalaya is rich in mineral resources and a number of minerals like coal, limestone, sillimanite, clay, gypsum, copper, phosphates and uranium are located in various parts of the state. Out of these, coal is one of the most important and widely spread mineral resource which occurs mainly in the Jaintia Hills, east and west Khasi Hills and Garo Hills Districts of the state. The total proven reserves of coal in the state are about 560.0 million tons which are spread over an area of 213.9 sq. kms. thus covering approximately 1% of the total geographical area of the state. Jaintia Hills District alone is having about 39.6 million tons of coal deposits which are spread over in the coal belts of Iroksi, Sutnga, Khillieriat, and Jariang and Lakadong.

Coal production in Meghalaya dates back to 19th century when it was first exploited in Cherrapunjee in the year 1840. Since then, coal remained as the most exploited mineral resource of the state. The coal production in Jaintia Hills has started sometimes in mid eighties. This district has now got the distinction of being the largest coal producing district as it is contributing about 80% of the total coal produced in the state.

The coal mining in Jaintia Hills District is performed by individual mine owners in most unplanned and unscientific manner. Mostly, the coal is exploited by the traditional Rat-Hole method in which a narrow tunnel is dug in the hills which runs parallel to the ground surface. This method, perhaps has become popular as the coal seams are located at shallow depths which makes the quarrying of coal possible from the sides of the hills. As the coal deposits available at the shallow depths are fast coming close to exhaustion, new underground mining methods are introduced in the area. In this method, well type of structures ranging from 20-40 meters in depth are dug till the coal seam is encountered. This method produces comparatively more overburden than the Rat-Hole Method.

These mining operations in the coal mining areas of the Jaintia Hills are generating potentially widespread environmental impacts in several sectors. The most prominent among these are : Land Use Impacts, Water Quality Impacts, Air Quality Impacts, Ecological Impacts and Socio Economic Impacts.

The present paper highlights the water and air quality impacts of the coal mining activities in Jaintia Hills District which are the outcome of a recently concluded study conducted by the Meghalaya Pollution Control Board, Shillong.

IMPACT ON WATER QUALITY

The surface water bodies and groundwater in the coal mining areas have become heavily polluted due to the discharge of the untreated acid mine drains and coal dump run-offs which contains strong mineral acid in the form of sulphuric acid (H_2SO_4) produced as the chemical activity. The Jaintia coal is associated with comparatively higher concentrations of sulphide mineral (FeS_2) which produces sulphuric acid when it comes in contact with water. The problem of water pollution gets magnified further because Jaintia Hills receives

heavy rainfall throughout the year and most of the mining areas are submerged under water during the rainy season. Washing of the coal loaded trucks before it is transported to the outside of the state and release of untreated domestic effluents from the adjoining labour and other settlements also contributes significantly towards water pollution. Table I, II, III and IV provides the average water quality status for some selected parameters of a few rivers, streams, springs and hand pumps of the coal mining areas of the Jaintia Hills District :

TABLE — I

RIVER WATER QUALITY OF THE COAL MINING AREAS OF JAINTIA HILLS DISTRICT

Sl. No.	Name of River	pH	Cond	TDS	Acidity	SO_4^{2-}	Fe	DO
1	Umrutkar	5.5	175	107.2	nil	33.9	0.9	5.2
2	Shutwakhu	3.0	157	131.9	12.1	39.3	3.7	4.8
3	Wahkhyrwei	3.5	220	139.9	28.9	43.2	1.6	4.7
4	Kmeum	3.3	535	317.3	91.1	49.1	4.8	4.6
5	Sarbang	3.9	356	207.0	40.2	95.8	4.2	4.3
6	Kyrhukhla	3.6	176	106.4	21.0	31.7	1.4	5.7

All values in mg/L except pH and conductivity. Conductivity in µmho/cm.

TABLE — II

STREAM WATER QUALITY OF THE COAL MINING AREAS OF JAINTIA HILLS DISTRICT

Sl. No.	Name of Stream	pH	Cond	TDS	Acidity	SO_4^{2-}	Fe	DO
1	Sohshrieh	6.7	91	57.1	nil	nil	0.6	—
2	Rymbai	2.6	173	109.8	24.4	43.5	8.2	
3	Charchare	5.3	75	39.9	7.9	8.1	0.2	—
4	Kongong	2.8	394	182.6	52.6	146.0	0.6	—
5	Sutnga	4.4	72	4.7	9.4	3.8	0.1	—

All values in mg/L except pH and conductivity. Conductivity in µmho/cm.

TABLE — III

SPRING WATER QUALITY OF THE COAL MINING AGEAS OF JAINTIA HILLS DISTRICT

Sl. No.	Name of Spring	pH	Cond	TDS	Acidity	SO_4^{2-}	Fe	DO
1	Lulong	6.8	53	27.6	nil	nil	nil	5.0
2	Wailong	5.9	111	80.4	nil	34.3	nil	3.6
3	Umlieh	6.0	42	25.4	nil	342	nil	3.6
4	Rymbai	5.9	83	55.8	nil	nil	nil	4.3
5	Lad Rymbai	7.2	67	45.9	nil	nil	nil	5.8
6	Charchare	6.8	64	27.8	nil	nil	0.4	4.0
7	Khlawsorkar	5.6	43	26.6	nil	nil	nil	4.6

All values in mg/L except pH and conductivity. Conductivity in µmho/cm.

TABLE — IV

HAND PUMP WATER QUALITY OF THE COAL MINING AREAS OF JAINTIA HILLS DISTRICT

Sl. No.	Name of H. P.	pH	Cond	TDS	Acidity	SO_4^{2-}	Fe	DO
1	Sohshrieh	6.5	71	37.8	nil	nil	0.2	2.1
2	Charchare	6.4	132	92.1	nil	nil	0.5	4.8
3	Wahkhyrwei	6.4	168	101.4	nil	34.0	0.3	3.9

All values in mg/L except pH and conductivity. Conductivity in μmho/cm.

It is evident from the above tables that the surface and groundwater quality has degraded to a large extent. The low pH, DO and high conductivity, acidity, sulphate and iron contents of these waterbodies are the clear indication of its polluted nature.

IMPACT ON AIR QUALITY

Various mining operations at different stages of mining like coal mining, handling, storage and transportation of coal play a major role towards air pollution in the coal mining areas of the Jaintia Hills District. The other factors like physical properties of coal (particle size and moisture contents etc.), local topography, vegetation cover and local climatic conditions also determine the overall impact of these mining operations. Mining activities in these areas are highly labour intensive and transportation is performed by means of the road transport only in absence of any other form of transport systems which further magnifies the problem of air pollution.

Table–V provides the average concentration of suspended particulate matter (SPM), Sulphur-di-oxide and oxides of nitrogen in the residential, coal mining and coal storage areas of the Jaintia Hills District.

TABLE — V

CONCENTRATION OF AIR POLLUTANTS

Sl. No.	Name of Place	SPM	SO_2	NOX
1.	Residential			
	a. Bapung	185	3.5	20.5
	b. Sutnga	98	3.2	11.8
2.	Coal Mining			
	a. Bapung	195	6.6	21.8
	b. Sutnga	218	5.9	27.9
3.	Coal Storage			
	a. Charchare	286	7.1	16.5

All values in μmg/L g/Nm^3

From the above table it is clear that SPM concentrations exceeds the national ambient air quality standards in the coal mining and coal storage areas of the Jaintia Hills District though the SO_2 and No_X do not pose any immediate threat.

CONCLUSION AND RECOMMENDATIONS

The haphazard and unscientific coal mining activities in Jaintia Hills District have already started showing significant adverse environmental impacts and there is an urgent need to adopt the corrective measures to help contain further degradation of the environment of the area. The following recommendations are suggested for implementation to minimize these impacts.

- To generate social awareness among the public of the problematic areas in general and the coal miners in particular about the adverse environmental impacts and the health hazards associated with such unscientific and haphazard coal mining activities.

- To engage expert institution for finding out the most suited technologies for exploitation of coal with appropriate pollution control measures in order to ensure that the environment as a whole is not subjected to further degradation.
- To engage expert institution to find out the suitable ways for rehabilitation of the already mined land in phased manner so that the scarce land resources can be brought back to the productive uses.
- To prepare an inventory of the mine owners, areas under mining and the rate of land use change to gate the ideas about the quantum of the efforts required for better management of the coal mining activities.
- To identify the suitable location for building of a Central Coal Storage Yard for sale of coal with adequate facilities to treat the wastewater and dump run-offs.
- To study the aspect of the trace elements in the surface and groundwater of the coal mining areas where the pH values were found to be extremely low (the low pH values increases the dissolution of trace elements in water) as some of these trace elements are serious health hazards to the mankind even in very low concentrations.
- To introduce lucrative public schemes for afforestation in the most affected parts of the coal mining areas.
- To develop State Mineral Policy with the active interaction of the government agencies, social institutions, local elders and miners keeping in view the specific land ownership system in the state.

DEVELOPMENT OF FORESTRY SECTOR IN MEGHALAYA : AN APPROACH TOWARDS ECOLOGICAL STABILITY AND ENHANCEMENT OF PRODUCTIVITY

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ABSTRACT

Department of Forestry Sector in the state in the last fifty years has been steady and in tune with the technological and socio-economic changes. Objective of management of forests in these years has shifted from timber harvesting to conservation. It has been the endeavour of the Forest Department to apply scientific management practices in all sphere of its activities to ensure conservation of biodiversity and enhance productivity of the forests.

Activities of the department to ensure ecological stability and enhance productivity have been summarised in the paper. Application of latest research and technology is key to achieve the desired goals. Greater emphasis is being attached to this aspect. Research activities in the department and its perspective expansion has also been highlighted.

INTRODUCTION

Forests occupy an important place in the land use Meghalaya. According to State of Forest Report, 1995 published by the Forest Survey of India, the total forest cover in the state is recorded as 15714 sq. km., out of which dense forest category constitutes 4045 sq. km. Forests in Meghalaya are endowed with rich bio-diversity of diverse climatic and topographic conditions existing in the state. These can broadly be grouped under the tropical type and the temperate type, mainly based on the altitude, rainfall and dominant species composition. Tropical forests are met within areas up to an elevation of 1200m and with an average rainfall of about 100-250 cm. There are numerous subtypes within this category such as evergreen, semi evergreen, moist and dry deciduous forests etc. The temperate forests occupy the higher elevations (about 1000m), mostly along the southern slope of Khasi and Jaintia Hills. It does not need any mention to highlight the importance of forest resources for the ecological stability and socio-economic life of the state.

Development of Forestry Sector in the state in the last fifty years has been steady and in tune with the technological and socio-economic changes. Objective of management of forests in these years has shifted from timber harvesting to conservation. It has been endeavour of the forest department to apply scientific management policies in all sphere of its activities to ensure conservation of bio-diversity and enhance productivity of the forests.

FOREST AREA

Forest area in the state has been estimated by an expert committee constituted for the purpose, following directions of the Supreme Court. Findings of the committee are summarised below:

The forest area under the Forest & Environment Department, Meghalaya is 1127.232 sq. km. This includes areas under Reserved Forests, Protected Forests, proposed Reserved Forests, National Parks and proposed National Parks, Wildlife Sanctuaries and under various parks and gardens. These areas are reservoir of bio-diversity and come under adequate legal protective cover.

The forests under the management of the three Autonomous District Council have in general been exposed to unprofessional and unscientific management in the past leading to over exploitation. These forests are in a degraded state.

The private and community forests form the bulk of the forests area in the state and these have borne the main brunt of commercial exploitation. In the absence of effective control mechanism these areas have been worked with the sole aim of short term financial returns and have therefore been heavily over exploited. The area figures available for these forests put these at 5004.47 sq. km. though the extent of most of such forest in Jaintia Hills and Khasi Hills Districts has not been ascertained.

The area of 4000 sq. km. classed under degraded and denuded category comprise of such areas which were forests at one time but wanton exploitation has left them without any tree cover. In most of these areas the top soil has been washed off and the moisture retention of the ground is almost lost.

A significant area of 1253.40 sq. km. is covered under plantation raised by the State Government and Autonomous District Councils. These are mainly meant for the purpose of protection of topsoil, rehabilitation of degraded lands, protection of catchment areas and for meeting local needs of the neighbouring communities etc.

STATE FORESTS POLICY & FUNCTIONS OF THE DEPARTMENT

In accordance with the National Forest Policy and taking into consideration local conditions, a draft state policy has been prepared with the following main objectives :

1. Preservation of existing flora and fauna, increasing forests cover through afforestation, social forestry, acquisition of private forests, restoration of ecological balance, maintenance of biodiversity and preservation of wildlife habitat areas..
2. Protection of river catchment areas and restoration of such degraded areas to conserve soil and water, to mitigate natural calamities like floods and drought and to retard siltation of lakes and reservoirs.
3. Meeting the increasing demand of timber, fuel, wood and other forest produce through social forestry plantations and maximising productivity of such plantations. Encouraging efficient utilisation of forest produce and simultaneously maximising substitutes of wood to reduce pressure on forests.
4. Ensuring viable prices of forest produce to encourage people to take up cultivation of forest crops to generate more employment and income in the forest sector.
5. Encouraging people's participation in forestry schemes through awareness programmes, generation of employment and economic incentives to ensure success of forestry schemes.

In accordance with the National Forest Policy, 1988 as adopted by the state, the main functions and objectives of the department are –

i. To ensure protection of water, soils, climate and wildlife by simple and natural means through forest conservation and improvement.
ii. To preserve multiple and stable eco-system.
iii. Intensive afforestation of all abandoned jhum lands, degraded areas, fallow government land and catchment areas of major rivers to restore the denuded ecological and hydrological symbiotic balance.
iv. To gradually restrict the export of timber outside the state in unconverted form to encourage wood based industries where the values added component is maximum.
v. To extend scientific management to forest areas under the control of District Councils.
vi. To manage the forests in a careful and sustained way which produce goods and renders services on the same site at the same time.
vii. Development and expansion of wildlife protected areas for protection and multiplication of rare and endangered species of flora and fauna.
viii. To check illegal poaching and killings of wildlife, both inside and outside the protected areas.
ix. Development of nature recreation centres.
x. To encourage and assist in privatisation of forest nurseries.
xi. Strengthen forestry research.
xii. Setting up of training school for the in-service training of the field executives like foresters, forest guards and malis for equipping them with technical skill. Also to provide training to unemployed youths in traditional handicrafts such as cane and bamboo based utility items and furniture making.
xiii. To set up a monitoring system to monitor stocking and health of forests in terms of their ability to regenerate by using Remote Sensing Techniques.
xiv. To effectively implement the following Acts and Rules –

   a) The Wildlife (protection) Act, 1972.
   b) The Forest Conservation Act, (1980).
   c) The Meghalaya Forest (Removal of Timber) (Regulation) Act, 1981.

ORGANISATION OF THE DEPARTMENT

The Department is headed by the Principal Chief Conservator of Forests, who is also the Technical Adviser to the Government of Meghalaya in the matter of forest management. The Department is comprised of four circles – (i) The Headquarter/Territorial Circle; (ii) The Social Forestry and Environment Circle; (iii) The Wildlife Circle and (iv) The Research & Training Circle. Each circle is comprised of forest divisions each controlled by a Divisional Forest Officer. There are in all nineteen forest divisions. Each division is further comprised of a number of ranges and each range is under the control of either an Assistant Conservator of Forests or a Ranger with specific function and duties assigned to them.

BIO-DIVERSITY AND ECO-SYSTEM

North-East India of which Meghalaya is a part, comprising an area of 171,423 sq. kms. is the bio-geographic "Gateway" for much of India's flora and fauna. The region represents the transition zone between the Indian, Indo-Malayan and Indo-Chinese bio-geographical sub-regions. It is in this lowland-highland transition zone that the highest diversity of biomes or ecological communities can be found and species diversity within these communities are also very high. Many of the species contributing to the biological diversity of the North-East India are either restricted to the region itself or to even smaller localised areas.

Shifting cultivation and widespread unscientific commercial exploitation of forests outside government controlled areas is a major cause of forest loss in the state. Short rotation cycles have depleted soil fertility and kept the vegetation arrested in early successional stages resulting in grasses and weeds. Unlike other states in the country, only a minor proportion of the forest i.e. 4.5% of the area of the state is under government control, the rest being village forests falling under the District Councils.

Population explosion and the increased demand on forest resources have put unprecedented pressure on the tropical evergreen and semi-evergreen forests for timber and fuelwood resulting in the loss of biodiversity because of removal of floristic elements from such forests. A single tree species can take away with it 10-30 dependent species. Moreover, the thin topsoil with micro-organisms that often supports this luxuriant growth is washed away by torrential rains reducing the ability of the soil to generate forests of the same type. The epiphytes (mostly orchids and aroids) that flourished and supporting growth of climbers have suffered most, causing enormous loss of genetic diversity. The population in rural areas traditionally living close to nature is largely dependent forests, utilising wild plants for varied purposes such as food and vegetables, medicines and dyes etc. Deduction of forests not only affected the ecological balance but also the economy of the tribal people due to gradual extinction of the plants they depend upon.

The peculiarity of Meghalaya is that the biodiversity is by no means confined to government protected areas. Many areas outside the protected areas are rich in biodiversity. So, any conservation strategy must include and recognise the values of non-protected areas as well. There is also a need to initiate Buffer Zone Development Programme which balances the conservation requirements with resources needs of the peoples.

The forest of Meghalaya can be broadly classified into the following types :

(a) Alluvial Sal – this type conforms to type North Indian Tropical Moist Deciduous Kamrup Alluvial Sal Forests (SC/C2 d(iv).

(b) Foothill and Plateau Sal – This type conforms to the type North Indian Tropical Moist Deciduous Eastern Hill Sal forests (3c/C1 a).

(c) Very Moist Sal Bearing Forests – Khasi Hills Sal (3c/C1 a (ii)).

(d) Mixed Deciduous Forests – North Indian Tropical Moist Deciduous (East Himalayan Moist Deciduous Forests (3C/C3 b).

(e) Evergreen Forests – These forests conform to type Northern Tropical Semi-Evergreen Forests (2B1/C1).

(f) Bamboo Forests – This type conforms to the type Northern Tropical Semi-Evergreen Forests – Secondary Moist Bamboo Brakes(2B/2S1).

(g) Grasslands – Northern Tropical Moist deciduous Forests – Low Alluvial Savannah Woodland (2/ISl).

(h) Assam Sub-Tropical Pine Forests – (9/C2).

PAST DEVELOPMENT STRATEGY

The forests of Meghalaya had been inspected by Dr Brandis, an Inspector General of Forests, in 1874. He recommended certain steps for consolidation of the forests and constituting these extensive areas into Research Forests. Unfortunately, his recommendations were not heeded leading to the present situation where the government has only about 4.6% of the total areas of the state under its control leaving the major portion of forest areas out of its jurisdiction and control.

Up to the time when the state of Meghalaya was created, only the reserved forests of Garo Hills and part of the forests under Khasi Hills District that were accessible and commercially unexploitable were given attention and management according to working plan prescriptions. The rest of the forests areas that were commercially unexploitable *viz.* the forests of Jaintia Hills District were managed without any long term plans and were not developed to the extent as the other exploitable areas. Up to this time, forestry activities were also restricted to government forests as the idea of Social Forestry was yet to be born.

Development picked up during the fourth Five Year Plan (1969-74) onwards. It was during this period that the state of Meghalaya was formed followed by the formation of the Directorate of Forests. Raising of plantations started during began of this period with the aim of improving and enrichment of degraded areas in existing government reserved. In the Fifth Plan (1974-79) and up to the Sixth Plan (1980-85), 17,410 hectares of plantation were taken up inside and outside the reserved forest areas. Social Forestry was started in 1978-79 and plantation in areas outside government control also materialised in that year. Besides the creation of the Social Forestry Wing during 1978-79, this period also saw more emphasis being given for conservation and protection of wildlife. During this period two wildlife sanctuaries were created at Siju and Nongkhyllem in 1979 and 1981 respectively. Later two National Parks were created at Nokrek and Balphakram in 1986.

During the Seventh Plan, massive afforestation programmes over 3320 hectares were raised within the reserved forests and another 12,226 hectares outside reserved forests by the Social Forestry Division. During the Seventh Plan, 32,456 additional hectares were afforested.

WILDLIFE CONSERVATION

The state of Meghalaya experiences a wide range of climatic conditions, ranging from sub-tropical to temperate type of climate with varied scales of rainfall in different parts of the year and at different altitudes and places, this varied type of climatic condition provides stretches of tropical, sub-tropical, moist evergreen forests including some temperate wood-lands which provide excellent habitat for large variety of wildlife species.

This region was once reputed to contain half the mammalian species found in the country. Meghalaya is the home of cats from the Royal Bengal Tiger to the clouded Leopard cats, Wild cat etc. The state is also the home of the Binturong (*Arctictis binturong*), a very rare animal and the Hoolock (*Hylobates hoolock*), the only true ape found in India.

Apart from its richness in animals life the state of Meghalaya is also considered to be the original home of many species of plants such as many *Citrus* and Orchid species. The pitcher plant (*Nepenthes khasiana*) is found in this state.

Over the years, the wildlife habitat has been greatly reduced due to clearance of large tracts of forests outside government control, for economic exploitation, jhum cultivation, human habitations, road, constructions etc.

At present, the wildlife population can be found in the remaining pockets of forest area comprising of 1027 sq. kms. of government controlled Reserved Forests, Parks and Sanctuaries and comprises of remote inaccessible areas unfit for exploitation cultivation and human habitations.

Proper wildlife management began after the Wildlife (Protection) Act, 1972 which came into force in the state in 1977.

The first sanctuary was created at Siju in 1979. Subsequently, within a span of seven years, two more sanctuaries and two National Parks were created. Following is the list of sanctuaries and parks existing in this state :

Name of Wildlife Sanctuary / National Park	Date of Creation	Extent in Sq. Kms.
Siju Wildlife Sanctuary	30-03-79	5.10
Nongkhyllem Wildlife Sanctuary	25-03-81	29.00
Baghmara Pitcher Plant Sanctuary	24-05-84	0.027
Balphakram National Park	15-02-86	220.00
Nokrek National Park	29-11-86	47.48
	Total	301.28

The increase in population of the elephant and tiger over the years reflects on the success of the various protection and management measures undertaken in the wildlife and wildlife habitat areas under government control which at the present extent forms less than 4% of the total geographical area of the state, too small an area to make an adequate impact on the welfare of the wildlife. With the view to sustain and increase this success by implementation of all-round development work for wildlife and the habitat, Project Elephant has been started in certain protected areas in the state.

ECO-DEVELOPMENT

The natural forests in the state are fast becoming depleted. However, there are still some areas containing a unique flora and fauna, which need to be conserved, specially those which are the sources of the mainstreams and rivers of the state.

The State Government has identified such areas, which need immediate protection. In order to conserve these areas the government realised that the population should be part of such a programme as well, in particular in the field of developing alternatives for jhumming.

The state government has created a society called 'Eco-Development Society of Meghalaya' to execute the schemes. Headquarter of the society is located at Tura. Objectives of the programme are :

- to meet the basic needs of the people in the identified villages;
- to improve their economic condition as a whole, through improved agricultural practices and facilities and where possible, development of cottage industries;
- to educate them about the importance of conservation and to educate them to be custodians of the forests;
- to generate more employment facilities so that the people can become self-supporting, making them part of the viable socio-economic group of the society;
- to build up confidence of backward tribal people by making them feel that they are part of the mainstream of developmental activities.

SOCIAL FORESTRY PROGRAMME

The Social Forestry Circle started functioning in 1978-1979, and was at this time clubbed with the territorial divisions. In 1980, the first division under Social Forestry was established in Shillong, which led to natural expansion. Today there are five social forestry divisions with divisional offices at Shillong, Tura, Jowai, Nongstoin and at Williamnagar. Till date 819.41 sq. km. area has been brought under plantations in this programme.

The FD rent the land from individuals and communities. The FD takes care of planting and maintaining the area during the lease period. After the lease period is over, the FD has to hand over the plantations to the owner.

The thrust of the Social Forestry Division was in terms of plantations only, as it was found that these plantations were more beneficial to the rural communities, but later on the circle has been active in other fields such as raising avenue plantations in the district headquarters, stabilisation of land slip prone areas, abandoned jhum areas and coal mining areas by tufting and planting cover tree species. Reclamation of degraded areas and waste lands is another field where the circle is also very active.

FOREST DEVELOPMENT CORPORATION OF MEGHALAYA

The Forest Development Corporation of Meghalaya was created in 1975 with a view to do away with the agency of middlemen in forestry operations, and to afforest the rapidly deterioration forest cover in the state. With its inception, the organisation immediately took over those areas of forestry which involved the harvesting and the removal of forest produce. The corporation was handed a Saw Milling Unit by the Department at Darugiri and also a Timber Treatment Plant and from these beginnings the organisation has today expanded its activities in various fields and has apart from the normal business of trading in timber products diversified into the business of production of *Citronella* oil for which purpose the corporation has set up two stills, one in the Khasi Hills and other in the Garo Hills. The company also grows and sells rubber bud grafts to the Rubber Board and to the Soil Conservation Department of the state.

The corporation also has raised plantations of Teak, Sal and Pine in various districts of the state on private lands and in community lands which have been obtained on a profit sharing basis with the landowners and also by guarantee of employment to the owners of the land.

FORESTRY RESEARCH

Forestry Research in Meghalaya under the Silviculture Division has been in progress since 1971. Initial emphasis has been primarily on the study of the growth behaviour of some important tree species in plantations as well as in natural forests, through sample plots etc. Simultaneously, experiment was also carried out on resin tapping in pine forests of Khasi and Jaintia Hills for finding out the effect of various chemicals on the yield of resin from *Pinus kesiya*, but this had to be abandoned as the channel made for resin tapping encouraged the people to collect "Torch Wood"(Dhup lakri) and ultimately most of the trees collapsed due to deep resin tapping. An experimental plot was also laid out at Umsaw (now under Ri-bhoi district for the cultivation of Lemon and *Citronella* grass to find out the rate of biomass production and by distillation of the same to find out yield of oil, but the experiment lasted only from 1973-1975 since the entire scheme was implemented by the Forest Development Corporation of Meghalaya Ltd, from 1975 onwards. Inter-cropping of agriculture/cash crops with forest crops was for sometime experimented but the findings were discouraging. The cultivation of *Rauwlfia serpentina* and Ipecac which was introduced during 1976, 1977 and 1978 has to be discontinued as the experiment revealed that on a small scale, its cultivation was uneconomical. Trial plots laid out for other exotic tropical pines are in progress and presently these plots have been demarcated as "Sample Plots"for studying growth rate of these exotic tropical pine species.

Over the years, the increasing importance of forests as repositories of various medicinal plants has created a need for focusing research in this direction. The Silviculture Division realising the need, has given priority to propagation of medicinal plants especially those which are being used in local health traditions as well as those in demand for commercial manufacture of medicinal drugs.

This emphasis is justified as this state is endowed with large varieties of herbs, shrubs, climbers and trees on account of its wide range of climatic zones. Besides being of ecological importance the immense biodiversity and gene pool are of enormous potential from financial point of view.This is especially true in case of tropical forests that cover the lower elevation areas in the state.

In addition to the above, the sphere of activities of the research works include the following :

1. Standardisation of nursery techniques for some important tree species. Application of growth hormones to the seeds and cutting, in order to study their effect on seed germination, root and shoot growth with different doses of hormones.
2. Application of Nutrients (Urea, S.P., M.O.P.) to the plantation of important tree species (at different doses), in order to study the optimum dose which can boost up tree growth, thus enhancing biomass production.
3. Tree improvement programmes by selecting seed production areas for different tree species including selection of plus trees, creation of seed orchards through bud grafting, air layering, cleft grafting etc. in order to get genetically superior quality seeds.

4. Creation of bamboo orchards for preserving the different species of bamboo available in the state and to study the seeding time and the best method of propagation etc.
5. Grafting of some fruit trees for the purpose of inducing fruit improvement.
6. Propagation of rare and endangered species in order to raise preservation plots for these species. This plot would also serve as "Gene pool".
7. Propagation of different species of orchards by Tissue Culture and preservation of the local orchids in the orchid rehabilitation centre.
8. Setting up of preservation plots in area which are rich in biodiversity. These areas would serve as monumental plots which should be free from biotic interference. Ecological studies will be regularly conducted in these plots and the findings therefrom could be compared with the ecology of the nearby areas.
9. Study of Phenology of the important tree species in the state.
10. Provenance trials of different tree species.
11. Experiments in and around Cherrapunjee (Sohra) by adopting different treatments and techniques including proper choice of species.
12. Preparation of Local Volume Table for commercially important tree species in order to estimate the volume of standing trees before felling and to make exact estimate of the volume of a coupe.

ASSESSMENT OF AMBIENT AIR QUALITY IN THE VICINITY OF NARIMANAM GROUP GATHERING STATION: PART I-SO_2

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ABSTRACT

The present survey is the characterisation of the ambient air quality in terms of sulphur dioxide (SO_2) a primary air pollutant with the objective of assessing the effects of emissions of sweet and sour gases and their hot flaring in the ambient air in the vicinity of the Narimanam Group Gathering Station, Oil and Natural Gas Corporation Limited.

INTRODUCTION

Over the years mankind has rather ruthlessly neglected the environmental protection aspects which has resulted in large scale pollution of air, water and soil. All these are seriously telling upon the living condition on the planet earth.

Air pollution is emerging as one of the most significant and challenging environmental problems of our society. The undesirable effects of air pollution on man, his property and possessions (Salmon, 1970; Yocom a McCaldin, 1968; Langwell, 1957; Treshow, 1970; Thomas,1961; Higgin and McCarrol,1970; and Stern,1973) have given rise to an increasing degree of interest and concern on the part of the government, industry and common citizens.

A variety of primary air pollutants are emitted regularly into the atmosphere, but a few are sometimes present in sufficient concentrations to be of grave concern (Jain et al, 1981; Rao,1991 and Amdur,1975).

Because of the importance of air to the biosphere as a whole the potential source of air pollution and the adverse effects of the air pollutants on living, non-living and inert materials, a discussion has been made on sulphur dioxide (SO_2), one of the major vital air pollutants.

METHODOLOGIES

Keeping in view of the nature of the activities of the process plant and available environmental guidelines, outlined by the Ministry of Environment and Forests, Government of India, it was decided to cover an area of 10 kms radius from the process plant, for air quality data collection for a month during pre-monsoon season. The area under survey is depicted in fig-1.

Based on the production activities, the parameter chosen for assessment of air quality was sulphur dioxide (SO_2).

The modified West Gaeke Spectrophotometric method was utilised as the standard method for monitoring sulphur dioxide (SO_2) in the ambient air. Sulphur dioxide (SO_2) was collected in a scrubbing solution of 0.1m Sodium Tetrachloromercurate and was allowed to react with HCHO and then with pararosaniline hydrochloride. The absorbance of product red-violet dye was measured using digital spectrophotometer at wave length of 560 nm.

MICROMETEOROLOGY

Climatological and meteorological factors play an important role in the dispersion and dilution of pollutant when discharged into the atmosphere and their impact on air environment. As a part of this study, micrometeorological and microclimatic parameters recorded are presented in table–I.

SAMPLING LOCATIONS

A network of six ambient air sampling locations was designed for assessment of the existing status of air environment within the study zone. Details of the selected air monitoring locations are given in table–II and the sampling locations are shown in fig–2.

This monitoring network was designed, based on the available climatological normals of predominant wind direction and speed of Nagapattinam with the criteria that at least one location in upwind direction (to represent regional background) one location at process plant (to represent core zone) and the remaining locations in the downwind directions to represent cross wind distribution of air pollution concentration at

various distances (sampling location was shifted from Marungur to Chozhanallur with effect from thired monitoring covering 10 km radial distances is SW direction).

SAMPLE COLLECTIONS

At each monitoring location, three eight hourly samples in a day, twice in a week for four weeks were collected in such a manner that 50% of the collected data represent the daytime air quality status and the rest 50% of the elected data represent the nighttime air quality status.

RESULTS AND DISCUSSION

Out of the six locations, one location i.e. NRM-CGS (OA_1) represents core zone and industrial area. One location i.e. Nagore (OA_6) represents the sensitive zone of the study area and the other four locations i.e. Titachery (OA_2), Melbudanur (OA_3), Chozhanallur (OA_4) and Marungur (OA_5) represent the residential and rural areas.

The ambient air sampling was carried out continuously during the monitoring days at all the stations. The sulphur dioxide concentration ranged from 3-10/$\mu g/Nm^3$ at the process plant i.e. NRM-GGS.

Titachery location represents the residential area. Vehicular transportation in and around this location also forms the basis for air pollution. However, the influence of operation of ONGC is also evident. The sulphur dioxide concentration varies between 3-6 $\mu g/Nm^3$.

The location at Melbudanur represents residential/rural area and the data so generated in course of the study varies from 3-6 $\mu g/Nm^3$.

Chozhanallur location represents residential area. It is located by the side of the Nagore-Thiruvarur Road and the vehicular traffic may also contribute to the concentration of sulphur dioxide ranged from 2-9 $\mu g/Nm^3$.

The location at Marungur is very near to the group gathering station in the downwind direction, the observed data on the sulphur dioxide ranged from 3-4 $\mu g/Nm^3$.

Since the location of Nagore represents the sensitive zone of the study area and it is situated on the Karaikal-Nagapattinam highway where vehicular traffic density is very high, the air monitoring was carried out at this location. It is located in the upwind direction and it represents the background status of the air environment. The concentration of sulphur dioxide is in the range of 2-6 $\mu g/Nm^3$.

The complete results for sulphur dioxide and ambient air quality status SO_2 at the six sampling locations are given in tables–II & III. Predominant wind directions recorded during the investigation period is shown in table–I. A study of these tables reveal many interesting points as follows.

The highest concentration of sulphur dioxide was observed at the station NRM-GGS (OA_1). The lowest concentration was recorded at station Nagore(OA_6). The sampling location OA_1 is inside the process plant and hence the location had got a direct bearing on the data. The location OA_6 is located in the upwind direction and the station OA_6 represents the background status of the air environment. The next higher concentration after OA_1 was observed at station OA_4. The station OA_2 and OA_5 are situated almost equidistant from the process plant in the north and north west directions respectively. The variations in the data may be attributed to the different wind directions only.

All the values on concentration of sulphur dioxide fall below 10 $\mu g/Nm^3$ and the maximum was 10 $\mu g/Nm^3$. The arithmetic mean values ranged from 3-6 $\mu g/Nm^3$. The sulphur dioxide concentration levels were insignificant and were well within the prescribed limits.

ASSESSMENT OF IMPACT

The prime objective of assessment of the impact on the ambient air quality in terms of vital air pollutant, sulphur dioxide (SO_2) of the air basins surrounding Narimanam Group Gathering Station has been achieved through comparison with the standards prescribed for this parameter by Air (Prevention and Control of Pollution) Act, 1981. The standards prescribed in the subsection (1) of section 17 of APCPA (1981) for India is given in table–IV. According to this act, different localities are categorised into three types, namely, Industrial and Mixed, residential and rural and sensitive. In the present survey, the stations were chosen in such a manner that they represent all the three types mentioned.

Now comparing the concentrations of sulphur dioxide (SO_2) recorded at different sampling stations in different times, it is found that the concentrations are much less than the prescribed limits. On the basis of the findings and discussions given above, it can be concluded that there is no impact on the ambient air quality in the vicinity (covering 10 kms radius) of the process plant, Narimanam Group Gathering Station.

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TABLE — I

MICROMETEOROLOGICAL DATA DURING THE STUDY PERIOD

Date (April)	Wind Velocity Max.	Min	Predominant wind Direction	Temperature Max.	Min.	Rainfall
02/03	21.2	0.9	ESE-SSE	37.0	26.5	Nil
05/06	16.9	1.4	SSE	37.0	27.0	"
08/09	20.7	3.2	SSE	37.0	28.0	"
11/12	12.5	0.9	ESE	37.5	27.0	"
14/15	19.1	0.4	ESE	37.5	27.0	"
17/18	13.6	0.4	ESE	38.0	27.0	"
20/21	15.8	0.1	SSE+WSW	37.5	27.0	"
22/23	14.4	1.1	ESE+SSE	37.0	29.0	"

TABLE — II

AMBIENT AIR QUALITY DATA

Location	Sampling dates (April)							
	02/03	05/06	08/09	11/12	14/15	17/18	20/21	22/23
	3	3	5	3	7	10	3	5
NRM - GGS	5	5	4	4	4	6	6	6
OA_1	3	5	3	6	5	5	7	3
	5	6	3	4	5	7	6	6
Titachery	5	4	3	3	6	6	7	6
OA_2	7	8	3	3	7	6	7	5
Melbuda	3	3	4	5	5	3	–	–
nur	3	3	3	3	5	6	–	–
OA_3	8	3	4	4	4	3	–	–
Chozhana	–	–	6	5	7	3	2	6
11ur	–	–	8	4	8	4	2	5
OA_4	–	–	5	5	9	5	3	5
Marungur	3	3	–	–	–	–	–	–
OA_5	4	3	–	–	–	–	–	–
	3	3	–	–	–	–	–	–
Nagore	–	–	4	5	2	6	–	–
OA_6	–	–	5	4	3	4	–	–
	–	–	3	4	3	5	–	–

TABLE-III

AMBIENT AIR QUALITY STATUS–SO_2

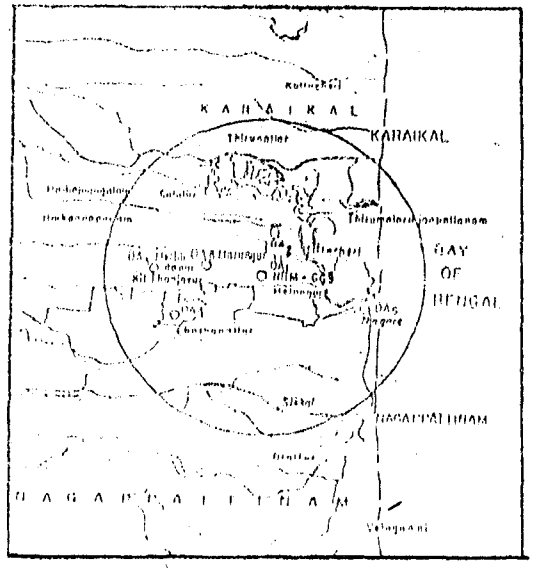
Sl. No.	Location	Min	Percentile					Max	Arithmetic mean	Geometric mean	Standard deviation	% of values exceeding tolerance limit
			10%	30%	50%	90%	95%					
1	NRM-GGS	3	3	3	5	7	7	10	4.9	4.6	1.7	0
2	Titachery	3	3	4	6	7	7	8	5.0	5.0	1.5	0
3	Melbudaunr	3	3	3	3	5	5	6	3.7	3.6	0.9	0
4	Chozhanallur	2	2	4	5	8	8	9	5.1	4.7	2.0	0
5	Marungur	3	3	3	3	3	4	4	3.2	3.2	0.4	0
6	Nagore	2	2	3	4	5	6	6	4.0	4.0	1.1	0

TABLE-IV

STANDARD PRESCRIBED FOR SO_2 BY AIR (PREVENTION AND CONTROL OF POLLUTION ACT, 1981)

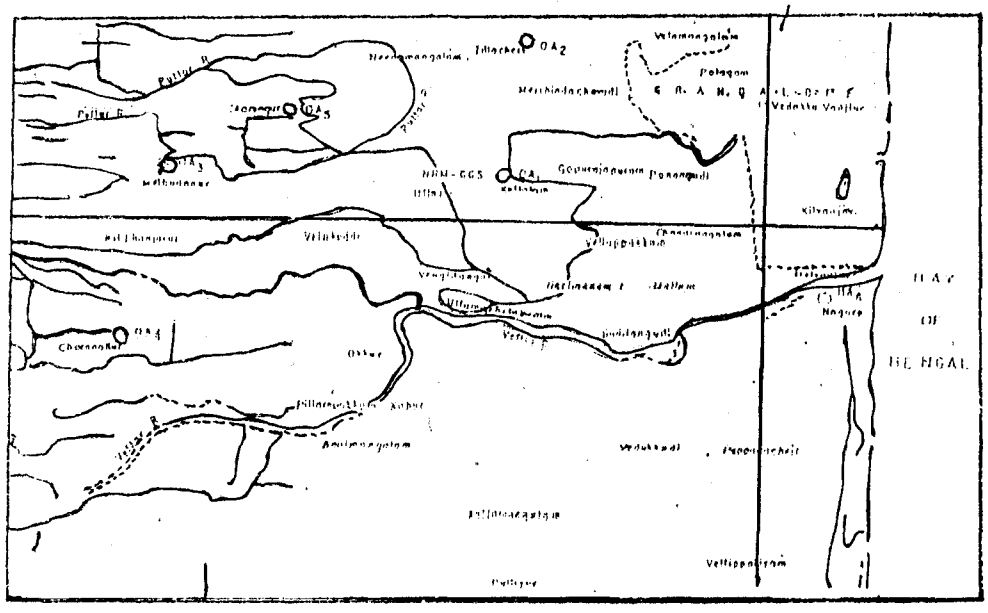
Area	Category	So2 µg / Nm^3
A	Industrial & Mixed	120
B	Residential and Rural	80
C	Sensitive	30

PROCESS PLANT AND SURVEY AREA



FIGURE–1

LOCATION OF AIR MONITORING STATIONS



FIGURE–2

PRACTICES AND STRATEGIES FOR ARRESTING ENVIRONMENTAL POLLUTION IN DHANSIRI VALLEY PROJECT, ONGC LTD. (ERBC) JORHAT, ASSAM

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ABSTRACT

Environmental pollution abatement related with hydrocarbon exploration is given highest priority in DVP Jorhat. A complete package for drill-site liquid and gaseous effluent management include effluent treatment plant, recycling of treated effluent and ambient air monitoring in and around its oil fields. Coordination and monitoring of pre and post-project statutory obligations from environment angle are strictly adhered to. A case study covering Borholla Oil Field is presented.

INTRODUCTION

In oil industry, the hydrocarbon resource exploration activities do interact with environment and thereby result in its contamination and deterioration. Environmental pollution can not be eliminated totally, but can be minimised considerably. ONGC is committed to maintain ecological balance and protection of environment around its work centres. Being aware of its socio-economic responsibilities, a comprehensive knowledge of process wastes and their impact on environment is made mandatory for all projects of ONGC, spread in different regions of the country.

Dhansiri Valley Project (DVP), which was set up to intensify exploration activities in the southern part of Assam-shelf has been categorised as an isolated oil mine by DGMS due to its logistically difficult terrain. Prolonged and heavy rains which is a natural characteristic of North-Eastern India, aggravate the drill-site waste-pit overflow. DVP has made concerted efforts to implement various environmental protection measures, a) to take remedial action, b) to deal with pollution control authorities and, c) on occasions, avoiding unnecessary confrontations with environmentalists and public. The present paper describes the strategies for monitoring environmental pollution in and around DVP, Borholla Oil Field.

ENVIRONMENTAL MANAGEMENT CONCEPT IN OIL FIELD DEVELOPMENT

Last few decades have witnessed a profound change in the concept of what is economically and technologically feasible, to include ecological permissibility also (Colby, 1991). The environment management concept has evolved from regulatory compliance to environmental protection to sustainable resource management to eco-development, as on today. This has created a drastic change from "polluter pays" to "pollution prevention pays" concept, thereby restructuring economy according to ecological principles.

The hydrocarbon exploration has culminated in the development of several major and marginal oil fields in ONGC. Though the environmental issues were not considered very important in the early phase of oil field development, especially due to near absence of regulatory controls, self control mechanism was considered conducive to organisational health and growth, even at that times. Subsequently the global awareness on environment protection led to the formulation of several national legislations and associated regulations on the control of emission and discharge of effluents from oil industry (Barapatra D.V. et al, 1997).

In line with organisation's commitment to environment and the national safety and environmental legislations becoming more stringent, the mechanism of "self-regulatory controls" have been adopted at DVP Jorhat. This mechanism has two fold controls. One, the project is required to monitor effluents disposed to environment and any contravention thereof. Secondly, it is required to periodically forward the data to regulatory agencies. This dual mechanism ensures and places greater responsibility on project's pollution control (SEM) cell.

PINPOINTING THE POLLUTION PROBLEM

It is necessary to fully understand and analyse the specific pollution problem of a development project/plant before establishing pollution control facilities. Pollution control is aimed at two main areas – a) Pollution, that are emitted to the surrounding environment which may endanger public health or property, and b) Those generated within the work centre's working area, which present a hazard to the safety and health of employees. Before considering specific controls and equipments a clear cut definition of the problem is necessary (Sharma J.S., 1994). It is noteworthy that it is the responsibility of polluter/organisation to meet

all governmental regulations and to avoid the threats of shut-downs and fines. Finally, the relationship between the public and industry (The Public Liability Insurance Act, 1991) must be on sound basis.

At DVP, a careful identification of the problem was done with the help of IPSEM, Goa through actual tests performed at the site of existing facilities in Barholla Field for ambient air-quality monitoring. The concept of recycling has been implemented by installing an Effluent Treatment Plant (ETP) in Borholla Field. The provisions for mobile ETP for far-flung areas like Khoraghat/Uriamghat has been kept in view of future requirements. Produced-consumed-disposed (PCD) approach which has prevailed in oil industry, takes for granted a proportional relationship between oil production rate and oily/drill-site waste volume rate, thus requiring Waste-Management-Technology (WMT). Presently a change in environmental attitude in petroleum industry is emerging (Raj N. et al 1997), as a result of which WMT is being replaced by preventive Environment Control/Management Technology (EMT). EMT approach adopted at DVP emphasises on three steps viz. source reduction, source separation and recycle/reuse.

ENVIRONMENT MANAGEMENT TECHNIQUES/PROCEDURES IN USE

In ideal situations, oil industry's need to integrate its operational functions with ecosystem will depend upon coherence between environmental studies before project formulation and environmental studies during operations. As most of the oil companies operate in relatively uncertain and comparatively un-ideal conditions, post-production stage environmental studies are sometimes adopted to off-set initial damage to ecosystem. A detailed feasibility study from environment angle was set up by ONGC (Majumdar N. et al 1996) to asses the adverse impact of the organisation's activities in Assam and to suggest remedial measures. The committee in its other operational and technical findings recommended that, "each oil field must have properly designed ETP/ETPs to treat liquid waste from the work centres under its command. The effluent from the pit should be regularly treated and then recycled or disposed off", and "gaseous emissions from working centres be monitored for ambient air quality standards".

In tune with above study's recommendations DVP Jorhat, has installed a fixed design conventional technology Effluent Treatment Plant (ETP) of 80 M^3/day capacity, for drill-site liquid waste/effluent treatment and disposal at Borholla Field where most of the rigs are operational. The treated effluent is periodically tested for its acceptability for disposal as per IS 2490 standard (Table IV). Institute of Petroleum Safety and Environment Management Goa (IPSEM) was entrusted to conduct Ambient Air Quality Monitoring studies around Borholla Field (Jayaraman P.S. et al 1996). The details of methodology, selection of sampling stations, duration of study and details of meteorological parameters as given in IPSEM report are not extracted in present paper. However, the relevant data on air quality at GGS Borholla and Rig-760-X are presented in Table (I&II).

DATA, OBSERVATIONS AND DISCUSSION

Drill-site effluents contain not only drain water, rig wash, drill cuttings, pump lubricants, but waste from cement operations and drilling fluids also. Presence of caustic soda increases the sodium levels in soil resulting in hard solid crust. Soluble salts make water absorption by plants difficult. Diesel used in drilling fluid is not only toxic but also shows phytotoxic effects. Barite which is used in water-based muds to increase weight is a carrier of cadmium and mercury. Thus water based drilling fluids are under close scrutiny of environmentalists. Central Pollution Control Board (CPCB) has formulated Minimum National Standards (MINAS) for eco-friendly effluent discharge. MINAS levels are very close to IS 2490 specifications of Oil Industry Safety Directorate (OISD) standards, adopted through BIS, New Delhi. At DVP, treated effluent is regularly tested for MINAS levels, by ONGC's regional chemical laboratory at Sibsagar. The results (Table-IV) clearly indicate that the quality of treated liquid effluent is fit for disposal for onland sewers or surface disposal and can be safely used even for irrigation purposes.

Major gaseous pollutants emitted in air are CO, CO_2, sulphur-oxides, nitrogen-oxides, hydrogen sulphide, particulate matter from engine exhaust and smoke. The character and quality of these gases at different installations of oil/gas industry depend upon the process adopted, type of product and quantity processed, maintenance and house-keeping of the plant/installation and the control measures adopted at the installation. From Table I and Table II, it is seen that the values of Suspended Particular Matter (SPM) lies between 41-81 g/M^3 . These values are within permissible levels of National Ambient Air Quality Standards (NAAQS) of India. The values of nitrogen-oxide and sulphur-dioxide are 38-84 g/M^3 and 1.0-6.0 g/M^3. These values are also well within the permissible limits of NAAQS.

As the concentration of hydrogen sulphide was found to be in not-detectable range around Borholla Field and concentration of carbon monoxide less than 1 ppm, which is far below hazardous limits of NAAQS, IPSEM has concluded that there is no appreciable impact on environment due to drilling activity in Borholla area in DVP Jorhat.

Similar studies are also envisaged in other operational area of DVP i.e. Khoraghat. Provisions of mobile ETP in view of increased drilling activities have been kept for this operational area. As on today only one rig is in operation and pollution by liquid drilling effluents are managed by effluent pits of APCB desired capacity and capability i.e. made impervious by brick lining and high density polyethylene lining.

CONCLUSION

1. Pre and post-project environmental statutory obligations can be effectively met with a self regulatory "pollution-prevention pays" approach.
2. The treated liquid effluent parameters from ETP Borholla confirm to MINAS/IS 2490 specifications.
3. The concentration of air pollutants around Borholla Field are well within the tolerance limits prescribed by NAAQS 1994 by CPCB.

TABLE–I
AIR QUALITY DATA : GGS-BORHOLLA CONCENTRATION OF SPM, NO_X AND SO_2

Hours / Date	SPM				NO_X				SO_2			
1 – 24	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4
25.3.96/ 26.3.96	59.0	36.0	62.0	88.0	36.0	42.0	43.0	53.0	5.7	1.0	1.0	1.0
24–48 26.3.96/ 27.3.96	37.0	31.0	35.0	41.0	45.0	39.0	48.0	62.0	3.0	3.0	3.0	3.0
48–72 27.3.96/ 28.3.96	36.0	20.0	70.0	127.0	32.0	45.0	64.0	55.0	1.0	1.0	2.0	B

CONCENTRATION OF H_2S AND CO

Hours / Date	H_2S				CO			
1 – 24	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4
25.3.96/ 26.3.96	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
24–48 26.3.96/ 27.3.96	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
48–72 27.3.96/ 28.3.96	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

TABLE–II
AIR QUALITY DATA : DRILL SITE-E-760-X CONCENTRATION OF SPM, NO_X AND SO_2

Hours / Date	SPM				NO_X				SO_2			
	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4
1 – 24 25.3.96/ 26.3.96	51.0	66.0	58.0	41.0	63.0	76.0	45.0	50.0	1.0	6.0	1.0	1.0
24–48 26.3.96/ 27.3.96	81.0	73.0	46.0	53.0	61.0	84.0	45.0	38.0	2.0	1.0	2.0	2.5
48–72 27.3.96/ 28.3.96	56.0	51.0	44.0	27.0	53.0	82.0	63.0	27.0	2.0	1.5	4.0	2.0

CONCENTRATION OF H_2S AND CO

Hours / Date	H_2S				CO			
	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4
1 – 24 25.3.96/ 26.3.96	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
24–48 26.3.96/ 27.3.96	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
48–72 27.3.96/ 28.3.96	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

(BDL – Below Detectable Limit)

TABLE–III
NATIONAL AMBIENT AIR QUALITY STANDARDS NOTIFICATION – 11TH APRIL, 1994 (CPCB Standards)

Pollutant	Time Weighted Average	CONCENTRATION IN AMBIENT AIR		
		Industrial Area	Residential Rural & other areas	Sensitive Area
SO_2	Annual average	80	60	15
	24 hours	120	80	30
NO_X	Annual average	80	60	15
	24 hours	120	80	30
SPM	Annual average	360	140	70
	24 hours	500	200	100

TABLE–IV
CHEMICAL CHARACTERISTICS OF TREATED WASTE WATER OF ETP OF DVP & STANDARD TOLERANCE LIMITS

Chemical	Value	TOLERANCE LIMITS AS PER IS 2490 1981		
		Into Onland Surface	Into Public Sewers	Onland For Irrigation
pH	7.47	5.5-9.0	5.5-9.0	5.5-9.0
Dissolved Solids (mg/l)	400	2100	2100	2100
Suspended Solids (mg/l)	144	100	600	600
Chloride (mg/l)	55.4	1000	1000	1000
Sulphate (mg/l)	67.2	1000	1000	1000
C.O.D. (mg/l)	66	250	–	–
Oil/grease (mg/l)	46	10	20	10

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GEO-ENVIRONMENTAL APPRAISAL OF JAINTIA HILLS DISTRICT, MEGHALAYA

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ABSTRACT

The baseline geo-environmental data of Jaintia Hills District has been collected encompassing the details of geology, geomorphology, landuse, drainage, water resources, soil etc. Besides a rapid scanning of 3819 sq. km. of Jaintia Hills has been carried out with remote sensing methods followed by extensive field study. Based on the synthesis of these data four geo-environmental zones have been established in the district which can be utilised by the planners for undertaking eco-friendly and sustainable development in these areas.

INTRODUCTION

Jaintia Hills district of Meghalaya is endowed with fertile agricultural soil, good forest cover, abundant water resources and mineral wealth in the form of coal and limestone. With the growth of industries and urbanisation along with unsystematic and unmechanised mining activity; the pressure on the environment has increased resulting in geo-environmental degradation of the dissected plateau land ecology prevailing in Jowai township and surrounding areas. As such geo-environmental appraisal of Jaintia Hills District was taken up so that optimum landuse planning and judicious eco-friendly exploitation of resources can be undertaken. The study has led to the identification of a fragile ecosystem in the southern part of the area classified as unstable land due to the presence of inherent geomorphic set-up, soft low resistant sedimentary rocks and active tectonic lineaments.

PHYSIOGRAPHY

North-West south-east trending Jaintia Hills ranges occupy the central part of the district form approximately the Brahmaputra Basin in the north and Meghna Basin in the south. Umiam-Kopili river system represents the northern watershed with master slope to the north-east whereas the southern slopes have Lubha, Hari, Umngi, Umngo river system with master slope to the south-west. Jaintia Hills district is bordered by North-Cachar and Karbi Anglong Hills in the north-east and Sylhet plains in the south. Central portion is a plateau on which Jowai (1350 m.) is located. The southern portion has some steep escarpments. The heights of the peaks and ridges vary between 1050 m. to 1350 m. One of the important ranges in the south-east is Marangkshih Range (1601 m.) from where the Barail Range runs eastward to North-Cachar. The most important river is Kopili which rises from the plateau region east of Passi, flows towards north west in Karbi Anglong before joining with Brahmaputra. A major reservoir for hydel project is located on this river just in the border between Jaintia Hills and Karbi Anglong.

The area experiences rainfall ranging between 200 to 600 cm. With more than 70 percent of the rainfall taking place in the monsoon season spread over June to September.

GEO-ENVIRONMENTAL EVALUATION

With a view to evaluate the overall environmental aspects and to bring out a comprehensive picture of man nature relationship the district has been classified into the following geo-environmental zones.

Zone I	Most Stable Land (MSL)
Zone II	Moderately Stable Land (MdSL)
Zone III	Poorly Stable Land (PSL)
Zone IV	Unstable Land (USL)

The basis of this classification is their geomorphic expression, macro and micro relief variations, litho character, soil type, degree of dissection, and dominant environmental hazards (Fig–I).

MOST STABLE LAND (MSL)

This unit is in the state of stable geo-environmental conditions. Geologically it consists of the older and stable rock types which are highly resistant to weathering, mostly belonging to the Archaean Gneissic Complex and the Shillong Group. Rock types include Granite, Granitic Gneisses, Quartzite, Pyroxinite etc. Here the amount and intensity of rainfall have been marked lower than the average with strongly weathered well developed soil profile and good vegetation cover. Geomorphologically, it comprises of deeply dissected

plateau (table land), denudational hills and valleys. Springs and seepages are common along the slopes. Valleys are marked by perennial streams/rivers. Faults, fracture zones, lineaments and break of valley slopes are suitable for bore-wells, subject to recharge. The zone is mostly prone to sheet erosion and is free from any major hazard. Thus the land in this unit is of excellent inherent quality without productivity limitations and it should not be allowed to degrade.

MODERATELY STABLE LAND (MdSL)

Flat topped hills of limited areal extent (Mesa and Butte) which are bounded by steep slopes and escarpments constitute this unit. It consists of sandstone and limestone of Jaintia Group(Eocene) with the basement of stable rocks described under MSL. The land here is also stable except at the margins which are prone to rock fall and mass wasting processes. Valleys of this unit which are marked with springs and seepages are suitable for dug/shallow tubewells. However, only limited potential of ground water exists in the uplands.

POORLY STABLE LAND (PSL)

The land underlain by Cretaceous-Tertiary shelf and basin margin sedimentary rocks is categorised as the poorly stable land. The rock types comprising this unit are sandstone, siltstone, shall, coal beds, limestone, conglomerate and marl. Landforms here are represented by dissected plateau, denudational hills and valleys. These areas are highly prone to landslides and mass wasting processes due to active erosion along steep slopes. Moreover due to unscientific *rat hole*/trench mining of coal, the land degradation in this unit is constantly increasing. The acidic effluent generated from the coal and over burdened dumps due to high sulphur content in coal have polluted the agricultural fields and water bodies, thereby making them unproductive.

UNSTABLE LAND (USL)

The areas in the south of Jaintia Hills district falling within the highest rainfall zone (more than 500 cm.) presents deep Canyan topography with deep gorges, messa, butte and dissected mounds. Similarly, the area south of Dauki fault represents structural and denudational hill which are under active erosion. Such land has been classified as the unstable land as it is in the state of high degradation/erosion due to high intensity rainfall, steep slopes, poor soil and vegetation cover. Moreover, this area is highly seismogenic due to close proximity of Dauki fault which was responsible for the Great Shillong Earthquake of 1897. In the gorges springs and seepages are common along slopes. Valleys here are also marked by perennial streams/rivers. To the south of Dauki fault semi-confined to confined aquifer exist which can be suitably tapped through tube-wells. Intermontane valleys can be utilised for dug well. Faults, fractures should be carefully studied before taking up any major construction in these areas. As such this area should be of prime concern for the planners as it deserves watershed management on priority basis for the conservation of soil, water and vegetation.

ENVIRONMENTAL ATTRIBUTE RATING SYSTEM

In order to make an assessment of environment in four zones identified in Jaintia Hills district, eleven distinct parameters have been quantified. This quantification of the abstract/qualitative judgement of the parameters has been done on the analogy of rock mass rating parameters ('Q' system) of Barton et al, (1974). The logic has been evolved based on the fact that these intertwined eleven parameters govern and control the state of environment. The basis of ratings of subdivisions has been done on cause and effect relationship. For example, under lithology, granite, granitic gneisses and quartzites of Shillong Group have been considered *least degradational*, therefore have been assigned the value of 5 (five) because hard rocks, being resistant to weathering produces lesser silt. These are less slide prone too. Similarly, low population creates less interference with environment, and hence the lower scores of only 10 has been assigned as against 25 for high population zone and so on. Rating aggregate computation of these four zones of Jaintia Hills district along with the conclusion derived is given in the Table-I.

TABLE – I
RATING AGGREGATE COMPUTATION

Characters	Most Stable Land	Moderately Stable Land	Poorly Stable Land	Unstable Land
Climate	10	10	25	30
Lithology	5	16	16	20
Soil	18	18	18	18
Landuse	13	10	25	25
Agriculture	10	20	20	25
Mineral Wealth	5	5	15	15
Water Resources	10	10	10	5
Communication	2	5	5	8
Population	5	10	20	20
Scarcification	5	5	5	5
Hazards	5	5	20	20
Total Aggregate	108	124	179	191

CONCLUSION YOU DERIVE IS

Zone I	Marginal Degradation	Zone III	Remedial measures be adopted
Zone II	Level where relook becomes necessary on the developmental schemes	Zone IV	Zone of serious concern

RESOURCE POTENTIAL

Jaintia Hills district is rich in coal and limestone deposits and it governs the economy of the district. Newly discovered caves within limestone have drawn attention of the tourist world-wide and if developed it may form the main tourist attraction in the state. All these resources occur within MSL and PSL.

In the Bapung Khleriahat area a coal seam ranging in thickness from 0.31 to 1.05 m. is found in the Basal part of the Sylhet limestone. Drilling has revealed that the seam rarely exceeds a thickness of 0.7 m. Moreover, the seam shows frequent pinching and swelling within short distances. A gross reserve of 0.1 m. tonne has been estimated.

In the Lakadang area coal occurs around Umlatdoh and Pamsaru are important. GSI drilled in the Umlatdoh and found seams having an average thickness of 0.5 m. In the Prmsaru plateau a seam of 0.3 – 1.1 m. thick has been encountered. In the Umlatdoh plateau, a gross reserve of 0.5 m. tonne has been calculated. Besides these occurrences of coal have been recorded around Malwar, Lumshnong, Mutang and Jatang areas. Coal analyses indicate 1.8 – 4.2 percent moisture, 2.3 – 17.1 percent ash and sulphur 2.77 – 5.3 percent.

The limestone in Jaintia Hills is usually of high purity and is suitable for both metallurgical and cement manufacturing. Huge reserves of limestone with intermittent coal bands extends all along the southern part of the district. This provides enough scope for the development of cement and refractory industries.

CONCLUSION

Since thick overburden is present on top of the coal seams which are mostly less than 1.2 m. in thickness; coal mining by scientific methods may not be economically viable in near future unless new technology is evolved. At the same time rat hole mining may not sustain for long time unless a pragmatic approach to check land degradation and water pollution is adopted. The following measures are thus recommended for hazard prevention and mitigation.

- Not to allow dumping of coal in areas free from coal occurrences.
- Trenches and Pits should be back filled with overburden dump material along with waste products from limestone mining so as to neutralise the acidic effect
- Top soil should be preserved before digging the trench/pits and utilised after back filling for restoration of ecology.

Extensive conservation measures to protect the soil, water and vegetation should also be undertaken in the unstable land category to check further deterioration and sustainable development.

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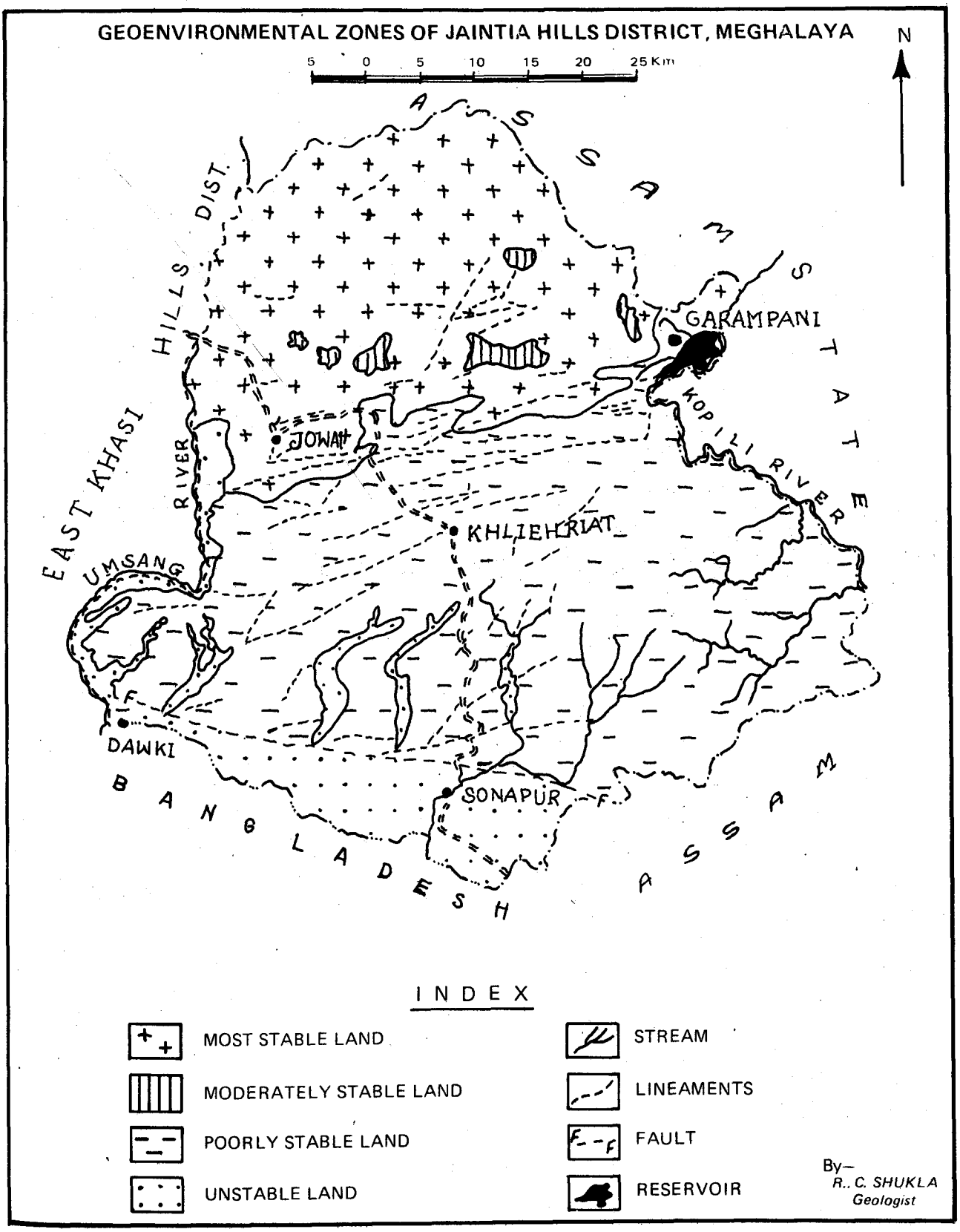
GEOENVIRONMENTAL ZONES OF JAINTIA HILLS DISTRICT, MEGHALAYA
5 0 5 10 15 20 25 Km
N
ASSAM
EAST KHASI HILLS DIST.
GARAMPANI
KOPILI RIVER
JOWAI
RIVER
KHLIEHRIAT
UMSANG
DAWKI
SONAPUR
BANGLADESH
ASSAM
INDEX
MOST STABLE LAND
MODERATELY STABLE LAND
POORLY STABLE LAND
UNSTABLE LAND
STREAM
LINEAMENTS
FAULT
RESERVOIR
By–
R. C. SHUKLA
Geologist

FIGURE–1

TECHNICAL SESSION – V

APPLICATION OF SCIENCES

DEPARTMENT OF PHYSICS : NORTH EASTERN HILL UNIVERSITY

C.S. Shastry
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ABSTRACT

This article summarises salient information about the Department of Physics, North Eastern Hill University, Shillong since its inception in 1976 and its role in nurturing scientific manpower in the North Eastern Region. The achievements of the department in teaching and research are highlighted.

INTRODUCTION

The North Eastern Hill University (NEHU) was set up by an Act of Parliament as a Central University on July 19, 1973. The objectives of the university are to disseminate and advance knowledge by providing instructional and research facilities in such branches of learning as it may deem fit; to pay special attention to the improvement of social and economic conditions and welfare of the hill areas of the North Eastern Region and in particular their intellectual, academic and cultural advancement.

In pursuance of the above objectives, the Department of Physics of NEHU was established in 1976. It functioned from its temporary premises at Bijni Complex, Laitumkhrah, Shillong till 1994 and at present is housed in its permanent building at NEHU campus at Umshing-Mawkynroh, Shillong 793 022. Professor K.K. Gupta who was formerly at Tata Institute of Fundamental Research, Mumbai, was its first Head of Department. This department is a part of the School of Physical Sciences, NEHU.

In the course of several years the department could attract a wide spectrum of talented faculty and has identified Nuclear Physics (Experimental and Theoretical), Laser Physics (Experimental), Solid State Physics (Experimental and Theoretical) and High Energy/Particle Physics (Theoretical) as the thrust areas in its teaching and research programmes. These areas are included in the list of thrust areas by the Department of Science and Technology, Government of India. The department conducts teaching and research programmes leading to M.Sc, M.Phil. and Ph.D. degrees. The department plays, through the Board of Under Graduate Physics, a pivotal role in framing the Physics syllabus for B.Sc. (Gen) and B.Sc. (Physics Major) programmes of affiliated colleges. Similarly, the Board of Postgraduate Studies in Physics monitors the M.Sc., M.Phil and Ph.D. programmes including the framing of syllabus. The M.Sc. syllabus which was operating since 1985 was revised in 1996, within the general framework of UGC guidelines.

FACULTY MEMBER

Head of the Department — **Professor C.S. Shastry**
Office Phone Number — **0364-250035**

Name of the faculty member		Designation	Broad area of research
A.L. Verma	Ph.D. (IIT, Kanpur)	Professor	Laser Physics
C.S. Shastry	D. Phil. (SINP, Calcutta)	Professor	Theoretical Nuclear Physics
Y.S.T. Rao	Ph.D. (Maryland, USA)	Professor	Theoretical Nuclear Physics
P. Shukla	Ph.D. (Temple Univ., USA)	Professor	Theoretical Solid State Physics
R.Singh (on lien)	Ph.D. (IIT, Kanpur)	Professor	Experimental Nuclear Physics
K.Kumar	Ph.D. (IIT, Kanpur)	Professor	Laser Physics
Y.S. Jain	Ph.D. (IIT, Kanpur)	Reader	Molecular Physics
D.T. Khathing*	D. Phil (Bose Institute Calcutta)	Reader	Experimental Nuclear Physics
P.N. Pandita	Ph. D. (Kashmir)	Reader	High Energy Physics
P.N. Ram (on lien)	D. Phil. (Allahabad)	Reader	Theoretical Solid State Physics

M.K. Parida	Ph.D. (Utkal)	Reader	High Energy Physics
B.M. Jyrwa	Ph.D. (NEHU)	Reader	Theoretical Nuclear Physics
P. Nongkynrih	Ph.D. (NEHU)	Reader	Experimental Nuclear Physics
P.K. Bajpai (on lien)	Ph.D. (NEHU)	Lecturer	Experimental Solid State Physics

* On deputation from the Department, working as Head, Regional Sophisticated Instrumentation Centre (R.S.I.C.), NEHU, Shillong.

The department function is supported by several technical and office staff which include two senior technical assistants, technical assistant, laboratory assistants, stenographer and storekeeper.

M.Sc., M. Phil. AND Ph.D. PROGRAMMES

a. M.Sc. (Physics) :

The M.Sc. (Physics) programme is conducted using semester pattern spread over four semesters. Each academic year has two semesters : (i) March-July and (ii) August-December. Fresh admissions are done in July. Till 1996 the intake capacity for M.Sc. was 16. However, in order to meet the local needs and aspirations, from 1996 the intake capacity has been increased to 26. Of these seats, 13 are reserved for SC/ST candidates and 10 seats are filled from general category. Remaining 3 seats are filled using Vice-Chancellor's discretionary quota from the applicants who have participated in recognised sports and games, who are physically handicapped etc. The minimum qualification for admission is a B.Sc. degree with Physics Major or Physics as one of the subjects with requisite number of marks in Physics.

The M.Sc. programme has both internal and external evaluation components. 25% marks are evaluated internally using sessional tests conducted during the operation of the course; remaining 75% are evaluated by the external examiners. A student gets a maximum of 6 semesters to complete the M.Sc. programme.

The M.Sc. course structure is as follows :

First semester (marks)

Classical mechanics (100)
Quantum mechanics I (100)
Mathematical Physics (100)
Laboratory I (150)

Second semester (marks)

Electrodynamics (100)
Electronics (100)
Quantum mechanics II (100)
Laboratory II (100)

Third semester

Atomic & Molecular Phys (100)
Solid state physics (100)
Nuclear physics (100)
Laboratory III (150)

Fourth semester

Thermal Physics (100)
Experimental Techniques
OR
Many body theory (100)
One of the following four Special papers :
Laser physics (100)
Solid state physics (100)
Nuclear physics (100)
High energy physics (100)
Environment (50)
Project work (100)

b. M. Phil. Programme : It is a 2-3 semester programme having both course and thesis components.

c. Ph.D. programme :

M.Sc. or M.Phil. graduates who get admitted to this programme undertake research under the guidance of supervisors appointed to guide their research. It generally takes about 4 years to complete Ph.D. research. Admissions to M.Phil. and Ph.D. are done twice in a year generally.

EQUIPMENT, COMPUTER AND LIBRARY FACILITIES

The department has made significant contributions both in theory and experimental research. The list of major equipments and facilities for research is given below :

(i) Laser physics related equipments :

SPEX Ramalog Spectrometer (SPEX 1403 with CCD detector)
DATAMATE Control unit for Spectrometer
Liconix He-Cd laser
5 watt argon dye laser
600 mW Krypton laser
Closed Cycle Helium Cryocooler
Hydraulic press, spinning cells and other accessories
Closed cycle water chiller for laser
Multi frequency LCR meter
Tektronix 7704 oscilloscope
PAR 124-A lock in amplifier
PC based systronix UV-vis spectrophotometer

(ii) Nuclear Physics related equipments :

Neutron source for neutron inelastic scattering experiments
HP Ge, Ge (Li), Si (Li), NaI (Tl) and surface barrier detectors
Ortec modules
Two multichannel analysers
Atomic absorption spectrometer
Gamma ray spectrometer
Scintillation detectors
Radiation counting systems
Triple distillation apparatus

(iii) Solid state physics related equipments :

Vacuum coating unit
Helium cryocooler, diffusion pump

(iv) Computational facilities :

HP 735 work station

A number of pentiums, PC 486, PC 586, laser printer, etc. Several of these are available as common facility for faculty and students, and others are procured under different externally funded projects by different faculty member.

(v) Library facilities :

The physics books and research journals procured by the NEHU Central Library are housed in the department itself for the convenience of users. The physics library has about 8000 back volumes of journals, about 2200 M.Sc. and research level books. Due to financial constraints, over the years the subscriptions to journals is being reduced; however, the physics library still gets reputed international journals like Physical Review Letters, Physical Review, several sections of Journal of Physics, Physics Letters, etc. In spite of drawbacks, NEHU Physics library is perhaps the best physics library in the North East region.

M.Phil AND Ph.D. OUTPUT

Over last 20 years our faculty members have trained a good number of M.Phil and Ph.D. students in NEHU. A summary is given below :

M.Phil :

Field	Number of of Students	Number of Male / Female	Number of ST / SC
Experimental Nuclear Physics	5	2M, 3F	3 ST, 2 Gen
Theoretical Nuclear Physics	2	2F	2 Gen
Laser Physics	1	1M	1 Gen
Theoretical Solid State Physics	1	1M	1 Gen
High Energy Physics	2	2F	1 ST, 1 Gen

Ph.D. :

Experimental Nuclear Physics	3	3M	3 Gen
Theoretical Nuclear Physics	6	1M, 5F	2 ST, 4 Gen
Laser Physics	9	3F, 6M	9 Gen
Experimental Solid State Physics/Spectroscopy	2	2M	2 Gen
Theoretical Solid State Physics	5	3M, 2F	3 ST, 2 Gen
High Energy Physics	3	3M	2 ST, 1 Gen

The M.Phils and Ph.Ds trained by the faculty include a significant number of SC/ST candidates and women. The quality and relevance of the M.Phil and Ph.D. graduates is indicated by the fact that a good number of them are employed in National Institutes like Nuclear Science Center, New Delhi, Inter University Centre, Calcutta, Gauhati University, Assam University, Ghasi Das University, NEHU, colleges both inside and outside North Eastern Region, administrative positions etc. Currently about 17 students are working for their Ph.D. including 7 ST, one OBC and 9 women students.

RESEARCH ACTIVITIES

The high level of research activity is reflected by the fact that over the years a good number of faculty members presented papers in various national and international conferences, were invited to give invited talks, chaired different sessions, gave lectures in advanced SERC Schools financed by DST and in UGC financed Refresher Courses and were selected as speakers in Theoretical Physics Seminar Circuit financed by DST. All these are documented in the Annual Reports of NEHU. An approximate estimate shows that our faculty have published during the period 1976-1997 approximately 400 papers in reputed international journals, about 50 papers in national journals, edited two books, authored a book, published about 6 reviews in international journals, 11 reviews in national journals, in addition to a number of popular science articles. An estimate shows that physics faculty participated in about 60 conferences and symposia during the period 1992-1997. Academic standing of the faculty is further reflected by the fact that several of them have worked in various committees of UGC and DST and have been members of faculty selection committees in different universities, worked as referees for national and international journals and research projects submitted to DST, UGC, CSIR, etc. have been made members of organising committees of various conferences, etc.

(i) Externally funded research :

Almost all faculty members of the department have procured substantial research grants to carry out their research projects from National Agencies like University Grants Commission, Department of Science and Technology, Department of Atomic Energy, Indo-French Collaboration Scheme etc. in all the thrust areas identified by the department. An estimate indicates that total amount sanctioned under various externally funded schemes is more than 1.5 crore since the inception of the department. These projects, in addition to increasing the research output, substantially enhance the research and infrastructural facilities and provide financial support to research scholars working in the research projects.

(ii) Collaborative research :

In spite of being located in a geographically isolated region, in order to maintain international standards in research, the faculty members of Physics have set up collaborative work with scientists in various national and international institutions. The list of national and international institutions visited by members of the faculty is impressive. The list of institutions visited by the faculty members over past several years is given below. For further details one may refer NEHU Annual Reports.

a. Institutions within India

Bhabha Atomic Research Centre, Mumbai; Tata Institute of Fundamental Research, Mumbai; Saha Institute of Nuclear Physics, Calcutta; Institute of Physics, Bhubaneshwar; Indian Institute of Science, Bangalore; Indian Institute of Technology, Kanpur; Indian Institute of Technology, Bombay; Nuclear Science Centre, New Delhi; Variable Energy Cyclotron Centre, Calcutta; Mehta Research Institute, Allahabad; Viswa Bharati University, Shantiniketan; Benaras Hindu University, Varanasi; Aligarh Muslim University, Aligarh; MATSCIENCE, Madras : PRL, Ahmedabad etc. Several research scholars have carried out part of their research work in some of the above institutions.

b. Institutions outside India

International Centre for Theoretical Physics, Triests, Italy; University of Maryland, USA : Virginia Polytechnic Institute, Blacksburg, USA; Uppsala University, Sweden; Yukawa Institute of Theoretical Physics, Japan : Temple University, USA; University of Illinois, USA; University of Scherbrooke, Canada; University of Bordeaux, France; University of Munich, Germany; Atomic Energy Establishment, Harvell, UK; University of Dortmund, Germany; International Atomic Energy Agency, Vienna; University of Kaiserslantern, Germany; Institute of Molecular Sciences, Okazaki, Japan; Kwansei Gakuin University, Nishinomia, Japan; Deutscher Electron Synchrotron, DESY, Germany; Helsinki Institute of Physics, Finland; University of Bergen Norway; NORDITA, Copenhagen, Denmark; etc.

(iii) Conferences, Symposia, Organised by the Department :

The department has organised the following conferences and Schools –

i) Physics of Disordered Solids with Dr P. Shukla as Director during March 1981.
ii) National Symposium on Biomolecular Recognition, with Professor A.L. Verma as Convenor and Prof. K. Kumar as Director during May 1990.
iii) Summer School on Principle and Application of 2D FT-NMR Spectroscopy in collaboration with TIFR, Mumbai in June 1990.
iv) II-SERC School in Nuclear Physics-Nuclear Reactions with Professor R. Singh as Director.

(iv) The main areas of research in recent years :

The main areas where the research is being done are :

Nuclear Physics :

Prof. C.S. Shastry : Nuclear heavy ion fusion, heavy ion barrier top resonances, relativistic optical model, formal scattering theory.

Prof. Y.S.T. Rao : Quantum tunnelling in multiple dimensions, quantum chaos near barrier region.

Prof. R. Singh : experimental work on heavy ion elastic and inelastic scattering near Coulomb barrier.

Dr D.T. Khathing : Trace element analysis and bulk element analysis using neutron sources.

Dr B.M. Jyrwa : In depth study of optical model parameters with respect to variation of mass and energy.

Dr P. Nongkynrih : Establishment of critical limits of micronutrients for rice soils and plants in Meghalaya, Investigation for understanding the mechanism inherent by Biological Clocks.

Laser Physics :

Prof. A.L. Verma : Laser induced photophysical and photochemical studies on some porphyrins probed by Resonance Raman techniques; Dynamics of Phase Transformations in liquid crystals.

Prof. K. Kumar : Solvent dependence on non-coincidence effect for C=0 stretching in molecules and vibrational relaxation in liquids.

Solid State Physics :

Prof. P. Shukla : strongly disordered solids and related problems in statistical physics.

Dr P.N. Ram : Point defects in solids.

Dr P.K. Bajpai : Experimental spectroscopic studies using local facilities.

High Energy Physics :

Dr P.N. Pandita : Investigations on the Higgs sector of low energy supersymmetric models, estimate of the mass of lightest Higgs Boson.

Dr M.K. Parida : Deduction of three Theorems minimising the uncertainties in electroweak mixing angles, formulation of minimally modified grand desert model, problems related to proton life times, neutrino oscillations and neutrino masses, Low energy formulas for neutrino masses.

Molecular Physics :

Dr Y.S. Jain : Studies of low temperature behaviour of many body systems interacting quantum particles; unified approach to understanding of superfluidity and superconductivity.

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TELECOMMUNICATIONS IN INDIA WITH SPECIAL REFERENCE TO THE NORTH EASTERN REGION DURING THE LAST 50 YEARS

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Shillong – 793 003, Meghalaya

ABSTRACT

The story of Telecommunications is a very fascinating one. Though Telegraphy was invented in 1839 and the Telephone in 1876, yet telephone became much more popular and also developed much more faster. In those days it was possible to communicate either through Telegrams or Telephones only within a limited distance and the inventions were mostly confined to the more advanced and rich countries only. India being a part of British Empire in those days, telegraph and telephones came to the country almost immediately after their inventions. Over the years great innovations and rapid advances in the field of Telecommunications took place which has made the globe a small village within the instant reach of our fingers through the buttons of the telephone.

Compared with the advanced countries and even with the less developed countries, India is one of the poorest country in the world in terms of telephone density per 100 population. It was 0.2 and increased to 0.3 and then to 0.6 at the beginning of the seventies, the eighties and nineties respectively. At the time of independence there were 86,000 telephones in the whole country. The progress was slow till the eighties. With the advent of new technologies and with the new telecom policy and liberalization the number of telephones will increase to 20 millions by the turn of the millennium. Coming to North-East the skeleton Telecommunication facilities available in the region in 1947 was meagre and mostly served only the dignitaries and high officials for defence and administrative purpose. There were only five small manual exchanges with only 460 telephone connections in the whole region. Today we have 269 exchanges, all electronics of world standard digital types with 1,16,479 telephone connections in the six states of North East, excluding Assam. National and International Subscriber Trunk Dialing Services are available from 168 stations of the six states. Twenty-eight per cent of the villages in the six states, excluding Assam, are covered by Multi Access Rural Radio village public telephones. With respect to telegrams we have the computerized Store and Forward Telegraph system where telegrams are received from the various stations in the region or from outside and stored in the computer and then automatically forwarded to their destinations without any loss of time. World standard technologies and services are now here to serve the people of this region.

INTRODUCTION

The story of Telecommunications is a very fascinating one. While Telegraphy was invented in 1839 and the Telephone in 1876, yet because of its instant both way communication, telephony became much more popular and also developed much more faster. In those days it was possible to communicate either through Telegrams or Telephones within a limited distance only and the inventions were mostly confined to the more advanced and rich countries only. India being a part of British Empire in those days, telegraph and telephones came to the country almost immediately after their inventions. The first telegraph line in India between Calcutta and Diamond Harbour was commissioned in 1851 and the first Telephone Exchange was commissioned in Bombay on 30.01.1882 with 90 telephones followed by Calcutta with 102 and Madras with 24 only. Over the years great innovations and rapid advances in the field of Telecommunications took place, as a result of which today we are able to communicate to outer space millions and millions of kilometers away. The globe has become a small village within the instant reach of our fingers through the buttons of the telephone.

1.0 TECHNOLOGICAL ADVANCEMENT AND TELECOMMUNICATIONS

1.1 Magneto Telephones and magneto exchanges using Dry Cells for energising the mouthpiece transmitters and the earpiece receivers with hand operated generator for signalling were the first generation in telephone switching technology. Then came the Central Battery Non-Multiple in short CBNM Exchanges using Central Lead Acid Wet Batteries for energising the transmitters, receivers and for signalling. As the number of subscribers increased rapidly the CBNM exchanges could not accommodate all the subscribers hence the modified Central Battery Multiple in short CBM Exchanges came next in use. All the above types of exchanges required the service of telephone operators for connecting the calls.

1.2 The next generation was the new and important Step by Step Strowger Automatic Telephone Exchange System which utilises electro-mechanical relays to switch and connect calls without any help from operators.

1.3 After the Step by Step Strowger System we had the Common Control Penta-Conta Cross Bar System which still used electromechanical relays for switching and connecting calls.

1.4 After the invention of Semi-Conductors, the transistor and Large Scale Integration we then had the Analog Electronic Telephone Exchange system which eliminated the use of bulky electro-mechanical relays.

1.5 With the advent of Digital Electronic Switching System we presently have the state of the art Digital Exchanges which can cater and take care more than hundreds of thousand of subscribers dialling and speaking simultaneously and provide wide ranges of services and phone plus facilities.

1.6 In the transmission side, initially we had over head copper open wire lines for long distance transmission of telephonic electro magnetic waves. Then came 1+1, 3 Channels, 8 Channels and 12 Channels open wire carrier systems which provided more than one telephone circuits in one pair of over head wire. We then had underground telephone cables, Co-axial and Submarine cables which provides more number of telephone circuits. Next came the wireless, Very High, Ultra High Frequencies and Microwave methods of transmission. Now with the advent of Satellite, Broad Band Microwave and Optical Fibre, thousands of persons can speak simultaneously over large distances covering the whole globe and even to outer space.

1.7 On the telegraph side we first had the Morse Code for telegraphic communications. We next had the 1+Dx, 1+3Dx, 1+4Dx, 12 Channels and 24 Channels FMVFT Systems will tape type and page type teleprinters working. We then had Telex Services and now we have Bureaufax and Store And Forward Telegraph Message Systems which has revolutionised the telegraph services.

1.8 With the advent of Computers, Digital Switching and Transmission, Optical transmission, Data and Satellite Communications and with the latest state of art equipments and technology we can have a varieties of services such as Electronic Mails, Voice Mail, INET, INTERNET, Radio Paging, Cellular Mobile Telephones, Satellite Telephones, Personal Communications, Integrated Service Digital Network and many more Services and Networks.

2.0 GENERAL INFORMATION ON NORTH-EAST INDIA

2.1 Before the country's independence in 1947, the whole of North-Eastern Region which presently comprises the seven sister states viz. Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland & Tripura was only one single province known as Assam Province which also included Sylhet District of the then East Bengal later called East Pakistan and after 1971 named Bangladesh.

2.2 The topography of the North-Eastern Region is quite varied. Except the valleys of Brahmaputra and Barak, the rest are hilly and mountainous. There are the huge snow bound Himalayan ranges in the North, Patkai, Tirap, Aksai ranges in the East, Khasi, Garo, Jaintia Hills in the West and Berail, Alharamura and Lushai hills in the South. A large part of the terrain is covered with lush green forest with wide varieties of flora and fauna. The region is susceptible to earthquakes and frequented by severe floods due to very heavy rainfall during monsoons. Cherrapunji & Mawsynram are well known for the highest rainfall in the world. The entire region is strategically important as it is surrounded by Bhutan, Tibet and China on the North, Myanmar on the East and Bangladesh on the South-West. It is connected to the main land only by a narrow passage between Bhutan and Bangladesh.

2.3 A number of different and distinct tribes with varied colourful cultures, speaking different languages and dialects inhabit the region. The population is generally well spread in plains and sparsely in the hilly areas. Providing Telecommunication facility in such an area is indeed a challenging task. Table–I gives some of the general information related to the six states of this region, excluding Assam.

3.0 GROWTH OF TELECOMMUNICATIONS IN INDIA WITH SPECIAL REFERENCE TO THE NORTH EASTERN REGION DURING THE LAST 50 YEARS

3.1 Even though telephones came to India in early 1882 i.e. just six years after its invention in 1876, yet the growth and penetration of telephone services in this country has been very very slow. Compared with the advanced countries and even the less developed countries, India is one of the poorest countries in the world in terms of telephone density per 100 population. At the beginning of the seventies the density was only 0.2 which increased to 0.3 and 0.6 at the beginning of the eighties and nineties respectively. Even the less developed country like Brazil has telephones per 100 population while in the advanced countries like the United States, Japan, Sweden and Europe the telephone density is about 80 per 100 population. In the city of New York alone the density of telephones is more than 150 per 100 population while the city of Tokyo has more telephones than in the entire continent of Africa.

3.2 At the time of independence in 1947, India had about 86,000 telephones. Our exchanges at that time were mostly small manual exchanges and a few electro mechanical exchanges. We then had our telephone factories which manufactured manual boards and line materials. In 1948 the Indian Telephone Industries Ltd. came into being and started manufacturing Strowger type switching equipments, telephone instruments and later transmission equipments also. In 1952 another Government undertaking, the Hindustan Cables Ltd. started manufacturing underground cables and the Hindustan Teleprinter Ltd. started manufacturing Teleprinters in 1962. The beginning has been made but the pace of development was slow until the early eighties when other Central Government undertakings like Bharat Electronics, Electronic Corporation India Ltd., Telecommunications Consultant India Ltd. and other State Government Electronics Development Corporations entered into the fieldroll to manufacture telephone instruments and other telecom equipments. In 1984 another Central Government undertakings and the pioneer in the design and development of digital switching in the country, the Centre for Development of Telematics in short C-DOT, came into being and since then the production capacity of digital switching equipments has tremendously increased several folds and today we are proud that the country is self sufficient in the production of small and medium capacity digital switches like 256/128P C-DOT RAX, 512 Single Base and Multi Base Modular switches which are also exported to less developing countries. Production of large capacity digital switches, VHF, MARR, digital UHF, Microwave, Optical Fibre Cables, Communication Satellite and many more has picked up and tremendously increased the availability of telephones and other telecom services in the country. With the new telecom policy and recent liberalisation it is expected that by the turn of the millennium the country will have more than 20 millions telephone subscriber lines and several other services, at par with the rest of the world.

3.3 Coming to the North-Eastern Region the skeleton telecommunication facilities available in the region at the time of independence was very meagre and mostly served only the dignitaries and high officials for defence and administrative purposes. There were only small capacity manual exchanges of Central Battery Multiple, Central Battery Non-Multiple and Magneto type exchanges with long open wire lines connecting the major towns and cities to Calcutta, Sylhet, Dacca and to Malay (present Myanmar) via Dimapur, Kohima, Imphal & Morreh. The pace of progress and development in the field of telecommunications in the region during the period upto 1960 was rather very slow. The real importance of telecommunications in the region was badly felt only during and after the Chinese aggression in Arunachal Pradesh in 1962 after which the government took special attention to plan and provide better Telecom facilities like Wireless, High Frequency Radio, Microwave and Satellite Communications. The Narrow Band Microwave Link was commissioned during 1964-65. Electro Mechanical type automatic exchanges were also provided to replace the manual exchanges. The first MAX – I Strowger type automatic exchange was commissioned at Guwahati in 1966 and the Penta Conta Cross Bar Exchange was commissioned at Shillong in 1969. The first point to point STD route between Shillong Guwahati in 1970. During the seventies smaller type MAX – II and MAX – III Strowger automatic exchanges were installed at major towns, district headquarters, sub-divisional headquarters to replace manual exchanges. To provide STD services from various state capitals, district headquarters and major towns, the first and only Penta Conta Trunk Automatic Exchange was commissioned at Shillong in 1980 and the Satellite Earth station was commissioned in 1982 followed by another five satellite earth stations at Kohima, Imphal, Aizawl, Agartala and Itanagar. The region saw tremendous achievement in the development of Telecommunications during the decade from 1980 to 1990 and after. Almost all manual exchanges were replaced and expanded by automatic and electronic exchanges. Dibrugarh 1680 Lines manual exchanges was replaced in 1985 by a 2000 Lines Containerised electronic exchange with STD facilities to all major cities and towns in the country. Containerised electronic exchange was also commissioned at Imphal and later at Jorhat. Agartala Central Battery Multiple exchange was replaced by the 2400 Lines MAX – I Strowger exchange in 1985. All the major towns, district headquarters, most subdivisional headquarters and even smaller towns were provided with electronic exchanges and STD facilities. The state of Mizoram has the distinction of being the first state in the country to have converted all its exchanges into electronic exchanges. A record number of Microwave and Ultra High Frequency Systems were commissioned at various places during the decade facilitating STD services from those places. All these were made possible because of the fact that the special Task Force headed by the General Manager was created for the North Eastern region in August 1983 with headquarters at Guwahati for speedy implementation of developmental works in the area. The separation and creation of the Department of Telecommunications at the national level effected in January 1985 and the bifurcation of N.E. Circle into two separate Telecom

circles of Assam and N.E. Telecom circles in 1987 had great bearings in the faster development of telecommunications in the region.

3.4 During the period from 1990 onwards, with the advent of digital electronic transmission and switching systems into the region, the introduction of optical fibres cables and the invasion of computers into every sphere of activities, state of the art equipments and technologies comparable to world standards were inducted and a good number of E-10 B exchanges were installed to replace the old electromechanical exchanges at Guwahati, Shillong, Imphal, Agartala, Jorhat, Dibrugarh, Tinsukia, Silchar and recently the latest state of the art OCB-283 switches were commissioned at Guwahati and Aizawl. C-DOT MAX is functioning at Kohima and many C-DOT MBM and SBM exchanges, 256/128 Port C-DOT RAX were installed and functioning in many smaller towns and villages. Multi Access Rural Radio systems were installed throughout the region to provide telephone facilities to all the remote villages.

3.5 On the Telegraph side, because of its early advent into the country and the region, long distant telegraph lines connecting Shillong, Guwahati and other major towns to Calcutta, Sylhet, Dacca and also Malay (presently Myanmar) were existing at the time of independence. Morse code of transmission was in use and phantom circuits prevalent. At later stage point to point Teleprinters circuits were introduced between big telegraph offices. In the seventies Telex services come into the region and in the mid eighties Computerised Store and Forward Telegraph system was installed at Guwahati and later at Shillong. In this system telegrams from various stations are received and stored into the memory of the computer and thereafter transmitted to their destination as when the line is free. Human interaction and delay is drastically cut down besides being efficient. 64 Lines Store and Forward Message Switching system is installed at Guwahati and is being installed at Shillong to bring more stations to Computerised Telegraph systems. Bureaufax services was also introduced at all central and departmental telegraph offices and within a short period of time, thousands of privately owned fax machines are working in the region.

4.0 PRESENT STATUS OF BASIC TELECOM FACILITIES PERTAINING TO THE SIX STATES OF N.E. CIRCLE (EXCLUDING ASSAM STATE)

4.1 Telephone Exchanges and number of connections:

There were only 5 (five) small manual exchanges in the whole of N.E. Region at the time of independence, and the number of telephones working was 460 only. At present there are 269 exchanges, all electronics of latest world standard digital type and the number of telephone connections is 1,16,479 in the six states of N.E. Region, excluding Assam. The statewise break-up is given below:

	Arunachal Pradesh	Manipur	Meghalaya	Mizoram	Nagaland	Tripura	Total
Number of Telephone Exchanges	68	30	45	41	35	50	269
Number of Telephone Connections (DELs)	14931	17839	23630	19995	14582	25502	116479

4.2 Long distance public call office and village public telephones :

In the earlier days until the late eighties and early nineties, Long Distance Public Call Office to groups of villages were provided on overhead wires which were prone to faults and interruptions. With the advent of Multi Access Rural Radio System and the policy to provide telephone facility to remote villages, a total of 3629 village public telephones were installed till 31.03.98 covering nearly 28% of the total number of villages in the six states of N.E. Region, excluding Assam.

4.3 National/International Subscribers Trunk Dialing :
When subscriber Trunk Dialing was initially introduced in 1980, only one station i.e. Shillong was having the facility but today out of 259 stations in the six states, excluding Assam, 168 stations are having National/International Subscriber Trunk Dialing facility.

4.4 STD / ISD Public Call Office :
To facilitate availability of STD/ISD services to the general public, STD/ISD Public Call Offices are provided for public use. The number of such STD/ISD Public Call Offices in the six states, excluding Assam, is 1122.

Arunachal	Manipur	Meghalaya	Mizoram	Nagaland	Tripura	Total
128	208	203	80	245	258	1122

4.5 Telegraph facilities :
While telegraph facilities is available from all telegraph and combine offices, telex, bureaufax STD/ISD facilities are available for the general public through CTOs / DTOs and Telecom Centres, the list and number of such stations in the six states, excluding Assam are given below :

Central Telegraph Office(CTO)	Departmental Telegraph Office(DTO)		Telecom Centre	
1. Shillong (SFT 141 system)	1. Imphal	8. Kailashahar	SSA	No Wkg
2. Agartala	2. Itanagar	9. Bomdilla	Arunachal	2
	3. Aizawl	10. Passighat	Manipur	2
	4. Kohima	11. Churachandpur	Meghalaya	2
	5. Dimapur		Mizoram	1
	6. Tura		Nagaland	4
	7. R.K. Pur		Tripura	3

5.0 INTRODUCTION OF NEW TECHNOLOGIES AND ENTRY OF NEW SERVICES INTO THE N.E. REGION.

5.1 Optical Fibre Cables :
Until the seventies electrical signals containing voice and non-voice informations are transmitted through conventional open wire lines, underground cables, Analogue Microwave and UHF systems. With the advent of optical transmission, electrical signals are converted into light signals using laser-diode transducers and then transported through Optical Fibre cables whose traffic handling capacity is quite large. Because of the high cost and low traffic requirement in the region, we never dreamt that optical fibre cables will be extended to this region. But today Bongaigaon, Rongia, Guwahati, Shillong, Tezpur, Jorhat, Dimapur, Dibrugarh and Tinsukia are all linked by OFC systems to Calcutta, Patna, New Delhi etc., which can carry huge bulk of traffic from, to and within this region. Laying of OFC cables to other stations in the North East are in progress.

5.2 Satellite communication :
The North-Eastern Region is prone to natural calamities like flood, earthquakes etc. which may affect terrestrial communications and in such situation satellite communication will be less susceptible to calamities. Besides the primary earth station at Shillong and the secondary earth stations at Kohima, Agartala, Aizawl, Imphal and Itanagar we also have twenty LCTs (Low Cost Terminals) and fourteen VSATs (Very Small Aperture Terminals) spread over the six states of N.E. Region.

5.3 Microwave and Ultra High Frequency Communication :
Due to frequent faults and failures of open wire line and systems, Analogue Narrow Band Microwave links were commissioned as far back as 1964-65 in this region and later on Wide Band Microwave were

introduced to increase the channels capacity. Now digital Microwave and Ultra High frequency Systems are working in a large number of routes in the region.

5.4 Digital Switching System :

With the advent of micro-electronics, very large scale Integration and digital switching, a large number of C-DOT RAX, SBM, MBM exchanges have been installed in the villages and small towns while bigger towns and cities are provided with bigger digital switches like E-10B and OCB-283 which can give a wide range of services and facilities.

5.5 Multi Access Rural Radio Systems :

To overcome the difficulties experienced in the construction, maintenance and very poor service conditions of overhead open wire Long Distance Public Telephones and to provide village public telephones to all remote villages, Multi Access Rural Radio Relay systems were introduced into this region in the early nineties.

5.6 Store and Forward Telegram System :

Earlier telegrams were booked at the originating stations and transmitted to their destinations or intermediate stations either on Morse or point teleprinter circuits which created a lot of delays. The Store and Forward Telegraph System in short SFT is a microprocessor based system which can receive messages from various stations and store in the memory, then automatically transmit to their destinations without delay.

5.7 Integrated Service Digital Network :

Integrated Service Digital Network in short ISDN is basically a network that provides end to end digital connectivity and support a wide range of voice and non-voice services. The service will be available through new technology exchanges like EWSD and OCB - 283 Exchanges. In ISDN, even subscriber's voice is sent in the digital from right from subscriber's premises. Besides the voice channel, several new modern services like DATA Transmission through Personal Computers, Video Conferencing and many other phone plus facilities are possible. ISDN subscribers will have full connectivity to national and international Networks and can also communicate with analog subscriber.

5.8 Cellular Mobile Radio Telephone system :

Top executives, managers, high officials and businessmen are always out of their workplace or homes. To maintain accessibility at all times a cellular subscriber in a cell. A big city may have several cells with base stations in each cell. Call can be originated from or received at any location in the city from any cellular subscriber or PSTN subscribers and conversation can continue while moving from one cell to another cell in the same city or area. The service is very popular but costly compared to fixed telephones. In India the services is provided by private companies on the license issued by the DOT.

5.9 Internet :

Internet is a network of computers containing more than sixty millions computers spread all over the world. It is possible to send a message from any of the computer to any other. An internet access provider maintains a server that is directly connected to the Internet. One must connect through an access provider unless the corresponding organisation is directly connected to the Internet. Connecting to an access provider entails calling the provider and setting a PPP (Point to Point Protocol). The Government has evolved a policy of giving license to Internet Service Providers who can set up their own backbone network or access the service through DOT's network. The criteria for entry of service providers are liberal and the five year licence fee waiver will help promote many ISP ventures. Service Providers can operate for the whole country or some major cities or certain Secondary Switching Areas depending on the license as defined by the government.

5.10 Wireless Local Loop(WLL) :

Wireless Local Loop (WLL) is a local telephone loop for connecting a transreceiver telephone set to the exchange using radiowaves and radio technology instead of copper line loop. It is resorted to when wire line is inadequate especially in congested urban areas or non-feasible remote rural areas. A small transreceiver at site can provide a standard two wire interface to telephone set, modems and facsimile machines at the customer's premises.

5.11 Radio Paging :

Radio Paging is a low cost version of mobile communication which enables only one way simplex communication to the mobile subscriber. The subscriber usually receives telephone numbers where he is

required to call back immediately on reaching any fixed telephone. This service is also popular, much cheaper and is available in all major towns and cities and is operated by private companies on licenses granted by the DOT.

6.0 OBJECTIVES AND TARGETS OF NINTH PLAN (1198-2000) FOR N.E. TELECOM CIRCLE

The North-Eastern Telecom circle has prepared an ambitious development programme for the six states, excluding Assam in the N.E. Region during the Ninth Plan (1998-2002). The objectives of the plan and some of the targets to be achieved by 2002 for the six states, excluding Assam, are given below :

6.1 Objectives of Ninth Five Year Plan in the N.E. Circle :

- – To provide telephones on demand
- – To provide telephone facility in all villages by the year 2000
- – To improve existing telephone facility in villages for meeting increased economic activity
- – To provide public call offices for every 500 population in urban areas
- – To provide STD PCOs on National highways every 10 kms
- – To provide STD facility to all exchanges by year 2000
- – All exchanges to have reliable media
- – Exchanges upto SDCC level to have Digital connectivity
- – Diversity in transmission network between TAXs
- – To computerise Trunk Manual services at SSA Hqs
- – OFC, WLL, HDSL and ADSL technologies to be gradually introduced in the local network
- – CCS No 7 Signalling to be introduced upto DHQ level
- – Introduction of better and reliable technologies for providing Village public telephones
- – To replace life expired and unserviceable Analog systems, by Digital systems
- – Public Switch Package Data Network to cover all DHQs
- – To computerise billing, accounting and commercial activities in all the SSAs
- – To modernise Fault repair service
- – To computerise directory enquiry services for all SSAs
- – To provide single window customer service centres and greater accessibility for payment of bills
- – To provide ISDN service upto all SSA Hqs
- – To popularise Internet and INET services
- – To provide mobile satellite services
- – To improve modernisation of Telegraph services by introduction of Micro-processor based technology.
- – To provide telecom services liberally to sensitive border area, Tribal and hilly area and industrial growth centres.

6.2 Some of the Targets of the Ninth Plan for N.E. Telecom Circle :

(i)	Nos. of telephone exchange	– 443
(ii)	Switching capacity	– 3,65,987
(iii)	Nos. of telephone subscribers	– 2,72,462
(iv)	Nos. of stations with STD/ISD	– 508
(v)	Village public telephone	– 14,446
(vi)	Nos. of Central/Departmental Telegraph Offices	– 30
(vii)	Computerised Customer Service	– 44
(viii)	Optical Fibre Systems (RKM)	– 1747

7.0 CONCLUSION

In spite of the fact that adequate attention has not been given to the telecommunication needs of the region before the sixties and the lack of rail, road, power and many other infrastructures, the development of telecommunication services during the last two decades has considerably picked up and by the end of the

ninth plan this part of the country will be mostly at par with the other areas in the country in respect of telecommunications.

TABLE – I

State	Language	Area	POPULATION			NUMBER OF			
		Sq. Km.	Rural	Urban	Total	DHQ	SDHQ	SDCC	Villages
Arunachal Pradesh	Adi Assamese	83743	753930	110628	864558	13	28	33	3599
Manipur	Manipuri	22327	1331504	505645	1837149	8	30	13	2394
Meghalaya	Khasi Jaintia Garo	22429	144731	330047	1774778	7	15	14	5629
Mizoram	Mizo	22081	371810	317946	689756	3	9	9	770
Nagaland	Nagamese	16579	1001323	208223	1209546	7	22	10	1192
Tripura	Tripuri Bengali	10486	2335484	421721	2757205	4	11	7	862
Total		177645	5938782	1894210	9132992	42	115	86	14446

TABLE – II
GROWTH OF TELEPHONES IN INDIA DURING THE LAST 50 YEARS

Year	Equipped Capacity	Working DELS	No. of Stations	Nos. in Working List
1947	X	X	86,000	X
1951	122,000	102,150	1,68,397	29,101
1955	NRA	149,000	NRA	22,000
1960	NRA	297,000	NRA	140,000
1965	694,405	556,632	7,66,093	294,557
1970	1,120,490	888,721	1,216,731	414,387
1975	1,569,634	1,329,237	1,744,088	637,088
1980	2,336,609	2,016,066	2,615,075	335,548
1985	3,307,306	2,895,707	3,740,815	842.567
1990	5,266,754	4,588,972	5,574,122	1,713,456
1995	12,025,000	9,795,300	NRA	2,152,900
1997	17,741,766	14,542,651	NRA	2,887,220
1998	21,260,504	17,801,696	NRA	2,705,741

TABLE – III
GROWTH OF TELEPHONES IN N.E. TELECOM CIRCLE DURING THE LAST 50 YEARS (Excluding Assam)

Year	Nos. of Exchanges	Equipped Capacity	Working DELS	Waiting List
1947	5	NRA	460	NRA
1980	86	13,875	11,916	946
1985	127	19,480	15,805	2,052
1990	163	30,113	23,576	4,874
1995	216	77,500	58,969	5,217
1996	231	99,202	75,393	5,961
1997	249	123,922	93,449	12,066
1998	269	158,092	116,479	9,704

NRA - Not Readily Available.

CHANGE IN GEOMAGNETIC FIELD AND EARTHQUAKE

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ABSTRACT

Geomagentic field variation at Shillong, a station in the seismic prone region is examined for possible association with the felt shock earthquake in the vicinity. The result were compared with Jaipur, a station in the same latitude as Shillong but differing in local time by one hour. During the interval of Dec. '79 to April '82 about 29 shocks were reported and felt by the central seismological observatory Shillong. The preliminary examination of variation of the total field F, taken by sensitive "Proton precession magnetometer on the above individual events reveals that there is a depression of the total field prior to the shock when the epicenter of earthquake is not far away from the station. The field change is most likely due to the change in the crustal stress in this region. The regression analysis performed on the time interval between extreme field change and occurrence of shock in relation of the epicentral distance has given a time interval of – 30 hours for very close shock.

INTRODUCTION

The catalog of physical phenomenon of earthquake prediction hold much on the anomalous variation of the local geomagnetic field in the earthquake prone area caused by the mechanical stress on the rock of the earth's crust which is accumulated until break up the rock – resulting the earthquake. So the transitory change of the earth's crust depends upon the focal zone stress built up prior to an earthquake which is responsible for the distortion of local geomagnetic field.

In the literature extensive evidence have been reported on geophysical signatures of an impending earthquake. Amongst this are : ground deformation and tilt, geoelectric field, radon emission, ground water level and change of geomagnetic field etc. Such anomalies in areas near the epicenter, along geological faults and other weak zone have been reported from Japan, China, USSR and USA prior to an earthquake.

In the present communication an investigation on the epicentral distance & the localized geomagnetic fields changes in the north east part of India, which is one of the sixth highly earthquake prone areas of the world, have most probably studied for the first time. One of the main characteristics of the local geomagnetic field variation is the possible association with the changes of tectonic stress. The physical properties of the earth's crust change under stress and strain, introducing a change in the patterns of geophysical parameters (— a potential tool for monitoring earthquake). So the possibility of forecasting an earthquake in the seismic prone region, may therefore, be attempted from geomagnetic characteristics of the area.

An appreciable association between local geomagnetic field variation and earthquake, has been reported by geophysicists from China, Japan, USSR and USA.

A tectonomagnetic effect before an earthquake of magnitude 5.2 near Hollister California was reported by Smith & Johnston (1976). Simultaneous measurement of geomagnetic field with an array of seven proton precession magnetometers along the San Andreas fault showed that the most significant local magnetic field changes during 1974 were recorded at a site 11 km from the epicenter of an earthquake of 5.2 magnitude which occurred on 28 November 1974. The change of the geomagnetic field was observed at this site and recovered to its original value 4 weeks prior to the earthquake. Skovorodkin et al. (1978) in USSR made a resurvey of magnetic measurement with precession magnetometer in seismically active areas in Tajikistan which revealed that the local geomagnetic field variation was associated in all probability with the change of tectonic stress. The variation might be in different types (a) oscillation with a period of week or more unconnected with the occurrence time of earthquake, (b) Monotonic change of level during a considerable time with subsequent change of sign shortly before earthquake and (c) Monotonic change of field (for months at a time).

The anomalous behavior of local secular geomagnetic field variation is a long term process for predicting earthquakes. For this, monthly mean values of F at Shillong station derived by the standard nuclear magnetometer (Proton Precession Magnetometer, PPM) are taken and similar data of Jaipur station which is in the same geographical latitude are examined and compared with those of Shillong for finding out the possibility of earthquake associations in the N.E. Region. A finer study in the response of F (total field) values

derived by standard proton precession magnetometer of a particular place and at a fixed time has also been made in order to find out the possible association with the tectonic stress.

RESULTS AND DISCUSSION

The "tectonomagnetic" effect of Shillong station is compared with Jaipur, a station in the same latitude, but far away from the seismic belt. If one compares the feature of transient variation at the two places it is possible to isolate anomalies associated with the internal structure of one station over the other. The external component is almost comparable at the two places for the night time events. During the day time magnetospheric component is still the same whereas the ionospheric component will have some difference. But in assuming the external field to be identical at both the stations one would not be introducing serious error.

With the introduction of proton precession magnetometer at Shillong, since December 1979, and at Jaipur since April 1980 the stability of geomagnetic field measurements has been fairly improved. A comparison of the field values at the two stations reveals a systematic decrease in local magnetic field that occurs at Shillong prior to earthquake. The most probable source of this change seems to be tectonomagnetic effect. This could be seen through Fig 1, where the monthly mean values of the gwomagnetic field (F) of Shillong and Jaipur are plotted for the period April 1980 to April 1981. The frequency of felt shocks during this intervals are also shown in this figure. The general trend of F variations at Shillong and Jaipur is the same, but the most significant change of geomagnetic field value F were observed at Shillong during September to October 1980. During this period Shillong showed a change of –22 nT, whereas Jaipur had a change of +5nT. The changes at Shillong seem directly attributed to earthquakes, because this change happened prior to the period of maximum frequency of earthquakes. Thus, one could conclude that changes in regional geomagnetic field precede earthquakes in the N.E. Region.

It is apparent that an additional observation of magnetic signal near the time of earthquake is needed in order to establish the usefulness of magnetic observations for predicting the earthquake. The proton precession magnetometer shows some encouraging results. Certain systematic or reproductive precursor of magnetic event have been observed for an individual earthquake. Total geomagnetic field values on each of the days prior to certain shocks along with radial epicentral distance were collected. The magnetic observation are taken at about the same time everyday at the same location. It is noticed that the geomagnetic field had a bay-type of depression systematically prior to the earthquake in all the cases. The field is noticed to recover to the pre-depression value shortly before the day of the earthquake. The time interval in hours at which the minimum value of the field observed during the depression, to the time of shock is taken as the time interval (ΔT). This ΔT along with the radical epicentral distance listed by C.S.O. Shillong for respective shocks are collected with a view to examine further for a possible relationship. These datas are given table 2.

From table II, there is a suggestion of an association between the epicentral distance Δ and the ΔT. A relationship between the time interval of geomagnetic field precursor and the epicentral distance has been shown in Fig. 2 where a linear relationship is well marked. A straight line fit via regression analysis has been made to find out the slope and intercept. The correlation coefficient is found to be + 0.88 and the slope is 0.3625. From the fitted line there is a suggestion that the minimum in the geomagnetic field at the epicentre would be registered about 30.2 hours before the occurrence of the shocks. Further study with more sensitive proton pression magnetometer observations in the seismic zone, and increasing the number of observations (at least 3 hourly) may enable one to study the incoming signal of the earthquake (specially in the NE part of India).

In conclusion, it is proposed that measurements of total geomagnetic field by proton precession magnetometer at Shillong is very useful for monitoring the crystal stress changes in this area which is seismically very active. Few cases of geomagnetic field changes are shown about one month before the major earthquakes in this area. In addition, an anomalous field changes which resembles the 'bay' like disturbance is also noticed few days prior to the shocks. The time interval between the minimum of the field in this bay and the time of the subsequent earthquake appears to be related to the radial epicentral distance of the nearby shocks. However, these inferences are to be further examined with more sensitive magnetometer measurements and with wider data base.

TABLE – I
SEISMIC DATA OF SHILLONG STATION FROM 1 DEC. 1979 TO 30 APRIL 1981 (DATA COLLECTED FROM C.S.O. SHILLONG WHICH COVERS FELT SHOCKS AND WHOSE EPICENTRES ARE AVAILABLE

Sl.No.	Date	Date Month	Year	G.M.T. Hrs	Min	Sec	Direction
1	08	12	79	17	41	21	1.50 CNE
2	22	12	79	03	50	23	0.12 CSE, M=3.2
3	02	01	80	14	11	40	0.20 DSE
	30	01	80	02	36	11	0.12 SNW
4	30	01	80	02	37	48	0.10 DNW
5	17	01	80	00	16	33	0.62 DSW
6	27	02	80	16	57	19	0.42
7	09	03	80	19	47	10	0.49 DSW, M=3.7
8	28	03	80	16	15	49	2.53 DNW
9	16	04	80	21	21	38	0.12 DSE
10	20	05	80	13	19	46	2.53
11	11	06	80	05	25	38	1.34 CSE, M=5.0
12	06	08	80	14	31	25	1.04 DNE
13	14	09	80	18	59	16	0.06 CNE, M=2.5
14	30	10	80	50	30	07	1.53 DSW, M=5.2
15	01	11	80	04	20	20	0.39 CNE
16	03	11	80	17	29	05	0.96 DNE, M=3.7
17	10	11	80	16	38	05	1.13 CSW, M=4.7
18	19	11	80	19	01	41	3.90 NNW, M=6.5
19	23	11	80	12	14	49	0.37 SE, M=3.9
20	02	12	80	00	54	39	0.65 DNW, M=3.7
21	07	12	80	21	53	20	1.83 CNW, M=4.6
22	11	12	80	01	28	40	2.43 DNW, M=5.0
23	06	01	81	18	44	02	2.6 CNW, M=4.7
24	14	01	81	07	24	03	0.95 DSW, M=4.1
25	29	01	81	11	23	49	0.32 DNE, M=3.4
26	28	02	81	01	58	50	1.00 Reported from sprengnther
27	19	03	81	13	53	13	0.12 CSE, M=2.6
28	22	03	81	03	48	44	0.92 DNE
29	25	04	81	11	33	10	2.63 DNE, M=5.9

PPM data are insufficient in connection with the following date of earthquake:
Dec. 08, 1979; Feb. 27, 1980; March 09, 1980; June 11, 1980; Nov. 10, 1980; Jan. 14, 1981

TABLE – II

THE TIME INTERVAL (ΔT) AND THE EPICENTRAL DISTANCE OF THE EARTHQUAKE. THERE IS A SUGGESTION OF AN ASSOCIATION BETWEEN THE EPICENTRAL DISTANCE AND THE ΔT.

Sl. No.	Date of Earthquake			Epicentral Distance (km)	Hours (approx) prior to Earthquake (ΔT)
	Day	Month	Year		
1	14	09	80	07	32
2	30	01	80	10	16
3	22	12	79	13	42
4	16	04	80	13	35
5	19	03	81	13	33
6	02	01	80	22	29
7	29	01	81	36	31
8	23	11	80	41	55
9	01	11	80	43	42
10	17	02	80	69	63
11	02	12	80	72	62
12	22	03	81	102	94
13	06	08	80	115	82
14	30	10	80	170	91
15	07	12	80	203	83

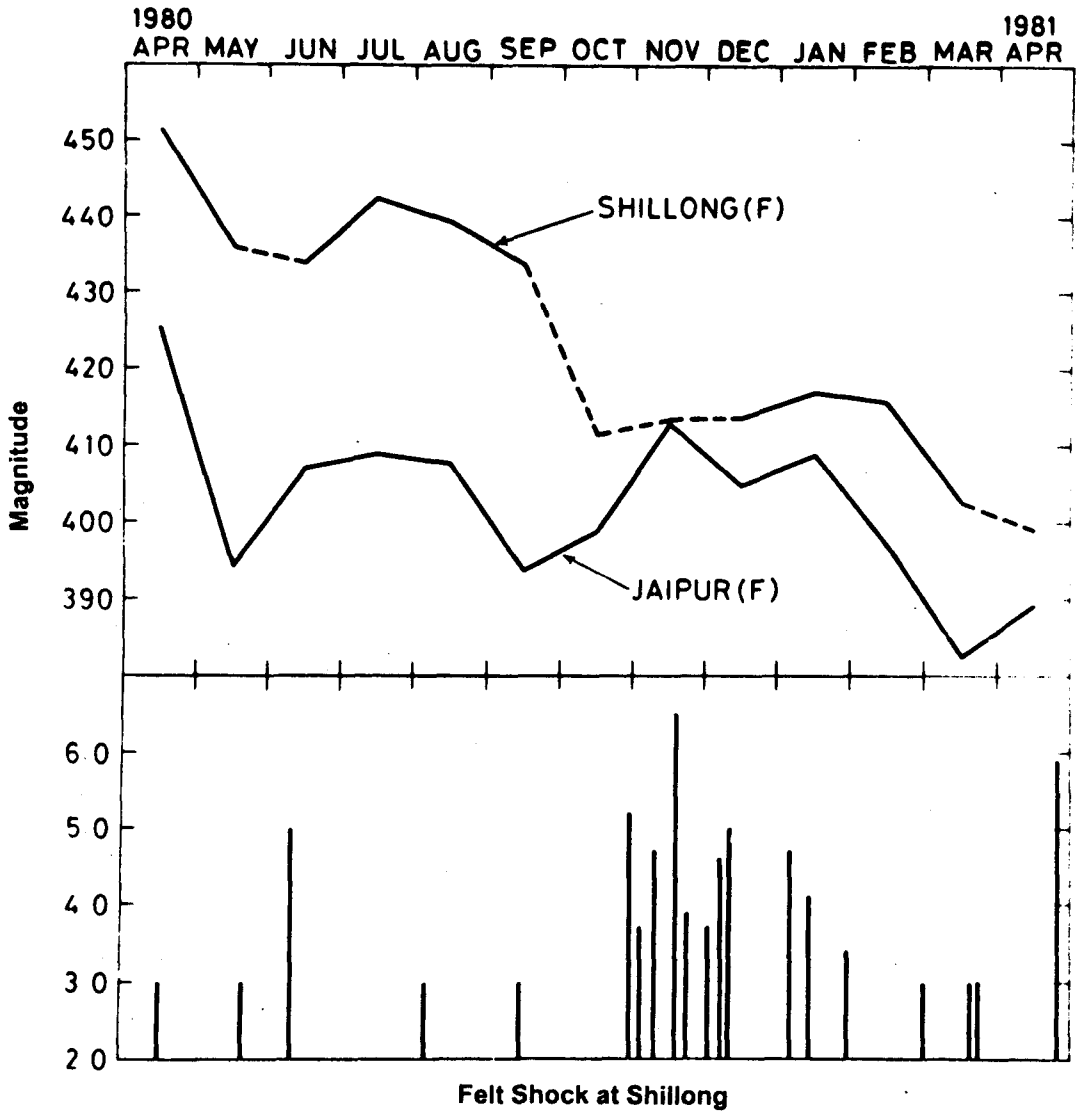

FIGURE : 1 Shows the change of Geomagnetic Intensity observed by Proton Precession Magnetometer at Shillong & Jaipur

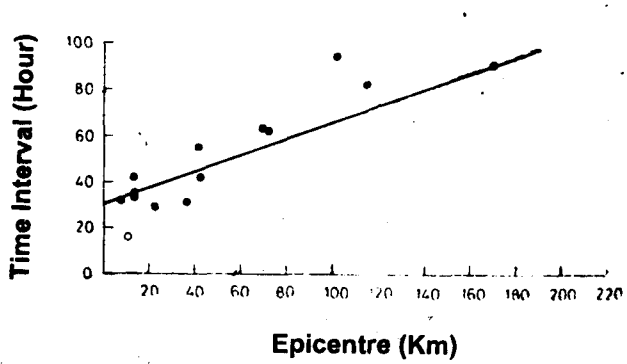

FIGURE : 2 Relation between epicentral distance and time interval of depression in F at Shillong

SATELLITE (VSAT) COMMUNICATION : TECHNOLOGICAL SOLUTION FOR NORTH EAST REGION

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ABSTRACT

The North Eastern Region of India consists of difficult terrains such as villages are located far apart, roads are not well connected, the railway network has a limited reach and conventional communication infrastructure does not suit because of terrain structure obstacles. There is evidence and no doubt that technology needed to connect different far flung and inaccessible areas through VSAT is available. In this paper, technological solution based on VSAT communication have been highlighted to provide reliable, efficient and most advance system to cater the need for North Eastern Region.

INTRODUCTION

The feature of India is 'Unity in Diversity' and 'Diversity in Unity'. Each and every region of the country exhibit this feature. N.E. Region is rich in biodiversity, its hydropotential is unparalleled, it has petroleum and natural gas along with minerals and forest wealth. The NE region is an astonishing confluence of diverse ethnic, linguistic, religion and cultural communities which not only exhibit diversity but reveals a strong underlying national unity which is a source of immense national strength. However, when people think of NE, they usually think of geographic distance which leads to mental distance as expressed by Hon'ble PM Sri Atal Behari Vajpayee. Similarly people in the NE think of other part of the country in terms of developmental distance which leads to the emotional distance. In such circumstances, the priority in the infrastructure development in communication and transportation can bridge either geographical or emotional distance. The time has reached to take a hard look at the possibility of using satellite bands for telecom/data in rural, urban and remote areas.

The whole of the NE having mountainous areas, difficult terrain structure; where, wireline communication are having certain limitations. According to the ITU estimates by the year 2000 A.D., there will be 3700 transponders over the Asian skies. There is evidence and no doubt that technology needed to connect difficult, far flung and inaccessible areas through VSATs is available. Since its inception of technology in 1980, the global VSAT market has grown phenomenally and is estimated to be 2,50,000 in TDMA with a growth of 35%. It seems that VSAT is viable and valuable option to extend the rural connectivity. Even the countries like Middle East, Africa, Indonesia, Malaysia and China have made extensive deployment of VSATs in their rural areas. It is unfortunate that rural India still awaits to receive its due share of connectivity.

There are 35,800 villages in the NE region out of total six lakh villages in the country. Out of the this only 5000 villages are connected with the telephone facility based on the report published in Communication today, July-Aug 97. It means the 15% of the villages in the NE have VPT as against the national average of 44%. Kerala is having 100% connectivity for villages followed by Tamil Nadu, Punjab, Haryana, Andhra Pradesh. At present in India, there are more than 3500 VSATs terminals, 10 Hubs.

VSAT technology basically uses satellite communication transponders for transmission of voice and data. This technology ideally suits for linking places which are not normally accessible trough terrestrial communication methods. More than dozens operators are working in the field of installation and maintenance of VSATs for point to point and many point networking. Generally VSAT network consists of satellite transponder, Central hub with antenna size between 4.5 to 11 m, and a network of several dozen to several thousands with smaller antenna in the star network. VSATs are currently available in C-band, extended C-band and Ku- band. The Ku band suffers from disadvantages of high attenuation due to rain.

However, this is compensated by suitable link design. However, C-band may suffer from interference from terrestrial communication in the same band. However, DAMA technology does not requires Hub and all VSATs terminals under DAMA technology behaves as hubless network with one Network Management system responsible for efficient use of the segment, however at present it is more expensive in terms of equipment cost.

CONCEPT OF VSAT

The VSAT based network creates for high reliable, error free and flexible information highway compared to the terrestrial alternatives available. In the Indian scenario, where reliability and availability of terrestrial links are highly inadequate, VSATs are an ideal communication methods. The VSAT network consists of satellite, central hub with large antenna (in general) or a hubless centre site with network manager system, and a network of several VSAT terminals with similar antenna as that of the central site, controls the entire operation of the communication network with the help of NMS system that performs the function of switching, network operation, management and control. In this, VSAT communicates between themselves by sending/receiving RF signals from satellites located at geostationary orbit. This technology provides the ability to expand applications and improve performance with the advancement of electronics and small antenna, that makes the system more efficient.

ADVANTAGE OF VSAT TECHNOLOGY

1. The ability to address point to point communication topology.
2. Provides a service that is free from last mile problems.
3. Flexible network configuration to accommodate growth and changes.
4. Excellent transmission quality along with fixed transmission cost regardless of the distance.
5. High reliability and easy to maintain and diagnose.
6. Dynamic allocation of transmission capacity based on instantaneous traffic.
7. Network manager system controls the monitoring and status of the network which is not available in the hybrid mode of communication.

TECHNOLOGY OPTION

There are various VSAT technologies each with its distinctive advantage over the other in specific configuration and applications. The following technologies are available today in our country.

1. TDM / TDMA and TDMA MESH
2. FTDM / TDMA
3. SCPC DAMA
4. Hybrid VSAT network with SCPC / DAMA and TDMA

The network can be classified into 4 basic parameters

(i) Growth in the network locations
(ii) Growth in the network traffic
(iii) Growth in nature of applications
(iv) Network management decisions

Considering the requirement of large data applications, higher number of voice channels delivering toll quality voice and high band width hungry future applications such as video conferencing, DAMA VSAT network will be suitable for this region.

NETWORK ARCHITECTURE

There are basically two classifications such as STAR (point to point) and MESH.

STAR : This is usually used for the broadcast of data, video, private voice/data networks and VSAT systems. The basic operational feature of the centralized data collection makes this architecture ideal for the traditional VSAT system. A large diameter antenna can be used at the central site allowing for the use of many very small diameter antennas and reduced RF power requirements at the remote locations. For large networks this can become very economical. Smaller networks are economically disadvantageous due to high cost of the large central hub antenna and associated RF equipment. Common satellite access methods utilized with STAR networks include SCPC, MCPC and TDM.

MESH : This systems are well suited for networks unable to tolerate the delay with a hub-star architecture. The MESH architecture allows any point within the network to establish a direct, single hop communication with any other point within the network. MESH systems usually do not require a large, expensive central hub site. A location within the network is often designated as the network controller and is populated with the

network control computer and associated network control software. The ability to establish direct connections eliminates double hop and conserves satellite bandwidth.

TDM / TDMA : In this scheme, all stations transmit and receive on the same frequencies. The access of these frequencies is based on time. The satellite bandwidth is divided on the basis of time to provide access to common frequency by multiple stations. This applications are mainly suited for low to medium volume traffic, and medium to large size networks. Data applications for which TDM/TDMA is suited are interactive data, batch file transfer, remote login and e-mail. Low quality voice, normally Fax are supported.

FTDMA / TDM : This is a combination of frequency and time division multiple access. It uses a frequency hopping mechanisms in addition to the traditional time slot. This is best suited for specific applications like ATM, Credit/debit, travel reservations, price look up. This does not perform well in applications like Desktop Video conference, ISDN, toll quality voice because of the restriction on the bit rates of the inbound channels which is much lower.

SCPC / DAMA : This permits a pool of satellite resources that are allocated to users on demand for the required periods, to be shared amongst an almost unlimited group of users which saves heavily on space segment and ground segment cost. However, it permits only low to medium traffic intensity traffic per site. There are three main components in any DAMA system such as Network Control Terminal, Network subscriber terminals and Network control system. DAMA functions like hubless kind of environment.

CONCLUSION

Based on the consideration of the requirement of traffic intensity and its potential utilization, DAMA hubless network suits to the north eastern region. This is most reliable communication network existing today in the world scenario due to inherent limitation of the traditional communication infrastructure available in the region. This can also be connected to the Internet gateway and used for the purpose mentioned in the information technology task force recommendation which in turn lead to techno-economic and socio-economic development of the region.

ROLE OF SURVEY OF INDIA IN DEVELOPMENT OF NORTH -EAST INDIA

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ABSTRACT

Survey of India, established in 1767 is the premier organisation in India engaged in preparation of topographical maps. Geographical maps are also prepared by the organisation compiling the same from topographical maps. These maps contain vast repository of terrain information which has not only been used by defence forces extensively but also by all levels of planners and administrators. Many departments also use these maps as reference maps for collection of other thematic data etc. of their use.

After independence the orientation of the organisation was diverted to various developmental project works in addition to commitment of departmental topo maps, This paper deals with the role of the organisation for development with special essence to development in the area of cadastral survey by way of taking up survey work of model areas and training their staff to handle further effectively.

Recently this organisation has begun work towards preparation ot thematic maps by taking up the reponsibility to prepare district planning map series. The maps of this series contains judicious mixture of spatial and thematic data/information useful for planners at district level.

As a sequel to the advancement of Science this Department has resorted to multidirectional modernisation both in the area of field survey and cartography. This will improve the quality and quantity of information of the maps making them more useful. Besides it will drastically reduce the time leg and cost.

Different sections of people such as administrators & policy-makers, planners entrepreneurs and others will be will guided by use of our achieving pragmatic solutions to their problems. However interaction with Survey of India of all those involved in devetopment planning and execution or otherwise those who want to derive benefit out of our maps, will be extremely useful for both the parties to find solution by preparation of maps with data/information of specific use.

INTRODUCTION

Survey of India is the premier organisation in India for preparation of topographical maps. It also prepares and maintains geographical maps. Topographical maps constitute vast repository of cultural and terrain informations, used by planners of different levels for effective planning both at micro and macro levels.

Map is an important tool for proper planning for detailed exploration and full exploitation of resources with scrupulous management of time. Every one of us are using maps knowingly or unknowingly irrespective of our educational qualifications or professions. Even an illiterate man chalks out a mental map and use the same for various day to day work and domestic responsibilities. Many organistaions and administrators, who do not use maps also make use of their mental maps to execute their programmes. But these mental maps are always subjective and are of little avail beyond a point. Evidently the use of maps containing various themes/details of importance and utilities of a particular user will undoubtedly enhance the output. Therefore, interaction between importance and utilities of a particular user will undoubtedly enhance the output. Therefore, interaction between Survey of India and various State/Central Government Organisations/Agencies of North Eastern Region involved in development projects and planning can prove fruitful for finding effective and pragmatic solutions.

The development of the nation is mainly chalked out by administrators, planners, scientists and engineers. The prime objective, however, of all development activities in developing countries is to raise the standard of living of the people and ensuring/improving provisions of their basic human needs. It is therefore, axiomatic that, the developing countries utilise and manage their resources to the optimum. To be able to do this they need to know the basic planning, data and informations. The cartographic data of maps form the fundamental framework for all planning and implementation activities. Thus the above mentioned persons responsible for nation's development ought to use maps, which is prerequisite for developmental work. The saying rightly goes "No planning without plans".

OBJECTIVE OF THE PAPER

The main objective of this paper is to provide information about the role of Survey of India for development in North Eastern Region highlighting the scope/potential of the organisation so that other Organisations/Agencies in this region can impart benefit from our maps by optimal dissemination of

geoinformations therein or by asking/indenting for maps with specific design and content as per need of theirs. Thereby all concerned Organisations/Agencies including Survey of India can succeed in their endeavour to discharge their obligations towards socio-economic development of the region.

ORGANISATIONAL SET-UP

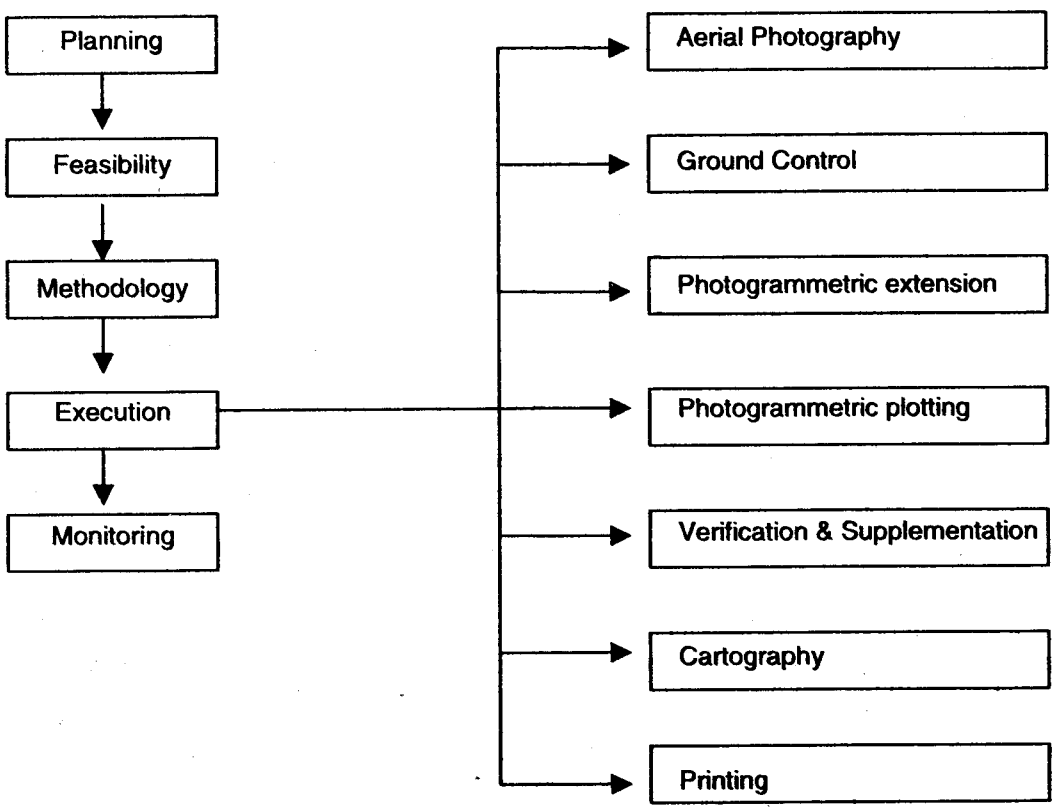
"Survey of India" established in 1767 has been actively engaged in preparation of Topographical maps. Now this oldest department is under "Department of Science & Technology", Govt of India with its headquarter at Dehra Dun. To divide the area of responsibility we have four zones viz. North Zone, South Zone, West Zone and East Zone. Each zone constitutes of some circle "North Eastern Circle" of Shillong is one of the three circles under East Zone" the zonal headquarter being at Calcutta. Other two circles namely "South Eastern Circle" and Eastern Circle" are at Bhubaneshwar and Calcutta respectively.

JURISDICTION OF N. E. CIRCLE

Each circle has its own area of responsibility. Accordingly North Eastern Circle has its responsibility constituting the whole North Eastern states popularly known as "Seven Sisters". All sorts of surveying and mapping need of these area are to be met by this circle only. It may be owing to departmental commitment or indentor's requirement subject to the scope and feasibility.

WORKING PATTERN / PROCEDURE

The normal working procedure of "Survey of India" to produce maps is based on the following broad steps:



However, the above is for normal departmental work. In case of maps for project and other development work the steps under "Execution" is decided as per the requirement or suitability.

THE STATUS OF N. E. CIRCLE

Organisation Unit Structure :

The North Eastern Circle of Survey of India is established on 10th March 1971. It has six field units, two photogrammetric units and two drawing offices. The headquarter i.e. Circle office together with four field units, one photogrammetric units and two drawing offices are located in Shillong. In Guwahati and Silchar we have one field unit each and another photogrammetric unit is at Dehra Dun.

Staff Training :

In this Circle we have a strength of about 400 technical staffs well equipped with fair knowledge of surveying and cartography. Almost everyone have been thoroughly trained by "Survey Training Institute, Hyderabad" in their respective disciplines. To refresh working knowledge, training in advance courses are availed by the technical personnel in phased manner.

Instruments & Equipments :

The field units of the circle are well equipped with adequate numbers of precision surveying instruments such as 1" glass are theodolites, auto levels, **EDM** Instruments are related camp equipments with transportation facilities. The photogrammetric units do have various types of stereo-plotters with many precision plotters. The drawing offices in the circles have totally adopted the latest technology of map production i.e. "scribing". Apart from this, a Map Digitisation Cell gas almost been established in this circle to introduce the map production by computer aided cartography. The photogrammetric machines of photogrammetric units are being attached with computer so as to obtain the data in digital form directly from aerial photographs.

Production Capability :

As amply clear from the above paragraphs, North Eastern Circle is rich in possession of equipments, instruments and expertise, and has tremendous capability to meet the requirement of any sort of mapping work in its area of responsibility.

MAPPING WORK DONE

Departmental :

The department has its own commitment for preparation of maps of the whole country in different scales which are widely used by defence forces, planners and administrators. The different departmental map series done by the circles are as below:

a. 1:50,000 Scale Surveys :

The maps of this series are widely used for general planning in all disciplines. The contour interval of this is 100m/20m/40m depending upon the topography. The whole North Eastern Region has been covered by this series of maps each covering an area of 15'x15'(Lat. x Long.). This achievement of Survey of India in North Eastern Region is great in view of the characteristics of this area i.e. high mountains, rugged terrains, thick forests, underdeveloped, virgin and inaccessible lands. It was possible only because of the hard and dedicated work of surveyors, officers and staffs of those days out of which some have to sacrifice their lives, The 2nd or 3rd edition of some maps of this series have also been brought out pertaining to the areas of rapid change.

b. 1:25,000 Scale Surveys :

The present commitment of the department is to cover the entire country by this series of maps with dimension 7½' x 7½' with contour interval 5m/10m/20m depending upon the topography. This circle is also in progress to bring out this series of maps of North Eastern Region and so far we have succeeded in achieving about 20 percent of the task.

Extra Departmental :

After independence, the major effort of the department to the Surveys for multipurpose development projects planned in the successive Five Year Plan all round economic development of the country. The North Eastern Region also received its share. Many project surveys were undertaken in the region viz. Hydro-

electric Projects, Town Development Projects, Flood Control Projects, Oil Refining Projects etc. In addition many other extra departmental works done by Survey of India in the region, abstract of which are given below:

DEVELOPMENT PROJECT WORK

The list of project works undertaken by Survey of India since independence in North Eastern Region in - various disciplines are as enlisted below:

Projects :

1. Barak Dam Project
2. Tipaimukh Damsite Project
3. Bhairabi(Dhaleswari) Hydro-electric Project
4. Demmai Hydro-electric Project
5. Diyng Hydro-electric Project
6. Dikrong Hydro-electric Project
7. Gumti Hydro-electric Project
8. Irang, and Makru Hydro-electric Project
9. Kopli Hydro-electric Project
10. Kerdemkulai Hydro-electric Project
11. Kalayani Hydro-electric Project
12. Khawiva Hydro-electric Project
13. Logtak Hydro-electric Project
14. Lower Umian-Umkhen Hydro-electric Project
15. Lower Barapani Hydro-electric Project
16. Kurichu Hydel Project
17. Jhansi and Dikhu River Valley Project (Reservoir & Damsite)
18. Lohit Dam Project
19. Subansiri Hydro-electric Project
20. Tenga Hydro-electric Project
21. Tuikumlui Hydro-electric Project
22. Tuivai Hydro-electric Project
23. Upper Khri Hydro-electric Project
24. Myntdu (Leska) Hydro-electric Project
25. Ranga Nadi Hydro-electric Project
26. Tuirial Hydro-electric Project
27. Sherlui Hydro-electric Project
28. Vanva Hydel Project
29. Noa-Dihing Dam Project
30. Papumpam Hydel Project

Flood Control Surveys :

1. Brahmaputra
2. Moriahole Erosion Site
3. Mukalmua Gumi Erosion Site
4. South Salmara Erosion Site

Guide Maps :

1. Tezpur (Open)
2. Dimapur (Restricted)
3. Jorhat (Restricted)
4. Agartala (Restricted)
5. Imphal (Restricted)
6. Nagaon (Restricted)

Town Planning Surveys :

1. Arunachal Capital Site at Itanagar
2. Agartala Town & Surveys
3. Aizawl & Lunglei Township
4. Assam Capital Site
5. Bagafa Town & Surroundings
6. Champhai Satellite Township
7. Dimapur Township
8. Hnathial Satellite Township
9. Jowai & Surroundings
10. Kohima Township
11. Kumarghat Town & Surroundings
12. Khawzawl Satellite Township
13. Khanapara & Environs
14. Guwahati Town & Development
15. Greater Shillong

Other Surveys :

1. Nagaland Administrative Headquarters and Villages
2. NEHU Campus
3. Assam University Campus
4. Cherra Cement Ltd. Development Surveys
5. Domiasiat Uranium Project
6. Kharsang Development Project
7. Lumshong Project
8. Khasimara(ONGC) Project
9. Jorajan - Duarmara Complex
10. Pilot Project Tripura
11. Making of Roads Rivers on base map of NEFA
12. Manu Basin Project
13. Brahmaputra Basin Survey
14. C.A.D. Barak
15. Umngot Barak

Town Planning Surveys (contd)

16. Byrnihat
17. Nongstoin
18. Williamnagar (Simsangiri) and Environs
19. Mairang & Environs
20. Vairengti
21. Mokokchung
22. Tuensang
23. Serchip Town & Surroundings
24. Baghmara & Environs
25. Thenzawl satellite Township
26. Saiha Township
27. Tura Town & Envoirs

Railway Project Surveys :

1. Dharmanagar - Kumarghat Rly Alignment
2. Guwahati - Byrnihat Rly Alignment
3. Diphu-Karang-Imphal M.G. Rly Alignment
4. New Rly line M.G. from Laila Bazar to Sairang Project

Oil Refineries :

1. Guwahati – Naharkotia

Thermal Plant Surveys :

1. Bongaigaon Thermal Power Project
2. Borgolai Thermal Power Project

Ropeway Alignment :

1. Ichamati – Byrnihat
2. Shella – Pandu

Cadastral Survey :

1. Aizawl
2. Bikhawthlir

Other Surveys (contd)

16. Kynshi Basin Project
17. Gumti Basin Project
18. Haora Basin Project
19. Khowai Basin Project
20. Brahmaputra Bridge Project (Dibrugarh)
21. Brahmaputra Bridge Project (Jagighopa)
22. Greater Shillong Water Supply Scheme(Mawphlang)
23. Umiew Water Supply Project
24. Sukla Irrigation Project
25. Dihang River Valley Project
26. River Trend Survey
27. Seismic Lines Survey
28. Rongrengiri R. F. Boundary Demarcation
29. Morphological Studies in Brahmaputra
30. Namchik - Namphuk Coalfield
31. Borjan Coalfield
32. Delhi - Jaipur Coalfield
33. Darrangiri Coalfield
34. Nongalbibra Coalfield
35. Barak Watershed Management
36. Kynshi Basin Project
37. Jiya Dhol Project

Project in Hand :

1. Slyom River Project Damsite Area
2. Kamala River Project Damsite Area
3. Siang River Project Damsite Area
4. Subansiri River Project Damsite Area
5. Cadastral Surveys of Pasighat
6. Kumarghat - Agartala Railway Line

Oil Pipe Line Surveys :

1. Digboi - Tinsukia White Oil Pipeline
2. Survey of Pipe Line Route
3. H.F. Communication system for Digboi/ Tinsukia/Guwahati

Cadastral Survey :

Some sample surveys in the cadastral area has also carried out this circle on the request of State Government such as Mizoram & Nagaland. However it is not possible to concentrate in that area because the quantum of works involved is more. But the surveyors of the concerned State Government were trained by Survey of India experts so that they can handle their work effectively. However now the work of "Pasighat" cadastal survey is in progress with us for an area of about 8 sq. km. with the request of Arunachal Pradesh Government. The success of said project will decide the involvement of this Department in the area of cadastral survey subject to feasibility.

GUIDE MAPS

The circle has produced the guide maps of various cities/districts of states of this region on request of the concerned authorities. These maps were not only useful for the town planners but also equally useful for tourists.

FLOOD MANAGEMENT SURVEYS

A mega project "Flood management surveys for the Brahmaputra valley in Assam" was undertaken by us so as to provide adequate data/informations to state authorities for making plans to control the flood which certainly happens to be one of the biggest challenge to the Government in Assam. The contour interval of this survey was 0.05 metres and scale of survey 1:15,000 on rectified enlarged aerial photographs.

DISTRICT PLANNING MAPS

The varied physical, cultural and economic conditions prevailing in different parts of India results in uneven socio-economic development. This prompted to think for a smaller unit for monitoring the homogeneous development. Therefore in the 8th Five Year Plan, it was decided that the districts should be the best unit for monitoring the progress of the country's development work. Accordingly it was decided to bring out a special series of maps called "District Planing Maps Series" covering all districts as per the policy decision formulated by Government of India, Ministry of Science & Technology.

This mega task was distributed equally to "Survey of India" and NATMO. The maps are to be brought out in 1:250,000 scale with eight or more thematic insets containing all sorts of informations related to district. It is hoped that this series will be extremely useful for administrators and planners at district level so as to monitor the development and rationally plan for developmental work. This in fact in conformity with the latest trend of the government to involve people at the grass root level in the developmental process.

This circle has its own share of responsibility to bring out the maps of following districts, out which some have already been printed out and others are almost at the verge of printing.

1. Bishnupur	2. Bongaigaon	3. Dhemaji
4. East Garo Hills	5. Goalpara	6. Golaghat
7. Imphal	8. Karbi Anglong	9. Kokrajhar
10. Marigaon	11. North Tripura	12. South Garo Hills
13. South Tripura	14. Tawang	15. West Garo Hills
16. West Khasi Hills	17. West Tripura	18. Aizawl
19. Churachandpur	20. Darrang	21. Dhubri
22. East Kameng	23. Kohima	24. Nagaon
25. Phek	26. Sonitpur	27. Upper Subansiri
28. Tamenglong	29. West Kameng	30. Wokha
31. Zunheboto	32. Lower Subansiri	33. Papumpare

FUTURE PLANS

It has been observed that, the time leg for accurate surveying and cartography for an accurate map is more. It can never be drastically reduced without sacrificing the accuracy. Compared to the olden days we have enough improvement as on today by introduction of latest technology and modern survey instruments and equipments. However, this circle has many more plans to improve in this angle by adopting many new methodology as below, based on the fact that there is always a room for improvement. This will enable us to achieve our commitment and also to deliver the requirements to the indentors in time.

Digital Mapping Cell :

As envisaged by the "Task Force" constituted by the Dept of Science and Technology for computerisation in Survey of India in phased manner to operationalise digital cartography, two digital Mapping Centres were established. These Centres were not sufficient for digitising the maps of different series covering whole of India. Besides, the digital cartographic data generated are quite outdated based on the facts that maps used for digitisation are old. Therefore with a view to acquire up-to-date cartographic data, latest topographic maps are required. Up-to-date digitisation is possible if the digitisation facilities are

available in regional circles. It was thus, decided by Surveyor General to equip various circles with necessary computerised systems so as to acquire digital data from latest maps/surveys.

As a part of the same facilities extended to various circles a "Digital Mapping Cell" has been installed here at North Eastern Circle, Shillong. This will be functional and updated maps in digital forms could be available from this office pertaining to North Eastern Region in a very short period from now. This will enable Engineers and planners of this region to obtain digital informations in magnetic media and use the same for their plannings intractively in computerised methods, this method will considerably reduce the requirement of time for map production.

Upgradation of Photogrammetric Instruments :

We have a planning to upgrade all the available analogue Photogrammetric instruments by attaching a computer system to them so as to acquire digital data from aerial photographs directly. These data can be processed subsequently for obtaining blue print to be taken for field verification. Subsequently the same data can be updated as per the verified field records. This updated data itself will enable us to produce maps with short duration by computer aided cartographic process.

CONCLUSION

Since independence this department has been playing a significant role in the development of North Eastern Region by meeting the Survey requirement of various projects as reflected in para 6.5.1 (a) above in addition to the departmental commitment. But there is still much scope for use of data collected by Survey of India by State Governments of this regions at various levels for developmental work in different areas. Special purpose maps also can be prepared by carrying out such surveys to suit different agencies/organisation engaged in development work if so indented, subject to the feasibility.

It is amply evident that, North Eastern Circle is well advanced with latest technology, instruments, equipments and expertise to meet any type of surveying and mapping need. The proposed steps for multilateral modernisation will strengthen future making the surveying and mapping work less time consuming and less cost effective. This is the area where the indentors are often dissatisfied.

A continual interaction of the State/Central Government organisation/agencies associated with development and execution in the region is required with the regional circles of Surveys of India for a better understanding and fulfillment of their need. This will enable both the parties to work out modalities for mutual co-operation for pragmatic approach to the planning activities. It need be emphasised here that development works planned, should not benefit only the urban people but also the benefit must percolate down to rural populace so as to ensure real development from grass-root.

FUTURE AIR NAVIGATION SYSTEM

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ABSTRACT

Aircraft operating all over the world have been using a combination of ground based and air navigation aids by an intricate mechanism of traffic control during takeoff to the landing of the aircraft. However much of the world air-space is without radar and at places having without VHF communication. But extensive oceans prevent the use of the radar and ground based navigation aids. Besides, deserts and mountains also cause problems with this context. Ground based infrastructure, which most of the nations have been developing so far but extremely cost intensive. A sub-committee set up by International Civil Aviation Organisation (ICAO) developed a plan for global implementation of new satellite based system for communication, navigation, surveillance and air-traffic management. This modem technology will revolutionise the air traffic management to overcome all the difficulties of present system and likely to be completed by 2005. In this technology, besides global positioning system and communication satellite, a major component is automic dependent surveillance which gives aircraft position information to airport via satellite data link to enable the controller a more updated and accurate position of aircraft location. Airports Authority of India has taken a major project in this direction along with differential GPS and satellite communication system in order to provide radar coverage to about 80% of the Indian Airspace. The secondary surveillance radars besides providing positional information of aircraft movement also gives details on call sings of the aircraft, flight level which are vital information for the air traffic controllers.

INTRODUCTION

When you travel by aircraft, are you aware that each moment of your travel, right from take-off to landing, is cradled in the air by an intricate mechanism of Air Traffic control. In India, this work has, so far, been done by Airports Authority of India. One of the important aids which modern science has offered is Communication Navigation Surveillance - Air Traffic Management (CNS-ATM). This innovation which is likely to be ready by 2005 AD will revolutionise ATM. It will cut down costs drastically and extend the purview over the oceanic air space as well, The current technology is radar based which is both cost intensive as well as limited to covering only the land mass over 256 NM radius. It is in that context that the CNS-ATM offers a complete revolution which will be affordable and cover both terrestrial as well as oceanic airspace.

DISCUSSION

Aircrafts operating all over the world have been using a combination of ground-bases and air navigation aids and on this basis current standards have been set. In addition, the progress of the aircraft movement over land has been done through radar, both primary and secondary. Much of the work's airspace is without radar and at places even without VHF communication. The extensive oceans prevent the use of radar and ground-based nag aids. Besides, deserts and mountains also pose problems in this context. Ground-based infrastructure, which most of the nations have been developing so far and augmenting, was extremely cost intensive. Moreover, low density of traffic in some of the regions including ours has posed infracturcture versus cost problems. Beyond the VHF range, high frequency has been extensively used. This has been the scene before satellites came into sharp focus for their utilization in the Civil Aviation sector.

A sub-committee set up by the International Civil Aviation Organisation(ICAO) on the FANS, developed a plan for global implementation of new satellite based system for Communication, Navigation, Surveillance and Air Traffic Management (CNS / ATM). It is expected that the present programme of research, development trials and demonstration is likely to continue upto 2010 when CNS / ATM will be fully established.

CNS / ATM is revolutionary since it will overcome all the difficulties of the present system; like for example, it was extremely expensive to extend radar surveillance to ocean and continental airspace. This has found an answer and will, therefore, extend a more precise form of air traffic control to those parts of the world which presently have a few or no adequate nav aids.

Besides Global Positioning System (GPS) and communication through satellites, a major component of CNS / ATM is Automatic Dependent Surveillance(ADS) which is nothing but giving aircraft position information to airports via satellite data link to enable the controllers a more updated and accurate position of aircraft location.

Significant technical and operational experience has been gained through CNS/ATM trials conducted by various countries with the airline operators and other aviation industry organizations throughout the world.

India has been no exception. India whole-heartedly supported the ICAO adoption of satellite aided CNS/ATM system. Airports Authority of India (AAI) has taken on some major projects in this direction. At Calcutta and ADS system supplied by M/S Airways Consultancy Services, New Zealand has been installed and is undergoing extensive trials. An ADS system installed at Madras which is a computer based system developed by one of our indigenous manufacturers namely ECIL which has proved worthy enough and a prototype is being developed in collaboration with them. This is a major step and will definitely pave the way towards CNS / ATM harmonization.

Besides ADS, AAI is also undertaking significant work in differential GPS and satellite communication system. The only answer to somewhat no communication, both ground-to-ground and air-to-ground, is satellite communication.

To provide radar coverage to about 80% of the Indian Airspace, installation of 11 secondary radars have been planned and taken up. Radars at Trivandrum, Hyderabad, Ahmedabad and Guwahati have been commissioned. The installation and testing at 'Delhi and Mumbai' has been completed and at 'Madras and Calcutta', installations are in progress. These radars are scheduled to be commissioned by the end of the year 1998. The other 3 radars at Bhubaneswar, Nagpur and Varanasi are expected to be commissioned by end of 1999.

These secondary surveillance radars besides providing positional information of of aircraft movements gives details on call sign of the aircraft, flight level etc., which are vital information for air traffic controllers.

DEVELOPMENT OF INDIAN FORENSIC SCIENCE IN THE LAST FIVE DECADES WITH SPECIAL REFERENCE TO NORTH EASTERN REGION

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ABSTRACT

Forensic Science, an integral part of the Criminal Justice System, had grown up as a multi disciplinary Science by induction of the principles and technologies of other basic sciences like Physics, Chemistry or Biology. The basic aim of this branch of science is to provide evidence to the court of law for the administration of Justice. Indian Forensic Science is yet to celebrate it's 50th birth day, as the first Forensic Science Laboratory of the Country was established at Calcutta in the year 1952 only. During these four and half decades it has grown up to its maturity. Today the country has 4 Central Forensic Science Laboratories, 20 State Science Laboratories, 28 regional Laboratories, and 121 mobile Forensic Science Laboratories[1]. In the North Eastern Region, Assam Forensic Science Laboratory was first established at Shillong, in the year 1967. In 1970 it was brought down to Guwahati. Meghalaya had started its own Laboratory in the year 1987 and in the next year Manipur had also started it's Forensic Science Laboratory at Pangei, near Imphal. Other North Eastern state like Arunachal Pradesh, Nagaland, Mizoram and Tripura are yet to establish their Forensic laboratories. These states are still utilising the service of state Forensic Science Laboratory Assam or Central Forensic Science Calcutta. Growth development and functions of Forensic Laboratories with special reference to the North Eastern States are discussed in the paper.

INTRODUCTION

The word Forensic is derived from the word 'Forum' which literately means "related to Court". Since ancient times Kings or Jurors were in search of objective truths to arrive at correct judgement. We all know how king of Siracus indented the service of Archimedes to prove whether his golden crown contains adulteration. Archimedes 'Eureka' may thus be credited as first use of Forensic Science in the Court of Law. Since then, quest of knowledge and scientific information for decision making made to develop this multi-disciplinary subject of science. It began humbly with the mysterious science of Fingerprint in the early 19th Century and accumulated weights by addition of more and more disciplines like Chemical Science, Physical Science, Biological Science and the process is on even today. At present Forensic Science is a very strong arm of Law and an effective tool for the Crime Investigation for the final goal of administration of Justice. It is even viewed with a wider prospective as Prof. Chandrasekharam, an eminent Forensic Scientist Observes," **Forensic Science has a wider role to play than simply that of Laboratory hand maiden to the study of criminality. It should be seen to act as a watch dog on behalf of Community against all hazards that may threaten. It should act as educator stimulator of Public Opinion in order that Legislation may be enacted to improve the general health and will being of all"**[2].

American Academy of Forensic Science defines–**"Forensic Science is the study and application of all the Sciences to Law in the search of truth in Civil Criminal and Social matters, to the end that injustice shall not be done to any member of the society**[3].

BASIC OBJECTIVES OF FORENSIC SCIENCE

For administration of Law, courts require unrefutable evidence to punish the guilty and acquit the innocents. Evidence come from two sources (1) human witness (2) Physical or circumstantial evidence. Courts although put more credence to reliable eye witness it is seldom found, as most crimes are committed with intelligent planning and taking due care for non exposure. Even some body really saw or know about a crime, they are reluctant to come forward for giving evidence for fear of unnecessary involvement. Some persons are intimidated or gained over by dubious means as a result court of law does not get the required evidence and as a result even the known criminals also cannot be brought to book. On the other hand, Physical or circumstantial evidence are mostly available in the crime scene or place of occurrence. If these evidences are properly collected, scientifically evaluated and matched with similar materials available with the victim or accused, good and reliable physical evidence may be tendered in the court of law, on the basis of which criminal can be punished even in absence of eye witness.

Evaluation and interpretation of physical evidence in the court of law is termed as expert evidence. Under Section 45 of Indian Evidence Act, an expert is defined as a person with sufficient knowledge and experience in his field [4], originally, different experts like finger print experts, chemical examiners, handwriting experts or serologists were working in a more discrete manner. At present, all these different expert services are brought under common umbrella of Forensic Science, In a Forensic Science Laboratory different types of Exhibits are

examined in certain well defined Divisions, such as Toxicology, for analysis of poisons in viscera, chemistry for general chemical analysis, Biology and Serology for analysis of blood and body fluids and other Biological matters. Firearm, ammunition and explosives are examined under Ballistic Division. Handwritings and other white collar crimes are examined in the Questioned Document Division. Physics Division examines and evaluates exhibits of accident cases, burglary, theft and testing of materials with non-destructive and instrumental techniques, These major divisions are further subdivided into more divisions like blood Alcohol, Narcotics, Instrumentation etc. Certain yet newer divisions like DNA analysis, lie-detection or Polygraphy, Forensic Engineering, Forensic Odontology, Forensic Stylistics etc., are inducted to make Forensic Science more broad based to achieve the goal that injustice is not done to any member of the society.

DEVELOPMENT OF FORENSIC SCIENCE IN INDIA

Medicolegal expert service is perhaps the forerunner of subsequent development of Forensic Science. Kautilya's Arthasastra and Manusanhita and even Veda's gives vivid account about important medical opinion in the administration of justice. During the British era, in case on unnatural deaths, dissection of body and analysis of viscera became mandatory. Since then, opinion of medicolegal expert become essential to ascertain cause of death, age and sex of individual. Injury report in case of rape, suicide or assault cases. Doctors have to examine both living and dead and collect samples from the body of the victim for further Laboratory examination.

Finger Prints, the most celebrated physical evidence was developed during the mid eighteenth century to early nineteenth century. India takes pride on the fact that, Sir William Harcel, the Asstt. Collector Hooghly District of Bengal, is considered to be the first man to take finger prints of the natives during financial transition. Pioneering works of Scientists like Henry Fold (1880), Sir Francis Galton (1894) and Sir Tichard Henry (1903), had established the science of Finger Print as the unrefutable evidence for personal identification. They had proved that no two finger prints of two different persons can be alike. A person can be singled out even from the entire population of the world on the basis of his fingerprint. The papillary ridges of the finger tips are full of so much individual characters that its discriminating power is as high as 1:10 [12]. Finger Prints of identical twins are also found to be different and that is why, it is considered as the primary evidence by the Court. India take pride of establishing the first Finger Print Bureau of the world in Calcutta in 1897 [5].

For examination of viscera of the dead and other poisonous substances used in criminal cases, four Chemical examiners Laboratories were established during the British period at Chennai (1849), Calcutta (1853), Agra (1864) and Mumbai (1870). The first Forensic Science Laboratory for evaluation of different type of physical evidence was however established in Calcutta, in the year 1952 with Dr N.K. Sen as its founder Director. Since then Indian Forensic Science had made tremendous progress. At present all the major states of the country have Forensic Science Laboratories of their own. Certain states like Tamil Nadu, Andhra Pradesh, Uttar Pradesh, Orissa, Maharashtra have more than one Laboratory, which are called regional Laboratories. To render expeditious help to the investigating officers, district level Mobile Forensic Science Laboratoties are established in many states, which are providing very important service in the crime scene investigation. At present in India, there are 20 States Forensic Science Laboratories, 28 Regional Forensic Science Laboratories, 131 District mobile laboratories in the states sectors. Over and above that, there are four Central Forensic Science Laboratories at Calcutta, New Delhi, Chandigarh and Hyderabad. Further, there are three well established Government examiners of Questioned Document (GEQD) Laboratory at Calcutta, Hyderabad and Simla [6].

DEVELOPMENT OF FORENSIC SCIENCE IN THE NORTH EASTERN REGION

The first Forensic Science Laboratory of the North Eastern Region was established by the Govt. of Assam in the year 1967 at Shillong itself, which was brought down to Guwahati in the year 1970. It is a well established Laboratory with 10 technical Divisions. North-Eastern Council is providing assistance to that laboratory, in case of equipments and building with a view that, all the North Eastern state may use it as a reference laboratory.

Meghalaya and Manipur had started Forensic Science Laboratories in the year 1987 & 1988 respectively. Meghalaya Forensic Laboratory have four technical divisions viz. Physical Division, Chemical Division, Biological Division and Questioned Document Division. This laboratory has examined and reported more than 2000 cases during these years. The State of Manipur had more cases on Drug as number of Narcotic Drug abusers are more in Manipur, Nagaland, Arunachal Pradesh, Mizoram and Tripura are yet to establish

Forensic Science Laboratory in their states. They are utilising the services of Assam Laboratory and Central Forensic Science Laboratory Calcutta.

MATERIALS AND METHODS

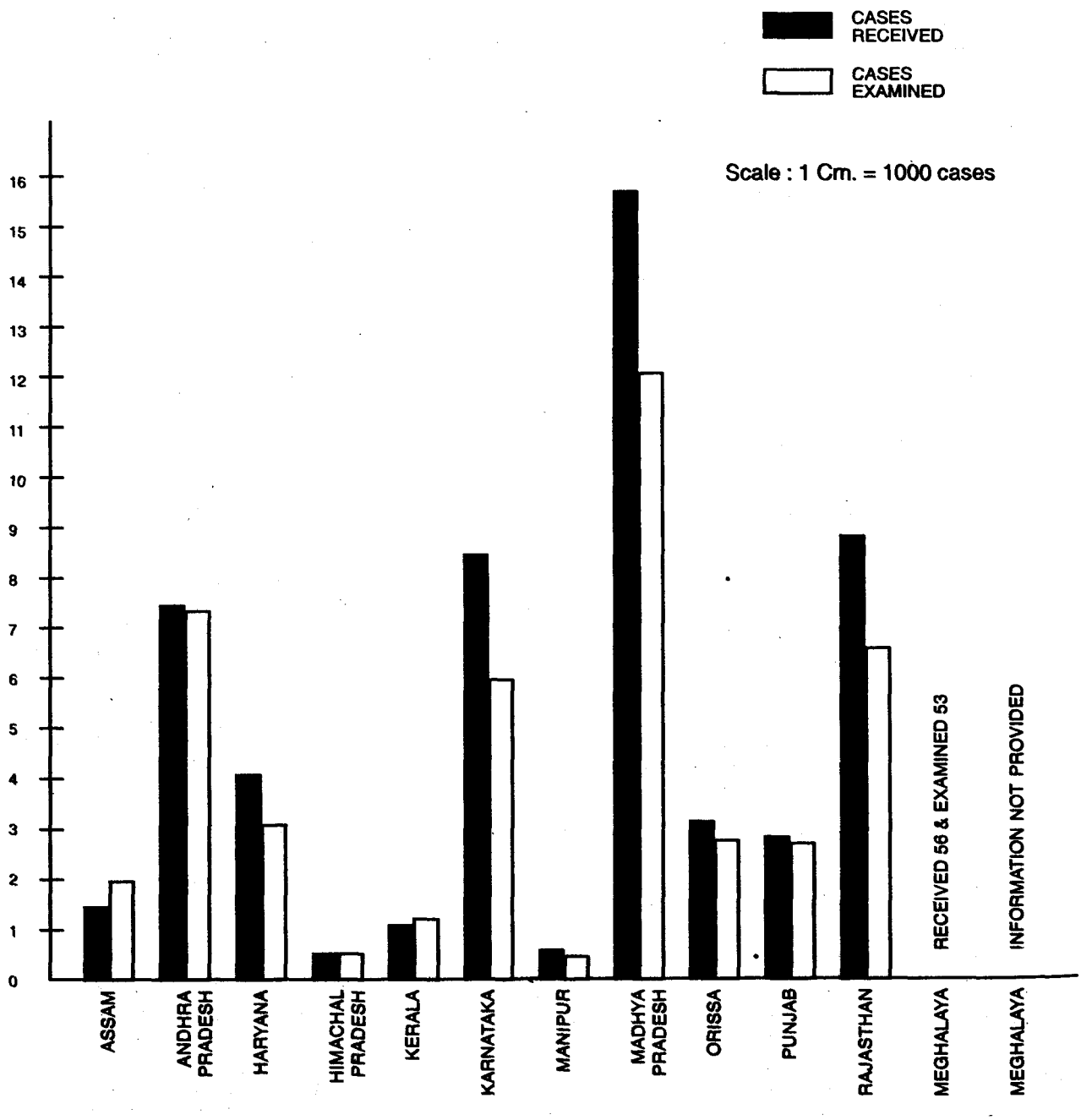
Depending upon the nature of crime various materials found to be associated with crime are referred to the Forensic Science Laboratory. Materials commonly received in this region are described in table – I.

TABLE–I

Type of cases	Type of material	Division in which examined	Major instrumental techniques used.
1. Accident, Burglary, Theft.	Glass paint, Broken pieces of metal, dust, soil, debris, hair, fibre, Erased Engine & Chassis No.	Physics Division	Physical matching, Microscopic comparison, Micro chemical testing Spectroscopy. Chemical etching of metallic surface and restoration of the erased number.
2. Murder by firing	(a) Firearm, bullet cartridge case	Ballistics Division	Microscopic Comparison, SEM with EDX.
Murder by Stabbing Assault, Rape.	(b) Blood stained cloth, Blood stained weapon, stick, cut mark etc., Seminal stain Vaginal swab	Serology Division	Benzidine test for detection of blood stain, species of origin. Blood grouping in ABO System. RH & MN factors. Detection of spermatozoa, under Microscope serological testing, Electro phoresis for detection of semen. DNA testing for individualisation.
	(c) Unidentified dead body. Plants & Vegetable matters, hair, fibre stain.	Biology Division	Anatomical study & Photographic superimposition Microscopic and instrumental analysis for identification.
3. NDPS Act.	Various contrabanded items like Heroin, Morphine, Cocaine, Ganja	Chemistry Division	Wet chemical technique, Spot test TLC. Gaschromotograph HPLC, UV Spectrophotometry & Infrared analysis, GC Mass Spectroscopy
4. Alcohol poisoning & other suspected poisoning cases.	Viscera of dead bodies. Gastric extract suspected substances recovered for chemical analysis.	Toxicology	Extraction of viscera exhibits by distillation. Testing by TLC, GC, HPLC UV & FTIR Spectroscopy.
5. Economic Offence	Forgery, Counterfeit, currency Lottery Tickets, Obliteration Erasure etc.	Questioned Document Division	Comparison of Handwriting & signatures by trained expert. Scientific aids like Magnifier Microscope, Infra-red, Ultra-violet light, Video Magnifier & Comparison.

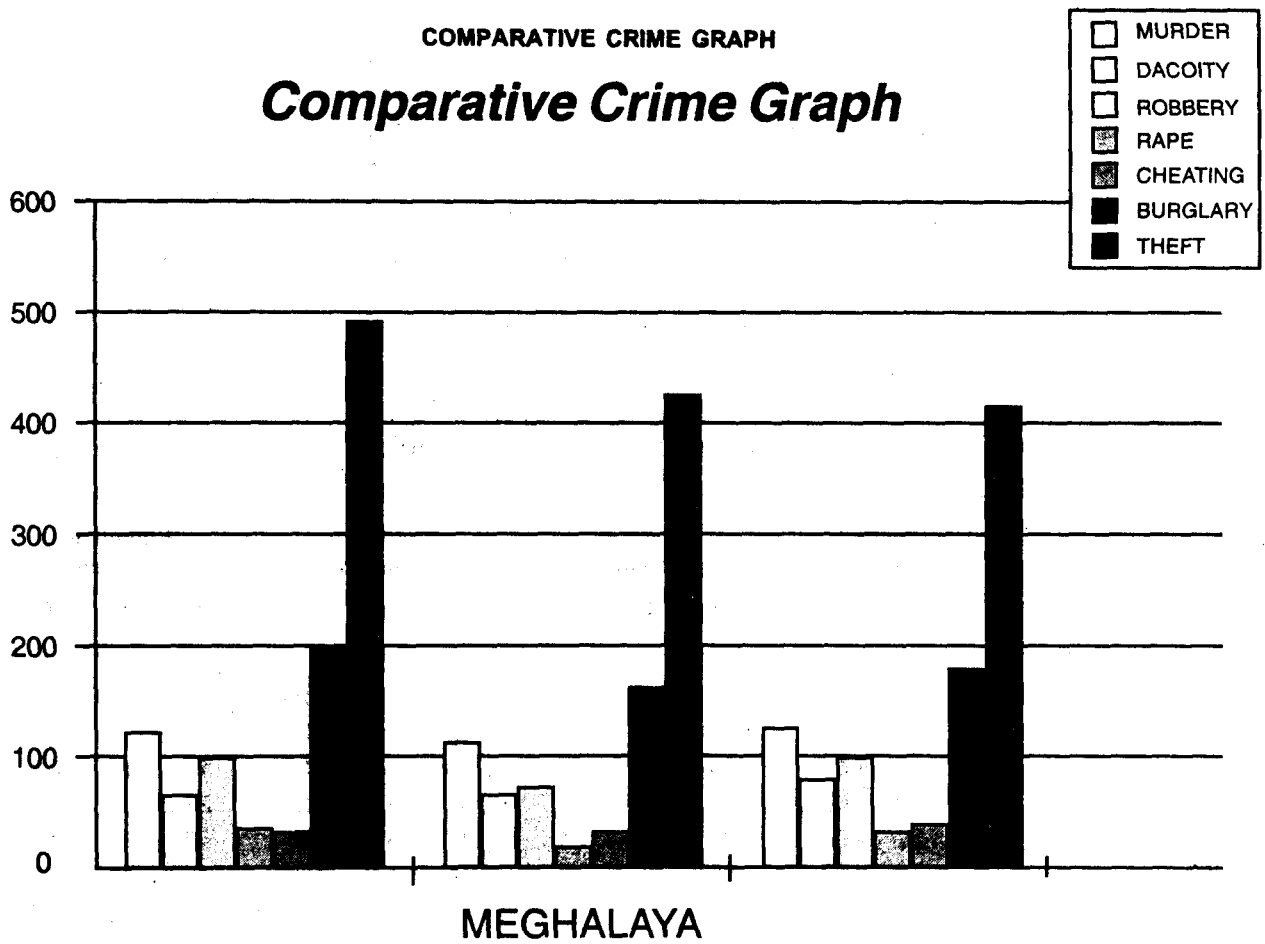
CASE STATISTICS

In bigger states like Uttar Pradesh, Gujrat, Madhya Pradesh etc. Forensic Science Laboratories have been developed in a multi-dimensional manner. Apart from well organised Forensic Science Laboratory at the State Capital, they also have regional laboratories in important places. They have developed district level crime scene units to visit crime scene with the investigating officers for collection of physical clues. An evaluation made by BPR&D in the year 1995 shows the number of cases referred to certain major laboratories during that year.



FIGURE–1

Figure–2 shows comparative crime graph during 1994, 1995 & 1996 which hardly exceeded 2000 mark in a year. Important cases are referred to the Forensic Science Laboratory, Meghalaya. This laboratory had started examination of cases since 1987. Different Divisions of the laboratory had been made functional from different times. Cases examined reported and pending in this laboratory since inception are shown in table–IV.



FIGURE–2

TABLE–II
CASES RECEIVED BY ASSAM LABORATORY DURING THE LAST FIVE YEARS

	1993	1994	1995	1996	1997
Cases received	1385	1423	1486	1259	1579
Cases examined	1281	1280	1345	1173	1486
Cases pending	980	1123	1159	1254	1341

Figures pending cases also includes carry out the previous years

TABLE–III
ANALYSIS OF TYPES CASES RECEIVED IN THE ASSAM LABORATORY

	1993	1994	1995	1996	1997
Drug & Narcotic	332	349	360	429	710
Use of Firearm	227	281	232	100	73
Explosive	21	31	37	35	62
Rape	21	11	12	16	15
Document cases	146	156	143	135	151
Others (Phy, Bio, Sero)	638	595	560	544	568

While NDPS Cases show considerable increase whereas use of Firearm and Explosive Cases show a decrease.

Meghalaya being a small and relatively peaceful state number of cognizable offences are quite low.

TABLE–IV
DIVISION-WISE EXAMINATION OF CASES IN THE MEGHALAYA LABORATORY

Year	Documents Division			Physical Division			Biological Division			Chemical Division		
	R	E	P	R	E	P	R	E	P	R	E	P
1992	49	26	23	52	[illegible]	14	14	12	[illegible]2			
1993	53	57	26	50	[illegible]	21	12	12	[illegible]il			
1994	70	60	10	64	[illegible]	11	20	17	[illegible]3	15	14	01
1995	38	30	07	81	74	07	31	29	[illegible]2	27	24	03
1996	36	32	04	82	58	24	47	47	[illegible]il	46	31	15
1997	25	18	07	88	65	23	41	41	Nil	40	38	02

R => Receipt; E => Examined; P => Pending

RESULTS AND DISCUSSION

In Forensic Science most of the results are obtained by comparison rather than absolute determination and for this reason it is also some time called science of comparison, as shown in figures 3, 4, 5(a&b), 6, 7 and 8.

CONCLUSION

In spite of considerable development of Forensic Science the impact made by the Forensic Science Laboratories is far from satisfactory. The main reason for this is considered to be due to lack of proper training of the investigating officers, awareness among the public in general, last but not the least is certain lacuna in our criminal justice system. Mr Justice V.R. Krishna Iyer observes that Court is always concerned with Evidence Act enacted in the medieval period. They have great apathy towards the new development of science[8]. Nevertheless, Forensic Science had to march with time to combat with the criminals of the 21st Century. Criminals are making potential misuse of modern discoveries like Laser torch, Computer Graphics and remote control electronic devices for their malafied intentions. Investigating machinery must be equipped with equivalent methodologies to counter these modern crimes for which, Forensic Science will not only prove useful but also will prove indispensable in the future time to come.

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(1) Cartridge or bullet recovered from the crime scene is compared with a bullet or cartridge case test fired at the Laboratory, with the suspected firearm by comparison Microscope. a match between the two establish that both have been fired from the same weapon.

COMPARISON OF CARTRIDGE CASE

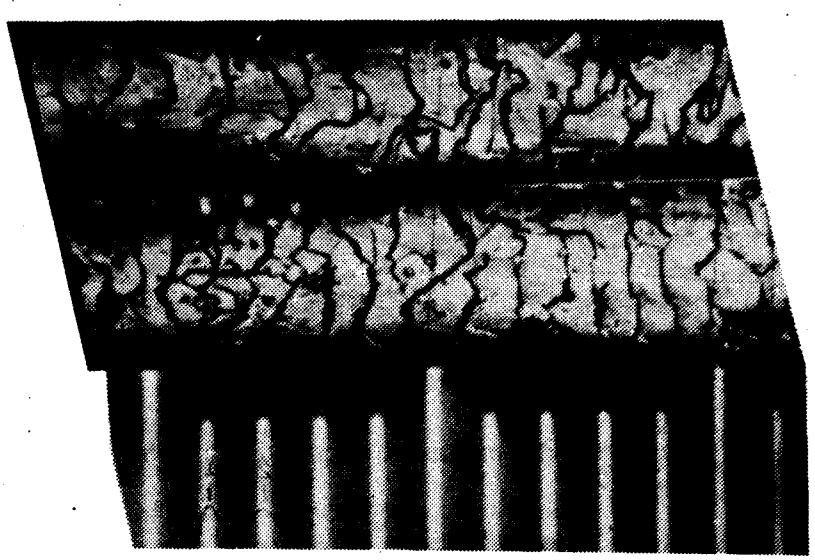
The photograph shows a perfect match between two such cartridges

(a) Exhibits

(b) Control fired at Laboratory

FIGURE–3

(2) Hair scale may be compared to identify commonness of origin. Similarly leaves of cannabis sativa can be identified with the help of cystolythic hair present in it.



FIGURE–4

(3) Drugs can be identified from UV and IR Spectra. GC and HPLC helps to quantify the amount of Drug present in a street of samples.

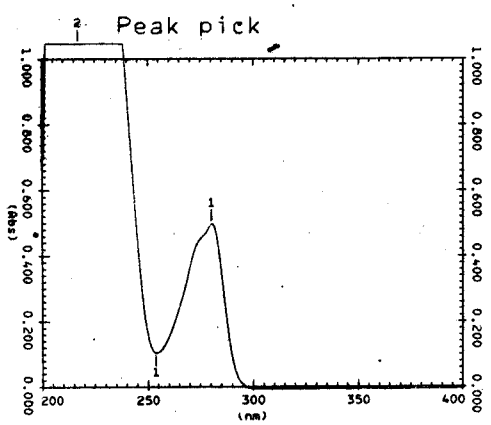


FIGURE-5(A)

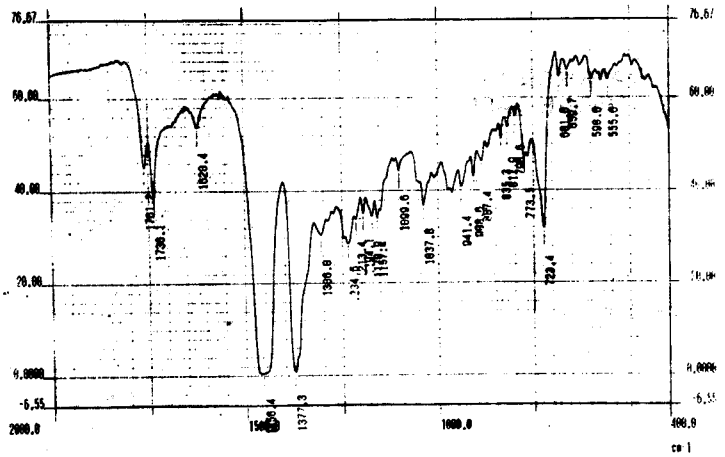


FIGURE-5(B)

A research work carried out in FSL, Meghalaya reveals that age of a blood stain may be predicted by studying it's UV Spectra. This particular work was selected for young investigator's award in the International Conference of Forensic Science held at Tokyo in the year 1997.

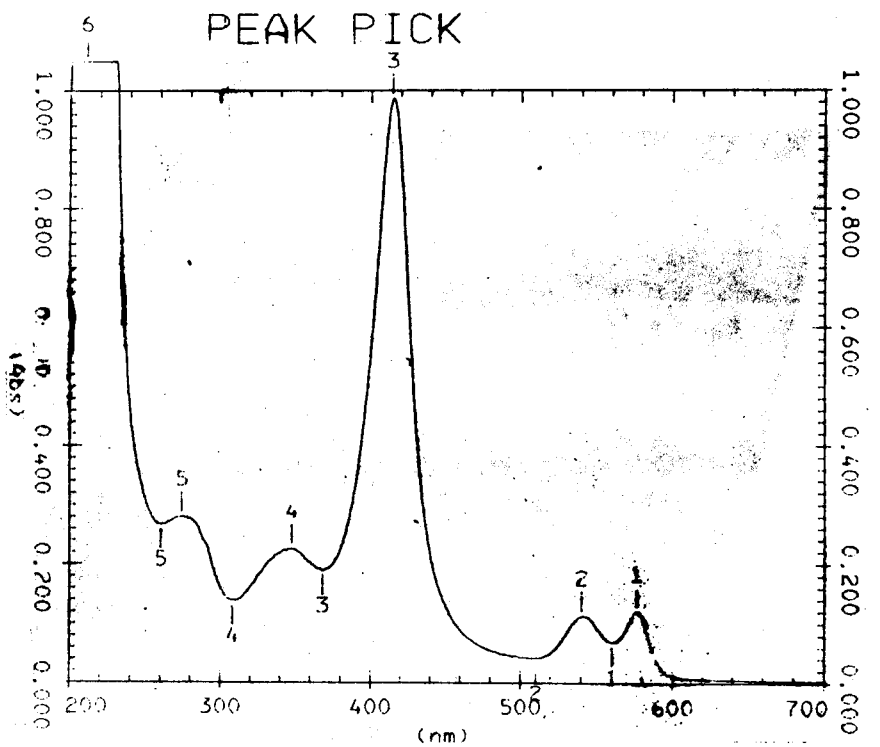
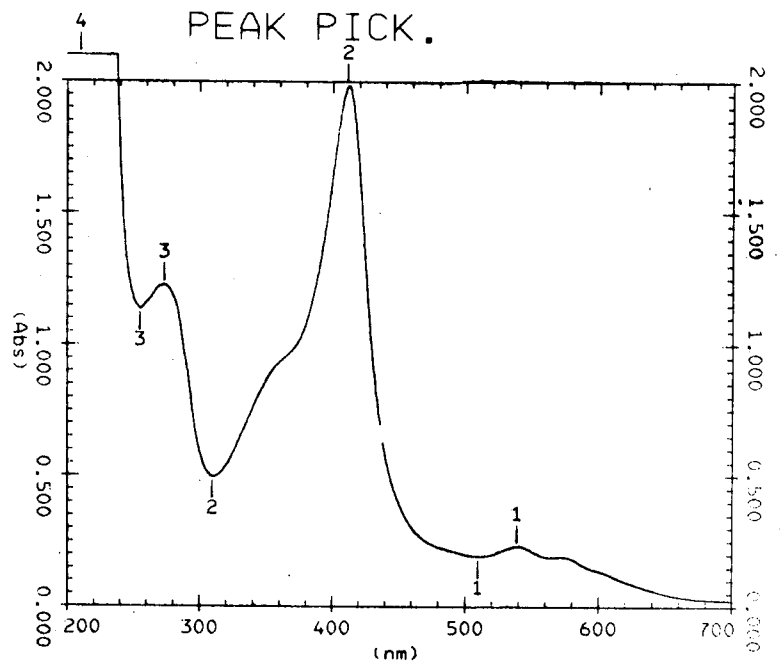
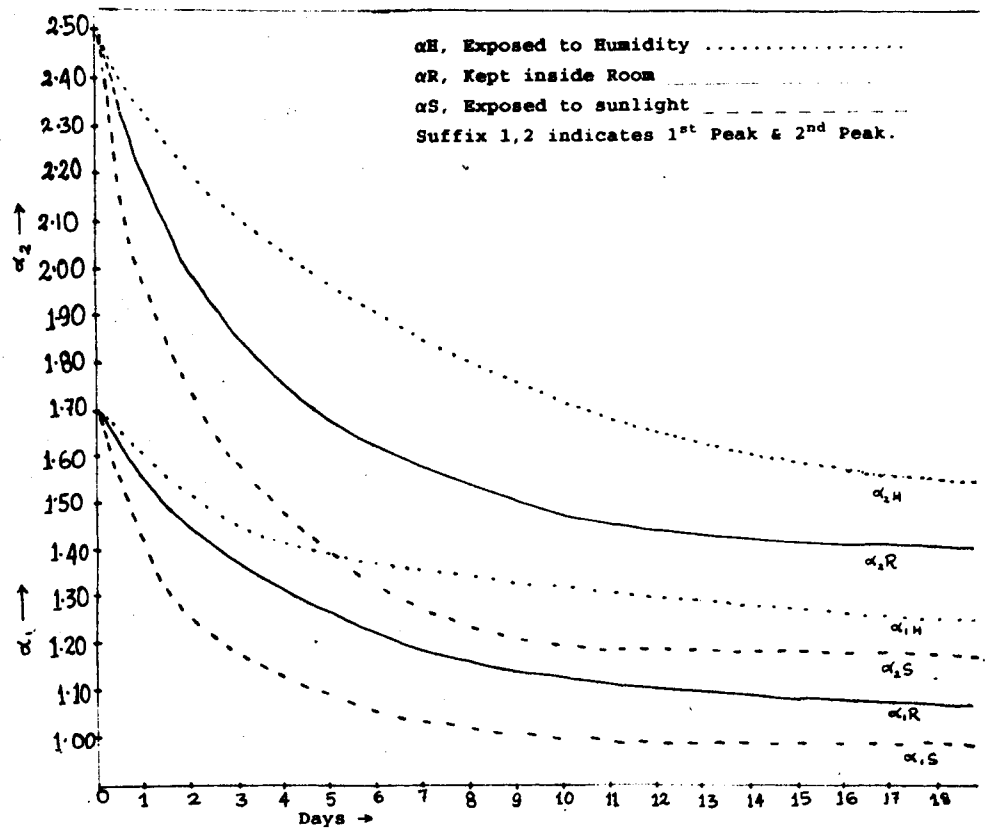


FIGURE-6

Absorption ratio ∝ value is calculated by dividing Peak value of absorption by valley absorption value and are plotted against time in days.



FIGURE–7



FIGURE–8

Decay curves of absorption ration of visible region peaks from whcih it is possible to calculate the approximate age of blood stain.

The present attention of Forensic Scientists are however drawn by the developent of DNA probe for genetic identification of human being. The individualising power of a multilocus probe is as high as fingerprint and for this reason the technique is also called the DNA fingerprinting. At present facility for analysing of DNA is available at CCMB Hyderabad and also for Forensic cases it has been centrally established at CFSL Calcutta.

EARTHQUAKE AND ITS HAZARDS

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ABSTRACT

One of the most frightened and destructive phenomena of nature is a severe earthquake and its terrible after effects. An earthquake is a sudden movement of the earth, caused by the abrupt release of strain that has accumulated over a long time. For hundreds of millions of years, the forces of plate tectonics have shaped the earth as the huge plates that form the earth's surface slowly move over, under and past each other. Sometimes the movement is gradual and at other times, the plates are locked together, unable to release the accumulating energy. When the accumulated energy grows strong enough, the plates break free. If the earthquake occurs in a populated area. It may cause many deaths and injuries and extensive property damage.

Earthquakes present a frightening experience in the lives of people. The disaster strikes suddenly, similar to that of lightning, tornadoes or nuclear explosions. The damage to property runs into billions of rupees. In India, where 55% of the land are falls under active Seismic Zones, considerable destruction was caused by the earthquake of Kutch (1819), Shillong(1897), Kangra (1905), Dhubri (1930). Bihar-Nepal (1934), Koyna (1967), Uttarkashi (1991) and Latur (1993).

INTRODUCTION

Seismology is derived from the Greek word seismos (i.e. earthquake) and logos (i.e. science) and thus it is the science of earthquakes and related phenomena. When a sudden rupture occurs within the earth, elastic (or seismic) waves are generated. When these waves reach the earth's surface, we may feel them as series of vibrations. Which we call an earthquake. Seismic waves can be generated by earthquakes or artificially by explosions or other means.

The scientific study or earthquakes is comparatively new. Until the 18th century, few factual descriptions of earthquakes were recorded and the natural cause of earthquakes was little understood. Some ancient people thought that Gods were responsible for earthquakes. In Greek mythology, Poseidon, the God of the sea was also the God of earthquakes. In one story, Poseidon chased the giant polylotes across the sea as far as the island of Kos. Poseidon broke off part of the island, threw it at the giant and buried him beneath it. Since Kos suffered many earthquakes, this myth gave an easy cause for earthquakes. In the folklore of the people of Kamchatka in eastern Siberia, a God called Tuli was responsible for earthquakes. Tuli occasionally travelled underground by dog sled and the earth above shook when his dogs paused to scratch themselves or to shake snow of their coats. Primitive people has also given explanations that earthquakes are caused due to super natural sources. A common theme was the belief that the earth was supported by an animal whose occasional stirring was responsible for the earthquakes. The animal species varied from country to country. For example, an elephant was responsible in Indian mythology and a giant spider or in later times, a catfish was favoured in Japanese folklore.

The super natural explanation of earthquakes was replaced by natural causes during the classical period of Greece and Rome more than 2000 years ago. The ancient Greeks and Romans constructed theories of earthquakes based on inadequate understanding of natural forces that shape the earth.

Earthquake seismology became an established science only after instruments were developed to record seismic waves in the latter part of nineteenth century. The great progress made in the past several decades has been stimulated mainly by the availability of increasingly plentiful and improved seismic data. Our ability to collect, process and analyse earthquake data has been aided by rapid advances in electronics and digital computers. Today, earthquake seismology is a quantitative science involving massive interplay between large quantities of high quality data, detailed models of earthquake source mechanisms and increasingly realistic models of the earth's internal structure.

SEISMIC WAVES

The two general types of vibrations produced by earthquakes are surface waves, which travel along the earth's surface and body waves, which travel through the earth. Surfaces waves usually have the strongest vibrations and probably cause most of the damage done by earthquakes.

Body waves are of two types, compressional and shear. Both types pass through the earth's interior from the focus of an earthquake to distant points on the surface, but only compressional waves travel through the

earth's molten core. Because compressional waves travel at great speeds and ordinarily reach the surface first, they are often called "**primary waves**" or simply "**P**" waves. P waves push particles of earth material directly ahead of them or displane the particles directly behind their line of travel.

Shear waves do not travel as rapidly through the earth's crust and mantle as do compressional waves and because they ordinarily reach the surface later they are called "**secondary**" or "**S**" waves. Instead of affecting material directly behind or ahead of their line of travel, shear waves displace material at right angles to their path and are therefore sometimes called "**transverse waves**". P waves travel about 1.7 times faster than transverse or S-waves. Both of these waves travel with their own characteristic velocities which at any given point in the medium is determined by the density ρ, and elastic moduli and μ at the point in the question. Elastic moduli are related to each other by means of the poisson's ratio σ. Hence, the velocity Vp and Vs of the P and S waves are connected by the equations :

$$Vp = \sqrt{(\lambda + 2\mu)/\rho}$$

$$Vs = \sqrt{\mu/\rho}$$

$$\sigma = \lambda/2\,(\mu + \lambda)$$

Surfaced waves are of two types, (1) Rayleigh waves, the earth particle motion is retrograde elliptical in a vertical plane through the direction of propagation and it arrives a short time after the S waves since its speed is about 0.92 that of the S waves, and (2) Love waves, the motion of the earth particle is transverse to the direction of propagation and earth particle is transverse to the direction of propagation and its velocity is 4.5 km per sec.

The complexity of seismic waves is a great advantage because it helps in elucidating the structure inside the earth.

The appearance of seismograms with different types of waves are shown in fig (I).

EARTHQUAKES AND PLATE TECTONICS

In plate tectonics, the uppermost part of the earth is considered to be divided into two layers with different deformation properties. The upper rigid layer, called the lithosphere, is about 100 km thick below the continents, about 50 km under the oceans and consists of crust and rigid upper mantle rocks. The lower layer, called the **anthenosphere**, extends down to about 700 km depth in it the mantle rocks are less brittle, i.e. more deformable when compared with the lithosphere. The rigid lithospheric shell is broken into, say, a dozen irregularly shaped major plates and a large number of minor or secondary plates, fig (2). The lithospheric plates are not stationary, on the contrary, they float in a complex pattern, with a velocity of some 2-10 cm/year on the soft rocks of the underlying asthenosphere like rafts on a lake. The plates are in constant motion, where they place, such as the formation of mountain belts, earthquakes and volcanoes. According to theory of plate tectonics, it is these plates (lithosphere) movement that are building the stresses and causing tectonic earthquakes. Internal structure of the earth and the velocity pattern of P & S waves are shown in fig (3) & (4).

Indian plate consisting of India, Australia and part of Indian ocean is moving at an average speed 5 cm per year in along the Himalayan. This resulted in faults, fractures in the Himalaya and these are responsible for some great earthquakes in the Himalayan region in the past.

CAUSES OF EARTHQUAKES

An earthquake is the vibration, sometimes violent of the earth's surface that follows a release of energy in the earth's crust. This energy can be generated by a sudden dislocation of segments of the crust, by a volcanic eruption or even by manmade explosions.

Faulting is the main cause for earthquakes. A considerable number of earthquakes have occurred in the neighbourhood of known faults. Earthquakes faulting is a result of the gradual accumulation of shearing stresses which build up until the breaking strength of the rock is exceeded. Such stresses accumulate slowly, the crust may first bend and then when the stress exceeds the strength of the rocks , break and snap to a new position. In the process of breaking, vibration called seismic waves are generated. These waves travel outward from the source of the earthquake along the surface and through the earth at varying speeds depending on the material through which they move. Fig(5) explains the process of breaking.

The focal depth of an earthquake is the depth from the earth's surface to the region where an earthquake's energy originates (the focus). Earthquakes with focal depths from the surface to about 70 kilometers are classified as shallow. Earthquake with focal depths from 70 to 300 kilometers are classified as intermediate. The focus of deep earthquake may reach depth of more than 700 kilometers. The focuses of most earthquakes are concentrated in the crust and upper mantle. The epicenter of an earthquake in the point on the earth's surface directly above the focus. The location of an earthquake is commonly described by the geographic position of the epicenter and by its focal depth.

MEASURING THE SIZE OF AN EARTHQUAKE

Magnitude is the quantity intended to measure the size of earthquake and is independent of the place of observation. Modern seismographic systems precisely amplify and record ground motion (typically at periods of between 0.1 and 100 seconds) as a function of time. This amplification and recording as a function of time is the source of instrumental amplitude and arrival time data on near and distance earthquakes. Although similar seismographs have existed since the 1890's, it was only is 1980's that Charles F. Righter, a California seismologist, introduced the concept of earthquake magnitude. Richter magnitude ML was originally as the logarithm of the maximum amplitude of seismic waves in seismogram written by Wood-Anderson seismograph at a distance of 100 km from the epicenter and the zero of the scale was fixed arbitarily to fit the smallest earthquake then recorded. Many types of magnitude exist, such as body-wave magnitude mb, surface wave magnitude Ms and moment magnitude Mw.

Earthquakes are classified by magnitude as follows:

1.	Great Earthquake	:	Magnitude equal to or more than 7.0
2.	Moderate Earthquake	:	Magnitude 5.0 to less than 7.0
3.	Slight Earthquake	:	Magnitude 3.0 to less than 5.0
4.	Tremor or micro-earthquake	:	Magnitude less than 3.0

Magnitudes are determined from the seismographic recording, but before the advance of seismographs, the best direct evidence regarding the nature of earthquakes came from observations of the shaken and damaged areas. The first systematic field investigation of a damaging earthquake near Naples, Italy. Mallet's method of study was quickly adopted by scientists for investigating earthquakes in many countries. Macroseismic effects of an earthquakes in many countries. Macroseismic effects of an earthquake, such as the damage to manmade structures and changes in land form, are largely due to shaking from the passage of seismic waves, in order to compare different earthquakes, seismic intensity scales were developed. At present, the most commonly used scale is the so called Modified Mercali Scale consisting of 12 degrees, also denoted by Roman numerals. The condensed form of modified Mercali Scale is given below:

I. Not felt.
II. Felt by persons at rest of favorably placed.
III. Felt indoors. Hanging objects swing.
IV. Obviously felt, Windows, dishes and doors rattle.
V. Felt outdoors, Sleeper wakened, Small, unstable objects displaced or upset.
VI. Felt by all, Windows, dishes and glassware broken, Furniture moved or overturned, Weak plaster and poor masonry structure cracked.
VII. Difficult to stand, Furniture broken, Damage to poor masonry structure, Ordinaary masonry structures cracked, Fall of plaster, loose bricks, stones and tiles.
VIII. Damage to ordinary masonry structures, fall of chimneys, factory stacks, towers, Frame houses move if not bolted down; loose panel walls thrown out, Cracks in Wet ground and on steep slopes.
IX. General panic, Poor masonry structures destroyed; heavy damage to ordinary masonry structues. Underground pipes broken. In alluvial areas, sand mud ejected.
X. Most masonry and frame structures destroyed. Large land slides, Rails bent slightly.
XI. Rails bent greatly, Underground pipelines completely out of service.
XII. Damage nearly total, Large rock masses displace. Objects thrown into air.

The energy radiated by an earthquake is a measure of the potential for damage to manmade structure. Many attempts have been made to relate earthquake magnitude to seismic energy as a convenient and

meaningful interpretation of magnitude. By manually integrating many seismograms from a reference set of earthquakes. Beno Gutenberg and Charles Richter arrived at the following empirical relationship:

$$\text{Log10E} = 11.8 + 1.5\ \text{Ms}$$

Where energy, E is expressed in ergs. Thus for every increase in Ms by 1 unit, the associated seismic energy increases by about 32 times.

SEISMIC BELT

1. The most important which runs along the pacific and includes the western coast of South-America, North-America, Eastern Coast of Asia, the islands of South Coast Pacific and New Zealand.
2. Runs from South Pacific Islands through Java, Sumatra and Central Asia mountains, further passing through Caucasus mountains to Greece, Italy and Spain.
3. The third which is not so important runs from north to south in the middle of the Atlantic Ocean.

In fig (6), ten largest earthquakes in the world are shown and also most destructive known earthquakes on record in the world (50,000 deaths or more) are also detailed in table (I).

SEISMICITY OF INDIA

1 M.D. maintains a catalogue on earthquakes in India and its neighbourhood from available historical records as well as instrumental data. This catalogue is continuously updated. Epicentral map of earthquakes in India and its neighbourhood is shown in the figure (7).

Six catastrophic earthquakes of magnitude 8.0 and above have occurred in the western, northern and eastern parts of Indian. Details are given below:

Sl. No.	Date	Place	Magnitude
1.	06.06.1819	Kutch	8.0
2.	12.06.1897	Assam	8.7
3.	04.04.1905	Himachal Pradesh	8.0
4.	15.01.1934	Bihar-Nepal Border	8.3
5.	26.08.1941	Andaman Island	8.1
6.	15.08.1950	Arunachal Pradesh	8.6

EARTHQUAKES EFFECTS AND HAZARDS

Topographical changes, in which the primary effects of earthquakes over terrain are fault offsets, fissures, scraps, uplift and subsidence. Landslides are common in hilly regions. Large masses of earth and rock may slide over considerable distances in earth avalanches. These cause considerable damage in the valleys. To arrest their advance, a series of earth dams are made. Another phenomenon is known as earthflows in which a sudden burst of water with mud and sand in colloidal flow could be destructive.

Liquefaction, which happens when loosely packed, waterlogged sediments lose their strength in response to strong shaking, causes major damage during earthquakes.

Such consequences of earthquakes are often seen in alluvial deposits. Vast of Uttar Pradesh and Bihar when soil is generally soft and the water table is high offer favourable conditions for such effects.

Cachar earthquakes of 1869 and 1984 produced widespread liquefaction. The great Bihar-Nepal earthquake of 1934 produced a 320 km belt of slumping in which all the buildings either sank or tilted.

Earthquakes cause damage to buildings, transportation system, bridges etc.

Tsunami is derived from a Japanese work 'tsu' meaning a port and 'nami' a long wave, The sea waves caused by sudden subsidence or uplift of large areas of sea floor associated with destructive earthquakes. Great damage is caused by these waves around pacific ocean.

SHILLONG

Scientifically the prediction of earthquakes w.r.t. time, place and magnitude is not yet developed but research is going on to achieve the goal. To minimise the loss of life and property, precautions can be taken such as :

(i) Standard building codes may be followed.
(ii) Contingency plans may be prepared for public services and utilities, reconstruction of public buildings, repairing or rebuilding roads, bridges, dam, runways and harbours if any .
(iii) Earthquake drill may be practised.

CONCLUSION

The earthquake prone North Eastern India is one of the most seismically active regions of the world which witnessed the devastating earthquakes in 1869, 1897 and 1950 of magnitudes ranging from 7.5 to 8.7. It consists of wide diffuse continental zone in which shallow earthquakes are associated with high mountain ranges like the Himalayas that nearly owe their existence to large compressive forces. Earthquakes of shallow and Intermediate depth are common along this belt.

The India Meteorological Department was established in 1878 and the recording of ground motion started at Central Seismological Observatory, Shillong in 1952, There are 58 seismological observatories in India. The first seismological observatory in the country was established in Calcutta (Alipur) on 1st September, 1898. The seismology division of I.M.D. is the nodal agency of the Govt. dealing with this discipline with its HQ at New Delhi. Activities of seismo division are:

(1) Monitoring earthquakes in and around India.
(2) Research work in pure and applied seismology.
(3) Catering to queries relating to earthquakes.
(4) Publication of National data and exchange of seismic data with national and international agencies.
(5) Assisting national organizations in seismic work and maintaining liaison with international agencies.
(6) Maintenance and manufacture of seismological instruments.

TABLE–I
MOST DESTRUCTIVE KNOWN EARTHQUAKES ON RECORD IN THE WORLD
(Listed in order of greatest number of deaths)

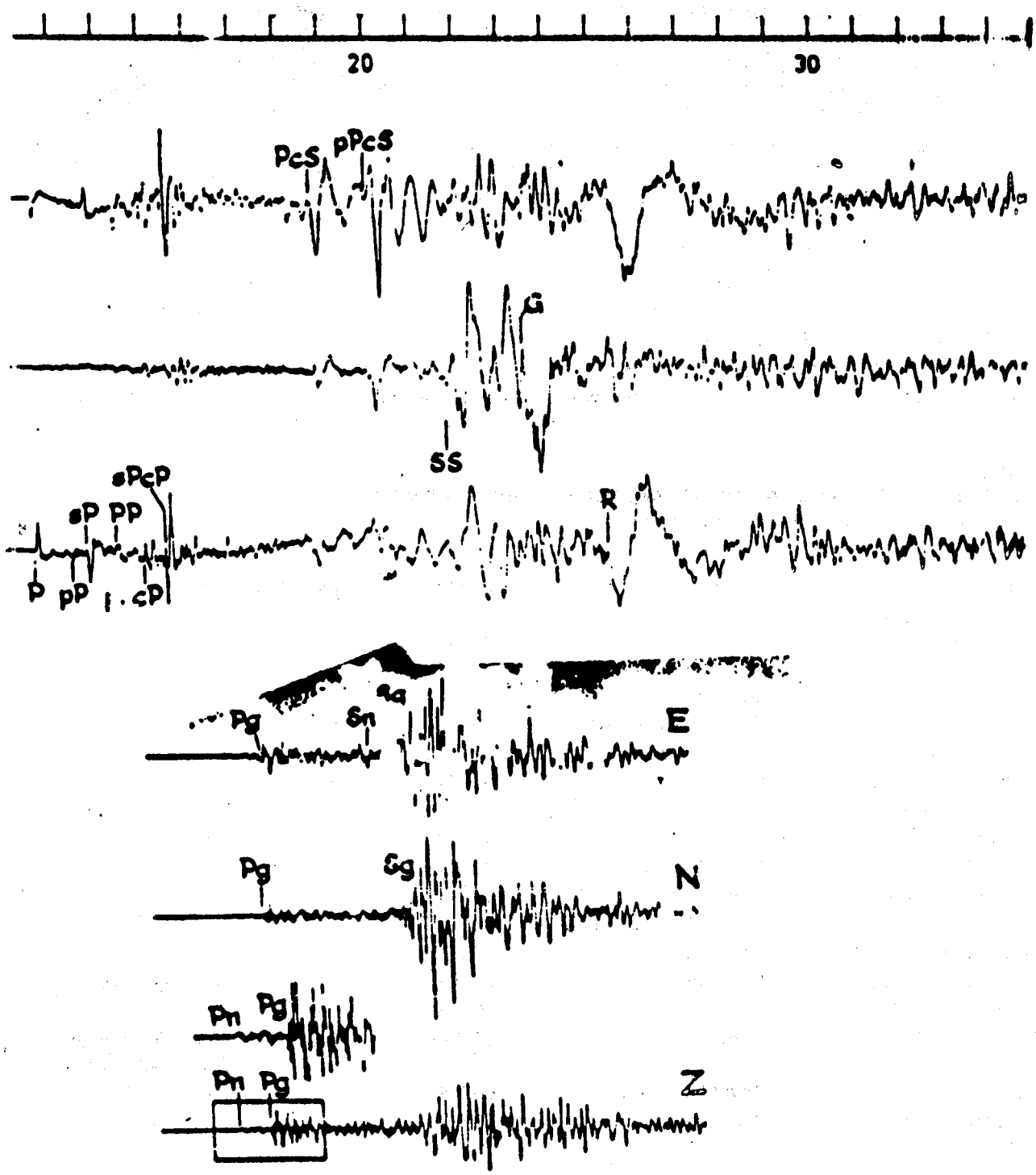
Date	Location	Deaths	Magnitude	Comments
January 23, 1556	China, Shansi	830,000		
July 27, 1976	China, Tangshan	255,000	8.0	
August 9, 1138	Syria, Aleppo	230,000		
May 22, 1927	China, Near Xining	200,000	8.3	
+December 22, 856	Iran, Damghan	200,000		
December 16, 1920	China, Gansu	180,000	8.5	
+March 23, 893	Iran, Ardabil	150,000		
September 1, 1923	Japan, Kwanto	143,000	8.3	Great Tokyo Fire
December 28, 1908	Italy, Messina	120,000	7.5	
September, 1290	China, Chihli	100,000		
November, 1667	Caucasia, Shemakha	80,000		
November 18, 1727	Iran, Tabriz	77,000		
November 1, 1755	Portugal, Lisbon	70,000	8.7	Great Tsunami
December 26, 1932	China, Gansu	70,000	7.6	
May 31, 1970	Peru	66,000	7.8	$530,000 Damage Great rock slide
1268	Asia Minor, Silicia	60,000		
January 11, 1693	Italy, Sicily	60,000		

May 31, 1935	Pakistan, Quetta	60,000	7.5
February 4, 1783	Italy, Calabria	50,000	

* Official Casualty figure—estimated death toll as high as 655,000.

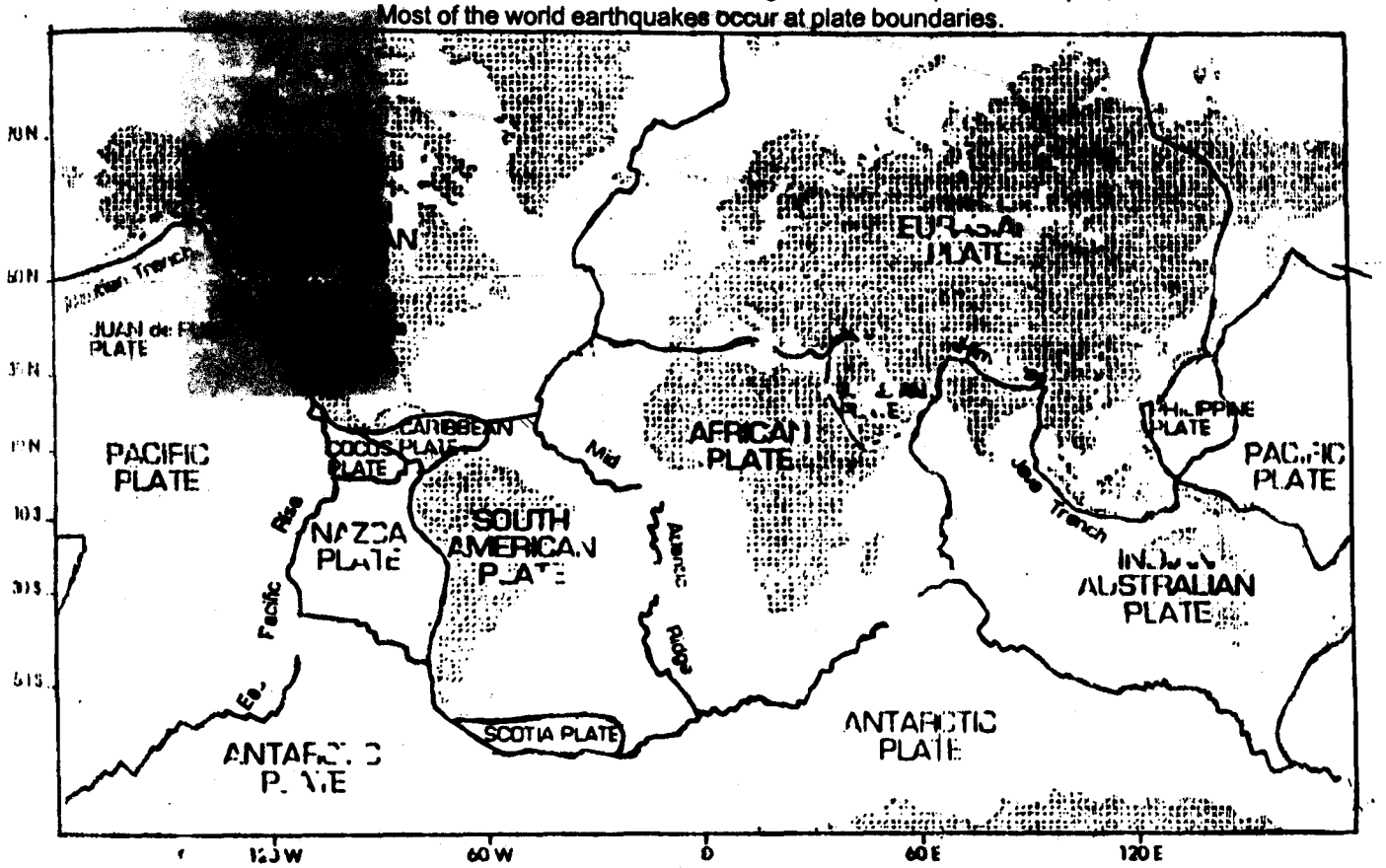
\+ Note that these dates are prior to 1000 AD. No digit is missing.

An earthquake that killed 300,000 people in Calcutta, India on Oct. 11, 1737. Recent studies (Bilham, BSSA 1994) indicate that these casualties were most likely due to a cyclone, not an earthquake. Bilham, R. (1994). The 1737 Calcutta Earthquake and Cyclone Evaluated, Bull. Seism. Soc. Am. V. 84 No. 5, 1650-1657.

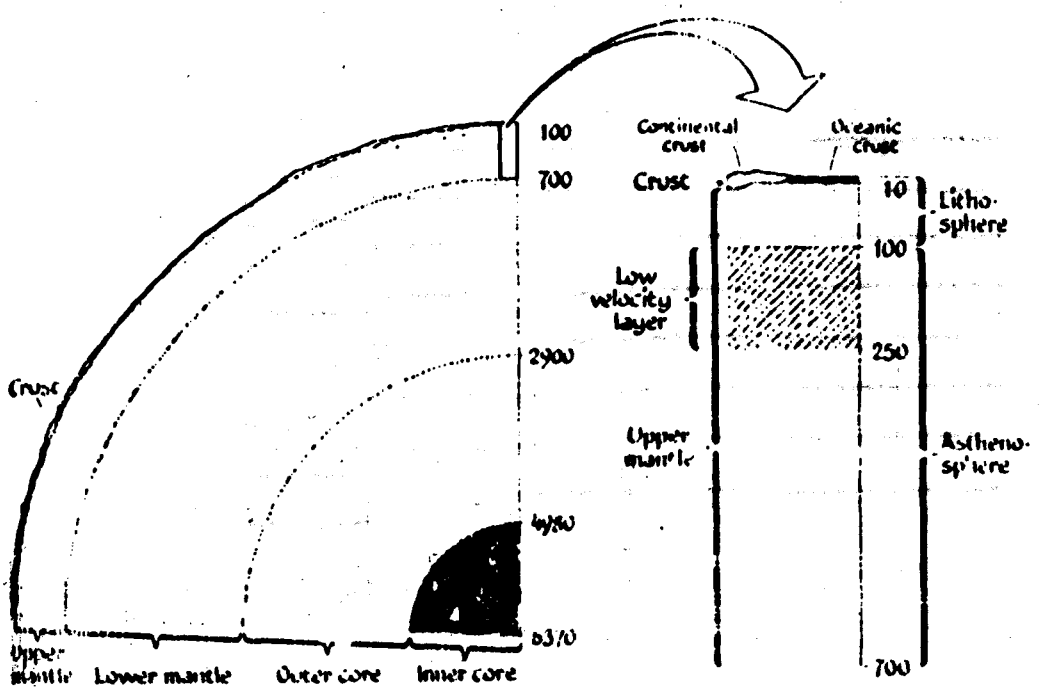


FIGURE–1

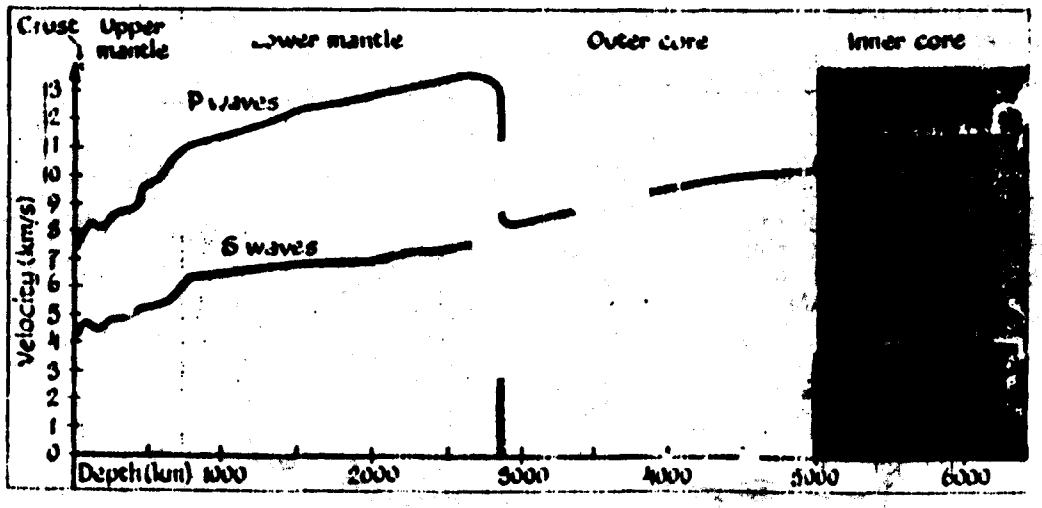
Division of the Earth's surface into a mosaic of moving plates, according to plate tectonic theory. Boundaries between the plates are actively sareading submarine ridges in the middle of the ocean subduction zones in ocean frenches or mountain ranges on the continer or margins where the plates slide post one another. Most of the world earthquakes occur at plate boundaries.



FIGURE–2

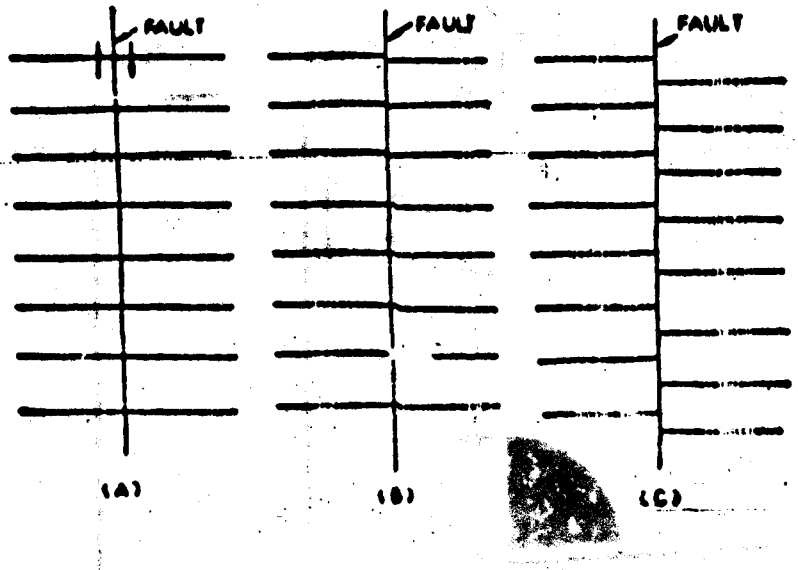


FIGURE–3



FIGURE–4

Mechanism of fauling. Horizontal lines in (A) become curved acorss the zone of at shown in (B) under the differencial streses across the fault and then take up new positions as in (C), causing earthquakes



FIGURE–5

TEN LARGEST EARTHQUAKES IN THE WORLD (1900 – 1994)

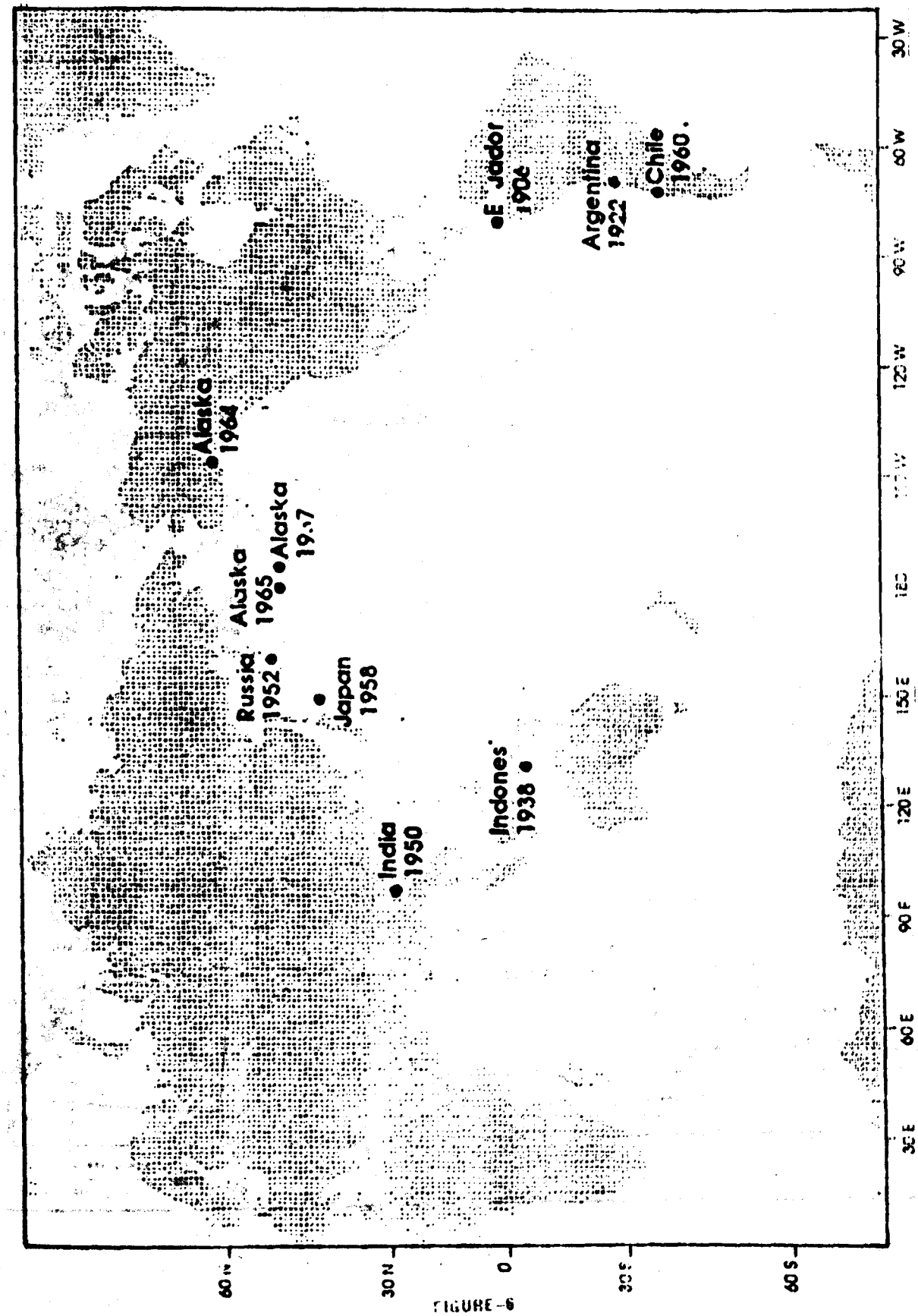


FIGURE-6

MAP OF INDIA SHOWING EARTHQUAKE EPICENTRES (UPTO – 1994)

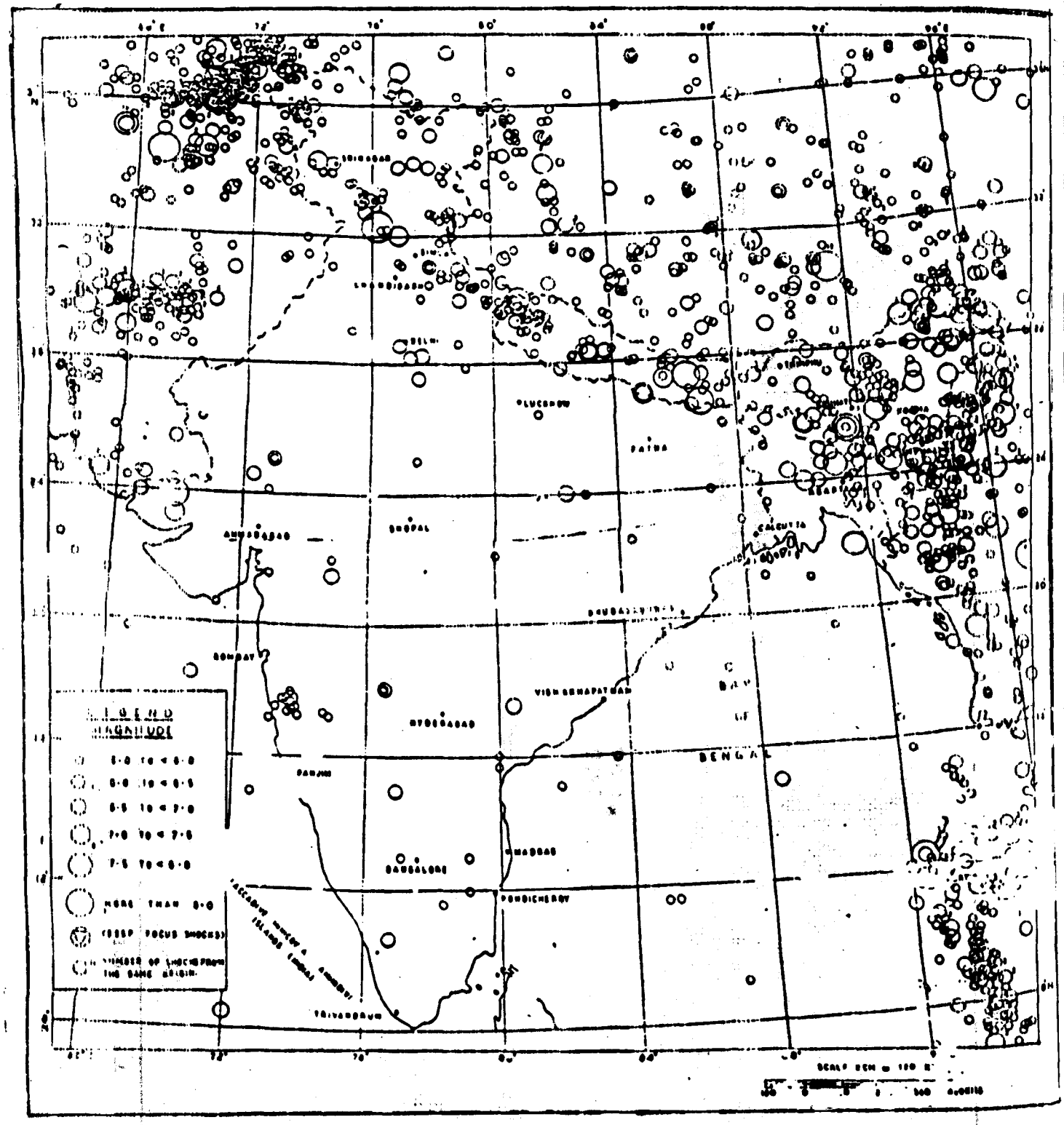


FIGURE – 7

TECHNICAL SESSION – VI

POWER & INDUSTRY

FIVE DECADES OF WATER RESOURCES DEVELOPMENT IN INDIA WITH SPECIAL REFERENCE TO NORTH EASTERN REGION

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ABSTRACT

Water Resource is one of the most vital national asset and holds the key to the nation's economic prosperity and stability. The availability of these resources being highly variable in time and space, calls for its planning, development, conservation and use with utmost care to cater to the ever growing demands for drinking, industrial, irrigation and to other purposes.

India is endowed with vast water and land resources. Renewable water resource in the country is about 4 per cent of global availability. Arable land is 184 million hectares (m.ha) which is second highest in the world. Notwithstanding these endowment, the large population offsets the advantage.

In the "Five Decades" since independence, we have witnessed spectacular development of water resources in the country, especially in respect of irrigation and hydropower. A large number of water resources projects for irrigation, power generation, drinking water, industrial uses, civic supplies etc. have been implemented and several others are under construction or under consideration all over the country. As an outcome of all these efforts, India is now not importing food. Installed power generation capacity has been increased from mere 1,400 mega watt (M.W.) in 1947 to more than 85,000 M.W. including 21,600 M.W. from hydropower. About 83 per cent of the population have been covered under drinking water supply schemes. Reasonable floor protection has been provided to about 14 m/ha of flood prone area. The country has been able to successfully combat severe drought situation such as the one that occurred in, 1987-88, one of the three most severe droughts that have struck in this century.

The North-Eastern Region of India is blessed with vast water resources and hydro power potential. An irrigation potential of 13.00 lakh ha has so far been created against an ultimate irrigation potential of 35.7 lakh ha. Assam and Mizoram are two states with highest and the lowest irrigation potential respectively. The North Eastern Region with 31850 M.W. (at 60% load factor) has got the highest hydro power potential, which is about 38% of the total hydro power potential in the country. However, only about one per cent of this has so far been developed. Meghalaya tops the list of the seven north eastern states in the hydro power generation.

Central Water Commission (CWC) & Central Electricity Authority (CEA) have been closely associated with the preparation of Detailed Project Report (DPR) & design consultancy of all the hydroelectric and multipurpose projects in the North Eastern Region. On specific request from the State Govts. Investigation of irrigation projects also has been taken up by CWC. Some of the important projects investigated are Kameng (600 MW Arunachal Pradesh), Tuivai (210 MW, Mizoram), Tuirial (60 MW, Mizoram), Serlai-B (10.5 MW, Mizoram) hydroelectric projects. T-Surang (2208 ha, Nagaland), Regional Valley(4775 ha, Assam) and Fulertal (120337 ha, Assam) irrigation projects and Mat Valley (3 MW, 1052 ha, Mizoram) multipurpose projects. Ten (10) hydroelectric and multipurpose projects are under various stages of investigation. The important among these are: Kolodyne stage-I (100 MW), Kolodyne stage-II (250 MW), Tuirini (50 MW), Tuivawl (48 MW) in Mizoram, Kamlang (22.5 MW), Nyukcharong Chu (50 MW) in Arunachal Pradesh, as hydroelectric projects; and Sissiri (225 MW, 16000 ha), Deopani (20 MW, 13000 ha) in Arunachal Pradesh as multipurpose projects. C.W.C. is also carrying out the work of flood forecasting in Brahmaputra-Barak Valley with a network of 29 stations from where nearly 2500 forecasts are issued every year an accuracy of more then 90%. C.W.C. is associated with Indo-Bangladesh Co-operation by issuing flood forecasts to Bangladesh from two stations in Tripura and one in Assam.

In spite of all these achievements made so far in Water Resources sector in the country we can not afford to brook complacency yet. Only 15 per cent of the hydropower potential has been harnessed and only 35 per cent of culturable land is irrigated. Still 70 per cent of utilisable river flows are discharged into the sea without utilisation. Water resources development is not getting due attention and financial support. Over 400 on-going projects are now held up for want of funds. Over a tenth of the irrigation potential created is unutilised because Command Area Development Programme is not given due attention by the state govts. Less than ninety per cent of the utilisable potential is actually irrigated in any given year.

We have to go a long way in development of our vast water resources potential. The challenge lying ahead is colossal keeping in view the rapidly growing population and rising demands from various competing sectors, while per capita water availability progressively decreases over the years.

INTRODUCTION

India is endowed with vast water and land resources. Renewable water resources in the country is about 4 percent of global availability. Arable land is 184 hectares (m.ha) which is second highest in the world. Notwithstanding, these endowments the large population offsets the advantage. Estimates of early nineties indicate that the per capita availability of land and fresh water in India has been 0.2 hectare(ha) and 2,200 cubic metre (cu.m) against world average of 0.27 ha and 7,400 cu.m respectively. Due to favourable agro-climate by and large, the Indian economy has been traditionally based on agriculture since centuries. During 1951, nearly 70 percent of the population comprised of cultivators and agricultural labourers. Even in 1991, the figure stands at 65 percent which amply indicates our continued dependence on agriculture.

The need for water resources development for overall social and economic development was duly recognised at the very outset of commencement of the plan period. Accordingly, systematic water resources development works have been carried out through successive Five Year Plans that followed since 1950. In the last nearly five decades, a large number of water resources projects for irrigation, power generation, drinking water, industrial uses, civic supplies etc. have been implemented, and several others are under construction or under consideration all over the country. As an outcome of all these efforts, India is now marginally surplus in food, resulting in savings on foreign exchange too which otherwise would have been invested on import of food grains. Installed power generation capacity has been increased from mere 1,400 mega watt (MW) in 1947 to 86,000 MW including 21,600 MW from hydropower. About 83 percent of the population have been covered under drinking water supply schemes. Reasonable flood protection has been provided to about 14 m.ha of flood prone area. The country has been able to successfully combat severe drought situation such as the one that occurred in 1987-88, one of the three most severe droughts that have struck in this century.

WATER RESOURCES OF INDIA

The average annual precipitation including snowfall, is estimated to be of the order of 4,000 billion cubic metre (b.cu.m) of which the monsoon rainfall during June to September itself is around 3000, b.cu.m. The average natural run-off as per the estimate of Central Water Commission is 1,869 b.cu.m which is about 4 percent of global supply.

The aerial distribution of the water resources in the country is highly uneven. Though the present national per capita annual availability is assessed to be about 2,200 cu.m. the average availability in Brahmaputra basin is as high as 18,400 cu.m., while it is as low as 380 cu.m in some of the east flowing rivers of Tamil Nadu. Excluding the Brahmaputra basin, the per capita availability in the country drops down to a mere 1,500 cu.m.

As per estimates of the Central Ground Water Board, the total replenishable ground water potential in the country is about 432 b.cu.m. Analysis of the basin wise potential indicates that the Ganga basin has the highest potential which is 171 b.cu.m followed by Godavari (41 b.cu.m) and Brahmaputra (27 b.cu.m) statewise, Uttar Pradesh has the maximum potential of about 84 b.cu,m followed by Madhya Pradesh (51 b.cu.m) and Maharashtra (38 b.cu.m).

Keeping in view the uneven nature of distribution of water resources and topographic constraints, the average yearly utilisable resource has been presently estimated as below:

Classification	Quantity (in b.cu.m)
Surface Water	690
Ground Water	432
Total	1122

India is blessed with a large network of rivers comprising 12 major basins having combined catchment area of about 256 m.ha. Besides, there are 46 medium basins of sizes varying between 2,000 to 20,000 sq.km covering a total area of about 25 m.ha. Other water bodies including tanks and ponds cover an area of about 7 m.ha.

The current stage of utilisation of surface and ground water resources is about 70% and 30% respectively of the utilisable resources. Remarkable achievement has been made in conserving the water resources for irrigation, generation of hydro-power and domestic water supply during the five decade of plan development of independent India. From less than 300 large dams existing at the beginning of planned development, the number of dams constructed (including 700 dams under construction) has gone up to 4300.

As a result of this, the total live storage capacity of dams and reservoirs completed in the country has since gone upto about 177 b.cu.m in 1995. Besides, dams to create an additional live storage capacity of 75 b.cu.m are under various stage of construction. In addition, dams under formulation/consideration will provide an additional live storage of 132 b.cu.m.

Inter basin transfer is also being contemplated in order to divert part of surplus monsoon flows which otherwise go to sea without any utilisation. With creation of further storages and realization of inter basin transfer it may be possible to further enhance utilisable water resources.

DEVELOPMENT OF WATER RESOURCES IN THE COUNTRY

Irrigation :

A broad assessment of the area that can be ultimately brought under irrigation, both by surface and ground water made by the various states in sixties has indicated that ultimate irrigation potential of the country would be of the order of 113 m.ha. The break up of the ultimate irrigation potential under the above three categories is, 58 m.ha by major and medium irrigation project, 15 m.ha by minor surface water schemes and 40 m.ha by minor ground water schemes. Present indications, however, are that the ultimate potential is 139 m.ha, the increase being primarily due to upward revision in assessed potential as minor ground water schemes and minor surface water schemes to 64 m.ha and 17 m.ha respectively.

At the time of commencement of the First Five Year Plan in 1951, population of India was about 361 million and annual food grain production was 51 million tones (m.t), which was not adequate. Import of foodgrains was then inevitable to cover up the shortage. Attaining self sufficiency in food was therefore given paramount importance in the plant period and in order to achieve the objective, various major, medium and minor irrigation and multipurpose projects were formulated and implemented through successive Five Year Plan to create additional irrigation potential throughout the country. This drive, compounded with green revolution in the agricultural sector, has enable India to become marginally surplus country from a deficit one in food grains. In 1996-97 food grain production in the county has been 198 m.t. for a population of about 900 million. At the end of 1996-97 irrigation potential created stands at 91.8 m.ha as against 22.6 m.ha in 1951. This gigantic task has been accomplished by undertaking 311 major projects, 944 medium projects and extension, renovation and modernisation (ERM) of 170 old projects. Of these, 129 major projects, 773 medium projects and 96 ERM projects have been completed. In addition millions of minor irrigation projects have also been completed. Total investment in this massive programme during the period 1951 to 1997 is of the order of Rs. 80,000 crores. Growth of irrigation potential created in different states is given in table – I.

The net irrigated area is 37 percent of net sown area and 29 percent of total culturable area. As stated earlier, the ultimate potential due to major and medium projects has been assessed as 58 m.ha of which 60 percent estimated to be developed by 1996-97. Total potential created by 1996-97 (as targeted) is 91.8 m.ha which is 81 percent of earlier assessed ultimate potential of 113 m.ha.

TABLE – I
STATEWISE IRRIGATION DEVELOPMENT DURING PLAN PERIOD

Sl.No.	States	Ultimate Potential	Potential created (Pre-Plan)	Potential created by end of VIII
1.	Andhra Pradesh	9200	2391	6349
2.	Arunachal Pradesh	168	–	82
3.	Assam	2670	230	845
4.	Bihar	12400	1423	8485
5.	Goa	82	–	35
6.	Gujrat	4750	460	3361
7.	Haryana	4550	460	3361
8.	Himachal Pradesh	335	716	160
9.	Jammu & Kashmir	800	332	553

10.	Karnataka	6000	762	3210
11.	Kerala	2100	225	1177
12.	Madhya Pradesh	10200	1008	5016
13.	Maharashtra	7300	1063	4865
14.	Manipur	240	5	140
15.	Meghalaya	120	7	53
16.	Mizoram	70	–	13
17.	Nagaland	90	5	68
18.	Orissa	5900	460	2973
19.	Punjab	6530	2065	5926
20.	Rajasthan	5150	1545	4758
21.	Sikkim	42	–	25
22.	Tamil Nadu	3900	2379	3754
23.	Tripura	215	10	101
24.	Uttar Pradesh	25700	5453	30726
25.	West Bengal	6114	938	4693

(Unit: Thousand ha.)

Hydro Power :

Water and energy are two vital inputs of the agricultural, industrial and overall development of a country. The per capita consumption of electricity is normally regarded as an index of the overall development. For the generation of electricity water plays an important role, be it hydro-power generation, thermal or nuclear power generation. Thus optimum use and management of water assumes an important role in energy sector also. The hydro-electric power plants utilise the river and canal flows for power generation and there is no consumptive use of water in these power plants, except for some evaporation and seepage losses. The thermal and nuclear power plants on the other hand consume seepage losses. The thermal and nuclear power plants on the other hand consume some water mainly in cooling water system and boiler make up requirement of the plants.

Hydro-power is a non-pollution resource with high conversion efficiency. It does not contribute to the Green House effect. In many cases, it is an integral and important part of development of water resources for multipurpose benefits. With storage facilities, flood waters are retained and also utilised for irrigation; for river regulation; for improving navigation, fish, wildlife and recreation potential; and for municipal use. Hydro power is a reliable energy source with relatively long life of equipment.

India has vast potential for hydro-power generation, particularly in the northern and north-eastern region. As per an estimate of Central Electricity Authority, the potential in the country is assessed as 84,000 MW at 60 percent load factor, which is equivalent to about 450 billion units of annual energy generation. The basin-wise distribution is as given below:

Sl.No.	Basin	Hydro-Electric Power Potential at 60 percent load factor (MW)
1.	Indus Basin	20000
2.	Brahmaputra Basin	35000
3.	Ganga Basin	11000
4.	Central India Basin	3000
5.	West Flowing River System	6000
6.	East Flowing River System	9000
	Total	84000

In addition to potential of medium and major hydro schemes, a sizeable potential also exist for development of micro, mini and small hydro schemes on streams and canal drops. According to the studies by CEA small hydro potential of the country has been assessed as 6000 MW from a total of 1512 number of schemes.

In terms of availability of exploitable hydro potential, India is ranked 7th in the world after erstwhile USSR, China, Brazil, Zaire, Indonesia and Canada.

At the time of independence, out of total installed capacity of 1362 MW. Hydro-power capacity stood at 508 MW. The capacity has since been raised to about 21600 MW (12960 MW at 60% load factor). In addition 6000 MW is available from projects under construction. A potential of about 3,000 MW is contemplated from projects already cleared. The total potential harnessed/under harnessing would thus be about 22000 MW (at 60% load factor) which is about 26% of the estimated potential.

The share of hydro power in the total installed capacity which rose upto from 37% in 1947 to 50.62% in 1963 and thereafter experienced a steady decline, at present, accounts for only 25% of the total capacity. However, it is a small consolation that notwithstanding the declining trend in terms of hydro installed capacity, our country ranks 8th in the wold after USA, erstwhile USSR, Canada, Brazil, Japan, China and France.

Recognising the fact that bulk of hydro potential is concentrated in states which have neither the financial resources to develop potential nor they have enough demand of power to necessitate this development, the Government has set up hydro-power corporations in central sector and in joint sector to develop some of the attractive sites for benefits of all the states of the concerned region. These are National hydro-electric power corporation (NHPC) – Central Sector (ii) North Eastern Electric Power Corporation (NEEPCO) – Central Sector (iii) Nathpa Jhakri Power Corporation (NJPC) – Joint Sector (Central & Himachal Pradesh) (iv) Tehri Hydro Development Corporation (THDC) – Joint Sector (Centre & U.P.). Besides these, the state electricity boards and state power corporation are engaged in the development and execution of hydro power projects.

Even though there has been good progress in the field of hydro power development, the pace of development, however, cannot be considered satisfactory by any standard as about 78 percent of available potential is yet to be tapped. The scarce fossil fuels reserves are getting rapidly depleted whereas the available hydro energy is draining into the sea.

Domestic Water Supply :

The National Water Policy adopted in 1987 has assigned the highest priority for drinking water supply needs followed by irrigation, hydropower, navigation and industrial and other uses. In the successive five year plans and the intervening annual plans, efforts have been made to rapidly develop water supply and sanitation systems. In the context of the "International Drinking Water Supply and Sanitation Decade", the Government of India launched the decade programmes in April, 1981 with a view to achieving population coverage of 100 percent water supply facilities in urban and rural areas, 80 percent sanitation facilities in urban areas and 25 percent sanitation facilities in rural areas respectively by the end of the decade i.e. March 1991. As on March 1981 about 72 percent of the urban population and 31 percent of the rural population had protected water supply facilities in our country. As regards sanitation, the coverage was 25 percent in urban areas and merely 0.5 percent in the rural areas. However, due to financial and other constraints the targets originally set for the decade were scaled down to 90 percent in the case of urban water supply and 85 percent in the case of rural water supply, 50 percent in the case of urban sanitation and 5 percent in the case of rural sanitation respectively. Among the major states Karnataka, Maharashtra and Uttar Pradesh have more than 90 percent of urban population covered under water supply schemes, while in the smaller states like Arunachal Pradesh, Haryana, Himachal Pradesh, Meghalaya, Nagaland and Union Territories 100 percent coverage has been achieved. As per policy adopted provision for drinking water is to be made in all water resources projects. The drinking water requirements of most of the mega cities/cities in India are met from reservoirs of irrigation/multipurpose schemes existing in near by areas and even by long distance transfer. Delhi getting drinking water from Tehri Dam and the proposal to provide drinking water to Chennai city from Krishna Water through Telugu Ganga Project are typical example.

Flood Management :

Prior to independence, very little attention was paid to planned flood management and people had often to face fury the floods. The national programme of flood management was launched in 1954. Since then more than 16,000 km of new embankments and 32,000 km of drainage channels have been constructed. In addition

906 towns (including some important villages) have been protected and 4,705 villages raised above flood levels. All these works have resulted in providing reasonable degree of protection to total area of about 14 m.ha against the total flood prone area of 40 m.ha in the country. Total investment on flood control during the last four decades has been of the order of about Rs. 40 billion. In addition to the structural measures non-structural measures like flood forecasting and warning, flood proofing etc. have also gained prominence. The flood forecasting network of the Central Water Commission, covers most of the flood prone inter-state river basins in the country. The Commission is responsible for issuing flood forecast at 157 stations, 132 river-stage forecasting and 25 inflow forecasting for operation of reservoirs.

DEVELOPMENT IN NORTH EASTERN REGION

Irrigation :

The North Eastern Region of the country comprising of the seven states of Assam, Meghalaya, Arunachal Pradesh, Nagaland, Manipur, Mizoram and Tripura constitutes 7.7% of the geographical area of country. A board assessment of the areas that can be ultimately brought under irrigation has indicated that the ultimate irrigation potential of these area would be the order of 3,579 m.ha against the country's total ultimate irrigation potential of 139 m.ha. out of the total ultimate irrigation potential of 3,579 m.ha only 1,302 m.ha i.e. about 36% has so far been exploited. Growth of irrigation potential created in different states is given in table–II.

Scenario in the hilly region of the North East, irrigation potential of state is as low as 0.16 m.ha. There was hardly any irrigation development in the state in the pre-plan period. During plan development, a number of minor irrigation projects have been undertaken which have created potential of 82,000 ha, which accounts for about half of the ultimate potential. A net area of about 36,000 ha out of the net sown area of 149,000 ha has been brought under irrigation by these projects.

ASSAM

Before the commencement of plan development, irrigation development in the state was limited to minor projects utilising surface and ground water which provided an irrigation potential of 0.23 m.ha. Under plan development about 20 major and medium irrigation projects and large number of minor irrigation projects were undertaken resulting in creation of an irrigation potential of 0.85 m.ha which is about one-third on the ultimate irrigation potential of 2.67 m.ha for the state. A net area of 0.57 m.ha has been brought under irrigation through these projects. Important projects taken up during the period include Bodikerai, Dhansiri, Kollong etc.

MANIPUR

An irrigation potential of about 5,000 ha. was created in the state during pre-plan period through minor irrigation projects. During plan development, six major and medium projects and a number of minor irrigation projects were added which has raised the irrigation potential to 0.14 m.ha. which is about 60 percent of the ultimate potential of 0.24 m.ha. A net area of 65,000 ha. has been brought under irrigation through these projects. One of the important irrigation projects taken up is the Loktak Lift.

MEGHALAYA

Minor irrigation projects are the source of irrigation in this hilly state. A potential of 7,000 ha. developed in the pre-plan period was enhanced to about 53,000 ha. by taking up more minor irrigation projects. The State has little scope of taking up major and medium projects. A net area of about 45,000 ha. has, so far, been provided with irrigation.

MIZORAM

There was hardly any irrigation development in the state in the pre-plan period. The terrain is not suitable for taking up major and medium projects. In the perlod of plan development, an irrigation potential of 13,000 ha. was created through minor irrigation projects, thereby bringing a net area of about 8,000 ha. under irrigation. The ultimate irrigation potential of the state is about 70,000 ha, which is one of the lowest of all states.

NAGALAND

Nagaland too has a low irrigation potential of about 90,000 ha. out of which about 5,000 ha. was created in the pre-plan period through minor irrigation schemes. This has been raised to about 68,000 ha. (about

three-fourth of the ultimate) by taking up minor irrigation projects. The net area provided with irrigation is of the order of 60,000 ha.

TRIPURA

Irrigation development in the pre-plan period in Tripura was mainly through minor irrigation. Potential of 10,000 ha. was created during the pre-plan period. With the addition of 3 medium and several minor irrigation projects during plan development, the irrigation potential, so far, developed has risen to over 100,000 ha. which is nearly half of the ultimate potential of 215,000 ha. About 16,000 ha. of sown area has been brought under irrigation. One of the important projects taken up in the state in Gumti Irrigation Project (Maharani).

TABLE-II
IRRIGATION DEVELOPMENT IN NORTH EASTERN REGION DURING PLAN PERIOD

Sl.No.	States	Ultimate Potential	Potential created Pre-Plan	Potential created by end of VIII Plan	% Potential created
1.	Arunachal Pradesh	168	–	82	48.8
2.	Assam	2670	230	845	31.6
3.	Manipur	240	5	140	58.3
4.	Meghalaya	120	7	53	44.2
5.	Mizoram	70	–	13	18.6
6.	Nagaland	90	5	68	75.6
7.	Tripura	215	10	101	47
	Total	3573	257	1302	36.4

Hydro Power :

The North Eastern Region of the country is blessed with vast hydropower potential. Its great and varied potential of around 32000 MW at 60% load factor in hydro-power alone offers not just local opportunities but a promise of national solution and wider regional prosperity through inter country grid connections and energy exchange. However, only 1.1% of this potential has so far been exploited. The per capita availability of power in the region is no more than 94 KWh against the national average of 330 KWh which is itself low even by developing-world standards. Barring Meghalaya whose current surplus may also disappear in another 5 year, unless fresh investment are made soon, the rest of the region has power deficit.

At present, the NER's total installed capacity from all sources (hydro, coal, gas) stands at 1570 MW as against the national total of 86,000 MW. Of this, the hydro component is 590 MW from 10 operational projects. On-going hydro schemes will add 640 MW of which 505 MW will come from nine central projects being built by NEEPCO and NHPC including Ranganadi (405 MW, Arunachal Pradesh), Kopili extension stage-II (25 MW, Assam), Doyang (75 MW, Nagaland) and 135 MW from various projects executed by the state.

Tuirial H.E. Project (60 MW, Mizoram) has recently been taken up for execution by NEEPCO, which is being funed by OECF, Japan. Four other projects with a capacity of nearly 1040 MW have been sanctioned by CEA. This includes Tuivai (210 MW), Loktak Stage-II Downstream (90 MW, Manipur), Kameng (600 MW, Arunachal Pradesh) and external financial institutions are being approached by NEEPCO. Centre intends to take over Kameng project from Arunachal Govt. for execution by NEEPCO.

Total installed power capacity in North Eastern Region and Status of Hydroelectric potential development in North Eastern Region is given in tables – III & IV.

TABLE–III
TOTAL INSTALLED POWER CAPACITY IN NORTH EASTERN REGION

Sl.No.	States	Hydro	Thermal	Total (MW)
1.	Arunachal Pradesh	23.93	20.02	43.95
2.	Assam	102.00 *	778.9	880.92
3.	Manipur	107.6	9.41	117.01
4.	Meghalaya	335.20 **	–	335.2
5.	Mizoram	3.38	21.7	25.08
6.	Nagaland	3.3	1.8	5.1
7.	Tripura	16	146.35	162.35
	Total	591.41	978.2	1569.61

* 100 MW from Kopili H.E. Project.
** 150 MW from Kopili H.E. Project.

TABLE–IV
STATUS OF HYDRO-ELECTRIC POTENTIAL DEVELOPMENT IN THE NORTH EASTERN REGION

Sl.No.	States	Pot. Assessed at 60% LF	Pot. Dev. at at 60 % LF	% Development
1.	Meghalaya	1070	201	18.8
2.	Tripura	9	9.6	100
3.	Manipur	1176	64.6	5.5
4.	Assam	351	61.2	17.4
5.	Nagaland	1040	2	0.2
6.	Arunachal Pradesh	26756	14.4	0.05
7.	Mizoram	1455	2.03	0.14
	Total	31857	354.83	1.1

Flood Development :

Floods have been bane of both the Brahmaputra and Barak valleys of Assam causing severe erosion, loss of life and livestock, and heavy damage to infrastructure and property, retarding agriculture production and productivity on account of risk-avoidance, disrupting communications and education and posting health hazards. Some 4.3 million ha in the entire Northeast is flood prone and the fury of the floods has impeded development generally. Majuli island is threatened. The flood damage to crops, cattle, houses and utilities in Assam alone between 1953 and 1995 is estimated at Rs.4400 crores with a peak loss of Rs. 664 crores in a single bad year.

Some of the contributory factors are indiscriminate forest felling (including jhumming), inadequate maintenance of flood embankments for want of funds, encroachment of the flood plain on account of population pressure, infrastructural gaps, and non-adoption of full scale non-structural flood management measures. Current flood management structures in Assam cover 1.63 m.ha. out of an assessed flood prone area of 3.15 m.ha. in the state. However, the failure rate is on high on account of inadequate maintenance and improvements. Many embankments require to be raised and strengthened or replaced. According to an Assam Flood Control Department study, substantial immediate relief can be achieved by constructing 78 km of embankments along the Brahmaputra and 1066 km along the tributaries of the Barak together with 35 major protection works, 219 anti-erosion works and 101km. of drainage improvements with sluice gates.

A Central task force with representation from the concerned states and the Brahmaputra Board is currently examining the North East flood situation critically. Its report is due shortly. The total expenditure on flood management in the region up to the end of the 8th Plan, including Central loan assistance of Assam, aggregates some Rs. 1175 crores.

The construction of the Pagladiya dam in lower Assam (Rs.480 crores, 26 m high dam) will benefit a 40,000 ha area in Nalbari district. A sum of Rs.11 crores is proposed to be spent on the Harrange drainage scheme in the Barak Valley and Rs. 189 crores on flood management schemes in other North Eastern States.

The main long-term thrust is to construct a number of multipurpose dams in Arunachal Pradesh, apart from the Tipaimukh dam, including the Dihang and Subansiri cascades, and other major dams on the Lohit, Dibang, Noa-dihing, Kemang, etc. These projects will significantly lower the flood peak in Upper Assam and have a moderating effect through lower Assam and into Bangladesh. The Subansiri cascade, in particular, could give long term protection to Majuli.

ROLE OF CENTRAL WATER COMMISSION IN NORTH EASTERN REGION

The Central Water Commission being the apex technical organisation in the country in the field of water resources development has been concerned regarding the need to speed up the development of water resources in the North Eastern Region. It has been closely associated with the investigation and preparation of detailed project reports (DPR) and design consultancy of all hydroelectric and multipurpose projects in this region. With the setting up of Water Resources and Flood Forecasting Circle in 1973 at Guwahati, CWC entered into the field of water resources assessment of the two river basins, the Brahmaputra and the Barak, and issuance of flood warnings. The network of gauge and discharge, and flood forecasting stations is expanding since then to cover more sub systems. Long term hydrological data is very essential for estimating the availability of water in different river basins and for planning of irrigation, flood control and hydropower projects.

Flood Forecasting :

Starting with a modest setup in 1973, CWC now has 29 stations in the flood forecasting net work of Brahmaputra and Barak basins. These stations are backed by 55 base stations. Important town like Dibrugarh, Sibsagar, Tezpur, Guwahati, Goalpara, Dhubri, Jorhat, Silchar, Nalbari, Barpeta, Ghugumari, Jalpaiguri and Tufanganj are getting the benefit of timely flood warning issued by CWC during flood season. Nearly 2500 forecasts are issued every year by the CWC from these 29 stations with an accuracy of more than 90%.

Hydrological Observation :

The observation of gauge and discharge including sediment observation is very essential to have reliable data for estimating the availability of water in different rivers for planning of irrigation, flood control and hydro power projects. Central Water Commission is maintaining a net work of 21 hydrological sites an Brahmaputra system. Besides these silt sampling is also undertaken at 14 sites and water quality testing is carried out at 13 sites. CWC is also maintaining a net work of 27 gauge and discharge sites including 11 silt sites since 1973 for planning of project in the Barak sub-basin. The run off and sediment data fully processed is published annually as "Water Year Book". This data has been found to be very useful by the state governments in the planning of irrigation and hydro-power schemes.

Monitoring & Appraisal of Projects :

The main objective of monitoring is to ensure the achievement of physical and financial targets for timely completion of projects. The regional office of Chief Engineer, B&BB, CWC, Shillong is monitoring a number of major and medium irrigation projects of North Eastern Region. This is likely to ensure better interaction with State Govts to render necessary assistance including removal of bottlenecks by frequent monitoring visits. Seven (7) major irrigation projects of Assam and Manipur and four(4) medium irrigation projects of Assam, Meghalaya, Tripura and Manipur are being monitored by Central Water Commission. Besides above schemes CWC is also monitoring the accelerated Irrigation. Benefit Programme (AIBP) projects of North Eastern Region.

The Regional Office of CWC is also entrusted with appraisal of all medium irrigation projects in the North Eastern region. Technical Advisory Committee (TAC) notes for the consideration of Planning Commission for

the clearance of the projects are prepared. The seven (7) medium irrigation projects of Assam, Manipur and Tripura are being examined at present for the preparation of T.A.C. Notes.

Investigation of Projects :

C.W.C. has been closely associated with the investigation and preparation of detailed project report (DPR) and design consultancy of all hydroelectric and multipurpose projects in the region. Starting with the investigation of hydroelectric projects like Kopili Loktak, Umium, Barpani, Doyang, Pagladia in the period 1953-65, CWC took up the investigation work of Tipaimukh Multipurpose High Dam (1500 MW, 3.05 Lakh ha) during 1977 and submitted the detailed project report (DPR) in 1983. Feasibility studies for the Tipaimukh Project had already been started in 1955. The Project has now been handed over to Brahmaputra Board for execution after further detailed investigation by the Board. A total of 26 hydroelectric (including micro hydel), irrigation, flood control and multipurpose projects so far have been investigated by CWC in North Eastern Region, and 12 projects are under investigation. Some of the important projects investigated are Kameng (600 MW, Arunachal Pradesh), Tuivai (210 MW, Mizoram), Tuiral (60 MW, Mizoram), Serlai-B (10.5 MW, Mizoram), Kamlang (22.5 MW, Arunachal Pradesh) hydroelectric projects: T-Surang (2208 ha, Nagaland), Rongai Valley (4775 ha, Assam) and Fulertal (120337ha Assam) irrigation projects; and Mat Valley (3 MW, 1052 ha, Mizoram) multipurpose projects. Ten (10) hydroelectric and multipurpose projects are under various stages of investigation. The important among these are; Kolodyne stage-I (100 MW), Kolodyne stage-II (250 MW), Tuivawl (48 MW) in Mizoram, Nyukcharong Chu (50 MW) in Arunachal Pradesh, as hydroelectric projects, and Sissiri (225 MW, 16000 ha), Deopani (20 MW, 13000 ha) in Arunachal Pradesh as multipurpose projects. The salient details of the projects investigaged; and under investigation are given in Table-5 and 6.

Future Requirement :

A major problem facing India is its rapid growth of population, which may surpass China by the first quarter of the twenty first century. A study by United Nation's Population Division indicates that the population of India by 2025 AD about 1.5 billion. In India the food grain availability is at present around 535 gram per capita per day where as the corresponding figure in China and U.S.A. are 980 gram and 2850 gram respectively. Assuming the level of consumption remaining the same as now the food grain requirement would be about 250 million tones.

Even our own assessment of future population and food requirement of the country indicates that the population of India may stabilise at 1.5 to 1.8 billion by 2050 AD and that would require about 450 m.t. of food grain annually at the present level of consumption. The present productivity of irrigated land is about 2.57 t/th and less than 0.5 t/th for rained lands. Assuming that these levels can go upto 3.5 and 1.0 t/ha respectively, it is imperative that we create an irrigation potential of at least 130 m.ha. for food crop alone and 160 m.ha for all crop to be able to meet the demand of the country by 2025 AD.

In power sector, total installed capacity at present has been about 86,000 MW. According to projection made by CEA, total installed capacity at the end of Eleventh Plan (2007-2012) will be about 2,40,000 MW. In this hydro component will be about 74,000 MW and thermal component will be 153,000 MW, which will be nearly four times and three time respectively with respect to the present installed capacity. So the projected scenario in power sector itself implies the rise in water demand that is going to come up in future.

It is projected the nearly 45% of the population will be living in urban areas by the end of first quarter of twenty first century. So the water supply for drinking, domestic use and various civic amenities has to be accordingly met with. Livestock population will also grow considerably requiring adequate provision for water for them. Industries are also growth over the years in keeping with the demand of the rising population.

A tentative study indicates that total annual requirement of fresh water from various sector will be about 1050 b.cu.m by 2025 AD. Thus the fresh requirement by 2025 AD will be almost at par with exploitable water resources including both surface and ground water. So our future water development programme has to go on exploring further scope for additional resources apart from harnessing the available resources and better management of existing uses.

CONCLUSION

During the five decades since independence the country has witnessed spectacular development in water resources sector in the country, especially in respect of irrigation and power. An irrigation potential of 66% of the assessed ultimate potential of 139 million ha. has been achieved. Installed hydropower generation capacity has increased from 508 MW in 1947 to 21600 MW. About 83% of population have been covered

under drinking water supply scheme. Reasonable flood protection has been provided to about 14 million ha. of flood prone area.

Hydropower provides cheap, renewable, clean and pollution free power. The growing energy needs of the country can be met only through tapping of the vast hydro potential. However long gestation period, non availability of easy storage sites, environmental impact of reservoir, resources crunch etc. are the impediment in hydropower development. The North East generally, and Arunachal Pradesh in particular could be India's power house.

The National Water Policy has assigned highest priority for drinking water supply. All storage projects are having a drinking water supply component. Though the Government of India launched the decade long drinking water and sanitation programme its targets had to be scaled down due to financial and other constraints. A number of villages are yet to get potable water even at a reasonable distance from their abode.

Floods of varying magnitude occur, year after year, in different parts of the country. The flood protection measures adopted, so far could provide reasonable degree of protection to about 35 percent of flood prone area of 40 m.ha. Though the flood sector has been receiving increased outlay year after year flood damage and flood relief in terms of money shows an increasing trend. Hence, more and more stress is given on nonstructural measures so as to keep the people and property away from floods. Thus management of flood plains is receiving increased attention through structural and non-structural measures. The flood forecasting service provided by the Central Water Commission has been acknowledged as the pioneering service to reduce the number of human lives and cattle lives lost in the devastating floods.

In spite of all these we can not afford to brook complacency yet. We have harnessed only 15% of the hydro-power potential and only 35% of the culturable land is irrigated. Water resources development is not getting due attention and financial support. Over 400 on-going projects are now held up for want of funds. Over a tenth of the irrigation potential created is unutilised because Command Area Development Programme is not given due attention by the state governments. Less than ninety percent of the utilisable potential is actually irrigated in any given year.

The North Eastern Region of the country constituting 7.7% of the geographical area is richly bestowed with the highest hydro power potential of 32,000 MW (at 60% load factor) which is 38% of the country's total potential of 84,000 MW. The actual utilisation of the immense water and hydro -power resources has however not been significant. Out of this potential only about 1.1% has so far been exploited in this region. The total irrigated area is 36% of the potential of 3.58 m.ha. from major, medium and minor schemes. This indicates the vast gap to be bridged in water resource development between resources available and actual utilisation.

We have to go a long way in development of out vast water resources potential. The challenge lying ahead is collosal keeping in view the rapidly growing population and rising demand for water from various competing sectors while per capita water availability progressively decreases over the years.

TABLE-V **PROJECTS INVESTIGATED IN NORTH EASTERN REGION BY CENTRAL WATER COMMISSION**

S. No.	Name of Scheme/Project	State	River	Type of Dam/ Structure	Height of Dam	Submergence Area	Installed Capacity	Irrigable Area
1.	Kameng H. E. Project	Arunachal Pradesh	Bichon/ Tenga	Concrete – do –	96.50 m 60.50 m	– –	600 MW	Nil
2.	Kamlang H. E. Project	Arunachal Pradesh	Kamlang	Barrage	15 m	0.259 sq. km.	22.5 MW	5000 ha (C.A.)
3.	Tipaimukh High Dam Project	Manipur/ Mizoram	Barak	Rockfill	161.00 m	3719 sq.km.	1500 MW	3.05 lakh ha (C.A.)
4.	Serlui-B Hydel Project	Mizoram	Serlui-B	Homogeneous Earthfill	51.30 m	2554 ha	10.5 MW	Nil
5.	Tuirial H. E. Project	Mizoram	Tuirial	– do –	77.00 m	150 ha	60 MW	Nil
6.	Tuivai H. E. Project	Mizoram	Tuivai	Rockfill	155.00 m	1600 ha	210 MW	Nil
7.	Saiphai M. H. cum Irrigation Scheme	Mizoram	Natachhara	Concrete	26.00 m	15.2 ha	80 KW	120 ha
8.	Tuiphal Micro Hydel Scheme	Mizoram	Tuiphal	Trench Weir	4.60 m	Nil	750 KW	Nil
9.	Lower Tuiphal M. H. Scheme	Mizoram	Tuiphal	Trench Weir	7.00 m	Nil	1.5 MW	Nil
10.	Laolui M. H. Scheme	Mizoram	Laolui	Trench Weir	4.60 m	Nil	750 MW	Nil
11.	Tuichanglui M. H. Scheme	Mizoram	Tuichanglui	Trench Weir	9.20 m	Nil	1.4 MW	Nil
12.	Mat valley Multipurpose Project	Mizoram	Mat	Earthfill	56 m	156 ha	3 MW	947 ha
13.	T-Surang Irrigation Project	Nagaland	T-Surang	Barrage	10.55 m	3.24 sq.km	Nil	1350 ha
14.	Khowai Dam Project	Tripura	Khowai	Homogeneous Earthfill	43.25 m	979.00 ha	7.5 MW	4515 ha
15.	Rambhadra Mini M. H. Scheme	Tripura	Gumti	Weir	5.26 m	Nil	1 MW	–
16.	Juri Dam Project	Tripura	Juri	Earthfill	23.70 m	Nil	Nil	2057 ha
17.	Champai Cherra Dam Project	Tripura	Haora	Earthfill	32.10 m	Nil	Nil	550 ha
18.	Dholai Barrage Project	Tripura	Dholai	Barrage	8.35 m	Nil	Nil	1910 ha
19.	Manchmara Barrage Project	Tripura	Manchmara	Barrage	9.60 m	Nil	Nil	551 ha
20.	Chaijlengtha Cl[illegible] Dam Project-Manu	Tripura	Manu	Earthfill	29.97 m	Nil	Nil	1106 ha
21.	Longai Multipurpose Project	Tripura	Longai	Earthfill	25.00 m	Nil	2 MW	15000 ha
22.	Haora Dam Project	Tripura	Haora	Earthfill	27.50 m	Nil	Nil	210 ha
23.	Juri River Basin (6 Scheme)	Tripura	Juri Basin	6 nos. of projects	–	–	44 KW	780 ha
24.	Dholai River Basin (6 Scheme)	Tripura	Dholai Basin	6 nos. of project	–	–	–	1120 ha
25.	Rongai Valley Irrigation Scheme	Meghalaya	Rongai	Barrage	10.50 m	Nil	Nil	3490 ha
26.	Fulertal Irrigation Scheme	Assam	Barak	Barrage	21.05 m	Nil	Nil	98844 ha

TABLE-VI

PROJECTS INVESTIGATED IN NORTH EASTERN REGION BY CENTRAL WATER COMMISSION

S. No.	Name of Scheme/Project	State	River	Type of Dam/ Structure	Height of Dam	Submergence Area	Installed Capacity	Command Area
1.	Dikhu Multipurpose Project	Nagaland	Dikhu	Earth/Rockfill dam	106 m	Being surveyed	45 MW	36000 ha
2.	Dzuza Multipurpose Project	Nagaland	Dzuza	Concrete dam	93 m	4.89 sq. km	18 MW	9540 ha
3.	Tuivawl H. E. Project	Mizoram	Tuivawl	Rockfill/ Concrete Dam	150 m	Not yet ascertained	48 MW	Nil
4.	Greater Shillong Water Supply Scheme (For Water Supply only)	Meghalaya	Umiew	Concrete dam	50 m	0.54 sq. km	W/S Scheme	Nil
5.	Phulbari Flood Protection Works	Meghalaya	Brahmaputra/ Jinjiram	Check Bund	9 m	–	–	Nil
6.	Kolodyne H. E. Project (Stage-I)	Mizoram	Mat	Earthfill dam	100 m	Not yet ascertained	100 MW	Nil
7.	Kolodyne H. E. Project (Stage-II)	Mizoram	Kolodyne	Composite dam	50 m	– do –	250 MW	Nil
8.	Tuirini H. E. Project	Mizoram	Tuirini	Earth/ Concrete dam	120 m	950 ha	50 MW	Nil
9.	Sissiri Multipurpose Project	Arunachal Pradesh	Sissiri	Concrete Dam	179 m	3.46 sq. km	225 MW	16000 ha
10.	Deo-Pani Multipurpose Project	Arunachal Pradesh	Deo-pani	Trench Weir	–	–	20 MW	13000 ha
11.	Nykcharong Chu H. E. Project	Arunachal Pradesh	Nykcharong Chu	Weir	–	–	50 MW	Nil
12.	Flood control measure to check erosion of the left bank of Brahmaputra near Porvita & South Salmara.	Assam/ Meghalaya	Brahmaputra/ Jinjiram	Check Bund	Not yet ascer-tained	–	–	Nil

POWER SCENARIO IN NORTH EASTERN REGION

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ABSTRACT

North Eastern Region is economically the most backward and underdeveloped area of the nation, having only 90 Kw per capita consumption of electric energy against a national average of 300 kw.

The region is richly bestowed with the highest hydel potential capacity of about 32,000 MW which is mere that 27% of the country's total hydel potential supplemented with abundant reserves of coal, oil, and gas, for thermal power generation, but the available natural resources have not yet been tapped properly.

Despite this region being rich in potential, the liberalised economic policies of the Central Government have so far been unable to attract private participation for power development in the N.E. Region.

This paper presents an account of the development of power and its planning which deserve regional as well as national attention.

INTRODUCTION

The North Eastern Region is economically the most backward and underdeveloped area of the nation, having only 90 kwh per capita consumption of electric energy against national average of 300 kwh. This has been due to the many reasons, such as slow industrial development, absence of adequate transmission and distribution network. The inadequate development of the enormous natural potential of this region can be attributed to the inhospitable hilly terrains, coupled with scarcity of financial resources and institutional linkages as well as absence of effective communication and transport network.

The region is richly bestowed with the highest hydel potential capacity of about 32,000 MW (at 60% load factor) i.e. more than 27% of the country's total hydel potential supplemented with abundant reserves of coal, oil and gas for thermal power generation, but the available natural resources have not yet been tapped properly due to the poor infra-structural facilities, lack of communication facilities, hilly terrains, difficult geographical conditions, inhospitable climatic conditions etc. coupled with an inadequately low industrial growth & difficult law and order conditions etc. making the region industrially backward & economically under developed.

Further, it is more surprising to note that out of the total hydel capacity potential of about 32,000 MW (at 60% load factor) only 555 MW i.e. about 1.73% potential has so far been exploited and projects having total installed capacity of 540 MW i.e. about 1.7% of capacity potential, are presently under construction, meaning thereby that remaining 30,905 MW i.e. 96.6% of hydel capacities are yet to be exploited and that to even after more than five decades of planned development. Similarly, vast thermal resources of the region also remain untapped, mainly due to lack of demands in the region.

The liberalised economic policies of the Central Govt. have so far failed to attract Private-participation for power development in the NE Region, despite this region being rich in potential. This may be for lack of proper infra-structure, transport and communication bottlenecks and insurgency. Unless all out efforts are made to improve the economy and quality of life of the people of NE Region, at par with other parts of the country, the feeling of insecurity can not be arrested. Under the circumstances, the pace of development of this region should be accelerated by providing adequate financial assistance for development of Power sector. The vast hydro potential in NE Region can also be exploited to export Power to neighbouring countries like Bangladesh and Myanmar (Burma).

DEVELOPMENT

After independence, North Eastern Region started practically with zero energy generation. Prior to Independence there were a few Private Licensees which were operating in some important towns like Guwahati, Shillong, Jorhat, Dibrugarh, etc. Also Govt. of Assam had created two TOWN & VILLAGE ELECTRIFICATION DIVISIONS. One for Upper Assam at Jorhat and other for Lower Assam at Guwahati for electrification of some isolated town and villages with the help of small diesel generating sets. Apart from diesel sets, a Private Licensee, mainly, Shillong Hydro Electric Company was in operation in Shillong with a small hydro station since 1922.

In the intervening period between independence till the formation of Assam State Electricity Board, Govt. of Assam had commissioned 8.4 MW (3x2.8 MW) UMTRU HYDEL PROJECT in 1956 which was a gift from GOVT. OF CANADA. Transmission network was at a level of 33 KV or 11 KV of a few hundred kilometers length only.

It was only after formation of the Assam State Electricity Board in 1958, the concept of POWER SYSTEM DEVELOPMENT was started in planned phases and Generation Projects comprising of Hydro and Thermal Stations were taken up with associated EHT Transmission network at 220/132 KV level. In 1975 composite ASEB was divided in two State Electricity Boards and five Electricity Departments under the direct control of the states.

Since the state resources were inadequate to cope up with the load growth of the region investment from the Central Sectors had become necessary to set up Generation Projects, North Eastern Electric Power Corporation (NEEPCO) was formed to execute Power Projects and associated Transmission Lines and Sub-station in N.E.R.

UTILITIES

At present there are two State Electricity Boards, five Electricity Departments and three Central Agencies in operation in North Eastern Regional Grid.

State Sector :

1. ASSAM STATE ELECTRICITY BOARD.
2. MEGHALAYA STATE ELECTRICITY BOARD.
3. POWER DEPARTMENT, GOVT. OF NAGALAND.
4. ELECTRICITY DEPARTMENT, GOVT. OF TRIPURA.
5. ELECTRICITY DEPARTMENT, GOVT. OF MANIPUR.
6. POWER DEPARTMENT, GOVT. OF ARUNACHAL PRADESH.
7. POWER & ELECTRICITY DEPARTMENT, GOVT, OF MIZORAM.

Central Sector :

1. NORTH EASTERN ELECTRIC POWER CORPORATION OF INDIA LTD.
2. NATIONAL HYDRO ELECTRIC POWER CORPORATION.
3. POWER GRID CORPORATION OF INDIA LTD.

TABLE – I
Generation Capacity (Installed/Derated/Available) in NER Grid

	Sector	Installed (MW)	Present Capacity (MW)	Peak Av. Availabity (Optimistic in grid) (MW)
A.	**State**			
(i)	A.S.E.B. BITPS(COAL) (4 X 60)	240	125	70
	CTPS (OIL) (2 X 30)	60	45	40
	NTPS(GAS) (3X 23 +1X12.5 +1X30+1X22)	133.5	60	50
	LTPS (GAS)	120	50	40
	TOTAL	553.5	280	200

(ii)	MeS.E.B. (ALL HEPs)	11.2	11.2	11.2
	UMTRU HEP (4X2.8)			
	UMIAM ST – I (4X9)	36.0	36.0	36.0
	UMIAM ST– II (2x9)	18.0	18.0	18.0
	UMIAM ST – III (2X30)	60.0	60.0	60.0
	UMIAM ST – IV	60.0	60.0	60.0
	T O T A L	185.2	185.2	185.2
(iii)	TRIPURA			
	ROKHIA (GAS) (6X8)	48	48	48
	BARAMURA TPS(GAS) (2X5+1X6)	16	8	6
	GUMTI HEP (3X5)	15	10	10
	T O T A L	79	66	64
B.	**Central Sector**			
(i)	NEEPCO			
	KOPILI HEP & Extn. (2x50+2x50)	200	200	200
	KHANDONG HEP (2X25)	50	50	50
	AGBPP,K' GURI (4X33.66+2X35.01 +3X30)	294.66	264.66	130 *
	AGTPP Ramchandra (4x21)	84.0	84.0	55.0
	Present Total	628.66	598.66	435.0

■ The availability is likely to increase to 210 MW stabilisation of steam units and availability of Gas by June, 1998.

(ii)	NHPC			
	LOKTAK HEP (3X35)	105	105	90
	Grand Total of NER Grid :	**1551.36**	**1234.86**	**974.2**

ISOLATED OPERATION OF GENERATING STATION

Tripura

Gumti HEP	}	
Baramura GT	}	
Rokhia GT	}	Average 98 MW
Ramchandra Nagar	}	

Assam

CTPS	}	
LTPS	}	Average 90 MW
NTPS	}	

Except Assam, Meghalaya and Tripura none of the state has got any major Hydro/Thermal Power generation except a few mini & micro hydro schemes and Diesel Station as given below :

Sl.No.	States	Diesel	Mini Hydro
1.	Arunachal Pradesh	15.81	23.55
2.	Assam	20.69	2.00
3.	Manipur	9.27	2.80
4.	Meghalaya	2.05	–
5.	Mizoram	19.07	3.38
6.	Nagaland	3.26	3.30
7.	Tripura	6.14	–

TRANSMISSION SYSTEM IN NER

The Transmission system in NER owned by states mostly comprises of 66 KV & 132 KV except Assam who has line of 220 KV as well. With the formation of Power Grid all interstate lines are being constructed by PPOWERGRID including 400 KV lines under Kathalguri and Ranganadi Transmission Scheme.

GENERATION AVAILABILITY Vs DEMAND OF NER GRID

NER being predominant with hydro generation, the region does not require any external assistance from Eastern Region during the period, June to November every year provided there occurs no outage of existing units. With the advent of lean water season hydro capacity gradually gets reduced and the region first approaches to peak shortage from December to January and peak as well as off-peak shortage during the period, February to May each year. The part of shortfalls being met by import of power from Eastern Region and the import is being reduced gradually however, NER will be surplus when Ranganadi Hydro Project is commissioned in 2000-01.

Ongoing Generation Prospects in NER :

Following Projects are under construction. If commissioned as per the scheduled programme, regional shortfall would no longer exist and a time is not far when NER would be able to feed other deficit region even during peak hours on completion of following Hydro Project by NEEPCO Ltd.

Sl.No.	Project	Capacity (MW)	Status	Expected Targets
1.	Doyang HEP (Nagaland)	3 x 25 = 75	In progress	1st Unit-Oct'98

2.	Ranganadi HEP (Arunachal)	3 x 25 = 405	In progress	2nd Unit-Mar99
3.	Tuirial HEP	60	Just started	X Plan

Following projects are under sanction for implementation and are likely to be taken up during IX Plan under Central Sector :

1.	Kameng (Arunachal Pradesh)	600 MW	X Plan
2.	Lower Kopili (Assam)	150 MW	-do-
3.	Tuivai (Mizoram)	210 MW	-do-
4.	Kopili II stage Extn. (Assam)	25 MW	-do-
5.	Ranganadi II (Arunachal Pradesh)	160 MW	-do-
6.	Dikrong (Arunachal Pradesh)	100 MW	-do-
7.	Baramura Gas (Tripura)	25 MW	IX Plan
8.	Loktak Down Stream (Manipur)	90 MW	X Plan

HYDRO-THERMAL MIX

Presently in the national scenario, the hydro mix ratio is 24:76 which may rapidly change in view of large numbers of thermal projects coming up in both public and private sectors, reducing hydro contribution much less in the next few years, thereby creating an acute crisis in peak power availability. To mitigate this national short fall in hydro power, long and sustained planning and efforts are most essential to tap huge national potential of the country instead of neglecting hydro development on account of long gestation period, environmental problems etc. Such problems can be solved only through advance planning and efforts.

With sunk fixed costs in a utility, Hydro power stations provide unique advantage of zero cost energy and hence the need for maximization of utilisation of available hydro resources. However, the share of hydro resources in the total installed capacity of the country has been declining since the end of the Fifth Plan. It got reduced to 28.8% at the end of the Seventh Plan from 41% at the end of Fifth Plan. This declining trend continued during the Eighth Plan also. The share of hydro power after fourth of year Eighth Plan was reduced to 25.2% and this is likely to reduce further by the end of the Ninth Plan. This declining trend in the share of hydro power is resulting in sub-optimal utilisation of existing power plant capacity in the country and in the absence of adequate hydro power plant capacity in the system, the peaking power is being provided by the thermal power plants particularly in the predominantly thermal Eastern and Western Regions. This often resulted in a backing down of thermal capacity during the off-peak night hours generally between 10:00 p.m. and 5:00 a.m. At present Eastern and North Eastern Grids are connected with Birpara (West Bengal). Salakati (Assam), 220 kV D/C Transmission Line and are running in synchronisation. The NER being predominantly hydro system, addition of new Hydel Capacity in NER will improve the present poor Thermal : Hydro mix of ER which at present stands at 88:12.

POWER PLANNING IN NINTH PLAN AND BEYOND

The Sub-Group on Generation and Transmission (constituted by the Planning Commission) has recently (May'96) prepared generation expansion for Ninth Plan. It is understood that Baramura Gas Project (1x25 MW) only has been proposed for NER during the Ninth Plan and the on-going schemes viz. Doyang (3x25 MW) and Ranganadi (3x105 MW). As per power study prepared by Sub-group based on 15th EPS. Peak load availability and energy availability of the NE Region are shown surplus at the end of Ninth Plan, with addition of 994.5 MW installed capacity from the on-going generation projects, surplus being 4.4% and 24.5% respectively.

Considering the peak demand and energy requirement as per 15th EPS for 10th Plan, the installed capacity and energy requirement would work out as is on display in the next page.

Year	Peak Demand 15th EPS (MW)	Availability Installed Capacity (MW)	Surplus Deficit %	Req. of Energy 15th EPS (MW)	Availability of Energy (MU)	Surplus Deficit %
2001-02	1722	1798	+4.4	8148	10142	+24.50
2002-03	1855	1798	(—)	8802	10142	+10.24
2003-04	2002	1798	(—)	9517	10142	(+)
2004-05	2162	1798	(—)	10292	10142	(—)
2005-06	2337	1798	(—)	11138	10142	(—)
2006-07	2527	1798	(—)	12062	10142	(—)

The summary of the forest of the terminal year of the Ninth Plan as made by 15th EPS for each of the five Regions of the country and All India basis is as follows :

Region	End of Ninth Plan	
	Peak Demand (MW)	Energy Req (Gwh)
Northern	31735	181649
Western	28430	176732
Southern	21975	134671
Eastern	11846	68243
North Eastern	1722	8148
All India	95757	569650

It is proposed to adopt 15th Electric Power Survey (E.P.S.) Committee Forecasts for formulation of Ninth Five Year Plan of Power Development Programme.

From the view of past performance, it has been clear that the actual availability falls far short of projected availability thereby causing serious conditions of deficit resulting in load shedding. The similar projections were made earlier. In all previous projections, NE Region was declared to have surplus. Such surplus was envisaged to be supplied to Eastern Region. But in reality the N.E. Region survived only by import of power from Eastern Region to meet its restricted demand. The region suffered for past 10 years due to such optimistic projection. Therefore, one should learn lesson from the past. This means that due care should be necessary to project the practical availability. Such a projection would need increase of installed capacity for N.E. Region to meet the restricted demand during the Ninth Plan.

Vast natural resources of NE Region particularly hydel resources is being wasted year after year. In fact, N.E. Region, particularly Assam has been facing frequent floods causing damages of several crores every year. If this huge sum is utilised to create large reservoirs in the tributaries of the mighty Brahmaputra, not only floods but also shortage in hydro power can be solved. This requires political will as well as sustained planning. Despite 50 years of planning, N.E. Region still remains far away from the National stream in overall developments. Without sufficient surplus power, no industries can come up in this region. There are many feasible hydro electric projects which are cleared at various levels. If some of these projects are started in the Ninth Plan, the benefits will be available in the Tenth Plan to ensure continued and accelerated economic growth and development of NER.

POWER SUPPLY POSITION

The existing Power Plants and Transmission system require immediate improvement. As per NEREB Annual Report for 96-97, the observed peak demands, load and energy availability are reproduced in the next page.

Year	Installed Capacity (MW)	Peak Demand (MW)	Availability (MW)	Energy Requirement (MU)	Energy Availability (MU)
1994-95	1228	751	639	3381	3077
1995-96	1398	810	741	4213	3500
1996-97	1570	846	872/818	4425	3540

TRANSMISSION SYSTEM

Along with generation expansion, matching Transmission lines are also required to be taken up during the Ninth Plan so that these lines are commissioned in the Tenth Plan. Detailed study has to be carried out to take up Transmission Line in State and Central sector to provide stable transmission network within NER.

Integrated planning for the country instead of region based approach is to be adopted so that power generated in N.E. Region can also be transported to other regions. The Eastern Region which was considered as deficit region till VII/early VIIIth Plan has become surplus region. Construction of high capacity lines like 400 kV/HVDC will be required in future, if projects like Subansiri HE Project, Tipaimukh Project etc. are taken up. The on-going 400 KV D/C line can transfer only upto 1000 MW.

Generation and Transmission of Power is not enough for the development of power system unless suitable distribution system ensures power supply in adequate quantity and appropriate quality to consumer.

Therefore, due emphasis is required to upgrade the state distribution system and modernise the same to cope up with consumers requirement. For distribution sector adequate provision shall be necessary under State Plan. North Eastern Council may also help in this respect.

CONCLUSION

Various studies have been carried out by Planning Commission/Central Electricity Authority etc. to ascertain the demand of Power & Energy in different States/Regions during the coming years/plans. Different scenario yield different set of figures on demand and availability. Anticipation on likely capacity addition during different years/plans may not come true due to various reasons. Thus, there are a number of assessments and forecasts based on the methodology adopted in the studies and perception of growth rates. But there is a common message that in varying degree shortage conditions will prevail in the States/Regions in coming years/Plans.

There are similar projections in respect of NE Region where the present shortage condition is likely to prevail all through the Ninth Plan. For example as per 15th EPS by the end of 1996-97, the terminal year of Eighth Plan, Peak Power shortage would be 6.7% and the energy shortage will be marginal (0.3%). But these are projections which have not come true. First, the installed capacity of 1570 MW as projected is unlikely to be achieved due to slippages. Availability (peak) of 1070 MW as projected may also not be achieved. It will be of the order of 818 MW as can be seen from the above against the peak demand of 1147 MW indicating a shortage of 28.6%.

Based on the status of the ongoing generation schemes in NE and on commencement of new schemes during the Ninth Plan, year-wise likely benefits from 1997-98 to 2006-07 and beyond has been assessed which indicates likely additions in installed capacity during Ninth & Tenth Plan are 773.5 MW and 961 MW respectively. Based on the actual peak availability as observed by the North Eastern Regional Electricity Board(NEREB) who are monitoring the Grid operation in NE Region, the power supply position has been assessed from 1997-98 to 2006-07 indicating continuance of shortage all through(from 47.11% in 1997-98 to 38% in 2001-02 and 38.8% in 2006-07). The experience of real time grid operation shows that on an average, peak availability in NER is of the order of 50% of its installed capacity. Needless to say that extra efforts are called for to bridge the gap in supply and demand.

In the area of Transmission and Distribution the position is much the same. Due to Transmission inadequacy, grid collapses are quite frequent in the region. Voltage profile is poor, particularly in the South Assam and tail-end states of Tripura, Manipur & Nagaland. At times, it is not possible to evacuate the generation due to Transmission constraints. Load development has been poor due to very poor Transmission and Distribution network in the region. As a result, T & D losses are very high. Communication system is also extremely poor leading to problems in load despatch/tied-up.

POWER SECTOR CHALLENGES – ISSUES & OPTIONS

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ABSTRACT

In spite of remarkable progress in the Power development programmes of the country in the five year Plans, there has been a continual growth in the energy demand and peak shortage. Though sustained planning in reforming the areas of renewal of/improvement of hydro-thermal mix, abnormal transmission and distribution loss, non-optional utilisation of installed generating capacity, schemes of renovation and modernisation, demand side management etc. has resulted in some benefit in adding the so-called wasted energy to the grid apart from the normal capacity additions. But we could not make much headway in bridging the demand and gap scenario. In fact, there have been abnormal slippage in the 8th Plan Power Programme. It is evident that we have to bring forward this deficit in the 9th and 10th plan period. However, the hydro-resource of the N.E. Region with its abundance can play a remarkable role if genuine interest is shown to develop certain major projects.

INTRODUCTION

Fifty years of efforts in the development of a nation cannot be considered as a very little of time for the very cause of the upliftment of the mass. But perhaps, the same logic cannot be applied in a country like India where there has been so much of diversity in any sphere that we can take as reference and thus demands more intricate reforms in the economics. The economic reforms package with which country is moving to the next century has been felt to be a real necessity because all the development programmes are virtually at cross roads. In this development process power is the essential input and per capita consumption of power is an indicator of progress.

When India became independent on 15th August, 1947, it inherited an exhausted and just surviving power supply system with enormous tasks of planning to cope up with the demands of the generation. Since then, there has been phenomenal growth with the power development programme which has been receiving adequate priority of the planners. Remarkable growth and progress has been registered in the use of electricity in the successive five years plans. In the last 50 years, electricity generation has increased from 1713 MW in 1950 to more than 86,000 MW by the end of the Eighth Plan. In fact, the fifth five year Plan (1974-79) was the years of changes in the power system development programme which witnessed the setting-up of large power projects to develop the coal and hydro-electric resources in the country as a supplementary effort in meeting the country's power demand. As on 31.03.97, the all India installed capacity of electric power generating stations under various utilities was 85919 MW consisting of 21645 MW hydro, 61149 MW thermal and 2225 MW nuclear and 900 MW comes from wind energy.

With an impressive track record of capacity expansion programme, the country is still encountering a situation of power shortages and poor quality of supply. The situation may further aggravate in the next century where there has been a demand as forecasted to have a compound growth of 6.6% in the energy and 8.4% for peal load. There may be manifold reasons attributed to this situation, but I went to mention some of the basic issues which need deliberations to mitigate the crisis.

IMBALANCE OF POWER MIX

From an impressive figure of hydro-thermal mix of 33 : 67 during 1950, we have reached to a figure of 25 : 75 by the end of 8th five year Plan. One can very well appreciate a standard of 40:60 hydro-thermal mix. The absence of which is felt today in frequent load-shedding, fluctuations in voltage and frequency, backing down of thermal units with low PLF and low efficiency resulting in poor grid economy. Apart from this there is definite pressure on the fixed inventory of fossil fuels.

It is needless to mention that the present power shortages could have been reduced to a respectable limit had preference been given to the development of more hydro-based power projects and also for a judicious hydro-thermal mix. This is more important when the country has abundance of hydro-electric potential of 84043 MW. Basin-wise distribution of the river system depicts that the Great Brahmaputra Basin alone accounts for 42% of the above mentioned potential which is in urgent need of consideration.

Sl.No.	Name of the River	Firm Potential (MW)	Potential at 60% LF Economic (MW)	Theoretical (MW)
1.	Great Indus	11992.80	19988.00	50172
2.	Great Brahmaputra	23951.90	34919.80	146170
3.	Ganga	6428.80	10714.80	52938
4.	West flowing rivers of South India	3689.40	6149.00	9437
5.	East flowing rivers	5719.00	9531.70	26972
6.	Central India	1644.20	2740.30	14888
	Total :	50426.10	84043.60	301117.00

ABNORMAL TRANSMISSION AND DISTRIBUTION LOSS

The main mode of transmission of power in the country are at voltage levels of 400KV, 220KV, 132KV/110KV, 33KV etc. The end of 7th Plan recorded 19284 Ckt. Kms. of 400KV lines, 59631 Ckt. Km. of 220KV lines in the country. A large network of distribution lines are available with the State Electricity Boards.

It is beyond that, the transmission and distribution loss is pretty high and we could not make use of the precious power to a large extent because of this loss. Even after concerted efforts, the transmission and distribution loss of the country could not be reduced substantially – which thus still remains a matter of concern. It has come down from 22.83% in the beginning of 8th five year Plan to approximately 21% by the end of the Plan.

The reasons of this abnormal loss is mainly attributed by the following parameters :

- Weak and inadequate sub-transmission and distribution system.
- Multiferous transformation stages.
- Improper Load Management.
- Operation at very low power factor.
- Large scale rural electrification involving long LT lines.
- Inferior quality of construction including equipment.
- Accidental causes of power line snapping.
- Supply voltage fluctuations beyond quality limit.
- Pilferage and theft along with commercial problems.
- Lack of commercial attitude.
- Awareness in the consumers etc.

Truly speaking, all the ambitious power development programme will perhaps yield very less result if attention is not given to augment the existing transmission and sub-transmission lines along with transformation capacities to enable delivery of required power to the load centres. The distribution system in all the load centres owned generally by the State Govt. also needs upgradation. These all are to be carried out sincerely along with the construction programme of new transmission lines.

Further, the concept of energy audit from the concept of energy input to energy output may be one of the major methodology in improving the system for which CEA back in 1992 has evolved the guidelines.

NON-OPTIMAL UTILISATION OF INSTALLED GENERATING CAPACITY

This is typically a problem in the thermal sector and partially to hydro-sector because of which both theoretically and practically we suffered loss in generation leading to non-fulfillment of load demand in spite of sufficient additions in the generating capacity. In this context, let us not deny that there has been phenomenal growth in the concept of yesteryears and today we have tremendous big size generating units from the small

size generating units and this has created a difficult situation in managing the old units both in the terms of size as well as out-dated technology many of which were shelved. Moreover, there has been depletion in the quality of coal-making even the newer generating units difficult to operate in certain occasions with problems in boiler etc. which are designed for higher grades of coals etc. – resulting in backing down of the units. Many of the old hydro units are facing the problems of repeated maintenance where time required is abnormally high. Also, depletion of reservoir levels is responsible for hydro-generating stations not able to generate to its capacity. Even in some new gas based stations, reports of failure in Gas Booster Units etc. associated with parameters of impurity in gas is attributing to the cause. Improper planning in evacuation system limiting generation of various units also cannot be ignored.

Fortunately, in view of various measures, the National Plant Load Factor which is a direct equation with the above points discussed has remarkably improved from 44.2% in 1980-81 to 56.50% by the end of Seventh Plan and has further registered a growth of 63% by the 1996-97. Also, there have been remarkable growth in the availability factor of hydro stations. But, it remains a matter of concern - even today that many of the units are still doing abnormally below the national average and no time cannot be wasted to take corrective measures for these units.

The main thrust though given in the area of renovation and modernisation still needs sufficient support to ensure substantial increase in the quantum of electricity generated within the installed generating capacity. Priority areas need to be identified inter-regional grids through HVDC and other lines to make use of this power for optimal exchange. Proper demand side management also needs to be planned and implemented.

Improvement in the growth P.L.F. and availability factor should not really make us complacent in view of alarm of the new century which demands substantial annual addition during the 9th and 10th five year Plan periods – looks little formidable task at this point of time.

CAN HYDRO-SECTOR BE A VIABLE SOLUTION ?

Hydro-schemes aggregating 9282 MW envisaged for commissioning during the 8th five year Plan, only about half could have been added to the grid. Also, a review of the performance of the power-sector during the 8th five year Plan shows that against a targetted capacity addition of around 30,500 MW, we would not cross the barrier of 18,000 MW thus there have been a direct shortage of approximately 12,000 MW in the projected programme. In the perspective of "National power development upto 2006-07" of CEA - a recommendation of 34.66% of hydro-thermal mix has been preferred by the end of 2006-07 by adding approximately 50,000 MW in hydro-sector during 1992 - 2007, which means an average addition of 4000 MW – 6000 MW annually during the 9th and 10th five year Plan, which looks not only to be a formidable task but also unrealistic to achieve. Let us recapitulate that share of hydro-power by the end of 8th Five Year Plan is only around 25%.

Again, one of the very interesting points that needs deliberations is the difference of opinion in the installed capacity because of less of integrated planning. During 1997 June, it was assessed by CEA that around 40,000 MW may be feasible capacity addition during the Ninth Plan (10,000 MW - hydro; 24,000 - thermal; 6000 MW - liquid fuels). There have been a general feeling that anticipated capacity addition programme would fall short of the expected demand for energy and peak power and perhaps this is a never ending game and only symptomic relief may be given.

While, the 15th EPS indicates that by 2001-02 the expected demand of energy will be 569650 MU and peak load requirement be 95757 MW. However, taking into account the future trend - addition of this 40,000 MW still means the peak and energy shortage, with a growth rate of around 8%.

Again, the National Development Council has indicated an 10.5% growth of energy during the corresponding period. The working group on power for Ninth Plan further calculated that for meeting the expected growth, a capacity addition of 57,734 MW will be required which is in sharp contrast with the CEA projection. They however, anticipated 3.8% energy shortage and 14.4% of peak shortage during 2001-02.

Further, the 4th "National Power Plan - 1997-2012" of CEA indicates that with accelerated hydro power development, the total installed capacity required in the country may be in the tune of 49530 MW by 9th Plan, 45682 MW in the 10th Plan and 57572 MW in the 11th Plan.

While arguing on this issue which is purely a statistical exercise, we cannot contradict the basic philosophy that there will be a consistent peaking shortage with likely increase in the demand, where hydro

generating stations can not only meet the requirement of peak-hours but also may satisfy the full-time need at a affordable tariff.

In this perspective, the North-Eastern Region can play the most important role with enormous hydro-potential being regarded as the 'Store-house' of the hydro-energy. It is amazing that in spite of available potential of 34919.80 MW at 60% load factor out of 84043.60 of the all India potential (accounting 33% of the total), only 2.14% has been harnessed so far. While programmes could have been initiated long and long back to harness the same – not only we could have changed the peaking shortage situation of today or may be of the coming years – this could also have helpful to give a phillip to the economy of this region. However, the time has not really elapsed – but truly speaking the time is ripe to invest in mega-hydro projects of this region in spite of typical inherent constraints of hydro generating power sector - which undoubtedly remains as the basic answer for mitigating the crisis of future years. This of course, has to be equated in terms of other generating sectors without disputing the importance of these sectors as well.

Truly speaking, we are in a cross-road of power development programme when there are indication of mass-scale industrialisation requiring enormous power. Judicious, sustained planning and efforts at every level can only face this daunting task.

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ROLE OF MEGHALAYA STATE ELECTRICITY BOARD ON POWER DEVELOPMENT IN MEGHALAYA

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ABSTRACT

Energy in the form of electricity is recognised as a basic necessity for economic development and social progress. This has been given special place in national planning and development.

Meghalaya State Electricity Board comes into being on 21st January, 1975 after the bifurcation of composite Assam State Electricity Board, to look after the generation and transmission and distribution need of power in Meghalaya. In its 23 (twenty three) years of existence it has made significant achievement which is one of the main contribution towards socio-economic development of the state. The generation capacity has gone up from 66 MW to 185 MW, annual generation capacity has gone up from 176 MKWH to 580 MKWH, per capita consumption has grown up from 34 MKWH to 176 MKWH, number of consumers has grown up from 7000 to 1,15,000 and the transmission and distribution line has gone up from 2000 Ckt KM to about 13,500 Ckt KM, number of villages electrified gone up from 185 to 2510.

Survey and investigation is being taken up for hydro (Conventional and Non-conventional) as well as Thermal power development in the State. In order to strengthen and augment the sub-transmission and distribution network, system improvement schemes have been taken up for implementation. During the 9th five year plan implementation of leishka HEP (2x33 MW) has been proposed.

In spite of significant achievement in different field of activities of Me.S.E.B., still there is much to be achieved in fulfilling its basic objectives. It is Me.S.E.B.'s constant endeavour to improve its activities and contribute towards the development of the power sector of the State.

INTRODUCTION

Energy in the form of electricity is recognised as a basic necessity for economic development and social progress. This has been given a special place in National Planning and development. There are other forms of energy including heat and chemical which are needed by the mankind, but electricity is easily conversable and is widely used to provide all those forms of energy which are of utility of mankind.

In recent years electricity has been assigned a magic role of bringing prosperity and welfare to the people. Power development has thus become a critical component of over-all economic development. The main objective of power development is to make available electric energy of appropriate quality and at the lowest possible cost.

In our country, the basic objective of power development is well conceived since inception of planned economic development. The character of power industry, its structure and complexion has also undergone several changes. Over the last five decades the progress in terms of growth of the industry, aerial spread and technological sophistication have been commendable. Still there is much to be desired and achieved by the power supply industry in fulfilling its basic objective.

MEGHALAYA'S POWER POTENTIAL AND ITS DEVELOPMENT

The river basins of Meghalaya have a potential of about 1200 MW of Hydro Electric Power. Out of this only around 200 MW have so far been harnessed.

The first Hydro Power Station of the state was established in 1920 by a Private Company-the Shillong Hydro Electric Company. The capacity of the station was 200 KW at the time of commissioning. The power station was basically established to meet the power demand of the city of Shillong. With the gradual increase in demand in subsequent years, other five generating units were installed raising the total capacity of the power station to 1.50 MW. After operation of about 64 (sixty four) years, the power station had to close down in 1984 due to economic and operational reasons.

A look at the map of Meghalaya reveals that the rivers in Meghalaya are either north flowing or south flow. The important south flowing rivers are (i) Umiam (ii) Umtru (iii) Khri. The important south flowing rivers are: (i) Kynshi (ii) Umngot (iii) Myntdu (iv) Umngni and (v) Simsang (see fig. 1).

In late fifties development of Umiam-Umtru basin was taken up. Detailed survey and investigation works were carried out on Umiam-Umtru basin (see fig 2). As a result five power stations could be developed so far in that basin. This system has three concrete gravity dams, two earthen dams, one weir, six earthen

dykes, four reservoirs and a network of tunnels and open channels, catering to five power generating stations with installed capacity of 185.20 MW. The first power station in this basin is **Umtru Power Station**, was built up at Dehal, Byrnihat in 1957 with three generating units of 2.8 MW each. As the firm power available from this power station was only 4 MW, a search was carried out in the valley for a suitable storage, which lead to the **Umiam Stage I Project. Umiam Stage I,** a trans-basin development scheme was commissioned in 1965 with 4 units of 9 MW. In this development, regulated flow from a reservoir on Umiam basin was diverted to feed the hydro-generators of **Stage I Power House** located in the Umtru basin. Between the tail water of **Umiam Stage I** and **Umtru Power House,** a drop of about 685 Mts was available for hydro power development in 5 (five) more stages. **Umiam Stage II,** with an installed capacity of 2 units of 9 MW each was commissioned in 1970. Side by side the fourth unit of 2.8 MW was installed in the **Umtru Power Station** as a result of which the firm power generation in this power station was raised to 11.2 MW. **Umiam Stage III Power Station** was the next stage of development in the **Umiam-Umtru basin.** This power station with an installed capacity of 2 units of 30 MW each was commissioned in 1979. In the immediate downstream of **Stage III Power Station,** the **Stage IV Power Station** with 2 units of 30 MW was commissioned in 1992. Two more stages of this trans-basin development - Stage V and Stage VI and diversion of Khri water to the Umiam-Umtru basin are yet to be executed. **Khri river,** located in close proximity to the Umtru basin, is to be diverted to the Umtru basin for developing 300 MW of installed capacity in the next two stages. In early eighties, development of south flowing rivers-Myntdu, was taken up. As a result, establishment of 2 units of 33 MW each has been considered for installation during 9th Five Year Plan. Survey and investigation of south flowing rivers has been considered during 9th Plan Period.

Although Meghalaya has so far invested only in the development of Hydro Power, there are considerable coal reserves in Garo Hills, which can produce upto 1000 MW of thermal power on a long term basis. A mixed of 30% thermal and 70% Hydro by the year 2002 AD is considered desirable for ensuring a reliable power system in the state. In order to achieve a better Hydro-Thermal co-ordination and to save the state from purchase of expensive power from Central Sector Thermal Power in the year of scanty rainfall, immediate construction of at least 135 MW of thermal capacity has become a matter of urgency.

RENOVATION AND MODERNISATION OF OLD GENERATING UNITS

Aiming at maximising the benefit from the existing installed capacity, renovation and modernisation of Umiam Stage I & II Power Station during 9th Plan Period under the Overseas Economic Co-operation Fund (OECF) Japan has been considered for implementation. Efforts are also initiated to upgrade the generation capacity of Umiam Stage III Power Station by 10%. Capital maintenance and overhauling of Hydro Generating Units of oldest Umtru Power Station have been undertaken. With the implementation of renovation, modernisation schemes and overhauling of the old generating sets, the life of the generating units will go up considerably. Energy availability from these power stations will increase and the operation and maintenance cost of the generating units will go down.

TRANSMISSION AND DISTRIBUTION

The Transmission and Distribution networks play an indispensable role in supplying power to the consumer. A strong T&D network backed up by reliability and redundancy, is all the most desirable for maintaining reliable and quality supply. The size and expense of T&D system in the state has increased manifold over the years. There has been progressive interconnection of power systems leading to evolution of large regional grid. A number of new technologies have also been introduced. There is adequate redundancy in the EHV transmission system but the reliability of the sub-transmission and distribution system has not reached upto the expectation. The energy losses in the T&D system is very high. There is also an urgent need to improve the quality of power supply by minimising the T&D losses.

In order to strengthen and augmentation of the existing sub-transmission and distribution network to serve the consumer better and also to reduce the T&D losses to a reasonable level, system improvement schemes are drawn up from time to time for implementation. At present two such system improvement schemes - (I) Improvement of electric supply system at city of Shillong and (II) Distribution Master Plan of Meghalaya are under implementation.

In addition to this, Board has also taken up a long term measure to install highly accurate electronic/static meters to all high tension consumers with pilfer proof capsule to stop theft of energy. Regular checking of consumers meters in the major town are being undertaken to arrest meter tampering and mal-practices. The ultimate aim of the Board is to establish a cordial relation with the consumer by bringing

transparency in supply and transaction. Computerisation of consumers electricity bills starting with 110 number of consumers in 1989-90 has culminated in covering almost 50% of the consumers of the state as of today, has been a major milestone in the history of utility management in this part of the region. The result is that the revenue earning has gone up from a meagre figure of Rs.60 lakhs in the year 1975-76 to a figure of Rs. 34.50 crores during 1997-98 accountable to sale inside the state only - a quantum jump of 62.50 times during the last 23 years of operation of the Board.

In view of the various steps taken up by the Board, T&D losses within the state has been brought down from 27% to 25% within a time span of 2 years. Implementation of various system improvement scheme and having highly reliable power supply at competitive rate coupled with congenial law and order situation, various industries are being set up in the state. To promote industrialisation and to accelerate economic growth and per capita income of the people, Government of Meghalaya is setting up an Export promotion Industrial Park at Byrnihat. An industrial Growth Centre is also being set up at Mendipathar. Astonishingly, within one year, Byrnihat area has recorded load growth of 108% from 6.3 MW (in 1996 to 13.1 MW in November, 1997). The existing transmission and sub-transmission line of Meghalaya State Electricity Board is shown in fig – 3.

Statistics of achievements in power sector of Meghalaya is shown in table – I.

RURAL ELECTRIFICATION IN MEGHALAYA

To uplift the rural areas, the Government of India in its 20 Point Programme has included rural electrification as one of the main programme. The Government of Meghalaya has entrusted the work to the Meghalaya State Electricity Board.

The Meghalaya State Electricity Board has taken up the electrification work very earnestly when the number of villages electrified was only 261 during the year 1975, just after bifurcation from the then Assam State Electricity Board. It has made a significant achievement by increasing the number of villages electrified to 2510 up to date. However, 100% electrification could not be achieved due to fund constraint, unremunerative tariff structure, poor load growth in the rural areas and high cost of electrification. The percentage of villages electrified is just 49% only covering a rural population of around 65%. If financial support is made available to Meghalaya State Electricity Board, 100% electrification of villages could be achieved by the end of 11th Five Year Plan.

TABLE – I
STATISTICS OF ACHIEVEMENTS IN POWER SECTOR – MEGHALAYA

Sl.No.	Particulars	Position in 1975-76	Position in 1996-97	Growth (%)
1.	Installed capacity(MW)	65.2	186.76	186.44
2.	Capacity utilisation factor (%)	92.0	98.0	6.52
3.	Energy Generation (MU)	175.33	486.01	177.19
4.	Energy availed from the entitled share due from central sector generating agencies (MU)	–	78.26	–
5.	Energy sold within the state (MU)	33.27	300.49	802.88
6.	Energy exported to neighbouring states (MU)	125.47	153.39	22.25
7.	Length of extra high voltage lines (KMS)	270.66	594.36	119.59
8.	Length of Sub-Transmission lines (KMS)	1268.30	7555.49	495.72
9.	Length of distribution lines (KMS)	533.61	5048.33	846.07
10.	Capacity of EHV Sub-Station (MVA)	41.00	158.00	285.36
11.	No of Distribution Transformers	305.00	1863.00	505.24
12.	No. of villages electrified	261.00	2508.00	860.90
13.	Level of village electrification achieved (%)	5.70	51.16	7975.54
14.	No. of consumers	7377.00	1,11,409.00	1410.22
15.	Per capita consumption	25.00	176.76	607.04

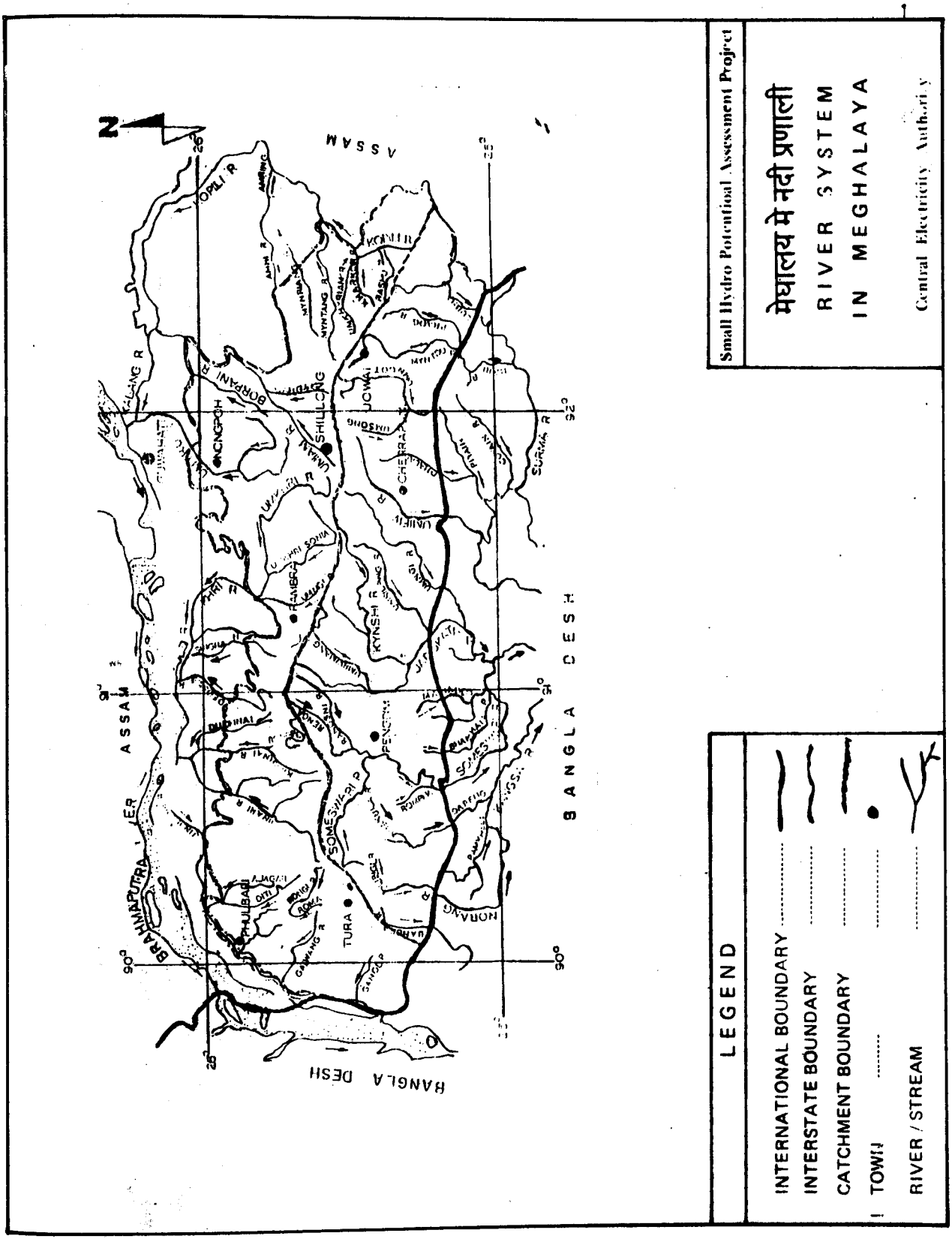
16.	T&D Losses (%)			
	i) overall	9.57	19.32	–
	ii) in the state	39.60	25.65	35.23
17.	Demand within the state (MW)	20.97	92.00	338.72
18.	Percentage of energy sold outside the state	71.56	27.18	–

TABLE - II
POWER STATION UNDER OPERATION IN MEGHALAYA STATE ELECTRICITY BOARD

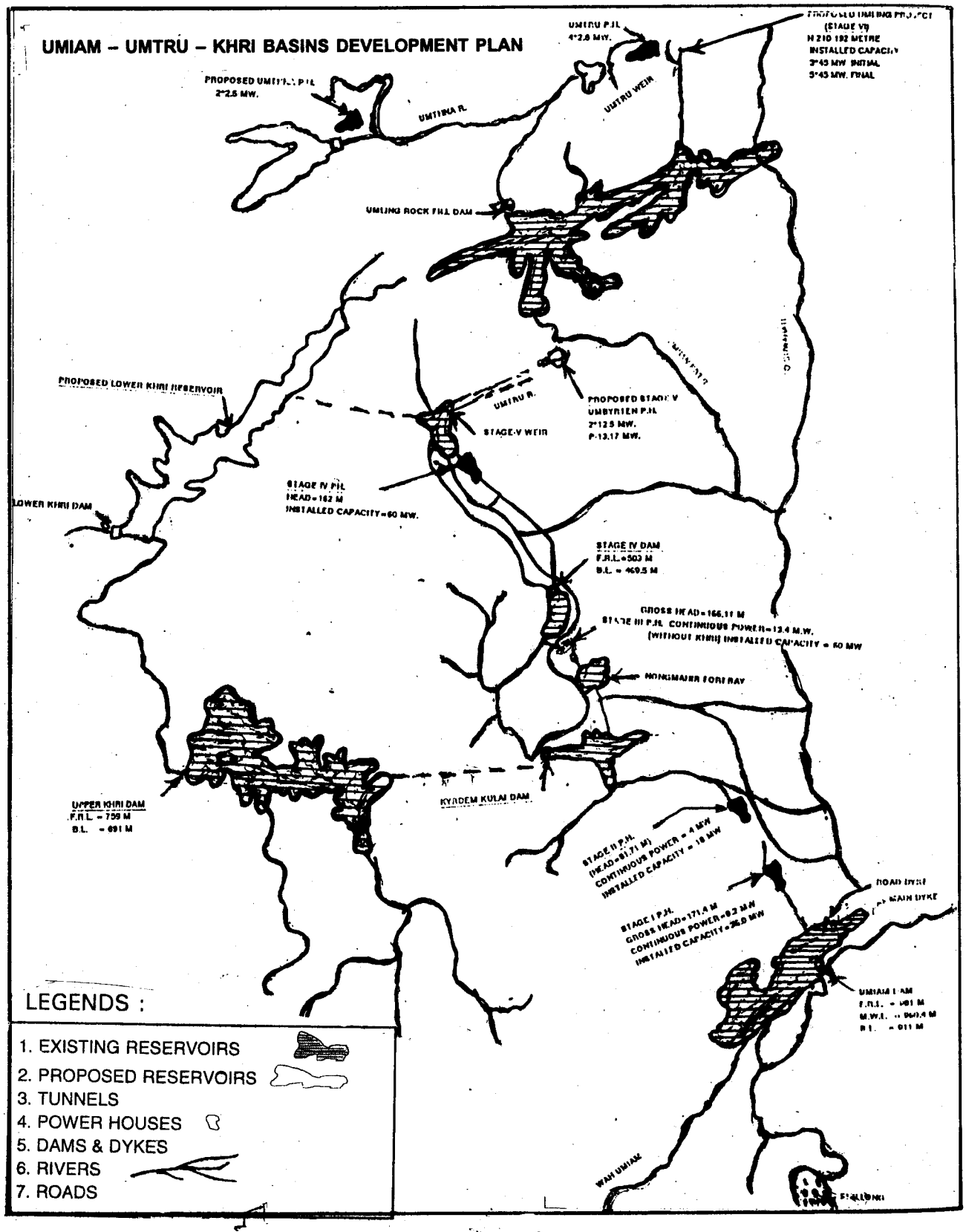
Sl.No.	Name of the existing Generation stations	Capacity (MW)	Year of commissioning
1.	Umtru Power Station	11.2	1957
2.	Umiam Stage I	36.0	1965
3.	Umiam Stage II	18.0	1970
4.	Umiam Stage III	60.0	1979
5.	Umiam Stage IV	60.0	1992

CONCLUSION

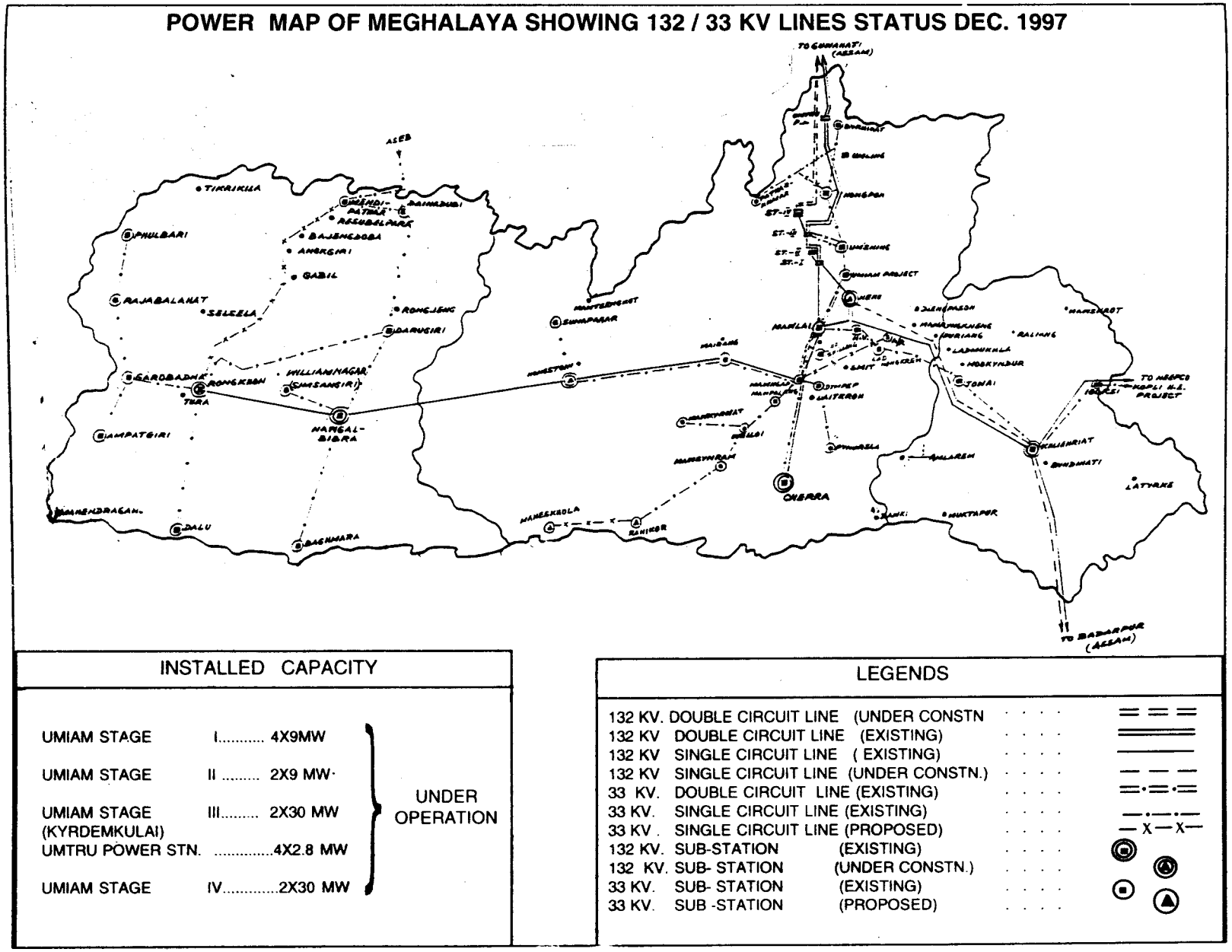
Inspite of significant contribution made by Meghalaya State Electricity Board in the different field of its activities towards the development of the state, there are still more to be done in fulfilling the basic objective for which the State Electricity Board is created. It is Meghalaya State Electricity Board's continuous endeavour to improve its activities and contribute more towards the development of the state.


Small Hydro Potential Assessment Project
मेघालय मे नदी प्रणाली
RIVER SYSTEM
IN MEGHALAYA
Central Electricity Authority
LEGEND
INTERNATIONAL BOUNDARY
INTERSTATE BOUNDARY
CATCHMENT BOUNDARY
TOWN
RIVER / STREAM
ASSAM
BANGLA DESH
BRAHMAPUTRA R
SHILLONG
TURA
JOWAI
CHERRAPUNJI
NONGPOH
BAGHMARA
PHULBARI
SOMESWARI R
KYNSHI R
UMIAM R
BORPANI R
SURMA R
GARO HILLS
KHASI HILLS
JAINTIA HILLS

FIGURE–1


UMIAM – UMTRU – KHRI BASINS DEVELOPMENT PLAN
UMTRU P.H.
4*2.5 MW.
UMTRU WEIR
UMTIWA R.
UMLING ROCK FILL DAM
PROPOSED LOWER KHRI RESERVOIR
UMTRU R.
STAGE-V WEIR
PROPOSED STAGE V
UMBYRTEN P.H.
2*12.5 MW.
P-13.17 MW.
STAGE IV P.H.
HEAD=162 M
INSTALLED CAPACITY=60 MW.
LOWER KHRI DAM
STAGE IV DAM
F.R.L.=563 M
B.L. = 469.5 M
GROSS HEAD=166.11 M
(WITHOUT KHRI) INSTALLED CAPACITY = 60 MW
KYRDEM KULAI DAM
UPPER KHRI DAM
F.R.L. = 709 M
B.L. = 691 M
STAGE II P.H.
HEAD=81.71 M
CONTINUOUS POWER = 4 MW
INSTALLED CAPACITY = 18 MW
STAGE I P.H.
GROSS HEAD=171.4 M
CONTINUOUS POWER=8.2 MW
INSTALLED CAPACITY=36.0 MW
ROAD DYKE
MAIN DYKE
WAH UMIAM
LEGENDS :
1. EXISTING RESERVOIRS
2. PROPOSED RESERVOIRS
3. TUNNELS
4. POWER HOUSES
5. DAMS & DYKES
6. RIVERS
7. ROADS

FIGURE–2


POWER MAP OF MEGHALAYA SHOWING 132 / 33 KV LINES STATUS DEC. 1997
TO GUWAHATI (ASSAM)
TIKRIKILLA
PHULBARI
RAJABALAHAT
SELSELLA
GAROBADHA
RONGKHON
TURA
WILLIAMNAGAR (SIMSANGIRI)
DARUGIRI
RONGJENG
GABIL
AMBAGIRI
BAJENGDOBA
RESUBELPARA
BAGMARA
DALU
MANENDRAGAN
NANGALBIBRA
SUMPAMAR
MANTEDIGHAT
MAWSTEON
MAWLAI
MAWLAIPHU
UMIAM PROJECT
UMIAM
UMSNING
ST-I
ST-II
ST-III
ST-IV
BORNIHAT
MEHGHAR
DJAIN(JASON
MAWSHOT
MAWPHLANG
PURIANG
RALIANG
LADMAWKHLA
MAWKYNDUR
JOWAI
TO NEEPCO KOPILI H.E. PROJECT
UMTRU
UMIAM
UMIAM
UMIAM

TECHNICAL SESSION – VII

APPLICATION OF TECHNOLOGY, PLANNING, ADMINISTRATION & ROLE OF UNIVERSITIES & COLLEGES

SCIENCE AND TECHNOLOGY EDUCATION FOR 2000–NEED FOR A NEW STANCE

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ABSTRACT

Over the decades the aspects of Science & Technology education has been discussed in so many forums, seminars and conferences and such a plethora of literature is available that it is out of place to ponder over the entire spectra of situation on science education. It will be only an attempt to explore nature and place of science and technology in the wider society and examine goals, priorities and achievements of Education of Science and Technology highlighting special issues of concern. Science being accepted as an essential subject of study in one form or the other yet uncontested assumption among teachers of Science and Technology, that the science they teach is simple and relevant not the replica of science in the R&D world is not correct. An attempt will be made to explicate reason why is this and why it demands critical analysis and debate. We must bear in mind that the most of the teaching of Science and Technology occurs in an organized school system within a society that has changed drastically in a short period of time.

That many problems exist in the society that influence the conditions in which teaching of Science and Technology occurs. The rate and nature of change as well as the problems facing the nation and the world also influence the outcomes that can be expected from instruction of Science & Technology. Certain of these problems are of such importance to the educational process that they frame the discussion of this document.

Further the threat posed by technology created in the advanced industrialized countries for its nature and incompatibility with sustainable biosphere and its effects in social conditions of human beings, is alarming. Urgency posed by the ecological crises, changing global environmental conditions in the wake of consistently increasing demand for energy and thereby on natural resources compel exercises and exploration of the ways by which education of science and technology be made responsive to help citizens form rational judgements and participate in the decision making processes in society.

INTRODUCTION

The examination of goals, priorities and achievements of Science and Technology education must begin with the recognition of a bare fact that the education of science and technology occurs by way of its reaching, in an educational system with in a society, which is continuously changing. Further science technology and society today is so intimately related and linked that none of these could be discussed without understanding their aspects of inter-dependence and mutual influences; Therefore any exercise to study the impact of developments of science technology education in isolation of society would be an exercise in futility without meaningful interpretation.

The rate and the nature of change in the society, the problems being faced by the nations, and the world, and the biosphere influence the nature of science and technology education and thereby expectations from its instruction. Some of these problems are so vital, that these demand priority consideration and are the frame work of this critical inquiry.

It is true that various aspects of Science and Technology Education, over the years, have been discussed in so many forums, seminars and conferences and huge plethora of literature is available, thus it is out of place, in this brief presentation, to ponder over the entire spectra of the situation of Science and Technology Education. Only in view of more important changes brought about in a few aspects of science and technology, I shall only attempt here to focus on our experience at Vikram A. Sarabhai Community Science Centre Ahmedabad and Centre for Science Education, North Eastern Hill University, Shillong in the last twenty years in the field of science education and project certain basic questions that needs critical appraisal to determine the nature of science and technology education in the year 2000.

In this context I can't refrain to remark that compared to the heaps of ideas and ideals on science and technology education spelt out on all these years by different bodies, those that have been put into action are far below by any standard. Implementation of many very valuable suggestions are sadly lacking. The reasons are too many to go into each one of these into depth.

At this moment, it is appropriate to recall the remarks made by Dr Vikram A. Sarabhai with reference to our country.

"We have today in India an excellent infrastructure for undertaking complex tasks involving science and technology for resolving the real problems of the nation in the production of food, industrial developments, energy resources, communication and transportation".....

"The Science Policy Resolution of 1958 of the Government of India enunciates clearly and concisely the relationship of science to national goals. And yet more than 10 years later most of us are largely dissatisfied with the role that science is currently playing in promoting the national goals".

(Dr V.A. Sarabhai 1974)

In trying to locate the problem, the fact emerges that "Clearly the development of a nation is intimately linked with the understanding and application, of science and technology by its people. The reality today even after 25 years is no way different. Thus its intimate linkage with education, its practices and practitioners and of socio-cultural structure.

While this is clear, a close look at the present status of science and technology education in the context of prevailing socio-cultural realities would prompt an intriguing inquiry revealing various facets requiring serious concern and in depth understanding.

It is a well known fact that even in the western world the introduction of education of science although was frequently advocated, yet it took two hundred years before this became widely accepted and that too only at higher levels. It took even longer for firmly establishing it in the schools. In our country only after Kothari Commission and later National Policy on education placed emphasis on science and science teaching in schools and institutions with an emphasis on integrated science and scientific temper; and a clause to this effect was introduced in Constitutional obligations under **article 51 A (h)**.

And the justification for science and technology education is not only for its relevance to an industrialised society but for its value in promoting critical understanding, its use in various vocations and transforming the personality which unfortunately can't be realised unless society in which the individuals live is essentially involved in the process.

Of the many circumstances that influence schools, education and thus teaching of science, existing socio-cultural realities and practices are one of the most important aspects which have to be considered and doctored equally well if science and technology education has to make an impact resulting national development.

Does it not surprise, that the advocates of Science and Technology education see science teaching as a necessary component of full education of "all round man" yet if any of these thinkers considered women within the same purview which is a hard but existing reality in our country.

CULTURAL ASPECTS

In India and the North East in particular, culturally and as a society, not only we are still very reluctant to habitually accommodate science and value science, scientific spirit and scientific temper for education of the 'whole', it is limited to the lip service. It is despite the fact that this has been included in fundamental duties of our constitution.

There is growing evidence that socio-cultural heritage under the unavoidable influence of scientific and technological advancements has caused tremendous pressure forcing changes in its structure and practices thereby affecting even primary institution of family by way of its eroding and becoming weaker.

In such circumstances, where science and technology developments in past and prospective for next millenium is the focul, can science and technology education be considered in isolation of the prevailing socio-cultural realities and the cultural resistance to science and technology education which goes much beyond?

- **Despite the fact that the government has made science compulsory, society does not yet acknowledge science as an integral essential part of education. Why?**
- **Is this because no attempt has been seriously made to break down the mystique associated with Science and Scientists?**
- **Is it because that the science is not accessible to majority or is it that we have not been able to make it accessible?**
- **Or we have not been able to convince ourselves why science and technology education for all?**

Intriguing revelation is that the science education being taken perhaps seriously for higher education at the university or professional institution level. But where from the entrants for such institutions come from? Naturally from schools, But then what is the situation of science education at the school level?

Moreover, if the science technology education has to embrace life in general how come serious attempt on science education could confine to higher level or professional level only? Where as the fact of the matter is if the Science is to be learned as a method for cultivation of Scientific temper and spirit, the child is the ideal stage to introduce such attributes.

- **Does it pose another important question that the science and technology education means different for higher education and for all?**

To my mind, it is important to answer above mentioned questions in order to recognise science and technology appropriate and accessible to all which may be different from those who will go for higher studies in science and technology for specialisation.

Why Science & Technology Education for All :

A number of advocates of teaching science have seen it as a necessary component of a full education, of the **'all round man'** may be a few may have considered women within the same purview too.

The major justifications for teaching of science were established early and have continued down today of course with a difference in trend target and necessity. Marquis de Condorcet (1743-94) - the Mathematician turned Politician in the French revolution, saw science as forming part of that essential minimum of knowledge which every citizen must possess in order to be both independent of 'experts' and able to play his part in the society.

John Dewey (1959 - 1952) saw science somewhat similarly, when wrote that it emancipated people from particular space and time and opened intellectual vistas unobscured by the accidents of personal habit and predilection. (Dewey 1916-230).

Famous for his advocacy of **'learning by doing'**, Dewey saw the problems of an educational use of science (as being) to create an intelligence pregnant with belief in the possibility of the direction of human affairs by itself (ibid 225). But situated firmly within the liberal tradition he did not recognise the divisions within this 'intelligence' and therefore the conflicts within science as an institution which we can recognise so clearly today.

The science education was not only justified for its relevances to an industrialised society, but also for its value of promoting understanding and use in various vocations repeatedly again and again in different periods and forms. And accordingly form of teaching was also challenged repeatedly. T.H. Huxley (1825-95), the best known and most persuasive advocate of science education in England advocated general integrated science.

What Should be the Nature of Science & Technology Education :

Integrated science tends strength to the phenomena of the world around us and invites those active methods of study which again have been reinvented from the time of Comenious (1592-1670) to the radical education period of Nineteen Seventies. While discipline divided science taught in the then USSR in 1920's is also focussed on the real world whether with vocational skills in mind or broader perspective of understanding and being master of the world.

Yet, for me it would not be out of context to emphasise here that no development of Science & Technology could be complete unless it is well linked with cultivation of values among **"human beings"** being at the epicentre of the knowledge to acknowledge the invaluable resources around him supporting living systems on earth and the need of their sustainability in order to avoid disasters of multiple nature.

Nevertheless, major focus shaping science at higher, college or school level has been the syllabuses for Entrance Examinations of the University and professional Colleges. Thus the influence primarily have been imparted through the relationship of western universities, which is responsible for linking science education to more specialised disciplines, economy and needs of discipline enrichment moving it far away from its relevance to human and building human capabilities for social and biological responsibility, raising many issues of concern for debate and consensus.

Once again, very appropriately questions may arise :-

- **Should we differentiate between the science and technology education for specialist (a minority) and those who will have no specialise (a majority)?**
- **Should we integrate specialised sciences for their application and use to develop human resources for sustainable biosphere and social responsibility or study science in isolation for its advancement uncaring how it effects the society?**

There is no doubt that the science plays an increasingly important role in all our lives. Many of the great ethical dilemma which we face, have a science base, genetic engineering animal transplants, cloning, fertility treatments, balancing between need and greed, necessity and luxury, personal affording or national or ecological affording power and environmental issues.

Once for all if the debate is settled recognising need of science and technology education for all. Scientific temper, enquiry and background will certainly become urgent priority which should help informed decision making in dilemmas facing society today.

If that be the purpose do we need to transfer all the detailed content and information if the above mentioned purpose is the aim of science and technology education?

- **If it is important that we prepare people and our new generations for a scientific world, which is of course undoubtedly true, then can we say that the science courses we have designed have been designed for this purpose ?**
- **Are they designed to prepare all to live in a scientific world or for a small proportion who will become scientists?**
- **If our purpose is to equip people especially young people to address these and other complex social issues then should we not reframe the science content details, undoubtedly needed for further study with a *consideration of the implications of scientific advances for society and the applications of science.***

It is a hard fact that the content of science is very much affected by the development of science irrespective of its social or developmental need. Therefore, whereas in the first half of the century the scientific theory had little place in the school programmes and appeared only at the higher level of education, primary education lacked the science content completely. But the present century, points to the fact that scientific theory has not only entered the secondary education but has very much permeated the primary level too. But has this resulted in any qualitative changes? No is the answer.

Unfortunately no thought was ever given before introducing the scientific theory at these levels as to what should be included and how it should be taught?

Moreover task of improvement of science education was entrusted to scientists (specialists) or science academicians who believe shifting of the syllabus of higher levels to lower levels or including more and more details of their specialisation is all that would improve science education.

Can this be considered sensible well thought out improvement?

The Way Science & Technology is Taught :

All of us as scientists are much enthused and moved at the great achievements of science and scientists but passing this on to young people is not easy. Perhaps it might be easier if we started with big picture before the detail rather than risk obscuring it with too much content.

Too much detail can obscure the beauty and the wonder of science and its laws, the spiritual and inquiry dimension of science an area which I think has been much neglected.

The syllabus at all levels is just loaded with content; no attempt is made as to find out the competence level of the teachers at the schools, and facilities required for experimentation and do it learn science etc. Thus the essence of science and technology education is completely lost.

How many times we have left the learner tired and sick with the facts and figures instead of exposing him to the wonder of stars or exciting phenomena?

Researchers brief history of school science has indicated that there have been repeated soul searching about what science should be taught and the way it should be taught.

Of the number of valuable critiques which have added to the understanding and made improvements possible in the way science may be taught; two of these are fundamental and promise to be of lasting and major importance.

One is the faminist critique of science expressed by such writers as Bleier, Kelly, Keller, Roser and others.

The other is research into the concepts with which the learners come to the classroom, research now known as alternative frameworks (also known as "Children's Science" or "Naïve Concepts") and which prove so difficult to dislodge. More so because most of us have not thought about them.

Another level is the attempt to improve questioning. This has two perspectives; the first probably more developed than the second. Firstly, considerable attention has been given to the relations developed between teacher and student during questioning.

Simulating an environment of free choice learning, by way of encouraging interactions among same age groups, immediate seniors, volunteers, teachers and professionals.

Help to break questioning into simple forms having recyclic inquiry to evolve solutions from simple to difficult and complicated problems.

Attempts have been made to reduce the tension and element of threat and to encourage a form of questioning which encourages the learners to express themselves and their ideas freely.

Secondly, less attention has been paid to the content of questioning beyond somewhat simple distinction between 'recall' questions and those requiring **'higher order thinking'** for an answer.

Further aspect of practical work in teaching Science which continues to be controversial is one which will have to be considered in the light of experience of teaching for social responsibility.

The debate about the amount of knowledge and the content the citizens of the new century will need not one which is confined to science. Society is already information rich today. How much content the information technology we have at our disposal today makes it easy to access whatever knowledge we need quickly and simply. In the light of this we should reassess how much knowledge we need to convey. I don't mean that the content is not possible but we need to distinguish between what I would call enabling knowledge, the knowledge which enables our students to understand and the knowledge which may be included just because we consider it useful now.

By concentrating on the former we can clear space to provide learners the skills they will need to access and manage information and reduce his school bag load.

It may not be out of place to mention of the story of person who goes into a store and stands besides a man and a dog. To make conversation he asks the man "Is your dog friendly?" The man replies "Yes very", so he bends down to pat the dog which promptly growls and bites his hand. Very much taken aback he says "I thought you said that your dog was friendly?" "I did" his neighbour replies, "but that is not my dog".

It is important to teach science to ask right questions with appropriate context and information and no other subject is better equipped than science and technology for such a learning. In the past we have not seen science in this way and as a result science may have restricted and constrained rather than releasing creative thought.

HOW DOES SCIENCE & TECHNOLOGY LEARNED - HELP UNDERSTAND THE WORLD BETTER?

Human and Social Dimension of Science and Technology is another aspect for concern. I sincerely believe we need to address Science and Technology Education in the year 2000 to the human and social dimension. We all are aware of the stereotype of scientists as strange, aloof and unworldly people and how this might act as a barrier to young people akin to take up science.

I believe we have never capitalised on this aspect and used the work and lives of Great Scientists sufficiently well to enthuse our young people.

What I am even more concerned about how we tend to look upon science as being something out of the human dimension and how we as science teachers are much more comfortable with our subject as an academic one and much less comfortable in dealing with the applications it may have for individuals and the society.

We will readily teach the physiology and anatomy associated with reproduction but not the human dimension and yet increasingly science is impinging on all aspects of human life.

There is a danger that we see science as isolated from the people and society that it affects to, that we dehumanise science. This is false and tragically false. Science is a very human form of knowledge, therefore total alienation of science from community (society) and society from science is a very big lecuna perpetuating tragically false notion of science.

Then the major question bothers me if the awareness of science, is to be brought about the community and the society what are the facilities open?

Moreover, as it impressed earlier that the purview of science and technology education extends to people than another important lacuna in the present pattern of science education is absolutely total alienation of the community (society) and educational opportunities.

They have neither any access to the school nor to the institutions of higher education to realise and appreciate the explosive advancements and impact of science and technology.

The Schools, Colleges, Universities and other levels of higher education and professional education are just isolated not only from the community but from each other also. The lacuna of link among the schools, community and higher schools of learning is a matter which merits urgent serious consideration.

There has to be an organised initiative to overcome such a serious lacuna and enable linking between science technology education, its schools of learning and the community. Such institutions may be informal institutions have scope for free choice learning providing access not only to participants of one level (school children) but for community at large, encouraging interactions at all levels.

At such institutions, facilities should be available to pursue voluntarily certain aspects of science education without the constraints of structured classroom, schedules and examinations. These institutions would thereby provide opportunities to not only the school children but also to all those who want to either learn or help learning various aspects of science in different ways and also kindle in them the spark for pursuing a science career or at the least do science joyfully by exposure to excitement of science learning. As most of them would have lost touch with science and its happening either by virtue or not having had a science orientation or having completed their education would have settled down to a particular profession.

"Pluto said that education is not about filling the vessel but about lighting the light, the task we face as we look into the new century and the millennium is the task of lighting that light within our young people."

The interaction of such institutions with universities and colleges would also pave the way to more realistic approach on the part of University personal to the problem of early science learning (school science).

It has been accepted worldwide that science and technology teaching is to contribute to a sort of intellectual stimulation as the basic approach to the study of science is after all an abstract process with respect to the natural environment. This is precisely the process by which children of elementary level should try to learn about the world around them.

If science and scientific spirit and method are the basis of life today.....there lies in science the search for truth on the other hand and betterment of humanity on the other".

Pt. Jawaharlal Nehru, address to National Academy of Science.

I believe that we as science & technology concerned persons and educators must come out from behind the barricade of science as purely a form of knowledge. This will not be comfortable. It will bring no into difficult and controversial areas for which we may not feel equipped. However not do so is to fail to acknowledge the real significance of science and technology in the new century i.e. year 2000 and new millennium.

In order to bring about such a proper understanding of the aspect of science not only at the school level but also develop a realistic awareness of the impact of science and technology in the community, a link institution (organised initiative) divested of all formalistic procedures would perhaps the right answer. Centre for Science Education, North Eastern Hill University set up in 1985 has been experimenting with such objective in the field science technology and mathematics education.

The results have been exceedingly exciting and positive. This Centre has acted as very effective link not only between the schools and community but also as a forum for interaction with the universities and the other professional, institutions and non-governmental, volunteer organisations. In fact, such community science

centres are catching up in western world. Lawrence Hall of Science, Exploratorium are couple of examples of similar nature.

CONCLUSION

End of 20th Century has made us convinced that —

- **There is a clear understanding if not agreement about the core elements of knowledge.**
- **Science and technology are now accepted fundamental elements of the education.**
- **There is also consensus on the need of science and technology education for all.**
- **The role and responsibility of such education need not only confine to formal schools of elementary or higher education which does not have an access to general community.**
- **We have more clearly defined the scientific processes and are making significant efforts to turn them into learning experiences, increases their access both by way of outreach and understanding and assess them for their relevance and impact.**
- **We have understood the role and responsibility of scientists, technologists and each one dealing with it and the educators and general community towards coming generations and biosphere supporting living systems.**
- **We have committed and concerned teaching force capable of bringing together expertise in science, pedagogy and social understanding of the people. There is no doubt that the knowledge and expertise for a truly informed debate is here. We need to harness it in debate and discussion so that we can use it to shape and mould scientific experiences of our young people into those most appropriate for the year 2000.**

All these above, and our experience at Centre for Science Education if is of any indication, such community oriented organised initiatives would definitely prove substantially effective to overcome big lacuna in science and technology education and fulfill the need to humanise science and technology.

INSTITUTE OF ADVANCED STUDY IN SCIENCE AND TECHNOLOGY – A PROFILE OF ON-GOING RESEARCH ACTIVITIES

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ABSTRACT

A Research Institute with the name 'Institute of Advanced Study in Science and Technology (IASST)' was established at Khanapara, Guwahati in the year 1997, by the Assam Science Society, a premier Scientific academy of Assam. The aim of the Institute is to promote high level research in the state of Assam in particular and the NE region in general. The Institute is being developed as per provision of the Assam Accord since 1991; Central Government agencies like DST, DBT and the Department of Environment have come forward to support its research activities through some time bound projects. The Govt. of Assam has been providing grant-in-aid to the IASST since 1991 for its maintenance.

At present, the institute is carrying out research and development activities in the following fields.

1. Plasma Physics
2. Mathematical Sciences
3. Bio-technical research on Bio-fertilizer
4. Sericulture with reference to the development of 'Muga' and 'Eri' Silk Worms.
5. Medicinal Plants of NE region.
6. Training and research in Computer Science.

The institute is registered under societies registration act of 1860. Details of activities done in different Divisions of the Institute are discussed in the paper.

INTRODUCTION

The Scientific Community of Assam has long since been demanding for a Research Institute having adequate infrastructure for carrying out high quality research in frontier areas of Science and Technology and applied areas which are bearing potentialities for development and management of the resources of the NE region. A humble beginning was made in 1979 by the Assam Science Society, the premier scientific academy of Assam, in setting up the 'Institute of Advanced Study in Science and Technology (IASST)' with meagre financial assistance from the Government of Assam. The Institute was formally inaugurated by Prof. Dorothy C. Hodgkin, the Nobel Laureate on November 3, 1979. The long standing demand of the Scientific Community of Assam for setting up a well equipped and financially viable National level Institute for Advanced Research in S&T with adequate support from the Central Government has, therefore, arisen as a national aspiration of the Scientists of the State which was reflected as one of the demands agreed to clause 7 of the Assam Accord.

The Task Force constituted by the State Government in 1989, as per advice of the Planning Commission, recommended that the Institute of Advanced Study in Science and Technology agreed to the Assam Accord should be nucleated around the existing Institute of Advanced Study in Science and Technology, Guwahati with suitable structural and organisational set up.

The Inter-ministerial meeting held on November, 1991 at Technology Bhavan, New Delhi, under the aegis of the DST, Govt. of India decided that the Scientific activities in Assam should be enhanced through the various recommendations in the Task Force Report, the research activities should be grown around the existing IASST and these activities could be eventually enlarged and consolidated in the form of the Institute of Advanced research in S&T.

The Central Government agencies like DST, DBT and Department of Environment have been providing financial assistance to the Institute under some specific time-bound projects as per decision of the Inter-ministerial meeting.

The IASST, registered under Societies Registration Act of 1860 as a separate entity, has been provided grant-in-aid for its maintenance by the State Government since 1991. The activities of the IASST are being carried in rented buildings of individuals. A plot of land measuring 20 acres had been allotted to the Institute by the State Government in greater Guwahati to set up its campus, the construction of which is yet to be started due to financial constraint.

OBJECTIVES

The primary objectives of the Institute shall be :

1. To build up a research centre with facilities for fundamental and advanced studies in different selected fields of pure and applied science with a view to enlarging the frontiers in these fields.
2. To promote original and/or applied and interdisciplinary investigations in areas considered appropriate.
3. To sponsor projects in selected fields in science & technology including projects concerning the development and utilization of resources of the NE region and on environmental science involving wherever possible in collaboration with advanced research centres both within and outside the country and also collaboration among academic and industrial research centres.
4. To diffuse knowledge by organising discourses, lectures and collequia, demonstrations, special courses and workshop, seminars and summer/winter school etc. in areas of interest to the Institute.
5. To institute visiting Professorship, Research Associate and maintain chairs and research fellowship.
6. To collect information in regard to research and development on various disciplines of Science and Technology and establish a Data Bank for use by the research workers.
7. To establish and maintain a research and reference library in pursuance of the objectives of the Institute.
8. To establish and maintain a 'Sophisticated Instrumentation Centre' primarily to cater to the needs of the Institute as well as for projects sponsored on inter-institutional collaborative basis and met the demands of other academic, Industrial and Government etc. for such facilities.

ACTIVITIES OF THE INSTITUTE – PROMOTION OF S&T IN NE REGION

The main aim of setting up the IASST is to create a congenial atmosphere of research in this part of the Country which is reported to be lagging behind the rest of the country, in terms of high quality research in frontier areas of Science and Technology. The talented students of the NE region are deprived of taking up research as career due to lack of adequate facilities in the region. The IASST aims at generating facilities to attract the brilliant students of the region towards carrying out substantial research in emerging areas of Science and Technology as well as development and management of the resources of the region which are dwindling at a faster rate.

Programme on Plasma Physics :

The IASST has, therefore, chosen the research fields carefully so as to avoid any duplication with those being investigated in different Universities and other research institutions. The IASST has taken up research programmes in a fascinating field like Plasma Physics which is related to generation of alternative source of energy for mankind. The developed as well as developing countries have undertaken programmes for carrying out research on Plasmas known as the Fourth State of Matter. The goal of the research in Plasma Physics is to create fusion reactor which might solve the energy problems of the mankind in years to come. It is expected that within next 25 years, the Plasma Physicists may reach their goal. If the technology of fusion reactor is made economically viable, a large number of technical manpower in the field will be required. It is encouraging that the Government of India has considered Plasma research as thrust area to meet the challenge of coming years. Keeping in parity with the Central Government, the IASST has taken up research programmes in Plasma Physics. The Institute has been carrying out research in Plasma Physics both theoretically and experimentally since 1983. During the last 15 years, the Institute has been able to occupy an important place in Plasma research in the Country. A sizable number of manpower in Plasma Science and Technology has been developed. This is besides making substantial contribution on the studies of basic properties of Plasmas. The IASST has set up a good laboratory for studying non-linear phenomena of Plasmas with the financial assistant of the Government of Assam & Govt. of India and also donation of a good number of sophisticated equipments by the Institute of Space and Astronautical Science (ISAS), Japan through the international collaboration of Prof. Y. Nakamura of the said Institute.

The Scientists have been studying both theoretically and experimentally, solution, chaotic phenomena of Plasma, Plasma - instarabilities and sheath phenomena in Plasmas. Some very interesting results have been reported in the standard research journals of national/international repute.

A double Plasma device has been set up for ion-beam Plasma system and parameterisation of chaotic systems in a well-designed vacuum chamber with Plasma parameter, n = 10 $^{-}$ 10 cm, Te = 2-3 ev where n and Te are the Plasma density and temperature respectively. It has been found that mode-mode Coupling leads to periodic bifurcation when an external sinusoidal signal of frequency close to the frequency of the internal cillation is applied to the source anode and the amplitude to the external signed is varied slowly. It is also found that chaotic threshold in multicomponent Plasmas increases with the increase ratio of negative ion to positive ion, but after a critical ratio it becomes saturated.

The sheath instability in multi-component Plasma has been studied. In a double Plasma device the ion-sheath is produced around a negatively biased grid placed between the two chambers. The instability excited by the ion-rich sheath in a Plasma is characterised by different parameters like Plasma density, ion-beam energy, sheath thickness, electric field in the Sheath region etc. It has been found that if the density difference between the two chambers is slowly decreased, the intensities exhibit oppositely different characteristics after a critical value. Below the critical value of the density ratio, the energy resonance of the background ions and the beam ions is a typical condition for the excitation of such instabilities. Chaotic phenomena happen to occur when there is a hump in the Plasma potential profile near the sheath edge.

The properties of a steady state ion rich sheath and sheath induced instability in multi-component plasmas with negative ions have also been studies. The study of sheath phenomena in negative ion-plasma is getting importance in Plasma processing, ion source, study of lower atmosphere, fusion research etc. The presence of negative ions in a plasma critically changes the plasma dynamics, dispersion relation, beam interaction etc. The dependence of sheath thickness on different concentration ratio of negative to positive ions and biasing voltage of the grid and the source chamber has been observed. In the multi-component Plasma, there exists a point near the negatively biased grid at which the negative ions are reflected. The potential at this point becomes equal to the K.E. of the drifting ions. Therefore, there exists a region with mostly of positive ions near the grid and few electrons towards the sheath edge. In this region, the positive ion current to grid is space charge limited and given by the child Langmuir Law. The Institute has been planning to undertake the programme of 'Plasma processing' which has industrial applications.

Programme on Mathematical Sciences :

It has been observed that the NE region is yet to generate a congenial atmosphere of research in the fields of mathematics and statistics. There are a good number of talented students who are interested to pursue higher studies in Mathematics and Statistics. But, they have to desist from their ambition due to lack of opportunities. With a view to generating an atmosphere conducive to research in Mathematics and Statistics, the IASST has set up a division of Mathematical Sciences in 1992. The Division is presently funded by the DST, Government of India under a major project of 5 years duration. The main object of the division is to generate interest for higher studies in Mathematical Sciences among the young talents of the region. The scientists of the division are conducting research on number theory, Harnomic analysis, Matrices, Probability and Statistics. In addition, studies on manpower planning in the NE region are being carried out. It is also proposed to make applied statistical studies on some socio-economic aspects of the NE region and to provide for a nodal centre for Science and Technology management information system for the NE region.

The scientists of the division during the period have published as many as 20 research papers in standard journals of national/international repute.

Programme on Bio-fertilizer :

The chemical fertilizer has helped immensely in the increase of agricultural products. It has been found to make adverse effect on the soil fertility as well as on the environment. As such, global awareness has been developed to replace chemical fertilizer by bio-fertilizer. Search for appropriate micro-organism(s), symbiotic or asymbiotic for future biofertilizer is continuing worldwide. The IASST has also taken up programme for studies and development of biofertilizer. The main objective of the programme is to isolate and identify the local viable strains of Rhizobia for fixing atmospheric nitrogen in symbiosis with common pulses of Assam. Till date Rhizobium strains/inoculants have been importing from outside the state. As Rhizobium is highly sensitive to change, it could not bring about the anticipated deserving results under field conditions.

We have so far screened 6 (six).native strains (Ar-I, GR-I, BR-12, Br-8, Ar-10 and GR-21) of Rhizobia from 134 pure isolates, isolated from t Common pulses (Black gram, Green gram, Arhar, Gram, Pea, Lentil and a local bean) of 6 Districts of Assam viz. Nalbari, Kamrup, Nagaon, Sonitpur, Lakhimpur and Jorhat. The

strains are brady Rhizobium of Cocopea group having wild host range capability i.e. the strains can infect Blackgram, Greengram, Arhar, Groundnut, Cowpea, Pea and Soyabean. The strains are found to be acid tolerance, Resistance to antibiotics and good nitrogenase activity (4-6 mol/Gr.) and they also increase the production upto 32 & 34% in B.G. & G.O. during Rabi & Kharif respectively on organic bleeding. The strains with characterisation were deposited in DBT's Culture bank at Micro-biological Division, IARI, New Delhi and also preserved in our laboratory for further studies. The IASST has planned to extend the study of Rhizobium soil in respect of blackgram, greengram, lentil, Arhar, Urdbean, lathyrus and Pea for the entire NE region and a project to this effect has been submitted to the DBT, Govt. of India. In the Biofertilizer unit, another project entitled "Survey Collection and study of Phytopathogenic fungi of cultivated Crops of Assam" is being investigated for disease fore-casting and bio-control of major crops diseases.

Programme on Sericulture :

Assam boasts of rearing mainly three types of silk worms namely Eri, Muga and Mulberry. But Muga Silk Worms could be reared only in Assam and some parts of Meghalaya mainly in Garopahar; no where in the world Muga silk worms could be reared. But, this indigenous muga industry is declining gradually due to various reasons. The IASST has taken up programmes for strengthening the industry. One of the reasons for declining muga products has been the practice of outdoor rearing of muga silk worms which is badly affected by the vicissitudes of nature. The myth of impossibility of rearing muga silk worms indoors has been belied through the evolution of a indoor rearing technique by Scientists of the IASST. It has been considered as a break-through in muga silk industry, if the technique be propagated among the muga rearers and made popular. The new indoor rearing technique of muga silk worms, evolved by Dr J.N. Talukdar, Honorary Professor, IASST has the following advantages over the out-door rearing being practised by the people from time immemorial.

The mortality rate is conspicuously low in indoor rearing. About 71% cocoons could be harvested from such rearing against only 22% in out-door rearing. The duration of larva period could also be reduced by at least 12 days in winter season. More man days are required round the clock for out-door rearing. For management of about 10,000-15,000 larvae of 1-3 and 4-5 stages, it requires, as estimated, only about 4-5 man hours and 7-8 man hours respectively per day. It is estimated that a person can rear about 7000-9000 larvae by applying the technique in a room with floor area of 6M x 4.5M having 9 racks with 8 trays each. Each tray made of bamboo, can hold about 100 larvae of 5^{th} stage. It is also envisaged that taking advantage of multivoltine character of muga silk worms, 4-5 commercial crops could be harvested in a year by adopting the new indoor rearing technique against only 2 such commercial crops under out-door rearing.

The Institute has already undertaken a programme for taking the technique from lab. to field with the financial assistance of the DST, Government of India. The technique has successfully been demonstrated among the muga rearers of Boko areas of Kamrup District and Karanga areas of Jorhat District of Assam and attempt is going on to demonstrate the technique among the muga rearers scattered in different parts of Assam. Attempts for generation of high-yielding varieties of seed for 'Eri' and 'Muga' Silk worms through the application of molecular biology have been initiated.

Programme on Medicinal Plants :

The entire North-Eastern region is endowed with rich flora and fauna. This region is full of medicinal herbs. Herbal Medicine is being used by the rural people since time immemorial for the treatment of several diseases, specially the tribal people of the region are the traditional users of herbal medicine. But most of the herbs are found to be threatened and endangered. It is need of the hour to preserve these valuable species and to find out the efficacy of these medicinal herbs for the treatment of various diseases. The IASST has taken up programmes for survey, collection and preservation of these rare herbs and also for making bio-chemical studies with special reference to treatment of hepatic disorder, diabetics, hypertension and birth-control. Active principle of two herbal medicinal plants namely Doerhaavia diffuse Linn and The vetia Nerifolia Juss have been isolated, the chemical nature of the active principles have been established with the emperical formulae of C16H25NO3 and C25H38O4. The active principles have been administered into experimental animals and effect have been investigated covering carbohydrate and lipid moities and some of the enzymes. The active principle of both the medicinal plants posses the hypogly caemic and hypolipidaemic effect either stimulating or inhibiting the enzyme systems. The Scientists working on 'Naphafu' Clerodendron Colibrookianum has isolated a glycosyl sterol, glycosyl stigmasta - 5, 25(27)-diene- a novel compound along with some compounds.

Extensive research works on the plant L. lavendulefolia has been taken up and the Scientists have determined the LD50 of this plant in different forms on experimental animals.

Programme on Environment & Resource Management :

The NE region has already been identified as the hot-spot of biodiversity. But due to natural calamities and man-made activities, the natural resources of the region are being depleted. Unless proper measures are taken up, a large number of species might be extinct within a short span of time. Although the region is industrially backward, a few industries, grown up, have been reported to be causing extensive impact on the environment. So, it is the need of the hour of conserve our eco-system. Keeping in view to this aspect, the IASST has undertaken programmes for evolving strategies for the sustainable development and management of plant and animal resources of the NE region and to suggest remedial measures to mitigate environmental pollution reported to be caused by several industries mainly due to oil exploration activities and opencast mining in Assam.

The Institute has already executed two projects namely —

(i) A study on impact of oil exploration on microflora in rice field soil of Assam and (ii) Development of micro-biological method(s) for control of hydro-carbonaceous pollutants in Soil of Assam.

The following results have been found through our investigations :

a. The occurrence of micro-organism were found to be higher level at a distance of 100 meter away from the flaring point of GGS/OCS as compared to the occurrence of micro-organisms at a distance of 50 meter in most of the experimental oil fields.
b. At a distance of 50 meter away from GGS/OCS, size of the microbial population was found to be minimum as compared to the other distance in most of the experimental oil fields.
c. The quantitative nature of the bacterial and fungal population in the soil near oil exploration region was found to decrease with increasing depths of the soil.
d. Free living nitrogen fixing and Ammonofying bacterial population were found to increase in the soil sample collected at a distance of 100 meter away from GGS/OCS.
e. Petroleum pollution had a direct on pH organic carbon content, water holding capacity, Ex ions, and bulk density of the soil.
f. Concentration of Zn and Pb in rice grain, husk and soil is found to be increased with increasing the crude concentration in the soil.
g. Fige different hydrocarbon degrading bacterial species viz. Pseudomonas aeruginosa, pseudimonas stutzari, Bacillus aneurinolyticus, Saratia Marcescens and Azotobacter chroococcum have been isolated from petroleum polluted soil of oil field of Moran (OCS No. - 1).
h. P stutzati was found to be more effective amongst the isolated.
i. Only A. Chroococcum shows ability to degrade hydrocarbons as well as to fix atmospheric nitrogen. Other species do not show ability to fix atmospheric nitrogen, though they degrade petroleum hydrocarbons efficiently.
j. All the above bacterial species except S. marcescens were present in the soil sample having natural to slightly alkalinity, while S. marcescens was present in soil sample having slightly acidic (pH6).
k. It is possible to enhance the local microflora viz. bacterial and fungi in the test soil samples by using nitrogen and phosphorus containing fertilizer. As a result, this beneficial impact on degradation of petroleum hydrocarbons can best be utilized in natural conditions in future.

The Division has undertaken a programme of developing tissue culture facility incorporating the state of art technology in the field which will be utilized not only for developing fast and suitable regeneration techniques for ex-situ maintenance of endangered and rare plants but also for experiments relating to other proposed projects.

Programme on generation of Manpower in Computer Science and application :

The Computer Science and Technology has already revolutionized every fields of human endeavour. It may be expected that the 21st century will be the age of computer and Bio-technology. The NE region is lagging behind in this aspect too. The IASST has made a sincere effort in this aspect. It has undertaken manpower generation programme to cater the need of technical manpower in the field for the NE region in

particular and the country in general. The IASST has been imparting training to unemployed youths/students/employed persons through different courses recognised by the Govt. of Assam and the Govt. of India. The Institute has been conducting DOEACC 'A' level advanced diploma of one-year duration accredited by the DOEACC Society, DOE, Govt. of India and Post graduate diploma of Computer application of one year duration recognised by the State Council for technical Education, Assam.

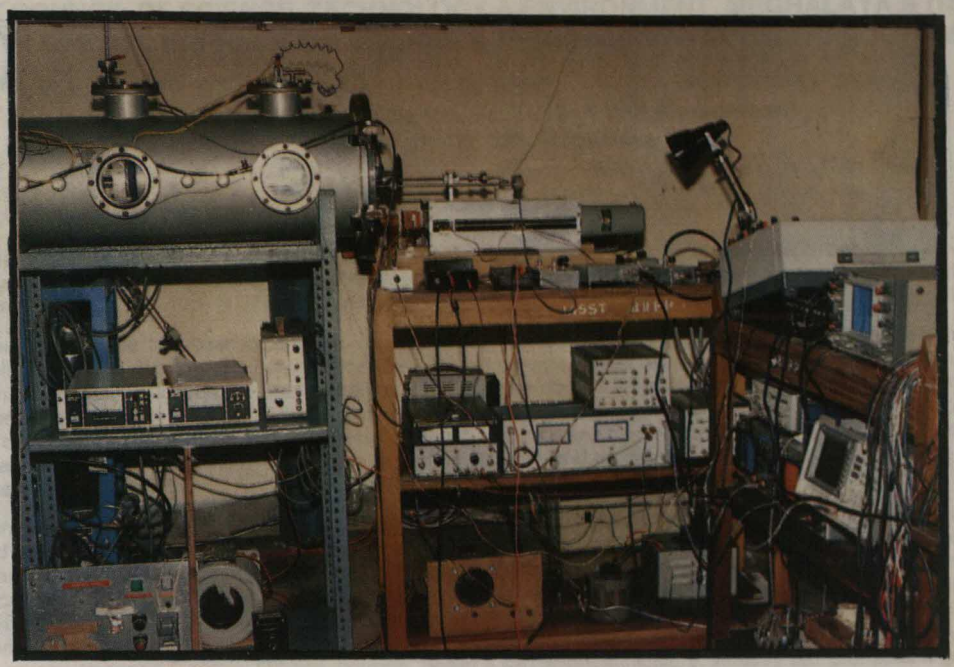
CONCLUSION

One must appreciate the significance of having adequate infrastructure for carrying out substantial research in the frontier areas of Science & Technology. Although the IASST was set up long back in 1979, it is yet to have its own campus, the activities of which are being carried out in rented buildings of individuals. The Government of Assam could not provide fund for setting up of the complex of the IASST due to its financial crunch. The State Government has requested the Government of India to support the Institute fully by the DST, Government of India and to upgrade it into a national level Institute.

Once the adequate infrastructure including laboratories, buildings etc. are made available the IASST might take up more plans and programmes relating to socio-economic development of the NE region. In this regard, it may be mentioned that the slow pace of industrial development of the region is due to shortage of power. Abundant power could be generated by tapping vast water resources of the region which is, in turn, becoming a liability instead of a resource.

The IASST has also initiated programmes for generation of Hydro-Electric Power by utilising the vast water resources in the state. The Institute has also approached Central Government for financial assistance and Grants to minimise the inadequacies and to bolster high quality research in frontier fields in the North-East. This will enable the Institute to be at par with similar institutions elsewhere in the Country.

Double plasma System along with the pump,motor driving system and different probes used in the experiment of Sheath phenomena.



FIGURE–1

Indoor rearing of muga silk worm in a bamboo trays.

FIGURE–2

STATE COUNCIL OF SCIENCE, TECHNOLOGY & ENVIRONMENT, MEGHALAYA & ITS ACTIVITIES WITH SPECIAL EMPHASIS ON SCIENCE & TECHNOLOGY – SOCIETY PROGRAMMES

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ABSTRACT

The word "Science" to us means the knowledge of the composition, structure, characteristic, behaviour etc. of all things around us including the human being. By "Technology" we mean the application of Science for useful purposes in our day to day life.

The human race has been putting into use Technology since the early days without keeping much thought on its applicability, capacity, diversity etc. For instance, during the stone-age people have been making a fire by rubbing two stones without having much thought on the Science behind it and the potential of it's application in the form of various processes and techniques. However, later, in view of the progress of civilisation and the need for alternatives in different sectors to suit the comfort of human beings, people started thinking on how to improve and diversify the existing or traditional techniques and processes through an in-debt study of the various such techniques and processes including the things around us. This has led to the advent of "Science".

Since then, Science and Technology have been moving hand in hand and developments in Science & Technology have led to new phases of transformation in the life of the people accompanying by many wonders. When we look back, much has been achieved in the area of Science & Technology in different sectors. However, a lot has to be done in the area of application of Science & Technology for the upliftment of the living condition of the people at large, especially the rural poor. A number of research agencies in the country are putting their efforts towards the development of new technologies and alternatives for solving the day to day problems in the society. It is indeed a fact that Science & Technology in the areas of food, energy, transport & communication, housing, health & sanitation, agriculture, industry etc. promises a great impact in providing a better living condition in the society. However, for effective utilization of Science & Technology for this purpose a coordinated effort among the scientific community, the society, the policy makers, voluntary agencies, Govt. machineries, etc. ought to be evolved.

INTRODUCTION

During the post Independence period, India has made remarkable progress in the realm of Science & Technology, especially, in the fields of Space Science & Technology, Atomic Energy, Modern Physics, Industry, Communications, Agricultural Sciences, Medical Sciences, Defence Science & Technology, Computers and Electronics and so on. The achievement in Science and Technology in the country was very significant in the first two decades after India's Independence. During the last 50 years, India has created a wide range of infrastructure for scientific research in varied fields of Science & Technology. By now, a network of laboratories is spreading in the entire length and breadth of the Country offering facilities to solve almost each and every problem needing science & technology inputs for solutions. A number of these laboratories, especially the Regional Research Laboratories are specially charged with the task of conducting research on local raw materials for gainful purposes and solving local problems in industry, agriculture, housing, health & sanitation, energy etc. and other problems in the society at large.

GENESIS, STRUCTURE ETC. OF STATE COUNCILS ON SCIENCE & TECHNOLOGY IN THE STATES

In the beginning of the Sixth Five Year Plan, it was realised that while India had achieved significantly in areas of high-Science & Technology like Atomic Energy, Space Science, Electronics etc. a great deal of concentration ought to be focussed towards directing the benefits of Science & Technology to the States at various levels i.e. state, district and block level. For this purpose, the necessity of creating State Council on Science &Technology in the States and Union territories was highlighted during the formulation of the Sixth Five Year Plan. As an outcome of the initiative taken by the Deptt. of Science & Technology, Govt. of India and the Planning Commission in this direction, almost all the States and Union territories have now established State Councils on Science & Technology. These Councils are serviced by respective professional S&T Secretariats.

Most of the Councils on S&T are headed by the respective Chief Ministers and many members of which are drawn from different Science & Technology disciplines. The heads and the officers of the Secretariats of these Councils are professionals drawn from different Science & Technology backgrounds.

The Deptt. of Science & Technology under the Ministry of Science & Technology, Govt. of India launched the scheme termed as "Assistance for Development of State Councils of Science & Technology" during the

Sixth Five Year Plan. This scheme continues till date. The scheme includes some support for staffs and other initial infrastructure for the Secretariats of the State S&T Councils.

The State Councils on Science & Technology are charged with the responsibility to act as focal agencies for the promotion Science & Technology for the development of the respective states. This responsibility includes the task of advising the State Government on S&T policy, identification, formulation, coordination/implementation, monitoring and follow-up of schemes on S & T for the benefit of the state as a whole and the country in general.

The State Councils are expected to bring together a broad spectrum of experts involved in S & T, planning and decision making, actual generators as well as users of Science & Technology including young research scholars in the process of application of Science & Technology for the development of the respective states.

Considering the innovativeness of S&T schemes, the Govt. of India has been stressing on the functional autonomy of State Councils on S&T and in many states the State Councils on S&T are functioning as autonomous bodies.

State Councils on S&T are mainly co-ordinating agencies where in the process of execution of various S&T plans and programmes in the state, the involvement of the scientific community, voluntary organisations, Govt. machinery, S&T volunteers, etc. is very much needed.

The Govt. of India also impressed upon having separate departments of Science & Technology in the States especially for the purpose of budget and for interaction with the other State Govt. departments on S&T policy, implementation and follow-up of S&T Schemes.

STATE COUNCILS OF SCIENCE TECHNOLOGY & ENVIRONMENT (SCSTE) MEGHALAYA

A State Council on Science & Technology was constituted in the state way back in 1984 and a Science & Technology Cell was created in the Planning Deptt. of the State Govt. thereafter for acting as the Secretariat of the Council. In the course of time, the activities of the Science & Technology Cell became predominant in the S&T picture in the state where the significance of the State Council of Science & Technology thus constituted got diluted.

In the beginning of 1995, in line with the pattern that exists in other states and the guidelines of the Deptt. of Science & Technology, Govt. of India, a State Council on Science & Technology was re-constituted afresh in the State in the form of a small and compact professional body under the name and style of **"State Council of Science, Technology & Environment (SCSTE), Meghalaya"**. The Council is headed by the Chief Minister with the Minister, Science & Technology as the Vice-Chairman. Representatives from the Planning, Finance, Education and Forest & Environment Departments of the State Govt. and heads of central scientific agencies located in Shillong are members of the Council.

The main aim of the Council is to promote Science & Technology in the State for the development of the state as a whole.

The basic role of the Council is to act as a focal agency for all matters pertaining S&T activities in the state and ensuring effective utilisation of S&T for the benefit of the state as a whole.

The Council is functioning as an autonomous body of the State Govt. registered under the Registration of Society's Act having its own technical secretariat.

ACTIVITIES OF THE COUNCIL

(I) **Popularisation & Communication of Science & Technology :** Under this programme, a number of schemes are being carried out in the State at the state, district and block level for inculcation of scientific temper among the general masses. Schemes on communication of Science, particularly, those related to natural events like the Total Solar Eclipse '95, Visit of Hale Bopp Comet in 1997 and many others were also organised by the Council. These schemes are carried out in the form of exhibition, quiz, essay competition, project works of children, debate, planetarium show, S&T audio visual show, popular lecture, science exposure trip, Science hobby camp, etc. Similarly, environmental awareness activities are also conducted from time to time under this programme.

(ii) **Introduction of Appropriate Technologies :** The task of identification, experimentation, modification, demonstration, training and popularisation of appropriate technologies is carried out under this programme through various schemes. Technologies like improved chulhas, low cost sanitation, low cost water filter, rain water harvesting, stabilised mud block technology, micro concrete roofing tiles, ferro-cement technologies are notable technologies taken up in the State under the S&T sector.

(iii) **S&T Entrepreneurship Development :** The basic objective of this programme is to encourage the utilisation of innovative technologies for self-employment generation among the unemployed youths of the State, particularly, those from S&T backgrounds. In the past, a number of S&T entrepreneurship development programmes were organised in association with research agencies like CBRI-Roorkee, CFTRI-Mysore, RRL-Jorhat, IISc-Bangalore, SERC-Ghaziabad, etc.

(iv) **Sponsored Projects :**

(a) **Specific Projects :** The aim of this programme is to promote scientific research, surveys/studies for accessing and solving local specific problems. A number of projects have been taken up in the past under this programme and currently a project on "Assessment of Breathing-level Air Quality of Greater Shillong" is being taken up in association with North-Eastern Hill University and the State Pollution Control Board.

(b) **Student Projects :** This programme is aimed at encouraging young students in general colleges, polytechnics, engineering colleges, universities to take up research-oriented projects related to the problems pertaining to the state, thus, motivating them to take up R&D activities in future.

(v) **Library & Documentation :** A small Library has been set up having a number of books, publications, journals, magazines, etc on various areas of Science & Technology. A video library section contains a good number of video cassettes on interesting topics of S&T. The library is also documenting regularly the trainings conducted by various scientific institutions on different scientific & technical areas. These training are being made aware to the general public through the media from time to time.

(vi) **Science Centres :** Under this scheme, facilities for supplementing science education in schools and for inculcating scientific temper among the general masses are being created in the form of science centres. This programme has been taken up recently at Nongstoin and Tura and currently the programme is being taken up at Nongpoh and Jowai.

(vii) **Remote Sensing :** This programme aims at promoting the use of remote sensing technology in the process of utilisation and management of the natural resources in the state. Currently, the State is co-operating with the Deptt. of Space, Govt. of India and the North Eastern Council in the establishment of the North East Regional Remote Sensing Service Centre at Shillong.

(viii) **Training of Scientists :** The programme aims at updating and enhancing the scientific and technical knowledge and skill of the S&T personnels in the various development sectors of the state.

SCIENCE & TECHNOLOGY – SOCIETY PROGRAMMES

Concentration was made during the Eight Plan Period in the state in the programme of Popularisation & Communication of Science & Technology. This was done so keeping in mind the fact that the people at large need to have a scientific temper to welcome the innovations that Science & Technology could bring in their day to day life.

In the Ninth Plan, the stress is shifted to the programme on introduction of appropriate technologies keeping in view of the role that Science and Technology can play in uplifting the living condition in the society, particularly, in the rural areas.

By appropriate technology, we mean the technology which is suitable for the prevailing local conditions and which is making maximum use of locally available resources and infrastructures like local manpower and skill, locally available materials, local climatic conditions etc.

Realising the fact that Science and Technology can play its role in reducing or eliminating the problems that exist in the society in areas of housing, health & sanitation, energy, food, industry, etc. effort is being made in the Ninth Plan to identify and introduce appropriate technologies aimed at providing a better living condition in the society. Thus, a number of appropriate technologies have been identified which could be introduced in the State during the Ninth Plan Period. Few of such technologies are highlighted here under :

SCIENCE & TECHNOLOGY SECTOR, MEGHALAYA – APPROPRIATE TECHNOLOGIES FOR THE NINTH PLAN

Sl.No.	Field	Technologies	Institutions / Agencies
1.	Housing	1. Mud-Block	IISc, Bangalore
		2. Micro Roofing Tiles	DA, New Delhi
		3. Prebaf-bricks panel etc.	CBRI, Roorkee
		4. Ferro-Cement Components	SERC, Delhi
		5. R.R. Blocks (Masonry Block)	CBRI, Roorkee, HESCO
		6. Lime Pozzolina Cement	IISC, Bangalore
		7. Non-erodable Mud Wall	CBRI, Roorkee
		8. Thatched roof (Fire Retardant & Extended life)	CBRI, Roorkee
2.	Energy	1. Gassifier (Biomass-based)	IISC, Bangalore, PE, HE
		2. Water-Mill	HESCO,CERT
		3. Kitchen-Waste based Biogas Plant	SPE
		4. Improved Chulhas (Fixed Models)	S&T Cell, HESCO
		5. Improved Charcoal Briquette	Centre for Villages, Wardhar HESCO
		6. Wind Mill	NAC, Bangalore
		7. Wind Pump (Samira)	NAC, Bangalore
		8. Drier	CFTRI, Mysore, HESCO
		9. Biogas for Lighting & Pumping (Biomass-based)	IISC, Bangalore
3.	Water Supply & Sanitation	1. Ram-Pump	HESCO
		2. Ferro-Cement Tanks	SERC, Delhi
		3. Rain Water Harvesting	SERC, Delhi, HESCO
		4. L.C. Sanitations-Stone based, brick based, Ferro-Cement	CBRI, Roorkee, HESCO
		5. Water filters (ferro-cement)	CBRI, Roorkee
		6. Waste Water Disposal	CBRI, Roorkee
4.	Communication	1. Citizen Band Radio	DOE, DOT
5.	Cottage Industries	1. Fruit & Vegetable Processing	CFTRI, Mysore, HESCO
		2. Agro-based Processing	CFTRI, Mysore, HESCO
		3. Paper – Recycling	Dev. Alternative, New Delhi
		4. Blacksmithy (Improved)	MERADO, NML, Jamshedpur
		5. Paper/Leaf cup-making	CFTRI, Mysore
		6. Ferro-Cement Components	SERC, New Delhi
		7. Copula Furnace	NML, Jamshedpur
		8. Mini Rice Mill	RRL, Jorhat
		9. Pickle & Chutney Making	CFTRI, Mysore, HESCO
		10. Micro-Concrete Roofing Tiles	Dev. Alternative, New Delhi
		11. Mud-Block	IISC, Bangalore
6.	Technologies for Women	1. Fruit & Vegetable Processing	CFTRI, Mysore, HESCO
		2. Pickle & Chutney Making	CFTRI, Mysore, HESCO
		3. Plantation of Medicinal & Aromatic plants, etc.	RRL, Jorhat
		4. Paper/Leaf Cup Making	CFTRI, Mysore

Coordinated by : The State Council of Science Tech[illegible]gy & Environment (SCSTE), Meghalaya.

Introduction of appropriate technologies will involve various Science & Technology – Society Programmes pertaining identification, experimentation, modification, demonstration and popularisation of such technologies.

The major role of the State Council of Science, Technology & Environment, Meghalaya in the S&T – Society Programmes will be in the form of providing effective co-ordination for implementation including certain financial and technical inputs etc.

In implementation of S&T – Society Programmes in the state, voluntary agencies and S&T volunteers have to play a major role particularly in the process of identification of problems which need solutions through appropriate technologies and in the process of executing the programmes in the field.

The scientific community in the state has its own role to play in the S&T – Society Programmes of the Council especially in the process of identifying solutions to the problems affecting the society and in monitoring the implementation of the programmes including follow-up.

National research agencies are the major sources of expertise for the execution of S&T - Society Programmes in the Ninth Plan. Their involvement would be in providing technologies available with them for introduction in the state with certain modifications to suit the local conditions and to generate new technologies and techniques to solve local specific problems as and when required.

Regarding the appropriate technologies available with the Council at the moment, the Council can arrange technical assistance in respect to technologies like, Improved Chulha, Rain Water Harvesting, Low Cost Water Filter, Low Cost Sanitation, Stabilised-Mud Block, Ferro Cement Technologies etc. Interested individuals and voluntary agencies are welcomed to interact with the Council in the implementation of these technologies for the benefit of the Society at large.

Few national research agencies who could render assistance in respect of S&T – Society Programmes are named below :

Central Building Research Institute, Roorkee - 247667
Central Food Technological Research Institute, Mysore - 570013
Central Leather Research Institute, Adyar, Chennai - 600020
Regional Research Laboratory, Jorhat - 785006
Regional Research Laboratory, Jammu - 180001
Regional Research Laboratory, Sachivalaya Marg, Bhubaneshwar - 751013
Regional Research Laboratory, Hoshangabad Habibganj Naka, Bhopal - 460026
Structural Engineering Research Centre, Sector 19, Kamla Nehru Nagar, Ghaziabad - 201002, UP.

The Deptt. of Science & Technology, Govt. of India is also implementing a programme termed as "Science & Society Programme" through its separate Science & Society Division. The basic aim of this particular programme is to promote the use of Science and Technology for the benefit of the society. The projects implemented under this programmes relate to (1) Science & Technology applications for rural development (2) Science & Technology application for weaker section (3) Science & Technology for women (4) Young scientist (5) Tribal sub-plan (6) Programme for schedule castes. These project aer normally of the following types - (1) Field investigations/survey of local economy (2) Development of new technology (3) Field testing (4) Adaptation of available technologies (5) Demonstration and skill development.

The support available from the Deptt. of Science & Technology, Govt. of India under the Science & Society Programmes are :

(i) Long term-core support :- Long term grant to selected voluntary organisations undertaking science & society activities.

(ii) Time bound support :- Support for innovative application of Science & Technology for rural development.

(iii) Small support :- Support for workshops, seminars etc. on specific areas of S&T for rural development.

The Deptt. of Science & Technology, Govt. of India through its Science & Society Division encourages voluntary organisations to take up activities aimed at socio-economic development through application of Science & Technology and offers the above supports accordingly.

A number of appropriate technologies have been implemented successfully by the Deptt. of Science & Technology in the areas of sericulture, rabbit rearing, water and sanitation, low-cost preservation and processing of horticultural produce, land and water management, low-cost construction technologies, blacksmithy and carpentry, herbal medicines, medicinal plants, leather processing, value-added products from bamboo, lemon grass oil extractions, micro hydel plants, electronics, leaf cup making, minor forest product etc.

Interested voluntary organisations may contact the Head, Science & Society Division, Deptt. of Science & Technology, Ministry of Science & Technology, Technology Bhavan, New Mehrauli Road, New Delhi - 110016.

A number of institutions and voluntary organisations are available in the country who are operating with the sole objective of promoting the application of Science & Technology in the society. These organisations are engaging themselves in the task of development of appropriate technologies as well as modification of available technologies for the benefit of the society at large. Most of such technologies are low cost technologies based on locally available materials and other resources. These technologies play an important role in reducing or eliminating the problems in the societies especially in the areas of housing, energy, farming, post-harvest technology, transport, health and hygiene, water and sanitation etc. A few of the organisations who have been active in promoting Science & Technology for the betterment of the society are listed below :-

- Centre of Science for Villages, Magan Sangrahalaya, Wardha, Maharashtra - 442001
- Himalayan Environmental Studies and Conservation Organisation (HESCO), Vigyan Prash, Gwar - Chauki, Gholtir - 246436, Chamoli, Garswal. UP (Hqrs Dehradun)
- Society for Rural Industrialisation, Bariatu, Ranchi - 834009, Bihar
- Development Alternatives, B-32 Quatab Institutional Area, New Mehrauli Road, New Delhi 110016
- Centre for Development of Rural Technology, Institute of Engg. & Rural Tech., 26-Chatham lines, Allahabad - 211002
- Sardar Patel Renewable Energy Research Institute, Vallabh Vidynagar, Gujarat - 388120
- Centre for the Application of Science & Technology to the Rural Areas (ASTRA) Indian Institute of Science, Bangalore - 560012
- Centre for Application of Science & Technology for Rural Development, Indian Institute of Education, 128/2 J. P. Naik Path, Kothrud, Pune - 411029.
- Council for Advancement for Peoples Action and Rural Technology, India Habitat Centre, Zone-5A (Core-C), 2nd floor, Lodhi Road, New Delhi - 110003.

The State Council of Science, Technology & Environment (SCSTE), Meghalaya welcomes ideas and suggestions from concerned individuals, institutions, voluntary agencies etc. for effective utilisation of Science & Technology in the state especially from members of the scientific community. The Council also welcomes interactions and discussion which would lead to improvement of the implementation of Science & Technology programmes in the state. At the same time the Council expresses its sincere gratitude to the concerned members of the scientific community, voluntary organisations, academic institutions including S&T volunteers and many others who have lend their support and co-operation for the successful execution of activities of the Council in the past.

PRIMARY HEALTH CARE & FAMILY WELFARE SERVICES IN INDIA IN THE CONTEXT OF THE STATE OF MEGHALAYA – AN OVERVIEW

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ABSTRACT

HEALTH CARE :

- Primary healthcare services in India is essentially provided by the public health sector. The significantly large public health sector of the country with a structure which is mostly a continuum from the colonial period, is however dwarfed by the larger private health sector, which has a strong urban bias. While a mere 32% of the hospitals are located in the rural areas, only 20% of the hospital beds are located in rural areas.

- The Central Plan Allocation on Medical & Public Health has constantly decreased, over the successive five-year plans, in terms of the percentage of such allocation to the overall plan outlay. This has handicapped the quality of health care services in general and primary healthcare in particular.

- The present focus of the country's public health care policies and strategies are for extending holistic healthcare services, with special emphasis on the rural population. Care has been taken during the present decade to ensure that the restructuring of out socio-economic strategies, consequent to the opening up of the nation's economy, did not effect the programme for provision of essential health care services, particularly to the uncovered segments of the rural population. Some of the steps taken in this regard, include specific efforts to consolidate and strengthen the primary healthcare infrastructure with earmarked funds under the new Basic Minimum Services programme and to enhance assistance for critical national health care programmes.

- A substantial proportion of the Specialist posts in the CHC's continue to lie vacant due to non-availability of Specialist of man-power. Consequently, the CHC's are unable to achieve their targetted function of serving as a first-referral-centre fort the PHC's. The shortfall has had far-reaching disenabling effects on the health care services delivery system.

- Growth and development of appropriate health care manpower, commensurate with the needs of the healthcare delivery system is essential for providing holistic healthcare services. The National Education policy for Health Sciences, as approved by the Central Council of Health and Family Welfare during 1993 has suggested setting up of an Educational Commission in Health Science to oversee, coordinate and support activities in this important areas.

- An analysis of the ongoing State and Centrally-assisted health care programme indicate that lack of properly trained and motivated medical and para-medical mmanpower in key positions, is one of the main factors for poor performance under the healthcare programmes, particularly in the rural areas.

- Communicable Diseases which have been and continue to be the major cause of morbidity and mortality in India, are the main concern of the primary healthcare services. In view thereof, several Centrally Sponsored programmes have been taken up for the contral of communicable diseases. The ground status of each of the ten main programmes for control of such diseases vi. The NMEP, NLEP, NTCP, NACP, WBD, IDD, CDS, NBCP, NCD, and ISM&H are briefly highlighted in the paper.

FAMILY WELFARE

- The National Family Welfare Programme was launched in India during 1951 with the objective of reducing the birth rare through voluntary but informed, responsible and planned choice, with a view to stabilize the population at a level consistent with the requirement of the national economy. This corresponds to an annual natural population growth rate of 1.2 per cent by the year 2000 A.D. The programme has faced slippages and the target ANPGR of 1.2% is now expected to be achieved by 2016 A.D.

- The targetted population stabilization corresponded to reducing the birth-rate (CBR) from 41.7 to 21 per cent per thousand, the crude death-rate (CDR) from 22.8 to 9 per thousand, the crude mortality-rate (IMR) from 146 to 60 per thousand. While the country has so far achieved a CBR of 28.3 per thousand, a CDR of 9 per thousand and an IMR of 74 per thousand, the State of Meghalaya has achieved a CBR of 29 per thousand, a CDR of 7.1 per thousand and an IMR of 58 per thousand.

- Consistent with the policy of ensuring a stabilized but healthy level of population, priority has been accorded to the matemal and child health programme. A technology mission for universal immunization has been introduced with full coverage of all districts of the country.

India now marches towards a healthier twenty-first century.

01.0 STRUCTURE

01.01 Primary health care services in India essentially provided by the public health sector. The significantly large public health sector of the country with a structure which is mostly a continuum from the colonial period, is however dwarfed by the larger private health sector. The private health sector basically caters for curative

care of qualitative standard for the economically more affluent sections of society. The private health sector has grown phenomenally since the mid-70's. Its presence is overwhelming in the area of general practice and super-specialist referral services. Numerous studies show that medicare services is being increasingly provided by the private sector. Available data presented in table-I below, establishes the ascendancy of the private sector hospital care services :

TABLE - I

Year	PERCENTAGE OF					
	Hospitals & Dispensaries Under –		Hospitals & Dispensaries Beds Under –		Allopathic Doctors Under –	
	Public Sector	Private Sector	Public Sector	Private Sector	Public Sector	Private Sector
1971	81.4	18.6	78.5	21.5	39.6	60.4
1981	71.2	28.8	71.6	28.4	29.4	70.6
1991	41.5	58.5	67.8	32.2	26.6	73.4

01.02 Apart from the public-private dichotomy which restricts access of the poor to healthcare services, there is an even more severe inequality, that of rural-urban distribution of healthcare services. Available data shows that –

- While 32% of the hospitals are located in the rural areas, only –
- 20% of the hospital beds are located in rural areas.

01.03 The comparative rural-urban distribution of healthcare services is reflected in table-II below :

TABLE – II

Parameter	In Urban Areas	In Rural Areas
No. of hospitals per "000 population	3.53	0.57
No. of hospital-beds per "000 population	238.00	20.00

02.0 POLICY FRAMEWORK

02.01. The present focus of the country's healthcare policies and strategies of extending healthcare services, particularly to the rural population can briefly be summarised as follows :

[1] Major investment in development and strengthening of primary healthcare infrastructure aimed at improvement in quality and outreach of services.

[2] Consolidation and expansion of the secondary healthcare infrastructure upto and including the district level services.

[3] Optimisation of the functioning of the existing tertiary healthcare network, and

[4] Building up of referral and linkage system so that optimal utilisation of available facilities, at each level is possible.

02.02. Special care has been taken during the present decade of the 90's to ensure that the restructuring of our socio-economic strategies, consequent to the opening up of the nation's economy, did not effect the programme for provision of essential healthcare services, particularly to the uncovered segments of the rural population.

02.03. Some of the steps taken in this regard, include :

[1] Specific efforts to consolidate and strengthen the primary healthcare infrastructure with earmarked funds under the new Basic Minimum Services programme.

[2] Enhanced assistance for critical programmes such as :

1. The National Malaria Eradication Programme in the North Eastern Region.
2. Which experienced high incidence of falciparum malaria.
3. Blood-Safety network for screening blood against HIV infection.
4. Free distribution of drugs for short course chemotherapy for indigent patients suffering from tuberculosis.
5. Free cataract surgery for treatment of cataract related blindness in the elderly.
6. Promotion of Indian System of Medicines and Homeopathy.
7. Involvement of NGO's in healthcare services.
8. Intensified IEC (Information, Education & Communication) activities.

03.00 PRIMARY HEALTHCARE

03.01 Primary healthcare infrastructure is essential for sustained and continuous outreach of healthcare and family welfare services in the country. Earmarked Plan funds for strengthening of Primary Healthcare infrastructure under Minimum Needs/ Basic Minimum Services Programme have therefore been provided under the Eighth plan with emphasis on consolidation and operationalisation of primary healthcare institutions with a view to optimise performance, through completion of buildings, filling up of vacant posts, supply of equipments, drugs medicines and in-service training of health workers.

03.02 Physical targets and achievements of the country vis-à-vis Meghalaya are briefly indicated in table–III below :

TABLE - III

	Parameter	Target	Achievement	
			India	Meghalaya
1.	Rural population by a SC.	3,000 - 5,000	4,752	4,068
2.	Rural population by a PHC	20,000 - 30,000	28,836	16,735
3.	Rural population by a CHC	1,00,000	2,61,000	84,476
4.	No. of SC's for each PHC	6	6	4
5.	No. of PHC's for each CHC	4	9	5

SC = Health Sub-Centres; PHC = Primary Health Centres; CHS = Community Health Centres

03.03 The financial norms for funding construction of SC's PHC's and CHC's were drawn up decades ago. The enormous cost-escalation during the last two decades has resulted in a critical mismatch between earmarked financial resources and physical targets for the establishment of primary healthcare institutions, leading to non-achievement of targets for creation of new facilities for uncovered segments of rural India. However, the progress of work for consolidation and strengthening of the three-tier network of SC's, PHC's and CHC's for delivery of health and family welfare services to the rural community, has been fairly satisfactory. Nevertheless, there is an urgent need to revise the norms for non-recurring as well as recurring funding of the primary healthcare institutions, as the present norms are wholly inadequate for achieving the assigned goals.

04.00 MEDICAL & PARAMEDICAL MANPOWER

04.01 A substantial proportion of the Specialist posts in the CHCs continue to lie vacant due to non-availability of specialist man-power. Consequently, the CHCs are unable to achieve their targetted function of serving as a first referral centre for the PHCs. This shortfall has had far-reaching disenabling effects on the health and family welfare delivery system.

04.02 Though the norms prescribe on Male Worker's and One Female Worker per 3000 population in hilly and difficult terrain, and one Male Worker and One Female Worker per 5000 population for all others areas, the number of Male Multi-Purpose Workers in position in only half of that of Female Multi-Purpose workers.

04.03 Vacancies of radiographers, laboratory technicians and other para medical personnel have serious implications on the successful implementation of programmes such as the NMEP and the NTCP. Board details of the medical and para-medical manpower vacancy position is reflected in table-IV below :

TABLE - IV

Category	No. in position	%'of posts vacant
1. Surgeons	678	37.2
2. Obst. & Gynaecologists	411	48.6
3. Physicians	452	34.8
4. Pediatricians	314	50.8
5. Doctors at PHCs	23803	14.8
6. Block Extension Educators	5770	7.7
7. Male Health Assistants	18505	7.8
8. Male Health Workers	61788	13.1
9. Female Health Assistants/LHV's	19084	11.4
10. Female Health Workers/ANM's	129089	6.0
11. Pharmacists	19317	10.1
12. Laboratory Technicians	9817	20.3
13. Nurse Mid-Wives	11433	24.0
14. Radiographers	1064	19.9

04.04 Growth and development of appropriate healthcare manpower commensurable with the needs of the healthcare delivery system is essential for providing holistic healthcare services. The National Education Policy for Health Science, as approved by the Central Council of Health and Family Welfare during 1993 has suggested setting up of an Educational Commission in health Sciences to oversee, coordinate and support activities in this important area. Further, keeping in view the changing disease profile and changes in the treatment regimens over the last decade, there is an urgent need for in-service training programme to enable the existing manpower to provide high quality and holistic healthcare services. There is also need to identify existing lacunae in the under-graduate and post-graduate level medical teaching programmes and to take suitable corrective steps to remedy them.

04.05 An analysis of the ongoing State and Centrally-assisted programmes indicate that lack of trained and motivated medical and para-medical manpower in key positions in one of the main factors for poor performance under the healthcare programmes, particularly in the rural areas. The non-availability of qualified laboratory-technicians and male multi-purpose workers has emerged as on of the main reason for poor case detection under Malaria Education and Tuberculosis Control Programmes.

Realising the need for generation of adequate para-medical and the fact that the need would vary from state to state and from year to year, the Planning Commission has accepted ten areas of health related vocational training programmes in the 10 + 2 stream, as identified by the Expert Group on health Manpower Development. Some states have so far made use of this facility. It is essential that optimum utilisation of this provision is made so that each State can generate appropriate manpower to fully operationalise the primary healthcare infrastructure which has already been put into position.

05.00 CONTROL OF COMMUNICABLE DISEASE

05.01 Communicable Diseases have been and continue to be the major cause of morbidity and mortality in India. In view thereof, several Centrally Sponsored programmes have been taken up for the control of communicable diseases. The main programmes for control of communicable diseases are briefly highlighted as follows :

05.02 National Malaria Eradication Programme [NMEP] :

05.02.01 The NMEP is the oldest of the communicable disease control programmes in the country. The estimated number of Malaria cases in the country during the last few years is reflected in table - V below :

TABLE – V

Year	No. of Malaria cases In lakhs	No. of falciparum Malaria cases in lakhs
1992-93	21.20	8.80
1993-94	22.00	8.50
1994-95	25.00	8.30

05.02.02 Focal outbreaks of malaria particularly of the falciparum strain with varying morbidity and mortality rates occur periodically. There is a progressive increase in the incidence of falciparum-malaria in the North Eastern region. Increasing resistance to "Chloroquin", the drug used for treatment of malaria, and to a variety of insecticides used for spraying operations for vector control, is a major cause for concern.

05.02.03 Problems of time non-availability of insecticide-sprayants and of reaching the insecticides to the sites of spraying-operations in time, coupled with critical resource gaps for meeting programme costs, result in disruption of timely spraying-operations.

05.02.04 It is essential to note that over 60% of all reported falciparum malaria cases with high fatality rate come from the tribal belts of the country including the north eastern states.

05.02.05 Keeping in view the emerging position, the NMEP has now been made a 100% centrally funded programme for the north eastern states with a Modified-Plan-of-Action for the control and eradication of malaria. Similarly, intensification of malaria control activities in the tribal areas of Andhra Pradesh, Uttar Pradesh, Madhya Pradesh, Rajasthan, Gujrat, Maharashtra, Bihar and Orissa have been taken up with assistance from the World Bank.

05.03 National Leprosy Eradication Programme [NLEP] :

05.03.010 India has over half of the known leprosy cases in the World. The NLEP has adopted a strategy for early case-detection and multi-drug-treatment(MDT) regimen. Initially, efforts were made to cover all the endemic districts where the prevalence rate of leprosy exceeded two per thousand population. Of late the NLEP has been extended to areas earlier not covered, such as the states of Madhya Pradesh, Uttar Pradesh, Bihar, Orissa and West Bengal with World Bank assistance. The present intensified programme is expected to reduce the rate of prevalence of Leprosy to one per thousand population by 2000 A.D.

05.03.02 While successful implementation of the MDT will cure leprosy, the deformities already developed or those developing later due to peripheral nerve damage will continue to handicap cured leprosy cases. Continuing efforts are there for essential to reassure such patients that persistence of such deformities do not mean that the infection has not been cured. In addition, correction of deformities and rehabilitation of those with persistent disabilities should receive due attention, so that these persons can function effectively and be assimilated into the productive workforce of the country.

05.03.03 In Meghalaya, Leprosy is endemic in a limited pocket of Umden and adjoining areas in the Ri-Bhoi District and the Rongjeng area in the East Garo Hills District. There are 1259 leprosy cases in the State with a prevalence rate of 0.68 per thousand population.

05.04 National Tuberculosis Control Programme [NTCP] :

05.04.01 The efforts for improved diagnostic facilities and streamlined provision of drugs for short course chemotherapy for treatment of tuberculosis patients have been intensified since the Eighth plan period. The focus of the programme is now on "early case detection", and "good case holding". These measures are important in view of the ever-increasing drug-resistant strains of M. Tuberculosis and the expected increase in the number of tuberculosis patients due to the association between TB and HIV infection.

05.04.02 Keeping in view the increased prevalence of HIV infection in metropolitan cities and the consequent potential for increase in number of tuberculosis cases, a World Bank funded project for NTCP in ten metropolitan cities namely, Calcutta, Mumbai, Madras, Bangalore, Hyderabad, New Delhi, Pune, Lucknow, Bhopal and Jaipur has been taken up for implementation.

05.05 National AIDS Control Programme [NACP] :

05.05.01 India has the distinction of having initiated the NCAP very early in the silent phase of HIV epidemic. The NACP was evolved on the basis on Indian data and is rational and feasible. Recognising the importance of initiating a vigorous intervention programme during the silent phase of the epidemic, adequate funds have been provided for the programme to combat and minimise the magnitude of an HIV epidemic in India, Keeping in view the benefit of having had roughly a decade's warning to the impending onslought of HIV zero positivity in epidemic scales, which is expected within the first decade of the twenty-first century.

05.05.02 The major components of the NACP and the share of allocation of funds for each component are indicated in table-VI below :

TABLE – VI

Sl.No.	Name of Component	% of funds allocated for The component
1.	Modernising the Blood Banks, Blood Safety – Screening donated blood sampled of ensure Its total safety.	35.00 %
2.	Strengthening of STD Control Programme	4.50 %
3.	Surveillance and Clinical Management	10.50 %
4.	IEC Activities	44.00 %
5.	Miscellaneous	6.00 %

05.06 Water Borne Disease :

05.06.01 Diarrhoeal diseases including cholera and other water borne diseases such as viral hepatitis and typhoid fever to extract a heavy toll in terms of morbidity and mortality, particularly in the North Eastern region including Meghalaya.

05.06.02 There is an urgent need to strengthen the efforts currently underway to provide safe drinking water and improve environmental sanitation, so that morbidity due to water borne diseases is reduced.

05.06.03 This is especially important in view of the emergence of strains of salmonella, shigella and other bacteria which are resistant to generally used antibiotics and consequent increase in the cost of therapy as well as case fatality rates.

05.07 Iodine Deficiency Disorders [IDD] :

05.07.01 Over 15% of the Indian population have the risk of developing Iodine Deficiency Disorders. Presently 540 lakhs Indians are suffering from Goitre, 66 lakhs have minor neurological disorders and 22 lakhs are victims of criticism.

05.07.02 Universal use of Iodised-Salt is the simplest, safest and cheapest way of preventing IDD. Although, the Goitre Control Programmes is also one of the oldest centrally sponsored programmes in the country. IDD remained essentially unaltered over the first four and a half decades of out nationhood. Lack of awareness of the necessity of consuming iodised salt, coupled with the problems of transportation and storage of iodised-salt have been the main cause for the continued high rate of incidence of Goitre.

05.07.03 As at present, although the country has an installed capacity for production of approximately 6.2 million tonnes of iodised salt per year, the actual production is approximately 3.0 million tonnes per year, only against a demand of 5.2 million tonnes.

05.07.04 Efforts are in hand to increase the production of iodised salt. Use of non-iodised salt has already been banned in the country. Simultaneously, Quality-Control measures to test iodised salt at all levels, from the manufacturer to the consumer, have been evolved and are being implemented.

05.07.05 The ultimate goal of the IDD Control programme is to reduce the incidence of Goitre to below 5 per 100 to totally eliminate criticism by the year 2000 AD.

05.08 Communicable Disease Surveillance :

05.08.01 The continued prevalence and periodic focal outbreaks of communicable diseases in the country is the result of overcrowding, lack of safe drinking water, and poor environmental hygiene.

05.08.02 The existing waste-disposal systems in urban as well as rural areas of the country are woefully inadequate and lead to adverse environmental hygiene and pollution of drinking water sources.

05.08.03 The existing network for surveillance of communicable diseases, reporting thereof and pre-emptive response measures thereto is most vulnerable and needs wholesale revamping, reorganisation and modernisation besides upgradation and strengthening.

05.08.04 A number of measures have been introduced during the Eight plan period to initiate corrective interventions. The recommendations of the High Powered Committee on Urban Solid Waste Management set up by the Planning Commission, as well as the recommendations of the Expert Constituted by the Union Ministry of Health and Family Welfare to review the Public Health System, which have extensively reviewed the quality of epidemic surveillance, effectiveness of the existing health schemes, status of primary health infrastructure in rural areas, and the existing health management information system, are now available. It is expected that the implementation of the recommendations of these two Committees will result in interventions which will make a dent on the control of communicable diseases and the rate of morbidity and mortality from such diseases in the country.

05.09 National Blindness Control Programme [NBCP] :

05.09.01 Over 85 per cent of the blindness in the country is due to Cataracts. The NBCP which is a 100 per cent centrally sponsored programme seeks o reduce cataract related blindness from 1.4 per cent during 1980 to 0.3 per cent by the year 2000 AD. A World Bank funded blindness control programme is currently under implementation.

05.10 Non-Communicable Diseases :

05.10.01 The last three decades have registered a substantial decrease in infant mortality and an increase in Life Expectancy in India. The changing demographic profile due to shift in are structure of the population and increasing longevity as reflected in table-V below, and alteration of life-style due to socio-economic changes, appear to have led to a progressive increase in prevalence of non-communicable diseases such as diabetes mellitus, cadio-vascular diseases, traumas and cancers. In addition degenerative disorders like cataract, hearing-impairment, and arthritis are common in the elderly and cause considerable disability.

05.10.02 Thus while the country gears itself up to combat the continuing communicable disease, it needs to simultaneously develop programmes to effectively deal with the emerging problems of non-communicable disease and degenerative disorders of the elderly.

05.10.03 Hypertension, diabetes mellitus, cardio-vascular diseases, cerebro-vascular diseases, traumas and cancers are major health problems which are increasingly affecting the middle-aged and elderly population in recent years. Early onset of diabetes, gestational diabetes, pregnancy induced hypertension, myocardial infarction and hypertension in the relatively younger age-group has been increasingly reported and has become a major cause of concern to all health-care planners.

05.10.04 Health education aimed at lifestyle alterations and reduction in the "at-risk" behavioural patterns of the population are essential to reduce the future burden from these diseases. Of equal importance is the early detection and prompt and adequate treatment of the victims of these emerging problems as well as management of complications and rehabilitation of those with disabilities.

TABLE – VII

Year	Percentage Distribution of Total population for the principal are groups(in years)			Population in the 60+ years age group in crores	Index of Ageing
	0-14 years	15-59 years	60+years		
1971	42.02	52.01	5.97	3.27	14.21
1981	39.70	54.20	6.10	4.17	15.39
1991	35.60	57.80	6.60	5.58	18.54
1996	33.70	59.30	7.00	6.49	20.77

05.11 Indian System of Medicine and Homeopathy (ISMH) :

05.11.01 The Indian system of medicine and Homeopathy have for long been widely accepted in the country and practitioners belonging to these systems are available and provide health-care at affordable costs in the remotes rural areas. With a view to consolidate and upgrade these ancient and affordable systems of health-care. The Government of India have set up a separate department of Indian System of Medicine and Homeopathy. Some states have followed suit. The Central Government has already urged the other States to do likewise.

05.11.02 The new Department of ISM & H. has focussed its efforts to encourage cultivation of medicinal plants, establishing facilities for quality control of ISM drugs and strengthening Research and Development efforts thereon. Efforts are also being made to enhance the capabilities of the existing network of hospitals and dispensaries practising ISM & H.

05.11.03 Keeping in view the well known herbal and medicine-plant resources of Meghalaya, steps are being taken for establishment of a Centre for Adaptation. Research and Training in ISM at Shillong, for full exploitation of the potential for ISM in the state.

06.00 OUTLAYS FOR HEALTH-CARE

06.01 The Central Plan Allocation on Medical Care and Public Health over the last five decades has constantly decreased in terms of the percentage of such allocation as compared to the total plan outlay. This is itself has handicapped the quality of health-care services in general and rural health-care in particular. The outlays under referenced are briefly reflected in table-VII below :

TABLE - VIII

	Plan-Period	Total-Plan Outlay	Allocation on Medical Care & Public Health	Investment on Medical Care & Public Health as A% of the Total Outlay
First	Five Year Plan 1951 to 1956	1960.00	65.00	3.30%
Second	Five Year Plan 1956 to 1961	4672.00	140.00	3.00%
Third	Five Year Plan 1961 to 1966	8576.50	225.90	2.60%
Fourth	Five Year Plan 1969 to 1974	13778.80	335.50	2.10%
Fifth	Five Year Plan 1974 to 1979	39426.20	760.80	1.90%

Sixth	Five Year Plan 1980 to 1985	97500.00	1821.10	1.66%
Seventh	Five Year Plan 1985 to 1990	180000.00	3392.89	1.88%
Eighth	Five Year Plan	434100.00	7575.90	1.75%

(Rs. In Crores

06.02 The analysis of the Eighth plan outlay for Medical-Care and Public Health is as follows :

Central Sector	–	Rs. 1800.00 crores
States Sector	–	Rs. 5308.00 crores
U.T.'s Sector	–	Rs. 467.00 crores

07.00 NATIONAL FAMILY WELFARE PROGRAMME [NFWP]

07.01 The National Welfare Programme was launched in India during 1951 with the objective of, 'reducing the birth rate to the extent necessary to stabilise the population at a level consistent with the requirement of the national economy. In keeping with the democratic traditions of the country, the NEWP seeks to promote responsible and planned parenthood through voluntary and informed choice of family planning methods best suited to individual acceptors. People's participation is sought through local self Government bodies, voluntary organisations and opinion leaders at different levels. Innovative use of mass media and interpersonal communication is made for highlighting the benefits of the small family norm and removal of socio-culture barriers to its adoption.

07.02 The long-term demographic goal, as laid down in the National Health Policy, 1983 is to achieve a Net Reproductive Rate of Unity (NRR-1) by the year 2000 A.D. This corresponds to achieving a crude birth rate (CBR) of 21 per thousand population, a crude death rate (CDR) of 9 per thousand population and an annual natural population growth rate (ANPGR) of 1.2%. The National Health Policy also envisages reducing Infant Mortality Rate (IMR) to below 60 per thousand live births, by the turn of the Century, i.e. 2000 AD.

07.03 Keeping in view slippages during the Sixth Plan period, the Seventh Plan document visualised that the goal of reaching NRR-1 may be achieved by 2011 A.D.

07.04 There were further slippages during the Seventh Plan period and the Eighth Plan document stated that the targetted of NRR-1 was likely to be achieved by 2016 A.D.

07.05 The present levels of achievement towards achieving NRR-1 are reflected in table IX below –

TABLE - IX

Vital Indicator	Target for achieving NRR – 1	Achievement	
		India	Meghalaya
Crude Birth Rate per 1000 population	21.0	28.3	29.0
Crude Death Rate per 1000 population	9.0	9.0	7.1
Infant Mortality Rate per 1000 live births	60.0	74.0	58.0

07.06 There are widely varying levels of inter-state achievements under the NFWP. While states like Tamil Nadu, Kerala and Goa have already achieved the replacement level of fertility, other states like Uttar Pradesh, Madhya Pradesh, Rajasthan, Bihar etc. have fertility levels and birth rates which are significantly higher than the national average.

07.07 The achievement of the Net Reproductive Rate of Unity is however largely dependent upon the performance and achievement under NFWP in the four large and populous states of Bihar, Rajasthan, Madhya Pradesh and Uttar Pradesh. Unless these states achieve the set targets under the programme, the all-India average target of NRR-1 cannot be achieved.

07.08 It has also to be noted that there is a significant younger-age bias in the emerging pattern of population distribution. This in itself indicates that more vigorous steps are essential, if we are to contain the 'population-momentum' as we enter the portals of the twenty-first century.

07.09 Recognising the close relationship between high birth rates and high infant mortality rates, high priority has been given to the maternal and child health programme since the mid-1980's. The Universal Immunisation Programme (UIP)., which has of late grown into technology mission, has been extended for full coverage of all districts of the country. The universal immunisation coverage levels have improved from 29 per cent to 96 per cent for BCG and from 41 per cent to 79 per cent for DPT/TT for expectant mothers.

07.10 The aforesaid increase in universal immunisation coverage levels have yielded commensurate decline in the levels of reported incidence of vaccine preventable diseases. The assumption is also borne out by the significant drop in the all-India average Infant Mortality Rate, from 95 to 74 per thousand live births, over the last decade.

08.00 EPILOGUE

08.01 Although, it may be said poetically that "there are many miles to go before the Health and Family Welfare Service planners and providers can afford to sloop", all said and done, India now marches towards a healthier twenty-first century.

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MANPOWER DEVELOPMENT ON INSTRUMENTATION WITH SPECIAL REFERENCE TO THE NORTH-EAST

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ABSTRACT

Instrumentation has developed at such a rapid rate that the development of supporting manpower has not been able to keep pace with it. Manufacturers and factories are quick to flood the markets with more and more and more gadgets and equipment of increasing versatility and complexity. These can range from toys to mobile phones to audio/video systems to computers. In the research and development sector too, the thrust of instrumentation techniques in almost all fields of science is now an established fact. These can range from simple air and water monitoring systems to remote sensing equipment to major analytical systems like electron microscopes, mass spectrometers and Fourier Transform Nuclear Magnetic Resonance Spectrometers. Major instrumentation techniques are now routine in medical diagnostics and these can range from X-rays machines to ultrasound to CAT scan and nuclear magnetic imaging systems.

With such mind boggling choices of sophisticated consumer items it would imply that there is no dearth of expertise in the designing and manufacturing of such systems. In the developed countries the trend is to discard defective units and to write off major equipment after about five years. Repair if any is generally only at the board level and not at the component level. Our country however cannot afford to have the same approach. Systems and appliances are used till they are practically worn off and falling apart. In such a situation the availability of trained manpower for the efficient upkeep and repair of such systems becomes imperative.

This paper discusses, with special emphasis on the North East, such problems and the need to act accordingly.

INTRODUCTION

Instrumentation has developed at such a rapid rate that the development of supporting manpower has not been able to keep pace with it. Manufacturers and factories are quick to flood the markets with more and more gadgets and equipment of increasing versatility and complexity. These can range from toys to mobile phones to audio/video systems to computers. In the research and development sector too, the thrust of instrumentation techniques in almost all fields of science is now an established fact. These can range from simple air and water monitoring systems to remote sensing equipment to major analytical systems like electron microscopes, mass spectrometers and Fourier Transform Nuclear Magnetic Resonance Spectrometers. Major instrumentation techniques are now routine in medical diagnostics and these can range from X-rays machines to ultrasound to CAT scan and nuclear magnetic imaging systems.

With such mind-boggling choices of sophisticated consumer items it would imply that there is no dearth of expertise in the designing and manufacturing of such systems. However, the ground reality is different. Repair of video game handsets, TV remote control units, cable transponders are almost absent. Even standard equipment like TVs, VCRs and PCs are generally repairable only if the fault is a common one.

Similarly for more sophisticated laboratory equipment which are microprocessor based, it is easier and more profitable for the supply company to have whole boards replaced with 'down time' being assured to be minimal. Replacement of PCBs is the easiest option with the cost being borne by the customer.

Quite often however the fault might be with just a simple IC or chip which replacement would be only a fraction of the cost of the full PCB. But trouble shooting at the component level is not economically viable for the supply company and it is not interested in the same.

Even with such an approach, the common refrain by end users is that even for general maintenance there is a lack of any good service back up readily available. The service experts are either Calcutta based or more likely Bombay and Madras based depending on the increase in sophistication of the system. One generally undertakes service contracts with such suppliers, the rate for such varying from Rs.30,000/- to Rs.60,000/- per year for two visits. As long as the system does not have any major faults, things are fine. Often however, when there is a problem with the system and a service engineer is urgently needed, he may be busy elsewhere and it could be weeks or months before he can attend to the problem.

DISCUSSION

With the fast pace of development in electronics and micro-electronics, systems become 'obsolete' before one has started feeling comfortable in operating the system. Since the stress then is on upgradation of

parts, not much effort is made in replacing the damaged part by equivalent parts or even assembling an equivalent unit. Spares become increasingly difficult to obtain and the end user might have an idle machine in his hands with little choice but of getting funds for a new replacement. This again means the end user has a bigger hole in his pocket.

Sometimes, even if the service back-up by a particular company is good, a common occurrence with major imported equipment is that the Indian agency can change suddenly. The next authorised agent might have neither the expertise nor the inclination to honour the former agent's commitments. This can lead to a near collapse of any after sales back-up. The end user can turn to the Principals but then response would largely be dependent on the earlier terms and conditions with the authorised agent and the endorsement by the principals then. It is also not uncommon that the principals themselves change hands and the new owner might not like to inherit the liabilities of a problem machine.

It is imperative then to develop manpower resources to provide service and repair back-up within the region itself. Manpower training in trouble shooting up to the component level should be given. The use of more specialised diagnostic tools can largely overcome the lack of circuit diagrams. Such specialised diagnostic tools might be expensive and more complicated to operate. For more complicated or difficult diagnostics, a regional centralised facility can be created where state of the art diagnostic tools can be based and operated.

Training in general trouble shooting of sophisticated analytical equipment can also be given. Training in repair and services and in trouble shooting of equipment can be given at different levels and to different target groups - entrepreneural and institutional. The latter can range from school level science teachers to University level faculty and technical staff of R&D organisations. Building up of such expertise will help strengthen the in-house maintenance capability of the end user institution. The feed back from such personnel to the service engineer will help the latter in being more focused as to the nature of the problem. Further, the service engineer can advise over the phone or fax instead of personally attending. This can save our time and cost.

A centralised spares bank can also be created by making an inventory of all major equipment in the region and the essential spares normally required for them. This will save the end user from stocking a whole pile of spares which may never be used. With the Guwahati airport being proposed to be an international one, an export/import zone with such a spares bank facility could be considered. With the Internet and the existing 'Lab Trader USA' among others, available spares as well as parts of almost any old 'obsolete' system can easily be communicated and obtained from other users – R&D organisations, universities, private parties. This is being practised overseas.

The region has several Central Universities, including a Central Agricultural University, many State Universities, an IIT, a RRL, several medical and engineering colleges, a Central Post graduate medical Institute, many Central Government R&D based organisation e.g. ICAR, GSI, AMD, etc. There are also the several development sector departments and directorates of the respective State Governments. End users however, will cover almost all sections of society.

Training facilities could be created within an existing institution or as an autonomous Centre. The establishment of CEDTI (Centre for Electronic Design and Technology of India) – one at Tezpur, one at Imphal and two more proposed at Shillong and Aizawl, could be one such facility that can consider the above need of the hour. The Regional Sophisticated Instrumentation Centre, Shillong has a range of analytical equipment and some advanced diagnostic tools. Consolidating the training and teaching facilities here too could offer first hand experience in trouble shooting of sophisticated analytical equipment.

The trend in acquiring more modern and sophisticated systems, from common items to R&D equipment will only increase. The manpower for servicing, repairing and maintaining such systems will be in high demand. It is high time that such manpower resources be developed. This would not only help in generating employment opportunity but in being able to derive the maximum utilisation of a sophisticated system.

TOWARDS 21ST CENTURY SOCIETY, TERRITORY AND ECONOMY OF THE NORTH-EASTERN REGION OF INDIA

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ABSTRACT

Even after five decades of Independence, the region continues to languish in terms of economic achievements and all-round stagnation. The requirements of individual groups in the Society have outstripped the economy while the territory has been subject to various forms of degradations. Opportunities have become too far and few, perhaps more competitive. These have undermined the stability parameters of the society and the territory. Consequently the region has become dynamic and volatile where every situation has the potential to disrupt normal transactions.

This paper is an attempt analyse, how these situations have compelled the functional aggregates to realise other aggregates as an obstacle in achieving their respective targets of aspirations. How this has led to struggle for a share in resources within a given political entry? How has it brought about externalisation of aspirations : How economic and technological achievements have moderated upon their respective status and response? Or have all these instances due to Geopolitical attributes of the region that provided necessary impetus to the society towards mobilisation at the cost of environmental and economic stability?

INTRODUCTION

The North-Eastern region of India comprises of the states of Assam, Meghalaya, Tripura. Mizoram, Manipur, Nagaland and Arunachal Pradesh. It extends from 22^0 to $29^018'$N latitude and from $89^046'$É longitude. It covers an area of 2,55,037 sq km or 8% of the total area of the country and has a population of 31 million or 3.7% of the total population of the country (1991). Out of the total population 87% are essentially rural, and 22.19% tribal in nature. Except in the case of Assam, Manipur and Tripura, all other states have predominant tribal population ranging from 80% to 94% of the total population. It has international frontiers with Bhutan in the east; and Bangladesh in the south. In the west, it is bordered by the state of West Bengal. It is connected with the rest of the country by a narrow corridor – The Siliguri Neck. The region accounts for more than one half of tea production and one fifth of oil production of the country. Besides, it has large areas under permanent forest cover and valuable mineral resources like sillimanite. In fact, the region had characterised itself as a primary product export area.

This region has marked individuality and personality that separates it from the rest of the country. In a sense, it is a transational zone between High Asia and Indo-China. Its orientation - cultural and economic - has remained adjusted to the heartland. As a result, the region displayed a multitude of ethnic formations with predominant Mongoloid traits, and multitude of religious and linguistic diversity with significant Indo-Aryan influences.

INDIVIDUALITY OF THE NORTH-EAST

India's eastern borderlands have marked individuality. This region, in a sense, is a transitional area towards South-East Asia and Indo-China and oven to China itself. Its orientation has been towards the heartland (India) and the south-eastern parts (or the peripheral zones). The population of the region conceal multitude of ethnic groups having predominant Mongoloid traits. Geomorphologically, it has a land structure belonging to the three macro-divisions of India, i.e. the hill ranges of Arunachal Pradesh, Nagaland, Manipur and Mizoram belonging to the extra-peninsular mountains; Brahmaputra - Barak valleys - extension of the Indo-Ganga trough; and, the Meghalaya-karbi which is an outliner of the Peninsular India. Historically it has been a district region which was never been under the effective control of mainland India except after the British annexation of the area in 1826. Socio-political influences crept into the region through the gateways of Cooch Behar, Cachar and Tripura from the mainland. Whereas, the mountain passes in the north, north-east, east and south-east allowed large, scale migration for peopling of the region from areas other than India. its locational character has brought about the fusion of elements typically Indian and characteristically South-East Asian in nature. This is true for all aspects in the region including the flora and fauna.

The microscopic nature of the physiography of the region has resulted in the indentification of areas of attraction, relative isolation and isolation. This, in turn, resulted in the location of ethnic groups in particular pockets, especially in the mountainous periphery of the Brahmaputra valley. The Brahmaputra valley, had remained the melting pot of technic, linguistic and cultural elements, e.g. the Ahom who entered the valley In

the 13th Century AD and effectively controlled the valley for 600 years, became part of the Indian society and culture. Contrary to this, the area of isolation or the Mountainous periphery and the intermontane depressions remained purity and peculiarities of the migrated groups. This distinctiveness has resulted in truncation of the North-Eastern Region into several political units, which embody the local versus regional overtones. The region may be regarded as a distinct "culture area, where Aryan and Non-Aryan elements have been blended together. Strictly speaking, it does not conform to the definition of culture area, as it is lacking the unity that is required for and of culture.

The region represents the three macro level divisions of the country, i.e. the hills and mountains of Arunachal Pradesh, Nagaland, Manipur, Mizoram, and North Eastern Tripura corresponding to the Extra Peninsular system; it covers approximately 60 per cent area of the region; the Meghalaya-karbi plateau section corresponding to the peninsular system with an approximate area of 12 per cent; and the Brahmaputra plains considered as extension of the Indo-Ganga plains. This included the Manipur plains and the Tripura Plains as well. The physiographic diversity resulted in easy indentification of areas of attraction, relative isolation and isolation. These reinforced the micro-regional or sub-regional distinctions. Although, for a substantial period, the region retained its unitary character, the continued distinction in cultural terms led to emergence of new political units (seven instead of the earlier state of Assam, the Union Territories of Manipur and Tripura as well as the North Eastern Frontier Agency in 1972) through the Administrative Re-organisation 1971. The emergence of political units based on dominant territorial minority groups in the erstwhile stare of Assam, embodied local variation regional dilemma (this still plagues the seven states of the region, where the other minority groups like the Bodos and Dimasas in Assam have expressed their desire for autonomy and separation from the existing state to form a new state.)

In other words, rigorous environment and varying location attributes fostered physical and socio-cultural isolation. These encouraged the respective population groups and sub-groups – each having a more or less distinct territory in the form of micro-regions – to express themselves against centralisation, in terms of demand for autonomy. In some cases, these were in terms of separation. These were largely due to separate and distinct social and political organisations of the population groups and sub-groups that encouraged the development of separate, ideological perspectives.

Historically, Balkanisation had remained the characteristic feature of the region. Between 13th and 19th centuries, the region was dominated by the Ahom and later by the Burmese and the Manipur rulers. Significantly, the region though under constant pressure from the powers based in the Indo-gangetic plains, never succumbed to it. It was only the British annexation of the region (it began with the defeat of the Burmese in 1826) that resulted in the incorporation of the region to the British India. The region is strategically located and is characterised by political instability and economic backwardness. The region has been constantly threatened by escalation of tensions and conflicts an inter and intra-group levels. These are fast assuming geopolitical dimensions. The problems have emerged despite a fairly long experience of planned development and known abundance of resources.

These are, moreover, largely due to alienation of land, raising resource requirements and political aspirations, and so on. These are also indicative of the incompatibilities-both latent and otherwise between static imperatives and planned transition.

This has led to the intransigence among the inhabitants and restricted the scale of accommodation in the region. Systemisation and re-orientation of administration for development was a post-independence phenomena. But, this extension of administration was frequently viewed by the inhabitants of the hill and mountain section (who in the pre-independence period were included in area that were excluded or particularly excluded territories of the British India) with hesitation and interpreted in terms of political and economic domination besides probable fear of cultural absorption. Consequent responses of these inhabitants suggested the existence of alternative centres of power and affiliations. It was at this point that the different social groups confronted the states with their demands and aspirations. At the same time, it also enabled the Government to strike a balance between potential demands of separation and creation of conditions that were conducive for strong effective integration processes.

Yet, one can clearly discern the function and operation of divisive elements that consistently polarised the inhabitants and the diverse sub-regions. As a result, the region frequently convulsed and succumbed to the designs of forces of extreme sub-nationalism. Although administrative and development policies have ushered changes, these have not been able to hide the latent ambiguities and complacency of the last four decades.

The later aspect has subjected each subsystem to a critical evaluation. In the process, it highlighted the strategic consideration of partisan effectiveness.

Situation as they began to be developed after independence in the region indicate the importance of destabilisation processes that affected in distinct phases. Existing territorial arrangement and consequent economics policies widened the disparities and inequalities. This led to confrontation and normally entailed a territorial adjustment. This trend, however, goes on with increasing intensity. Thus, a review of the social formation unveil the fact that potential explosive situation existed and continues in every part of the region.

This called for re-assessment of the perspective on which the idea of regionalism is based; for it is obvious that the sub national forces constituted part of the total processes of nationalism in the country. Apparent irritant that manifest in the form of movements are because of growing complexity of socio-economic relations as well as due to political linkages that dominate such relationships in the region. Needs and demands of the various subgroups can be met and articulated through the constitutional provisions as well as by the process of consensus among the participants and actors in the region.

Like other parts of the country, the administrative units in the region continued to be dominate by pre-1947 political configurations, it had exerted considerable influence on the nature and pattern of participation and intra sub regional diversities in the pattern of political economic and social relations. These were reinforced by divisions on cultural lines as well by territory (hills and plains) that were more or less parallel to the responses. This was strengthened by the fact that the region had substantially high percentage of tribal population.

Further, population agglomerations expressed loyalties and participation in cultural-political terms and represented the weak and fragmented character of the subsystems. These, highlighted latent instabilities through intense factionalism, tribal and feudal resistance. These effectively contributed to fragmentation of political activities and exerted their negative influence on the pattern of development in the region. However, efforts are on going to evolve effective measures to check the escalation of excesses that resulted from the prolongation of movements and it will tend to distort the instruments of democracy and the tendencies to turn natural compatibles tolerant tendencies.

In this context, quite a few known scholars have successfully argued the need for reviewing the existing territorial arrangements from the point of view of size, social cohesion, effective administration efficient Centre-State, relations leading to better development possibilities and so on. These had clearly emphasised the pre-eminent position of geography and history as determinants of relationships between people, territory and development on the one hand, and on the other between policy alternatives, accommodation and implementation. This is true for integration in the regional scale as well as at the national scale also.

Since independence, after the efforts towards integration of states, the concept of Union-States relations as a norm for territorial integration and interaction was widely accepted. The problems that arose in the course of time in this regard were resolved within this scope and organisation. The likely consensus of opinion on violence and irredentism among the various social groups and sub groups (in different regions and sub-regions) could probably have been due to atavastic considerations and intrusions that the occurred frequently to disturb the usually peaceful politics. Closer to the accepted patterns, therefore, were the situations and reactions of the minorities indifferent parts of the country, particularly in the North Eastern Region of India.

There were evidences from the cries in the 1950's and in the late 1960's which helped to crystallise the main issues through confrontation between the various groups and sub groups and the state. the consequent resolutions led the way out of the appeared to be threats to the territorial unity and integrity of the country (administrative re-organisation). The country was divided on a linguistic basis. This provided the needed political support and recognition of the linguistic groups. Thus the seeds of linguistic sub-nationalism was sown.

This aspect was reinforced by the fact that power was a great modifier of positions particularly in regards to regional accommodation. The threat of assertion of identities at the local level, came from population groups and sub groups who though distinct were assumed to have been assimilated in the dominant regional strains. Today, with the pattern of implementation of policies, and the processes of political competition and participation along with penetration of the establishment have opened up the possibilities of assimilation through politicalisation. But, these have led to building up of separate identities that have led to rising of expectations of sub nationalism. Under the present set-up, these demands of increasing sub nationalism

could not be accommodated for the fear of greater fragmentation. Instead, these have given way to fractionalisation of political end.

These developments only suggested the need for developing a new pattern of federal association and adjustment with a considerable political and fiscal economy as well as access for resources. As of present, the region's territorial patterns and the consequent problems have posed a continuous threat to integration (similar movements elsewhere in the country, likewise have posed a threat to the territorial stability as well as to existing territorial adjustments in the country). This feature has been recurring with greater incidence of sub-regional mobilisations.

These demands have found frequent expressions in the respective political forums, organisations and related activities, who put forth claims for region based territorial group identity at the cost of other variables and conditions. These demands were usually distinct from the ones that were put from the adjoining population groups. Some groups aspired for autonomy others speeded up the process through insurgency.

There has been conspicuous regional cum ethnic movements in the region that continued since independence. Insurgency in Nagaland, Mizoram, Manipur and Tripura as well as in Assam – all consistently historical patterns of geographical politics in the region. Moreover, though these incidence were responsible in administrative reorganisation and formation of definite territorial units the population in general was not able to overcome the latent structural and hierarchical discriminations that set apart from the adjoining units. These only induced ethnic resurgence as well as presence wider socio-economic tensions in the region. These had both directly and indirectly contributed towards integration.

Thus, today, the North Eastern Region of India clearly indicated the revival primordial factors rather that one of class politics that result from development. The resultant ideological positions adopted by the different groups proved to have inadequate support base to cope up with the pressures exerted by their respective territorial locations and resource endowments. This had compelled quite a few groups to adopt a rigid stand and extreme positions. What was in fact required by these groups was autonomy that sought resolutions to the problems in a wider politic-social framework.

This then suggested that the multi ethnic, multi lingual and multi religious characteristics were superimposed on the complex geographical setting of the region. These exhibited several layers of identity and expressions. Each of these contained potentials to encourage fissiperous tendencies as well as scope for effective consolidation and accommodation. These aspects revolved around how, whether and to what extent the metamorphosis from social and geographical planes to political expressions had taken place in the region. It is then obvious that –

a. growing diffusion of communication system, inaccessibility, ideologies and organisations exerted continuous influence on the social sub groups. As a result, their reaction and perception were radically transformed. This introduced competition in political and economic spheres and impact on the individual sub group's perception about itself and those surrounding it;

b. this intensified the demands and expectations man-power and other resources. The pressure to extend and expand welfare, educational, governmental jobs and other developmental activities alongwith increased assistance to non-productive sectors had consistently enlarged its scope. The increase in infrastructural facilities had corresponding influence on development; and,

c. there has been multiplication of efforts to mobilise the localities, regions and the peripheries against natural centres of power. Minority groups demands for greater representation and participation in the state's activities and particularly in the decision making apparatus has had significant headway. These aspects and their explanation help to account for the difference across the region and provide a broader perspective on which the federal accommodation and aspects of integration at different scales can be arrived it. The following concluding section is an effort towards this.

By way of conclusion, post-independence situation in the North Eastern Region of India has been dominated by ethic resurgence. Limited efforts towards strengthening of accessibility conditions, development activities and frequent demands for administrative reorganisations, among others, failed to check this tendency (that is also making itself obvious in other parts of the country as well). It, then, becomes obvious to seek answers for questions like why has there been a resurgence of ethnic identity? In normal circumstances answers are usually bound with the explanations of political and economic situations, and of inequalities and sub-regional disparities. In addition to this for the complex geographical mosaic of the North East,

explanations included the impact of the historical patterns, integrative processes and the politicalisation of ethnic elements. This has been compounded by the emergence of distinct middle class in identity as a factor in political, social and economic relations in the region.

Efforts towards resolving the conflict parameters in the region involved not only a broad understanding of the diversities and complexities of the elements that were involved but also policy measures that aimed at providing framework for achieving substantial economic self-reliance. These measures had broad comprehensive parameters that included redefinition of political boundaries between the various sub-units in the region: special administrative districts were formed with a latitude in political and fiscal autonomy that took into account the peculiarities of the group involved, developmental and specific emphasis on the consolidation and strengthening of transportation and communication sector in the region. All these initiatives, in more than one way, entailed accommodation and adjustments both by the state and the various population groups and sub-groups. In the process, the later found themselves at the cross roads with their traditional patterns and institutions subject to intense pressure. The resultant impact-manifested itself in the material and psychological perspectives that ran contrary to both the requirements of regional and national stability as well as to the aspirations of the society.

SOCIAL INTEGRATION

It was believed that strengthening of the infrastructural facilities and initiation of developmental activities along with administrative reforms will lead towards better forms of integration between the diverse people of the region and the territory (state). Policy measures were initiated and implemented to strengthen the rights of the inhabitants, particularly of the hills and to an extent in the plains for the tribals. This was particularly applicable to elements like land and the traditional associations which the tribal population of the region had. Moreover, it was this relationship with land that encouraged the development of specific socio-political responses and perceptions of the people. Thus, in cases of dominant, overt or covert, the responses of the affected population followed the historical patterns.

Besides strengthening the traditional institutions through the creation of autonomous councils to safeguard land ownership and control of land, specific measures like the Inner Line System (of the pre-independence period) were retained. These checked the movement of population and curbed further alienation of land. In recent times, many of the states in the region have consistently emphasised the need for extending this system. However, one of the important negative aspect of this measure of inner Line has been the perpetuation of the isolationist tendencies in the predominantly hill and mountainous section of the region. It has kept the diverse people apart and minimised the impact which the modernisation had brought in its wake. In other words, such measures have indirectly contributed to the growth and development of regionalism in scale. In addition to this gradual decline in the role of voluntary organisations and weakening of the processes of socialisation in the region had accentuated isolation as well. The possible alternatives to overcome these handicaps include a common theme of involving the existing organisations in the development process.

The pattern and relevance of the spatial ensembles in the region has been dealt in detail by various scholars belonging to the social sciences. Suffice, it say that, in recent years, the factors particularly political economy, ethnicity, language and religion, have become extremely potent forces playing consequential role in the stability and development of the region. Ethnically, region is diverse and indicated a strong tendency of conflict situation. Tibeto-Burma section of the Mongoloid branch and the Indo-Aryan elements are the prominent in the valley regions. Besides, there is also a general distinction of the population tribal and non tribal with former having more than 216 distinct elements that have been included in the Scheduled Tribes population classification. This agglomerate has nearly 420 languages and dialects that are well spread over the region (Arunachal Pradesh has nearly 160 dialects; 95 in Nagaland; 87 in Manipur, 112 in Tripura and the balance in Assam, Meghalaya and Mizoram). Further, due to high degree of historical mobility of population, these language and dialects are found common in all of the political units of the region. These aspects accelerated the movements highlighting the sense of relative deprivation, separate identity and social consciousness among the inhabitants of the region. The political implication of such a pattern is obvious from the position of the Assamese and Bengali as dominant languages of the region particularly in Assam, Tripura and to an extent in Meghalaya. Moreover, it was this aspect, through the Assam Language Bill of 1960, that paved way for eventual re-organisation of the region in 1971-72.

The post independent political system of the North East was regularly threatened by destabilisation tendencies. These tendencies reflecting as they did, the perceived inadequacies of the sub-regions manifested in forms of insurgency, sustained movements and so on. Insurgency for example, began with the Phizo effort to break away to form a separate independent Nagaland in the 1950's; this was followed by Laldenga for Mizos; Meiteis attempted wrest control since 1950's-this is still continuing. The basic themes in all these instance have been separation (secession) from the Indian Union (as a redressal to an historical injustice, heightened by economic backwardness). In this, these insurgent elements were encouraged by the spatial ensembles, relief and densely forested mountain slopes, rudimentary and inadequate accessibility linkages as well as by the presence of insurgent groups across the international frontiers in Myanmar or indirect material support from extra-mural forces. Besides, language as noted earlier in this section language and to a substantial extend immigration accentuated the problems in the region.

As a result of these broader perspectives of conflicts, there is no tailor made solutions to the complex socio-economics and cultural problems in the region although the administrative re-organisation of 1971-72 established unity of purpose towards development, security and socio-cultural affinities, subsequent developments in the region made the events of building an effective state system blurred.

ECONOMIC INTEGRATION

Partition and independence accelerated population movement in the region. The large scale influx of migrants, particularly from the present day Bangladesh and to an extent from Nepal, Bihar, etc. have drastically altered the demographic profile of the region and in particular the pattern of relations in Assam and Tripura. The question of minorities have assumed scale dimensions which ultimately led to widening of cleavages between the tribal and non-tribal components of the region's population. More importantly, the impact of migration was clearly reflected in the changing pattern of land-use as well as in the pattern of land holding. Correspondingly on the social and economic relations between the immigrants and the natives became detrimental to the stability and consequently on the development the region.

Economy of the region develop as a result of colonial commercial interests. As a result, the region became a primary product export area with all other development following its basic premises. This is clearly evident in the way in which transportation and communication linkages were encouraged to develop. Those remained concentrated in the upper Brahmaputra valley, while the remaining parts of the region were loosely linked with main centres. Tea and oil along with forest products determined the pattern of the economy. Vast rural hinterland continued with traditional agriculture. Disparities in various sectors of the economy between the various sub regions became a natural fall out. Besides, with the consolidation of the hill territories of the region and relative absence of resources that could be exploited commercially (at that level of technology applications) further reinforced the economic core that was located in the Upper Bramaputra Valley- the Dibrugarh-Tinsukia axis. Interestingly, the core was also a part of the historical nuclei and whose control enable many of the powers like the Ahoms to dominate the region. The superimposition of functions therefore directed the subsequent development in its favour.

Lack of proportionate development of the agricultural sector in the region is one of the factors responsible for economic backwardness. It is beset with many problems like primitive methods of cultivation, extensive practice of shifting cultivation or the Jhum cultivation, negligible growth and scope of irrigation facilities, absence of multiple cropping through large scale use of HYV of seeds, low consumption of fertilisers and Insecticides, limited applications of technological innovations, haphazard and rapid urbanisation, and small land holdings frequently accompanied by high degree of fragmentation. This has been compounded by problems and has given way to problems like deforestation, soil erosion and low of fertility of the soils. This has been made worse by Jhum cultivation. Jhum cultivation that is practised extensively in the hilly areas of the region out of the total land under cultivation, Mizoram has 50% under shifting cultivation, Meghalaya 32%, Nagaland 17%, Arunachal Pradesh 14%, Tripura 7%, Manipur 72% and Assam 25%. The percentage under shifting cultivation is more or less proportionate, to the tribal composition to the total population of the region. However, the deep rooted influence of the shifting cultivation on the socio-political and economic practices of the inhabitants of the hilly sections of the region, does not provide any scope, for changes will necessarily have to address to the basic postulates of the societies in the hill region before any substantive modifications and innovations can be introduced.

The basic problems in the agrarian sector of the economy lies in the size of the operational holdings. In the regions, 40% of the operational holdings are below the size of 2.5 acres; 34% are between 2.5 acres to

4.99 acres; and most of them are in a highly fragmented state. Another noteworthy but discouraging factor that is evident in the agriculture of the regions is the presence of large percentage of landless rural families; whereas in areas like Nagaland there is scarcity of agricultural labourers. Another important characteristics of the rural economy, is the dominance of food crops (rice cultivation has as share of 55% in Meghalaya, 60% in Nagaland, 67% in Assam, 90% in Manipur, 88% in Tripura. This has not allowed for the required diversification of cropping which could have led to a healthy agrarian economy. This could have provided a strong base for the development of agro-industrial complexes in the region. In all states, Agriculture, animal husbandry and forestry forms the core sectors.

Industrial growth and spatial development in the region, has been rather slow and sporadic. The sectoral distribution of the work-force, clearly suggests that the secondary sector of the economy accounts only for 7% of the total workers in the region (except in Manipur where the proportion is much higher at 12%; in all other states of the region, this percentage share varies from 0.75% to 7.5%). Besides the social parameters and the built in mechanism of politicalisation, factors such as low productivity in agricultural sector, untapped energy resources, particularly hydro electricity (the combination of the relief and terrain has created one of the largest hydro electricity potential in the country), inadequate infrastructure, lack of transportation and communication linkages, lack of entrepreneurship, lack of investible capital surplus and so on, have impeded development. However, taking a comparative view of the industrial development in the region, the district of Tinsukia, Dibruargh and Jorhat in Assam, record highest development ratio. This largely due to the petro-chemical complex and tea industry. This was followed by the districts of Sibsagar, Darrang, Tezpur, Kamrup and Nagaon, East Khasi Hills, Ri-Bhoi, Jaintia Hills and Cachar. Rest of the sub-regions indicated a low rate of growth. Except for the few medium to large scale industrial units like sugar factories, paper mills, oil refineries, cement factories, the region lacked scale industrial units like sugar factories paper mills, oil refineries, cement factories, the region lacked sizeable household Industrial cottage and handicraft industries. Those there are, are scattered all over the region. Paradoxically, the region statistically has more kilometerage per population than other states. The accessibility conditions are from encouraging and do not have the potential to support concentration of economic activities.

The industrial development in the region, is a post-1947 phenomenon (though there was significant development of industries like exploitation and refining of petroleum, tea and forest-based units in the pre-1947 period, particularly in the Upper Brahmaputra valley). The region, to a large extent, continued its practice of exporting primary raw materials to other areas of the country. This resulted (along with traditional practices) in over exploitation of existing resources like forest products and oil as well as by under utilisation of potential resources like hydro-electricity. Over exploitation of forest resources along with Jhum practice, construction of transportation networks and linkages through the predominantly hill terrain of the region, has created serious problems like soil erosion, siltation of river beds and consequent reduction in the carrying capacity of rivers, loss of primary forest covers particularly in the headwaters/upper reaches of major rivers, greater role of the process of desertification, land degradation and so on. The resultant impact along with the influences of the distribution of geographical phenomena suggested a specific thrust of development of the region with majority of the region remaining inaccessible and backward. To this was added the perpetuation of traditional associations in the region that prevented the efficacy of modernisation.

All these cumulatively influenced separate development of the diverse sub regions of the North East. The relationship, people-territory-development, depending upon the intensity and scale of progress, gradually transformed to political expressions. These expression became obvious after the independence, when the inhabitants of the Naga Hills and the Tuensang district voiced their desire for separate existence from the Union of India. The basic themes that dominated their expressions can be summed up to include, the fear of alienation and absorption, backwardness leading to dependence domination and so on. This later turned to insurgency. Similar situations with varying themes were evident in Manipur, Mizoram and Tripura. Although these instances are in various stage of settlement, it is obvious that geography and history of these sub-regions have played a significant role in accentuating the hesitant responses of affected population. These were reinforced by the problems of economic development.

Suffice it to say, that the Post Independence phase in the region saw rapid transformation in the level of economy. The efforts to reduce the spatial disparities and measures to minimise the isolation have among others have acted as stabilisation factors. Organisation and administrative welfare activities have substantially decentralised developmental activities in the region. Besides having village, block, district and state level organisations, central organisations and institutions have stepped in to accelerate the development process in

the region. However, latent fissiperous tendencieis particularly cultural confrontation and resultant conflicts have persistently obstructed these efforts. What is required the understanding of the role of geographical and historical factors and through the co-operative tendencies to resolve the problems of development. This will ensure the effectiveness of the state's role in development, and at the same time encourage the population to participate effectively (instead of depending upon the state completely and making the state subject to frequent latent pressures).

The region has undergone frequent administrative re-organisation that was more or less expected revolve the economic and social issues dominating the regional landscape. The demand for further sub division of administrative units persists even today. Presently there are suggestions to separate Cachar from Assam, northern territories along the Brahmaputra to form Bodoland and separated thus from Assam, separate territorial identity for the Meiteis in Manipur and so on. One can safely assume that administrative re-organisation (frequent) are hardly the solution that will ensure either faster economic growth or greater social harmony. This is because, in the North East, every sub division or district has the inherent contradiction of a polyglot society. Up graduation of administrative units or creation of special purpose units can be useful, these should be reinforced by institutions and ministries specially for the region.

Another important aspect in the process of integration is the role of regional political parties. The region as well as its constituent administrative units (like the national counterpart) reflects the presence of numerous parties that emerged to signify the interests and priorities. These have consistently undermined the possibilities of emergence of major political parties in the region. As such their role has more or less coincided with the centrifugal tendencies. The need and requirements are obvious and should exploit the Centripetal forces to strengthen the regional integration processes.

FIFTY YEARS OF DEVELOPMENT OF METEOROLOGY IN INDIA WITH SPECIAL REFERENCE TO NORTH EAST INDIA

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ABSTRACT

Concepts of meteorology is quite familiar from the time of Vedic ages. Human civilizations world over have realised the kindness of weather on one hand and its vagaries on other hand. Man, worldwide is trying to interact with meteorology of the globe to the maximum possible extent in order to utilise natural resources for well being of mankind vis-à-vis to save themselves from weather calamities. To meet this objective United Nations Organisation has set up World Meteorological Organisation (WMO) on 23rd March, 1950 to fulfil this goal. India is a founding member of WMO.

During pre-independence era, meteorological services in India have started in the year 1875, with its head quarter at Calcutta. Later it was shifted to Shimla. Its head quarter was again shifted to Pune in 1928 and administrative head quarter was set up at Delhi in 1940. Till 1945, seven Regional Meteorological Centre were set up namely at Bombay, Calcutta, Delhi, Karachi, Lahore, Madras and Nagpur.

After independence, meteorology in India has developed manifold. Today, India has a widely and closely linked surface and upper air observation for taking meteorological observations at fixed synoptic hours. At present India Meteorological Department (IMD) is equipped with standard and sophisticated weather instruments for taking observations of basic meteorological parameters. Meteorological radars, satellite and high speed computers are helping a lot in fast processing of meteorological data and end products are transmitted to user agencies well in time with the help of advanced developments in the field of telecommunication. The meteorology of North East India has special interest to meteorologists. Some stations of the region are equipped with latest meteorological instruments and meteorological services to the people of North East India has gained public awareness. Still this region needs speedy further development in terms of meteorological services to the people. To meet this requirement recently, Meteorological Centre at Guwahati has been upgraded to the status of Regional Meteorological Centre (RMC) to look after the requirements and development of meteorology of North East India. This is sixth RMC of IMD after independence. This has a special reference because RMC Guwahati has come up in the 50th year of independence.

INTRODUCTION

Meteorology is a science of the atmosphere. It covers both weather and climate. The atmosphere at a given location rarely exhibits a steady state. The ever changing state of the atmosphere constitutes the weather. Weather, probably is the most fascinating gift of the nature. But at times it becomes very cruel and devastating. Human civilization world over have cherished the kindness of weather on one hand and have doomed away with its vagaries on other hand. Man over world wide is trying to interact with meteorology of the globe to the maximum possible extent in order to utilise natural resources for well being of mankind vis-à-vis to save ourselves from weather calamities. To meet this objective World Meteorological Organisation (WMO) was set up on 23rd March, 1950 with formal agreement amongst Governments of member countries. It would be apt to discuss in brief about growth and activities of WMO in general and role of India with special reference to growth of meteorology in North East India during 50 years of Independence.

THE WORLD METEOROLOGICAL ORGANISATION

Atmosphere which provides the world's weather is truly global in character. Various nations of the world recognised this global character of weather as early as last century. As a result International Meteorological Organisation (IMO) came into existence in the year 1878. This was not an inter-governmental body. After World War II, in a meeting of IMO in 1947, at Washington, greater study and co-operation in the field of meteorology was felt and it was decided to transform IMO into a new World Meteorological Organisation (WMO) with formal agreement amongst Governments. It was on 23rd March, 1950 that the convention was ratified and came into force on 20th December, 1951. WMO became a specialised agency of United Nations. Its headquarter is at Geneva in Switzerland. India is a founding member of WMO.

Director General of Meteorological Department is the permanent representative of the country in WMO.

All the member countries are grouped into six regional associations for each continent. These associations coordinate the meteorological activities within there respective regions. The United Nations General Assembly on 20th December 1961, in a resolution singled out the WMO, recommending that it may undertake a comprehensive study.

(i) To advance the state of atmospheric science and technology so as to provide greater knowledge of basic physical forces affecting climate and the possibility of large scale weather modification.

(ii) To develop existing weather forecasting capabilities and to help member states make effective use of such capabilities through Regional Meteorological Centre (RMC).

To fulfill this objective the WMO in its fifth congress in April, 1967 approved the World Weather Watch (WWW) programme. Now WWW is basic programme of WMO providing support for nearly all the other programmes in the field of both application and research in meteorology. Under WWW member countries work under following group in respect of meteorological services worldwide.

a. World Meteorological Centre (WMC)
b. Regional Meteorological Centre (RMC)
c. National Meteorological Centre (NMC)

The WMCs make hemispheric forecast twice a day for two to four days ahead. There are three WMCs namely Melbourne, Moscow and Washington DC. There are twenty three RMCs. New Delhi is one such RMC under WWW. The RMC prepare more detailed analysis and forecast for the region and distribute them to all interested National Meteorological Centres. They issue warning of disastrous weather conditions like hurricane/typhoons and also provide marine and aviation weather forecasting services to the countries of their respective regions. The responsibility of New Delhi RMC extends from 25^0S to 45^0N and 30^0E to 125^0E. New Delhi RMC has also been designated as Regional Specialized Meteorological Centre (RSMC) with active specialisation as a tropical forecasting centre. More than 100 NMC feed data into WWW. NMCs provide weather forecast for their national use. New Delhi also works as NMC in addition to RMC.

The basic purpose of these programmes is technical cooperation and training to aid all members. particularly of less developed region of the world. India is an active member of WMO. Two of its Director General of Meteorology have been Vice-President of WMO.

DEVELOPMENT OF METEOROLOGY IN INDIA

The description of development of meteorology in India will not be justified if reference are not made regarding mention of weather and climate in our ancient literatures. Earliest references come from Rig Vedas. The two great ancient Indian epics The Ramayana and The Mahabharata have also described weather of that period. Discussion of about meteorology and amount of rainfall (its measurements) find place in writings of Panaini (5^{th} century BC), Arthashastra of Kautilya (505 to 587 AD). Manu Smriti of 2^{nd} Century AD, contains reference of meteorological phenomenon. The motto of India Meteorological Department, **Ādittya Jayate Vrishthe** has been extracted from Sloka 76 Adhyaya 3 of Manu Smriti. Modern meteorology may be said to have begun with the invention of barometer in 1593 and the mercury thermometer in 1644.

Development of Meteorology before Independence :

Following the unprecedented calamities in Indian subcontinent caused by two devastating cyclonic storms of Bay of Bengal in Oct-Nov 1864 in which about, 1,20,000 persons have lost their lives, the then Government of India set up the Indian Meteorological Department in 1875 with its head quarter at Calcutta. Finally it was shifted to Delhi in 1940. The basic meteorological parameters are pressure, temperature, wind speed and direction, humidity etc. Till 1946, seven Regional Meteorological Centres (RMC) were established at Bombay, Calcutta, Delhi, Karachi, Lahore, Madras and Nagpur to facilitate regional development of meteorological observatories and forecasting thereof. Before independence India had 8 type A forecast Centres, 3 type B, 6 type C, 17 Auxiliary centres, 48 Aerodrome Reporting stations, 15 Radiosound stations. 64 Pilot Balloon observatories, 303 surface observatories and 5 seismological stations. With independence and partitions of the country India was left with five RMCs namely at Bombay, Calcutta, Delhi, Madras and Nagpur. These RMCs were controlling 6 type A forecast centres, 3 type B, 5 type C, 12 Auxiliary centres, 40 Aerodrome Reporting observatories, 222 surface observatories and 4 seismological stations.

Development of Meteorology after Independence :

After independence, meteorology in India has developed manifold. Today India has a widely and closely linked surface and upper air observatories for taking meteorological observations at fixed synoptic hours. At present India Meteorological Department is equipped with standard and sophisticated weather instruments for taking observations of basic Meteorological parameters. Meteorological radars, satellites and high speed

computers are helping a lot in fast processing of meteorological data and end products are transmitted to user agencies well in time with the help of advanced development in the field of telecommunication.

IMD is the National Meteorological Service of the country and the Principal Government Agency in all matters relating to meteorology, seismology and allied subjects. It has its headquarter at Delhi and Director general of Meteorology is head of the organisation.

Major Objectives :

* To take meteorological observations and to provide and forecast meteorological informations for optimum observation of weather-sensitive activities like agriculture, irrigation, shipping, aviation, off-shore oil exploration etc.
* To warn against severe weather phenomena like tropical cyclones, nor'westers, duststorms, heavy rains and snow, cold and heat wave etc. which causes destruction of life and property.
* To provide meteorological statistics required for agriculture, water resource management, industries, oil exploration and other nation building activities.
* To conduct and promote research in meteorology and allied disciplines.
* To detect and locate earthquakes and to evaluate seismocity in different parts of the country for development.

Functions :

* Record observations of Meteorological parameters all over the country and the adjoining seas, both at the surface and in the upper air, by maintaining observatories and equipping ships and collection data from aircraft and satellite.
* Maintain fast telecommunication links within the country and with foreign countries for collection and dissemination of meteorological observations, analysis and forecasts on global scale.
* Analyse and interpret meteorological observations collected from India and other countries and issue forecasts and current weather informations required by different user-interests and warning for protection of life property.
* Scrutinise and process meteorological observations, for assimilation into climatological archives.
* Design, develop, manufacture and maintain meteorological and seismological instruments and procure sophisticated equipment for modernising observatories.
* Maintain a network of seismological observatories to record earthquakes and study of the earth's crust.
* Provide training facilities to all branches of meteorology, seismology, telecommunication and instruments.
* Conduct research in theoretical and applied meteorology, seismology and allied topics.
* International co-operation in meteorology and seismology.
* Provide Hydrometeorological informations and inputs for water resource management and flood forecasting.
* Maintain liaison with other scientific organisations in the country in the field of Agriculture, Hydrology, Oceanography, air pollution etc.
* To participate in special expeditions of meteorological interest like Antarctic Expedition, study of Himalayan Glaciers, total Solar Eclipse etc.
* To conduct study in Positional Astronomy, bring out related publications and issue Radio Times signals.

To carry out these activities IMD had set up five Regional Meteorological Centre (RMC) at Delhi, Mumbai, Calcutta, Madras, Nagpur, since 1946 and a sixth RMC was opened at Guwahati in 1997. With planned and systematic development IMD has widely and closely linked network of Meteorological observatories.

The statistics of observational organisation of IMD is given in table – I.

WEATHER FORECASTING ORGANISATION

Weather forecasting forms an important activity of the department. It consists of indicating the detailed weather conditions that are likely to occur in specified areas for periods upto few days. Outlook in general terms for periods upto a week is also given. The forecasts are also issued as warning to users against adverse weather. Other types of weather forecasts and warnings issued by IMD include, forecast for aviation, marine, fisheries, agriculture, floods reservoir management, world weather watch, long range forecast etc.

In addition, there are separate directorates to deal with specialised subjects, they are –

i Agricultural Meteorology.
ii Aviation Services.
iii Hydrometeorology.
iv Instrument.
v Indian Ocean and Southern Hemispheric Analysis Centre.
vi Northern Hemisphere analysis Centre.
vii Radar Meteorology.
viii Radio Meteorology.
ix Seismology.
x Satellite Meteorology.
xi Telecommunication.
xii Training.

The various operational unit of IMD are Meteorological Centre, Forecasting offices, Agrimet. Advisory Centre, Flood Meteorological Offices and cyclone Detection Radar Stations. A network of some of these operational offices are shown in fig. 1&2. It is difficult to describe all activities of IMD in a paper. In brief various activities of IMD are described in fig. 3.

DEVELOPMENT OF METEOROLOGY IN NORTH EAST INDIA

North-East India consists of seven states namely Assam, Meghalaya, Arunachal Pradesh, Nagaland, Manipur, Mizoram and Tripura. The weather and climate of the region bear its own importance. On the basis of meteorology of the region the whole region is divided into three meteorological Sub-Divisions, namely Arunachal Pradesh, Assam-Meghalaya and Nagaland, Manipur, Mizoram and Tripura. As such IMD has 35 Meteorological Sub-Divisions on all India basis. The special weather features of the regions include thunderstorm and squall in pre monsoon season, heavy rainfall during monsoon causing flood every year and low cloud hindering aviation activities and low visibility in post monsoon make this region unique in terms of meteorology.

Growth before Independence :

The observations of meteorological parameters have started in this region way back from 1869. Before independence part time surface observatories were established in the region under technical control of RMC Calcutta. Those were Silchar (1869), Guwahati (1902), Dhubri (1881), Tezpur (1901), Cherrapunji (1902), Lumding (1912), and Aizawl (1937), Shillong (1902), Dibrugarh (1901), & Sibsagar(1874).

Growth after Independence :

After independence a number of part time observatories were departmentalised and new departmental observatories were opened at airports which came up during the second world war viz. Borjhar Airport (1949), Mohanbari Airport (1949), Agartala Airport (1951), Imphal Airport (1952), North Lakhimpur (1954), Kumbhigram Airport (1955) shifted to Regional Engineering College, Silchar (1988), Tezpur Airport (1955) shifted to Tezpur Town (1977). Kailasahar Airport (1955), Shillong (1956), Rupsi Airport (1956), Passighat Airport (1957), Cherrapunji (1972), Barapani Airport (1975) and Dimapur Airport (1987). A number of part time observatories were also started in Assam, Meghalaya, Arunachal Pradesh, Nagaland, Manipur and Mizoram.

Surface observatories record data about pressure, temperature, humidity, wind, cloud, visibility and rainfall at synoptic hours. Upper air observatories were also opened along with surface observatories. Upper air observatories are of two types, namely pilot balloon and Radiosonde/Radiowind (RS/RW). Pilot balloon observatories record only upper air wind. Whereas RS/RW observatories records atmospheric pressure, temperature, wind speed and direction, humidity etc. Pilot balloon observatories were opened at Guwahati (1955), Mohanbari (1948), Imphal (1943) and Agartala (1941). The RS/RW observatories were opened at Guwahati (1955), Mohanbari (1978), and Agartala (1978), shown in fig.4.

Besides surface and upper air observatories there are many other type of observatories run by IMD over the region. A brief statistic of such observatories are given in table – I.

Observational Organisation :

During the last 50 years NE region has following set at meteorological observatories :

1.	Surface observatories	
	(a) Departmental	14
	(b) Part-time	26
2.	Pilot Balloon observatories	4
3.	Radiosonde/Radiowind observatories	3
4.	Seismological observatories	6
5.	Hydrometeorological observatories	56
6.	Flood Meteorological Station	64
7.	Evaporation Station	7
8.	Agrometeorological observatories	7
9.	Storm Detection Radar (Guwahati, Agartala, Mohanbari)	3
10.	Station receiving cloud picture	2
11.	Radiation observatories	3

To collect meteorological data from the meteorological stations IMD has its telecommunication network. These stations are linked with regional centre. At Guwahati with T/P links, WT/RT, Telex and Telefax etc. Meteorological data from this region is pooled at Guwahati office and it then exchanged with meteorological data of the rest of the country with the help of switching computer installed in 1996 at Guwahati office.

Meteorological Service of NE India and Administrative Setup :

The meteorological services of the region have grown gradually after independence. Under various development programme of the department, Guwahati office was developed as Main Meteorological office in 1950 with Mohanbari and Agartala as subordinate Meteorological office to meet mainly aviation requirements. Aviation services were further enhanced with the installation of storm detection radars at these stations in 1960. In 1971, Main Meteorological office was upgraded to Meteorological Centre (M.C.) . There are eleven more such MC on all India basis. Non-aviation forecasting services for seven states of the region was taken over by the M.C. Guwahati. The technical control of the region was also entrusted with M.C. Guwahati. In 1974 Flood Meteorological office was opened at Guwahati along with nine other places at all India basis for extending meteorological support to Central Water Commission (CWC) in their flood forecasting work. In 1976, a Hydrometeorological Centre was opened for climatological studies for planning of flood control and water resources management of the Brahmaputra Basin. This unit along with 56 rain gauge observatories and 6 seismological observatories was handed over to Brahmaputra Board in 1986.

Agricultural Advisory Service was introduced in Assam jointly with state Agriculture Department to help in agricultural growth of the state. Same is likely to be extended to other states of the region gradually. The telecommunication facilities of the region were upgraded with installation of MDD (Meteorological Data Dissemination) in 1990. The MDD reception of meteorological data, weather charts and satellite cloud imageries are done through INSAT series of satellite. Secondary Data Utilisation Centre (SDUC) at Guwahati was started in 1992 for reception of satellite cloud imageries from INSAT series of satellite with storage and processing facilities.

Airport Meteorological Instrument System (AMIS) was installed at Guwahati Airport in 1995. It was a big boost for aviation services during low visibility and bad weather conditions through instrumental observation near touch down zone of runway by continuous recording of meteorological parameter and runway visual range. The storm detection radar at Guwahati was replaced by new sophisticated radar with computerised operation facilities in 1996 along with nine other stations on all India basis. It has a range of about 400 Km for detection, approach and development of thunder cloud.

Major meteorological services of the region include aviation and non-aviation weather forecast and warning for hazardous weather, flood meteorological services, seismological data collection and agricultural Advisory services etc. These services reach to the user agencies through Doordarshan. All India Radio, Newspapers and with other telecommunication facilities. Besides, this, we are cooperating with state Governments of the region for the over all development and meteorological data and services are rendered. Research and meteorological data archives are other activities of the department.

CONCLUSION

In gist it can be said that meteorological services in North East India has grown up substantially after independence in keeping with fast development in national and global level. But this is not the end. To further enhance the development of meteorology and its services to the people of this region the Meteorological Centre at Guwahati has been upgraded to the status of Regional Meteorological Centre on 1st April 1997. This is sixth RMC of IMD and so far this is the only RMC which has come up after independence. This is a big achievement for the region and gives a message that IMD is dedicated for the development of meteorology and its services to people of the region. We can now hope that with this development IMD shall be able to serve the people of the region in better way by improving network of various meteorological observatories and utilization of the modern development in the field of telecommunication, space science and computer technology.

TABLE - I
OBSERVATIONAL ORGANISATION as on 1.1.1996

Type of Observatories	Number
1. Surface Observatories	559
2. Pilot Balloon Observatories	65
3. a. RS / RW Observatories	34
b. Only RS Observatories	1
4. Aviation Current Weather Observatories	72
5. Aviation Forecasting officer at National & International Airports	19
6. Regional Area Forecast Centre	1
7. Storm Detection Radar Stations	18
8. Cyclone Detection Radar Stations	10
9. High Wind Recording Stations	4
10. Stations for receiving cloud pictures from Satellites :-	
a. Low Resolution Cloud Pictures	7
b. High Resolution Cloud Pictures	1
c. INSAT-IB Cloud Pictures (SDUC Stations)	20
d. APT Stations in Antarctica	1
e. AVHRR Station	1
11. Data Collection Platforms through INSAT	100
12. Hydrometeorological Observatories	611
13. (i) Non-departmental raingauge stations :	
a. Reporting	3530
b. Non-reporting	5117
(ii) Non-departmental Glaciological observatories (Non-reporting) Type of Observatories	
a. Snowgauges	21
b. Ordinary Raingauges	10
c. Seasonal Snow Poles	6
14. Agrometeorological Observatories	211
15. Evaporation Stations	218
16. Evapotranspiration Stations	39
17. Seismological Observatories	57
18. a. Total Ozone and Umkehr Observatories	5
b. Ozone-Sounds Observatories	3
c. Surface Ozone Observatories	6

19.	Radiation Observatories :	
	a. Surface	46
	b. Upper Air	8
20.	Atmospheric Electricity Observatories	4
21.	a. Background Pollution Observatories	10
	b. Urban Climatological Units	2
	c. Urban Climatological Observatories	23
22.	Ships of the Indian Voluntary Observing Fleet	203
23.	Soil Moisture Recording Stations	43
24.	Dew-Fall Recording Stations	83

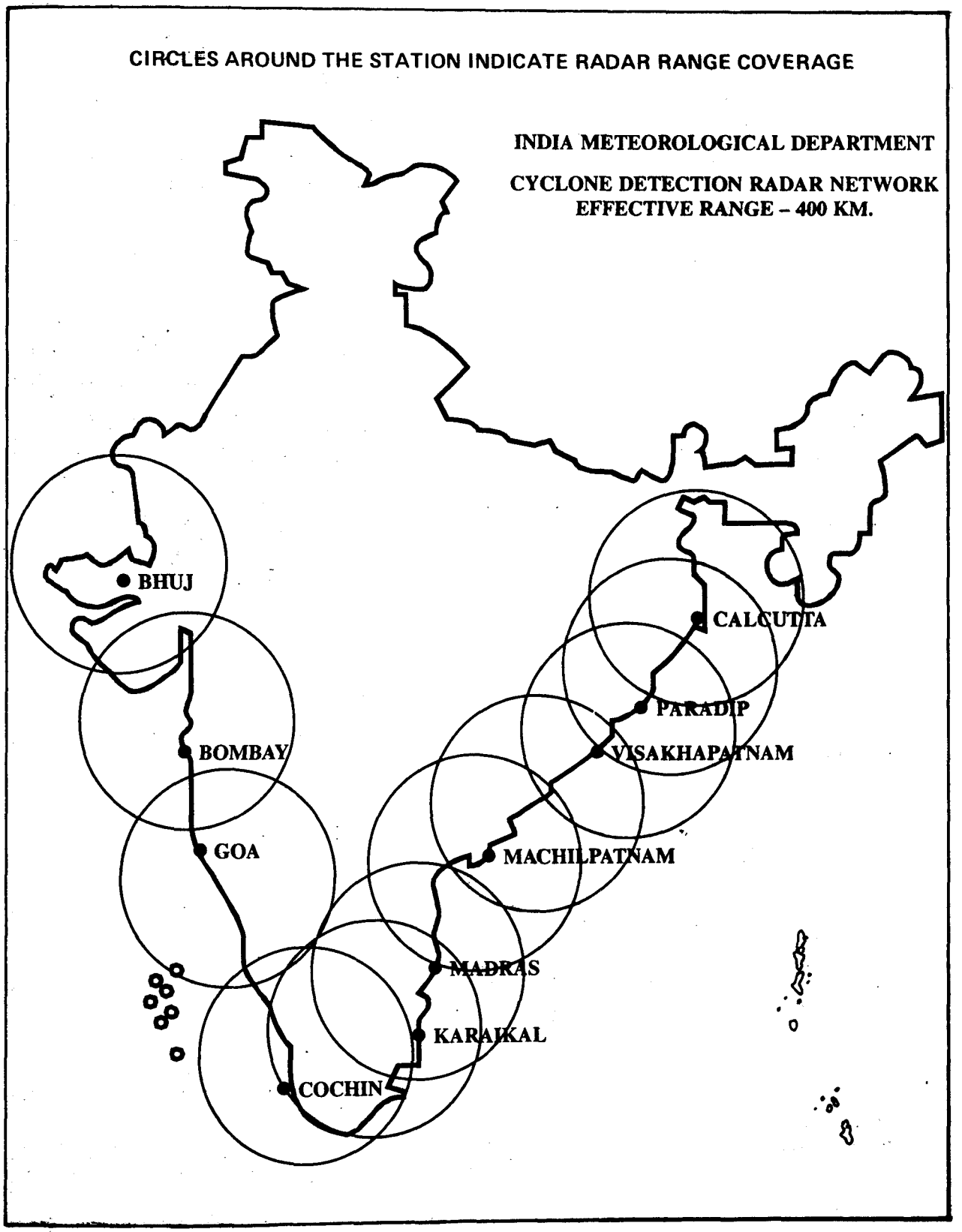
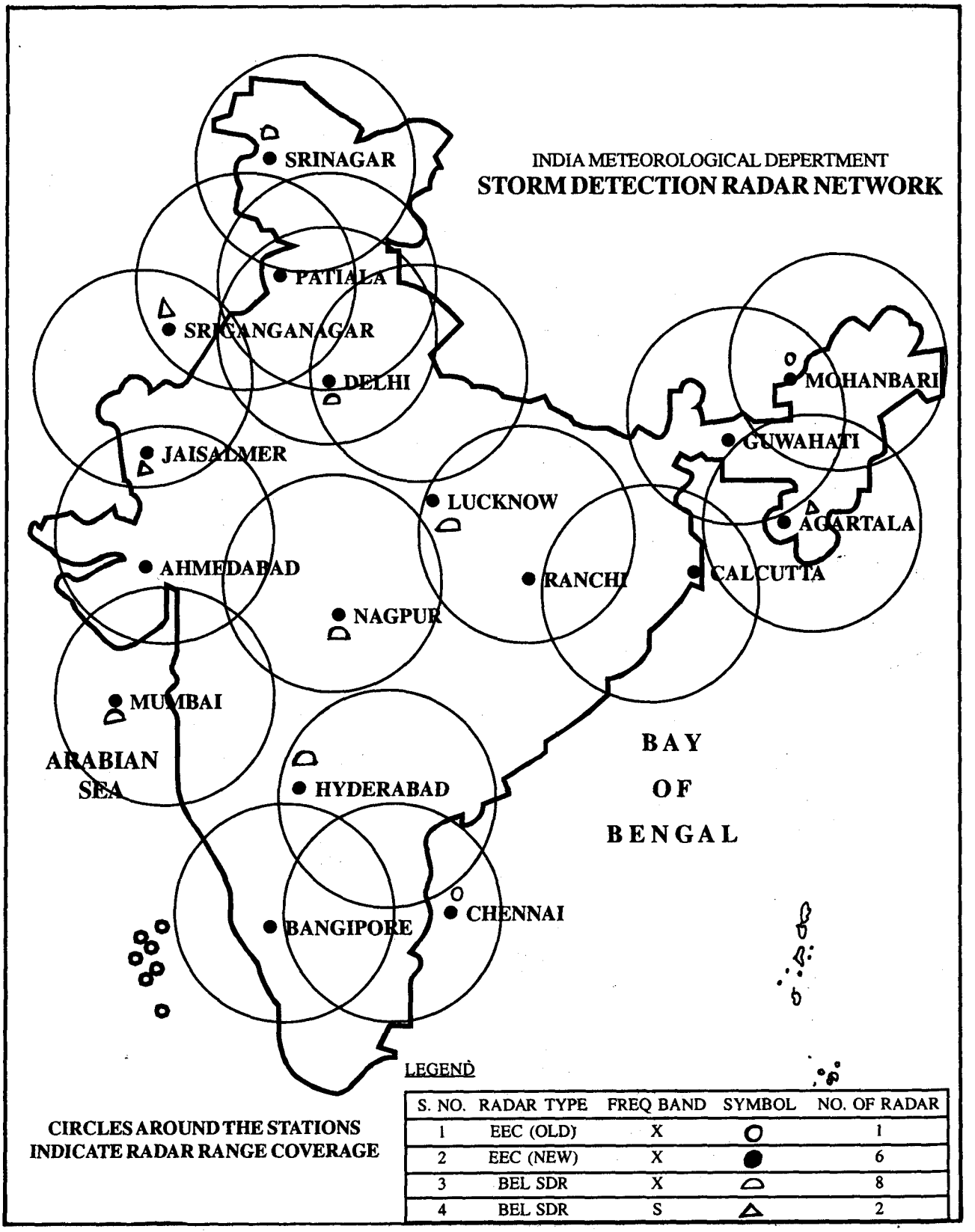

CIRCLES AROUND THE STATION INDICATE RADAR RANGE COVERAGE
INDIA METEOROLOGICAL DEPARTMENT
CYCLONE DETECTION RADAR NETWORK
EFFECTIVE RANGE – 400 KM.
BHUJ
BOMBAY
GOA
COCHIN
KARAIKAL
MADRAS
MACHILPATNAM
VISAKHAPATNAM
PARADIP
CALCUTTA

FIGURE – 1



S. NO.	RADAR TYPE	FREQ BAND	SYMBOL	NO. OF RADAR
1	EEC (OLD)	X	○	1
2	EEC (NEW)	X	●	6
3	BEL SDR	X	⌓	8
4	BEL SDR	S	△	2

FIGURE – 2

MAIN FUNCTION OF IMD

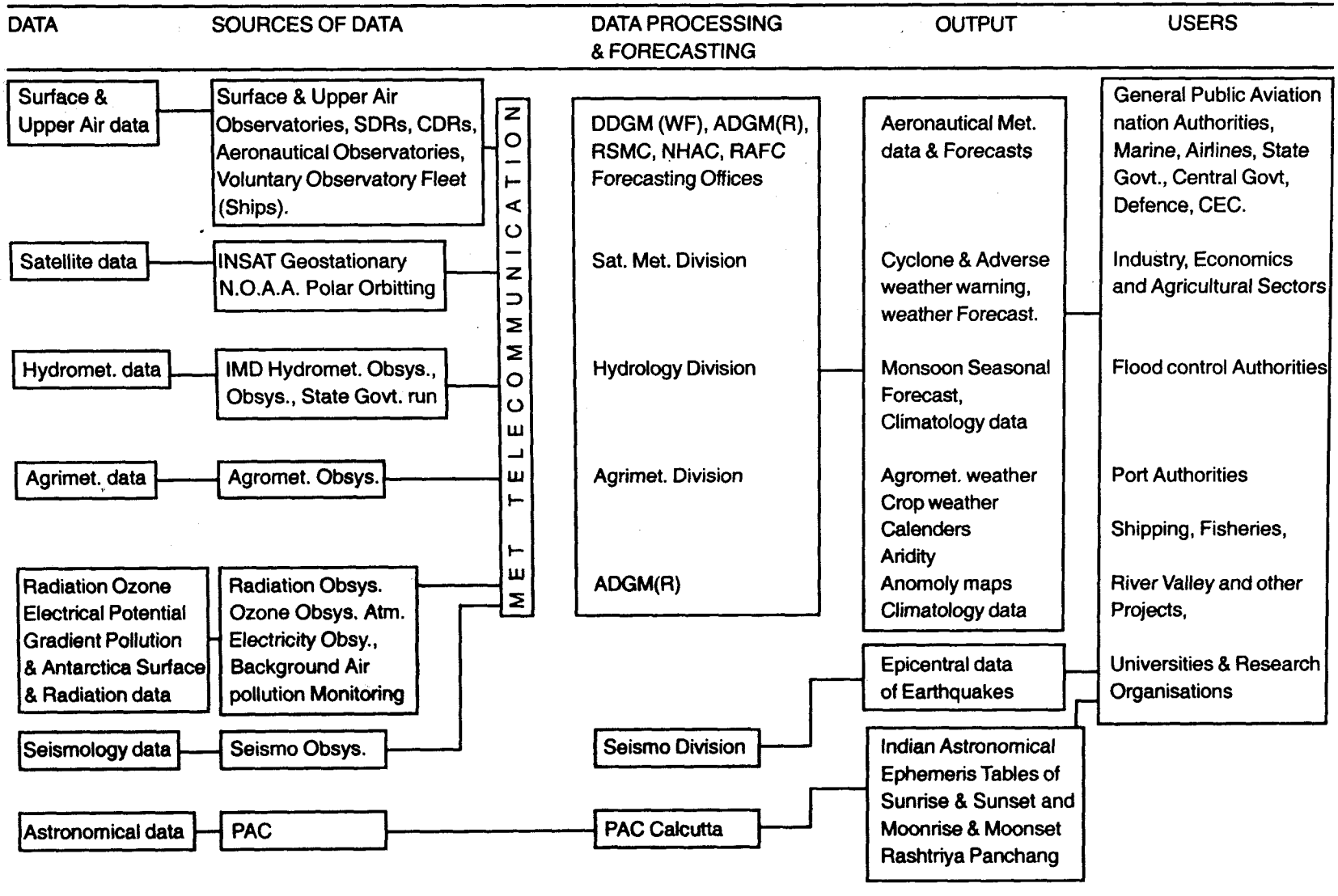
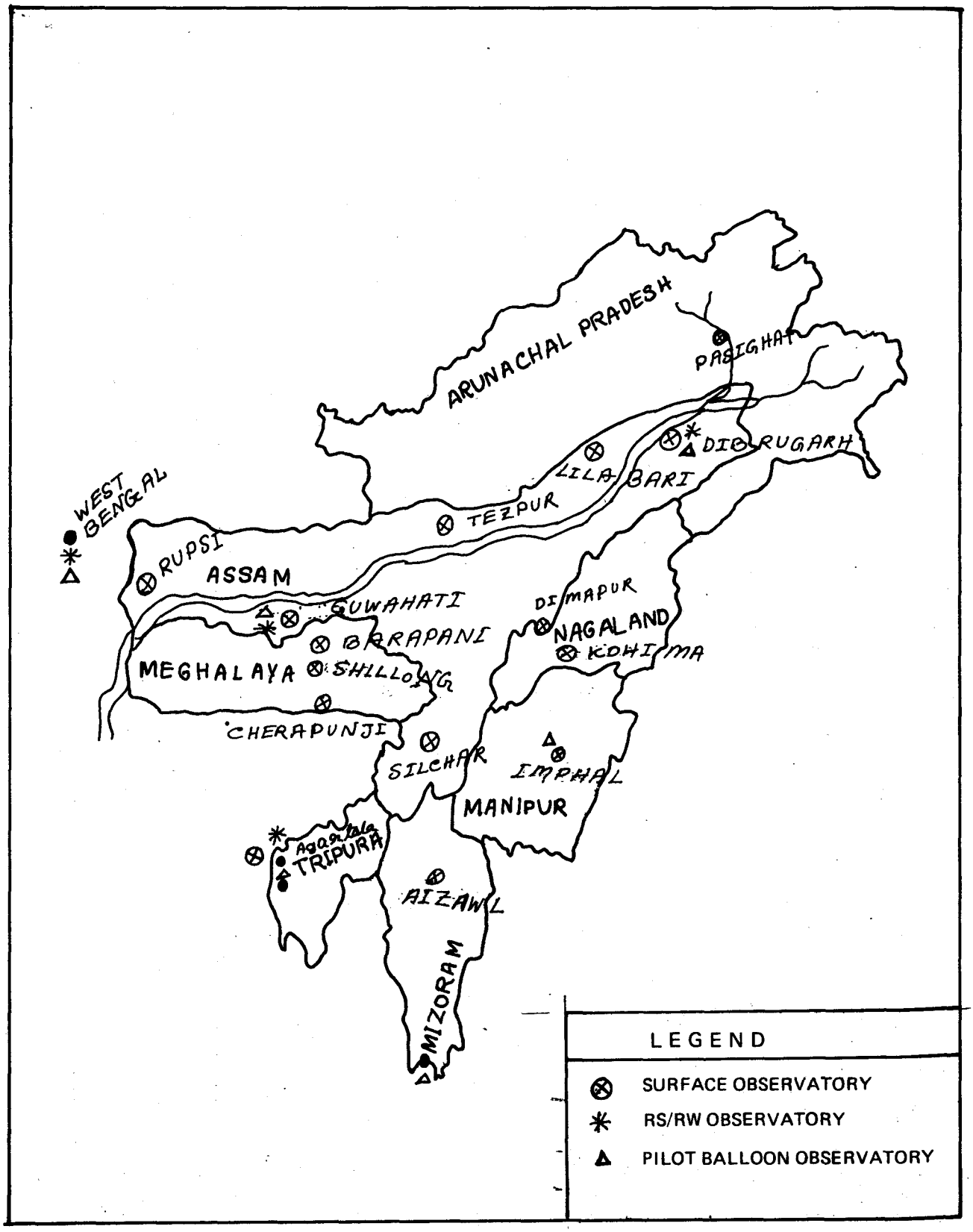


FIGURE – 3


ARUNACHAL PRADESH
PASIGHAT
DIBRUGARH
LILABARI
TEZPUR
WEST BENGAL
RUPSI
ASSAM
GUWAHATI
DIMAPUR
NAGALAND
KOHIMA
BORRAPANI
MEGHALAYA
SHILLONG
CHERAPUNJI
SILCHAR
IMPHAL
MANIPUR
Agartala
TRIPURA
AIZAWL
MIZORAM
LEGEND
SURFACE OBSERVATORY
RS/RW OBSERVATORY
PILOT BALLOON OBSERVATORY

FIGURE–4

HIGHER EDUCATION, EDUCATED YOUTHS VIS-À-VIS DEVELOPMENT OF THE NORTH EASTERN REGION

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ABSTRACT

Human Resource Development, being a chief objective of Govt. of India, has not been taken proper care of in college/university education for human resource generating which leads to the improvement of socio-economic conditions. The socio-economic and technological revolution plays an important role in order to exploit the natural resource of N.E. Region in which innovative ideas and constructive interventions play a catalystic role to achieve developmental process. The socio-economic development of this region can attain an incremented jump through proper education system which can lead to harmonious development and growth of the individuals in consonance with the physical, biological, psychological, political and economic environments.

HIGHER EDUCATION

The aim of education is to bring out the best in man. It should aim at an all round development of the person's body, mind and spirit so that a balanced personality emerges out after the education. This is more meaningful in the context of higher education – because the higher education being an end product for a large number of youths today should aim not only at individual perfection but also at social upliftment. After independence there has been a rise in number of colleges, universities mostly for general education, and hence the number of students completing the under-graduate degrees is increasing at an accelerated pace. But the qualitative improvement has not been attained keeping pace with this quantitative rise. Besides, the requirements of qualitative professionals are also not met up to a desired extent. Although, the Human Resource Development has been one of the chief objectives of Government of India, it has not been taken care of in a planned way at the collegiate as well as university education stage by the most state governments, specially in the North Eastern Region.

Though collegiate/university education-system should be the living conduit to provide opportunities for human resource generation, no such better and effective planning has yet been envisaged by the respective state governments of the region. Not only better planning is needed; but there is need to have proper coordination and monitoring to develop human resources in the region according to need. In this context, a significant point to be borne in mind is that the requirement of qualified, trained professionals will differ from state to state. There must be scope for utilising the services of such professionals profitably for the improvement of socio-economic condition of the concerned state. Collegiate/University education has to be strengthened to make it more responsive to human requirements and social calls.

Now, the question is to know the perspective of such development, specially towards science and technical education. Admitting the fact that the collegiate education as a system has failed today to give the society the desired finish and decisive edge to the products; that is, to the graduates passed out. Our academicians and planners must put their heads together to go for some definite need-based reforms in the curricula of collegiate education specially in science and technology. A workable national mechanism must be evolved to ensure that the collegiate S&T education can efficiently contribute to achieve desired targets in a unified manner and approach. In addition to it, S&T education system should be so set as to enhance the professionalism of finished products. Only then the educated youths will be functional, and then the degree holders, in general, will not have a feeling of disappointment as having wasted their time in colleges without attaining anything gainful for the settlement in life.

Truly speaking, the S&T education has been a great challenge for us in the North-Eastern Region, if we look at it through world perspective. In the other parts of the globe, even in the advanced cities of the country, there have occurred socio-economic and technological revolutions. This factor is most important in today's context, specially for the purpose envisaged to be attained by the 21st century. So, our Science education system enveloping the teachers and the students must overhaul the present state of education and induct new packages with innovative approaches both in curricula and teaching methodology so as to produce more professionals. For this the concerned authority should come forward to arrange infra-structural facilities for the teachers as well as for the students in order to make the S&T education functional and to use the educated youths for developmental purposes through various vocations.

One example will make it more clear. The North East Region as a whole is full of natural resources. In order to tap them and use them profitably without adversely affecting the ecology, our users, educated youths and scientists must acquire the know-how and proper knowledge on those resources. Unless such lessons are inducted in school and collegiate curricula, the products having degrees cannot dare to handle them profitably. At present, we do not have enough of such materials in the educational curricula. No one counts professional enrichment as worth unless it entails some opportunities in terms of job or vocation leading towards appropriate development of the region. To achieve such developmental outcome the academicians together with planners from the Government agencies must work hand in hand. It is significant to note that in planning of the state as well as of the centre innovative ideas and constructive interventions adduced by educationists should be counted with equal importance to achieve developmental progress specially in science and technology sectors. Only then the challenge of the day will be accepted by the learning and teaching communities. At present, the developmental part has been kept outside the pale of the duties and comprehension of the academicians for obvious reasons. As a result, the teachers and the students are never having anything of challenges to attain the shared goals for their guidance.

Nobody can deny that the collegiate/university education essentially forms the gamut of functional higher education. School and college education constitutes its base while university-education, that is, post-graduate and Research education leads to attain the quality of higher education, so as to give the education system as a whole a new direction and national purpose. It is a fact that today in the world economic market, the output including educational products is assessed and priced as per its utility and social relevance or use. That is why, a professional and technical graduate is always marked at higher salary than a general graduate. This naked truth must be realised in planning our collegiate educational curricula. The quality of the products is the most important ingredient in a competitive environment of a shrinking world. It may not be out of context to mention that our myopic planners, managers and users too are suffering from regional inhibitions and constrained, vested vision for which they cannot go beyond the frontiers of local wisdom. The feeling of local interest leading towards parochialism must not confront the educational planners or schemers while making the collegiate and higher education, specially S&T education system, functional. Or else, the collegiate education will get lost in the perspective of the new world without frontiers. The modern accepted idea of educational management is to manage men timely in order to earn profit and credit. In other words, our collegiate education is to be managed in such a way so that the finished products after completing their degrees can boldly face the challenge of time and society and also of life and function as better practical men. Thus with technological changes sweeping the world today in the exploitation of resources and in making them more productive, better directional practical planning in a pragmatic way will have to be envisaged in the collegiate education-system so as to produce better professionals technically sound. The pace of improvement in S & T education will have to be accelerated with time. During last fifty years whatever is done, there is still a big gap in our curricula. Such gaps will have to be bridged quickly. Achievement indicators will have to be redefined in terms of social output and relevance. For this, the collegiate educational curricula is to be redesigned accordingly.

Science and Technical education in the North East has to face time-bound pressure for change and transformation under market forces which has not been achieved during last five decades. Any lag in this direction may fetch undergrowth and poor economic condition since there has already appeared resource constraints in the region. In the other parts of the country privatisation of technical education specially in vocational-cum-professional courses has gained momentum, though it has made the education costly. Good or bad, this situation is solving at least a part of the problem faced by our society today to get an entry to the professional courses. We in the North East, are not having such facility till now. It is advisable that respective state governments wherever possible should adopt a liberal policy of encouraging the private sector to establish high quality professional/technical institutions. This will also relieve the pressure on the public exchequer. The Government of India and also the University Grants Commission have also encouraged the growth of private institutions upto the university level with a view to achieving educated youths for better use.

A number of factors, like limited places in the institutions of repute, specially in professional & technical colleges, resource constraints, mismatch of student population with institutional increase, degradation of value of university degree for career achievements together with expanding size of the middle class group are giving rise to several new trends after independence which, on the other hand, are going to shape the future of our youths undergoing science and technical education. It is to be remembered that such trends will have both positive and negative impacts not only on collegiate science education but on higher education as a whole

also. Coupled with it, there have been emerging some uncalled for trends such as the mushroom growth of science degree holders with low quality of education. So, before allowing private sector institutions in the region, the controlling authority – (the university as well as the state government) must take into account of factors that may usher in negative effect on the system and its products.

It is also to be seen whether the larger role of the private sector will remain merely exploitative or whether it will really help to improve quality and efficiency of the collegiate education, specially Technical cum Professional Education if the second factor is found to be negative, then there must be a device to be involved for quality control mechanism or a monitoring agency in the system.

DEVELOPMENT OF NORTH EASTERN REGION

So far I have analysed the state of higher education, particularly science and technical education and its produces, namely, the educated youths of North East Region. Now I intend to seek the state of development of the region vis-à-vis the educated youths.

By the development of the region, we, in fact, mean mainly the socio-economic development which is really in slow pace in the North Eastern Region. At the time of independence N.E. Region comprised of Assam [the composition of present Assam, Nagaland, Mizoram and Meghalaya and NEFA (the present Arunachal Pradesh) covering nearly 2,2,31590 sq.km.] Manipur and Tripura came under Indian Union only in 1949. Including these two states, the total area is 2,55,082 sq. km. (as per 1971 census) and its population is around 2 crores. In 1981, it rises to 2.6 crores. Thus we see that the north eastern region comprises 8% of the total area of India and the population was around 3.5% in 1981. It is to be noted that the most of the population live in rural areas or in rural environment. It is mainly due to slow growth of urban atmosphere and hence agrarian culture determines the socio-economic pattern of the region. The so-called educated youths are mostly detached with such environment which is perhaps one of the reasons of increase in unemployment situation.

If we look at the societal pyramid of the region, we find that it is composed of three tiers as : (i) the elite, a small group of talented men and women who have distinguished themselves in various walks of life. They are fighting their own battles against the inequalities of socio-political and economic system. (ii) The seething mass of the humanity, a poor and wretched group is at the base of the pyramid. This group of people is still steeped in the 'cowdung-age' struggling hard to extricate itself from grinding poverty. (iii) The so-called middle class people remains sandwitched between those two human layers with all its frustrations, bewildering confusions and struggle for status. This group is unable to absorb the shock of portentous changes in the rest of the country. Consequently, the quality of growth of Human Resource Development has not been harmonious, obviously due to defective higher education policy. The harmonious development of the youths means the growth of the individuals in consonance with the physical, biological, psychological, political and economic environment. Because, the individual, while allowing his socio-economic milieu to shape his career also moulds the social environment and vice versa. This is very ideal; but it is not taking place in the north east region. The psycho-social dictates mediate by the phenomenon of ethnic differences have been affecting the quality of growth of the human resource as a whole.

It is a fact that any physical/raw resource becomes wasteful if competent man-power resource is absent. In fact, it has been the case in the north eastern region. Although the region is full of potential (a) forest resources, (b) mineral resources, (c) water resources and (d) other natural resources, the resources have not found their profitable use to the desired extent due to lack of capable human resources. In other words, the educated youths of the region have not been prepared for skill development and as a result overall growth of development of the region has suffered a set back. Proper technical education at appropriate level is important to each educated individual; because, it can assist in improving and using one's capacities as well as potentialities to the utmost. With ever-developing skill and aptitudes, an individual becomes increasingly proficient. It also helps him/her to overcome many hurdles. It is seen that in the north eastern region skilled human resources are the least developed of all economic resources which has resulted in poor growth of development in spite of having large number educated youths mostly in the general stream. The region is having huge number underemployed, unemployable and under-trained or untrained youths whose talents are otherwise ideal or undiscovered.

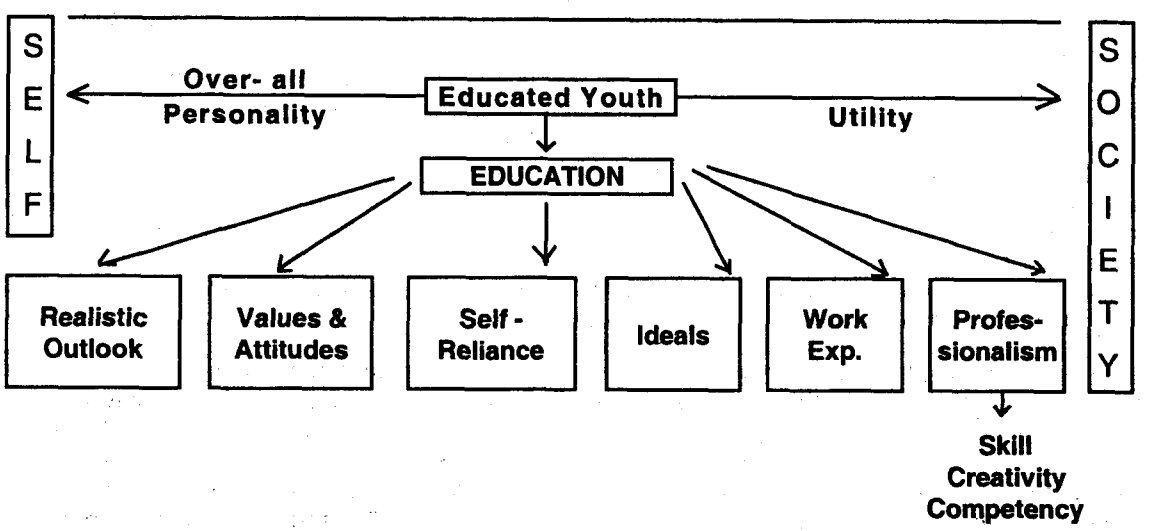
The main lag in the NE Region is that development planning to have human resource in a desired way has not been linked up with education. It may be mentioned in this context that the trajectory of human

resource development in a region is the outcome of various interdependent parameters and it is due to sustained efforts over a long period of time. Besides, the social political and economic interventions responsible for bringing structural changes in the society have not been placed in a dynamic frame of reference. The educated youths of the region are fighting for their identity and place without considering such complicated factors. In spite of rapid growth of colleges and universities quantitatively in the region, the main purpose of yielding leadership role to the educated youths has not been served qualitatively. Let me raise a few pertinent questions here :

Why do we need a college? Why do we need a university? Is it just to produce a few degree holders?

In reply, I do say – definitely not – not to yield degree holders who are not functional for the development of the region. University is not just a U-shaped vessel or an apparatus to produce some chemical solutions. So, I request the authority of newly set up or to be set up new universities to consider such vital considerations to yield professional/technical degree holders for the profitable use of the region. Even the old universities of the region are to think seriously to change their curricula drastically so that the region can achieve human resource development. We must plan our education is such a way, so that our produces can achieve the twin objectives of realising growth with equity together with bringing about modernisation. Our educated youths must be good professionals, may it be in any field(s) with self reliance to serve the region for proper development. Let us identify the needs first and then administer unique packages of such inputs through education-system to have desired outputs. A successful implementation of any scheme of human resource development would not only raise the overall quality of life of the masses but also facilitate the educated youths of the region to launch their progressive movements to higher levels along the path of development.

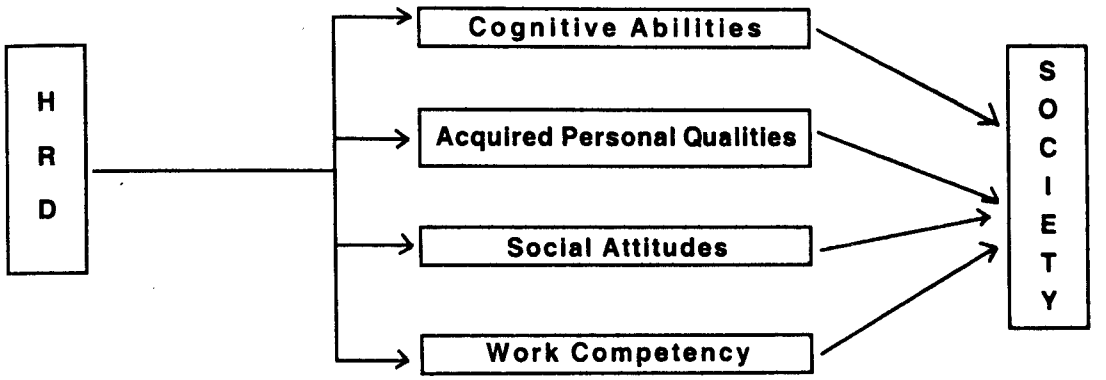
In fact, we must set our education system considering all local conditions in a way to make an educated youth functional for himself/herself as well as for the society.



If we analyse the above flowsheet diagram, we can understand that each and every product of a college or a university should come out with four attainments, namely:

1. Cognitive abilities (E.G. Intelligence)
2. Acquired abilities (personal) like logistic approach to analyse situation, work commitment for self and society, self reliance etc.

3. Social attitudes (yielding secularism, consumerism, co-existence etc.)
4. Work experience with competency.



PLANNING – THE KEY TO THE SUCCESS OF ANY DEVELOPMENTAL PURSUITS

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ABSTRACT

The success of any developmental activity or activities, which may form a project in the areas of Science or Technology or any other sector of development, depends on how vigorous efforts have been made in its planning. The planning is a process where conceptualisation of any developmental activity and analysis of its various parameters e.g. social, political, geo-ecological, technical, economical etc. have to be done quickly and rationally by associating a group of experts in the above fields as well as the people in particular, who are going to reap the benefits of the project.

INTRODUCTION

The Planning Commission, since independence of India, has been entrusted with the responsibility of planning the developmental activities needed for the country to make it self-sufficient and self-reliant in the area of agricultural production, infrastructural development, Science & Technology, small and large scale industries and projects of various dimensions to tap and harness the natural resources i.e. land, water, natural gas, minerals etc. for the developmental activities since 1951 in a phased manner. The time frame fixed for execution of the planned schemes has invariably been kept for five years and being reviewed on annual basis for re-allocation of the fund, depending on the physical progress achieved, financial expenditure incurred and the target set forth for the next annual plan. The configuration of the planning and the system of funding followed by the Planning Commission are being disseminated to the States/U.T.s of the country and in turn, they formulate the project proposals depending upon the priorities of their developmental needs. Thereafter the requirement of fund is decided by the Planning Commission through mutual discussion with the states/U.T.s representatives and the fund is routed through the various Ministries of the Govt. of India to the project implementing agencies. This process of planning is still existing in the country. The results achieved up to the VIII plan period, with respect to the targets fixed for each five year plan period at National level, have been of mixed type. In some of the sectors i.e. Small-Scale Industries, Agriculture and Allied sectors, Water Resources Development, the achievements were quite satisfactory. In order to create the basic infrastructure throughout the country to achieve the balance progress in the area of Industry (large, medium and small-scale), Agriculture and Allied sectors, Power, Irrigation etc. the planning process has already been decentralised to the state/U.T.s level.

In continuation to this Philosophy, to give emphasis on the regional planning for the development of cluster of states located in geographically difficult terrain of the North Eastern part of the country, the North Eastern Council was created in 1972 by an act of Parliament. Since then, it has been engaged in taking up the regional development projects in general and also projects of innovative nature, which have the regional ramification in the area of Transport & Communication, Power, Agriculture and Allied Sectors, Irrigation & Flood Control, Industries & Banking, Science & Technology, Man power Development etc. in the North Eastern region covering the seven states. The projects in the above areas have been implemented with the help of State Governments, Central agencies, Govt. of India undertakings, N.G.O.s/Registered Societies etc. The mode of NEC's project funding to the NE states from the Govt. of India is carrying the components of Grant (major portion of the total funding; in some cases upto 100%) and loan (nominal portion of the total funding), and routed through the NEC. The NEC has succeeded in completing many major projects and important studies since its inception, which had the direct impact on the Socio-economic development of the region.

A good example of evolving a suitable strategy and use of area-specific technology for the development of rainfed farming system on the perspective of Integrated Watershed Management at National level may be gleaned through the effort made by ICAR (Indian Council of Agricultural Research) since VII Plan. The ICAR in VII Plan launched an **Operational Research Project** in 46 Watersheds spread over all major states of India to develop/identify appropriate strategy for the development of rainfed areas. This is in view of the importance of the rainfed farming, which is currently being practiced in nearly 67% of India's crop-land and where production and productivity levels are low and bulk of rural poor of India live, an urgent need was felt to develop a suitable strategy for the development of this vast area using Science and Technology and vast largely untapped natural and human resources in a manner that it may be ecologically, financially and socially

sustainable. The report is based on this unique experiment conducted and experience gained in the development of a Watershed through farmers-agricultural scientists participatory action-research work – an effort which received appreciation of people from India and abroad.

While going in for Integrated Watershed Development and Management right from its conceptualisation, planning, investigation, implementation and performance evaluation of the Watersheds, instead of taking piecemeal approach, village as a unit and Sectoral Agricultural Development Approach with plan and execution oriented strategy blending with an inter-disciplinary and people's fullest participation at all stages was adopted. The unit of operation in such areas, for application of a set of developmental packages and interventions, was the Watershed - the concept of developing the entire Watershed for various land uses and land capabilities, provides a modern tool for integrated rural development. Further, lack of location-specific and field tested technology for the Watershed and resulting problem in extrapolating the former on the Watershed also, suggested desirability for the development of location-specific and need-based agricultural production technology for the area. The individual components of crop production technology developed elsewhere may not be equally appropriate. The approach of identifying specific agro-technology through adaptive trials on farmers' field and using them also simultaneously for dissemination of new technology with fullest participation of local people at each stage and level was the one used and adopted for working.

Another unique and distinctive feature was the establishment of a very strong working linkage with various State Govts' development departments and their district units. These strong points enabled the project to achieve so much with comparatively very small monetary investment. After analysing the data regarding soil, rainfall pattern, terrain etc. a technical approach to be adopted was worked out by a scientific consortium.

The experiences gained by adopting the above strategy and methods may be concluded that the Watershed-based integrated resource management approach with tested location-specific improved technology as a major input, fullest participation of local people at all stages coupled with the selective support of the state agencies, is probably the most viable strategy for the development of rainfed areas with undulating and hilly features.

The Government of India has accorded highest priority to the holistic and integrated development of rainfed areas constituting about 65% of the cultivable land for meeting the projected food grains requirement estimated at 210 million tonnes by 2000 AD, bridging the regional disparity in terms of production and productivity between the irrigated and rainfed areas, restoring ecological balance and generating employment opportunities for rural areas. With a view to effectively address the above mentioned developmental objectives, a Centrally sponsored Scheme namely National Watershed Development Project for Rainfed Areas (NWDPRA) was launched in 1990-91 and was implemented through the VIII plan at an estimated cost of Rs.1100 crores in 25 states and two union territories.

The current strategy for rainfed farming is based on the concept of conservation of rain-water for holistic and integrated development of potential Watersheds and promoting of farming system approach, management of common property resources, augmenting family income and nutritional levels through household production systems. During the VIII plan, using Integrated Watershed Management as a key approach for sustainable rainfed farming, a sizeable number of national and internationally aided projects have been launched by the Central Ministries, covering an estimated area of 16.5 million ha. out of this area, under the National Watershed Development Project for rainfed areas, an area of 4.3 million ha, spread over 2554 project centres (Micro Watersheds) in 25 states and 2 Uts has been covered by the end of VIII plan. One Micro watershed in each development block of the participating states/Uts, having less than 30% arable land under assured means of irrigation, qualifies for consideration under the project. The project is financed by the Government of India in the form of 75% grant-in-aid and 25% loan to the State Government and 100% grant-in-aid to the Uts.

In the first instance, model Watershed projects representing one each of the 115 agro-climatic zones were approved. Based on these approved models, the state level sanctioning committee approved other sustainable Watershed models at the state level for implementation in the participating states. It was targetted to cover an area of 2.8 million ha during the VIII plan with total allocation of Rs.1100 crores.

By the end of VIII plan period, 2554 micro Watersheds had been treated throughout the country covering an area of 4.3 million ha. Combining the unspent balance of VII plan, the project cost was fixed at Rs.1240.79 crores for the VIII plan, of which a cumulative release of Rs.1010.06 crores was made during the VIII plan. The area of 10 million ha was proposed to be treated during the IX plan, however, due to financial constraints,

a modest area of 3.0 million ha has been targetted for treatment. During this plan period, areas contiguous to the existing Watershed and a relatively small proportion of identified new areas will be considered under the project for treatment.

On the basis of experiences gained and lessons learnt during the VIII plan, feed-back received from the participating states as well as recommendations of the Working Group Report on Rainfed Agriculture, it was proposed to suggest certain need-based modifications, changes and additionalities on NWDPRA projects for the IX plan, incorporating the critical areas like revision of cost norms, introduction of flexibility and revision of componentwise resource allocation, development of sustainable modes, eligibility criteria, greater research support, provision of farm pond, cluster plantation under horticulture & agro-forestry, review of live stock components, enlarged roles of NGOs and Panchayats, Technology Transfer, improvement in Monitoring & Evaluation, HRD & Skill oriented Training, Strengthening of Staff and logistic support.

Further, in order to accelerate the pace of development in the North East from the IX plan period, the Govt. of India had constituted the Shukla Commission to identify the critical gaps of infrastructural development and submit its recommendation for bridging these gaps for providing Basic Minimum Services to the region. The Shukla Commission has already submitted its recommendation to the Govt. of India. The Planning Commission has also taken cognizance of the Commission's recommendations and given priority to the projects identified by it during the IX plan either for investigation or implementation.

The Govt. of India has also initiated the process for creation of non-lapsable fund for the North Eastern Region, by building up a pool of fund drawn from the 10% of the total annual budget of each Ministries of Govt. of India earmarked for the development of this region. This fund would be given priority first for meeting the short fall in the fund requirement for completion of all on-going projects and thereafter, to the new projects of ambitious nature. The modality for the distribution of this fund between the schemes of NEC and the NE states has to be finalised by the Govt. of India.

CONCLUSION

In view of the above measures adopted by the Govt. of India, it is mandatory to concentrate on the parameters required for the successful planning of the projects. The pre-requisites for the successful planning of the projects are :

1. Conceptualisation of the important parameters of the project by a group experts from multi-disciplines. The parameters are :
   - Technical
   - Environmental
   - Economic
   - Dynamic motivation and active participation of the people being affected/benefitted out of the project
   - Adequate and timely fund flow
   - Finalisation of size of the project depending on geo-ecological and social considerations
2. Investigation and preparation of detail project report based on the ground truth by pioneer organisations;
3. Initiation of parallel actions for seeking mandatory clearances required for project implementation;
4. Earmarking time frame for planning, investigation and implementation of the project;
5. Monitoring and evaluation of the project by a group of experts from multi-disciplines during Pre-construction, Construction and Operation & Maintenance; and
6. Post-construction evaluation of the project on annual basis by a group of experts from multi-disciplines to ascertain its performance.

In fact, there is still a lot of efforts required in planning stage to formulate the viable regional projects related to critical areas of development in the North East, so that, their time bound implementation within the stipulated cost, as identified by the Shukla Commission or any other developmental agencies or agencies of Govt. of India/State Govts. Of North Eastern states, could be ensured for the immediate development of this region.

NORTH EASTERN ELECTRIC POWER CORPORATION – A MOVEMENT IN POWER DEVELOPMENT PROGRAMME OF THE NORTH EASTERN REGION

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ABSTRACT

North Eastern Region is blessed by Nature with enormous reserve of hydro, coal & gas potential for generation of power. To harness these, North Eastern Electric Power Corporation was conceived in 1976 under North Eastern Council as a Govt. of India Enterprise. Since than, NEEPCO has been relentless in its effort and to-day it has to its credit 595 MW of installed capacity and meeting 40% power demand of the region. In addition several mega-hydel projects are under construction by NEEPCO. In spite of the best possible efforts, there has been a shortage in demand and supply of power in the region which by all means is likely to be enhanced further by 2006-07. Also, there has been a growing need of improving hydro-thermal approach of the country. All these demand the harnessing of potential of hydro-power of the region through sustained planning. NEEPCO perhaps remains as the viable answer in this programme with its proven record of excellence.

INTRODUCTION

The North Eastern Region is blessed with the highest hydro power potential of the country on account of highest mighty Brahmaputra and its tributaries at an estimated figure of 48,000 MW. Also, this region of the country has large deposits of low ash, high CV coal but could not be put to the power plants because of high sulphur contents. Again, this region is enormously rich in natural gas and about 2,000 million cubic meter of associated gas is generated every year when one-third is flared off. In spite of all these potential resources – the N.E. Region remain to be the poorest in terms of generation and consumption of electrical energy.

With a view to harness and to make best use of this abundant natural resources, the idea of creation of North Eastern Electric Power Corporation within the frame work on NEC was conceived in April, 1976 as a Govt. of India Enterprise. This was felt to be a real necessity not only to give a phillip to the power starving states of the region but also to contribute to the socio-economic development of the region. The main objectives assigned to this Corporation are:

- To plan, promote, organise, investigate, survey, design, acquire, construct, generate, operate and maintain power stations and associated structures in the N.E. Region.
- To harness enormous power potential of North Eastern Region in particular and nation as a whole and to contribute to the national economy by providing adequate power generation.
- To take up schemes for terrace cultivation, soil and water conservation through dam construction, afforestation and to preserve ecological balance in all Hydro Electric Projects etc.

Since its inception, NEEPCO remained dutiful to its commitments and today has in its credit 595 MW of installed capacity out of the 1611.04 MW of N.E. Region and meets above 40% of demand of the N.E. Region. The status of this achievement is as follows :

PROJECTS COMPLETED

a. Kopili Hydro Electric Project (1" Stage) 150 MW :

The project has the following breakup :
Khandong Power House: 2x25 MW
Kopili Power House : 2 x 50 MW

This was the first venture of NEEPCO and was sponsored by NEC. This is the first stage development of Kopili river basin and envisages creation of two reservoirs, one on the Kopili river and other on the Umrong streams with full reservoir levels at EL 719.3 m and EL 602.0 m. Water from the Kopili reservoir is now being utilised on the Khandong Power station through a 2759 meters long tunnel to generate 50 MW power (2x25 MW). The tail water from this power house is led to the Umrong reservoir and from there together with inflow from its catchment is taken through a tunnel of 5473 meters long to the Kopili Power Station to generate 100 MW of power from its two units of 50 MW each. This project was accomplished in totality in 1988 with generation capability of 806.

b. Kopili Hydro Electric Project (1ST Stage Extension), 100 MW :

This project was taken up as a stage development of the original Kopili Hydro Electric Project as a Central Sector Project with installation of two more units of 50 MW each by the side of the existing Kopili Power House and has been completed during 1997.

With the commissioning of this project, the annual energy generation has been enhanced to 1308 MU from 806 MU.

c. Assam Gas based combined Cycle Power Project, 291 MW :

This project is located in Upper Assam and accomplished as a Central Sector Scheme. This project envisages 1 MCMD gas for power generation from Oil India gas field to run a gas power unit of 6x33 MW Gas Turbine and 3x30 MW waste heat recovery steam turbines with a capacity of annual energy generation of 1697 MU in 6000 hrs of operation.

The project has been executed under loan assistance from the Overseas Economic Cooperation Fund, Japan and is executed by Mitsubishi-BHEL. All gas turbine units has since been commissioned along with two steam turbine units. The only remaining steam turbine is expected to be commissioned by 1998.

d. Agartala Gas Turbine Power Project, 84 MW :

The project is located near Agartala and has been executed as a Central Sector Scheme in open cycle mode with four units of Gas Turbines of 21 MW each.

The project has been executed under loan assistance from Germany with European Gas Turbine being the turnkey supplier.

PROJECTS UNDER EXECUTION

a. Doyang Hydro Electric Project, 75 MW :

The project is located in the state of Nagaland and envisages utilisation of discharge from the Doyang river, a sub-tributory of the river Brahmaputra with an installed capacity of 3x25 MW, the project is capable of generating 227 MU on 90% dependable year and 360 MU on 90% on average year after completion. Finance of this project comes from North Eastern Council.

Apart from already developed infrastructure facilities all major construction work like Rockfill Dam, Spillway, Water Conductor system, Power House, Switchyard etc. are in progress. While the 1st unit of the project is scheduled for commissioning in Sept '98, the other two units are likely to be commissioned within 1998.

b. Ranganadi Hydro Electric Project, 405 MW :

This project is located in Arunachal Pradesh and is sponsored by the North Eastern Council. The typical feature of the project is a huge 68.0 m high diversion dam and a 10.27 km long 6.8 m diameter modified horse show tunnel leading to power house of 3x135 MW generating sets with generation capability of 1876 MU of energy on 90% dependable year.

With the pace of work and as programmed, the project is expected to be commissioned by March, 2000.

c. Tuirial Hydro Electric Project, 60 MW :

This project is located in the state of Mizoram and is the latest addition in the NEEPCO family. All formalities for starting the project work through **OECF** loan assistance is completed along with infrastructural development works.

The project envisages construction of a 77 m high earthen dam with homogeneous section across the river Tuirial, with an installed capacity of 2x30 MW.

PROJECTS DUE TO BE TAKEN UP FOR EXECUTION DURING IX PLAN

The following projects are in advanced stages of consideration for execution by NEEPCO during IX Plan programme:

a. Lower Kopili Hydro Electric Project (150 MW) in Assam.
b. Kopili H.E. Project, Stage-II (25 MW) in Assam.

c. Tuivai H.E.Project (210 MW) in Mizoram.
d. Dikrong H.E.Project (100 MW) in Arunachal Pradesh.
e. Kameng H.E.Project (600 MW) in Arunachal Pradesh.

INVESTIGATIONS SCHEMES UNDER NEEPCO

4-number of projects totalling 1225 MW are under investigation with NEEPCO and all of these are located in Arunachal Pradesh. The projects are :

a. Pakke H.E.Project (105 MW)
b. Papumpam H.E.Project (100 MW)
c. Damwe H.E.Project (520 MW)
d. Upper Lohit H.E.Project (500 MW)

SECRET OF THIS ACHIEVEMENT

There is virtually no secret in this dramatic transformation where every aspects from conceptual stage to commissioning is carried out in all sphere with absolute transparency and dedication. The performance highlight as brought here under amply prove the credential of NEEPCO in the yesteryears and setting newer targets.

Particulars	1994-95	1995-96	1996-97
* Gross Generation (MU)	861.49	1043.28	1402.97
* Net Sales (MU)	796.64	895.85	1328.72
* Gross Profit (Crs)	28.19	59.25	44.96

CRISIS IN THE NORTH EASTERN REGION AND NEEPCO'S COMMITMENTS

The working group constituted by NEC for formulation of 9^{th} and 10^{th} five year plan for NER observed that North Eastern Region is having 90 Kwh per capita consumption of electrical energy in comparison to national average of 280 Kwh. Further, the analysis of the group establishes the fact that the existing installed capacities particularly the thermal units could not be utilised to full capacity to produce the required power resulting in shortfall of actual availability virus demand of the NE Region. The reason for this perpetual shortfall is mainly attributed to the inadequate provision of generation capacity to creat sufficient available power both at peak load as well as in terms of energy, particularly during lean period. Constraints like inadequacy of T&D system including the losses, demographical hilly terrains, scarcity of financial resources etc. are also partially responsible for this situation. It remains a fact that the region have a constant shortfall of 75 to 150 MW during peak load.

Further, there has been indication by CEA that though the region will have a surplus power position during 1999-2000 and 2000-2001 after commissioning on ongoing projects but there is likely to be a deficial period from 2001 onwards which will reach approximately 22% of peak loan deficit and 17% energy deficit by 2006-07.

Also, the Govt. is seriously concerned to improve the hydro thermal mix to a respectable figure from the present scenario of 25.75 and for which the entire power development programme will have to depend on the potential of NE Region.

Keeping the above in mind, the Ministry of Power has framed an active plan and proposed to take up 6(six) hydro electric schemes with an aggregate capacity of 1116 MW during the 9^{th} five year plan for commissioning during the 10^{th} five year plan. Also, another 52 projects with an envisaged capacity of 35,461 MW are under various stages of investigations in this region.

NEEPCO is today responsible for the execution of the major projects in the region and is ready to accept any challenge and duty for accomplishing this task with its indomitable spirit and dedicated work force of 3000 employees.

SOME THOUGHTS ON THE "SOCIO-ECONOMIC STATUS IN MEGHALAYA-PLANNING FOR THE FUTURE"

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ABSTRACT

Meghalaya is one of the backward regions of the country whose per capita income in 1994-95 was Rs. 6,136/-, which is less than $175. In this paper, the present status of the socio-economy of Meghalaya has been discussed along with the inherent reasons for its backwardness. The well-oriented futuristic plans here been suggested along with important strategies followed in different countries in order to bring in socio-economic changes in a balanced manner through economic developments.

INTRODUCTION

It will be appropriate to begin with a quote from an article entitled "New Dawn for New Don - 50 years of Lost Morality" by Swaminathan S. Anklesaria Aiyar appearing in the Times of India dated August 14th, 1997 at page 12 (Center Spread). The article begins :

"In 1947, we believed that India had been impoverished by the British, and when the British departed, poverty would go too. We believed the export orientation and capitalism fostered by the Raj were disastrous, and so switched to socialism. We jeered at supposed neo-colonial puppets (Korea, Singapore, Taiwan) that followed market-friendly, export-oriented policies. Today India remains miserably poor, while the supposed puppets have become rich. Around 320 million Indians today are below the poverty line, almost as many as the entire population of India at Independence –

"Our per capita income today is just $340. That of Singapore is $26,730, of Hong Kong $23,000, of Taiwan $13,000, of Korea $9700 and Thailand $2,740. Our great **Swadeshi** experiment in self-sufficiency yielded poverty, and those we once sneered at have ended up sneering at us"--------

The situation had developed to such a state that India was almost bankrupt in 1991. The Balance of Payments was sufficient to pay for only two weeks of imports. Gold had to be transported to the Bank of England to meet our Current Account Liabilities. The Indian Economy had become marginalised in World Trade almost to the point of irrelevance. A package of reforms had to be brought in, which included the opening up of the Indian Economy, and we also had to adopt a market-oriented approach. Today our Balance of Payments position has vastly improved ($26.133 Billion as on 3.4.98 as per Times of India dated 15.4.98). But much still remains to be done.

Meghalaya is one of the backward regions of the Indian Economy. Our position vis-a-vis the world economy therefore, can best be imagined. The per capita income in 1994-95 was Rs.6136, which is less than $175. Other indicators, which may give the economic picture, are given below :

TABLE – I
NUMBER OF REGISTERED FACTORIES

Year	Units	Employees
1993	53	2604
1994	56	2746
1995	58	2800

TABLE – II
NUMBER OF REGISTERED SMALL-SCALE INDUSTRIES

Year	Units (Plant & Machinery) (Rs. Lakhs)	Investment	No. of Persons Employed
1993-94	2094	1284.76	12042
1994-95	2294	1513.80	13483
1995-96	2533	1730.80	14791

TABLE – III
PRODUCTION OF CEMENT FROM MCCL

Year	Production (000 MT)	Employment
1993	104	602
1994	142	682
1995	124	653

TABLE – IV
TREND IN MINERAL PRODUCTION (000 MT)

Year	Coal	Limestone	Sillimanite
1993	2543	209	0.1 (3.9 in 1987)
1994	3264	380	Nil (3.0 in 1988)
1995	3199	152	Nil (4.2 in 1989)

TABLE – V
JOINT STOCK COMPANIES

Year	Public	Private	Total
1993	36	127	163
1994	37	136	173
1995	42	151	193
1996	36	147	183

In any developed or developing economy, the bulk of the work force is absorbed in industry. Considering that the work force in Meghalaya is more than 700000 (it should now be larger), and that the number employed in the industries at II & III are of the Order of 20,000, which are the major industrial establishments in the state, the number employed comes to a pathetic 6.67% of the work force.

It may also be relevant to point out that the number of persons on the live register of the Employment Exchanges in the state for 1993, 1994 and 1995 are 27604, 27282, 27584 respectively. Placements for the above three years are 237, 170 and 190.

Population trends in the last three decades as per census figures show the following picture :

Year	Population	Decadal (Growth %)
1971	10,11,699	31.50
1981	13,35,819	32.04
1991	17,74,778	32.86

The figures show an increasing trend in decadal growth which needs to be checked. If we extrapolate the decadal growth rate from 1991 upto the present year (1998), our population as on 1st March, 1998 will be around 21,94,500.

The figures for names on the live register of Employment Exchanges for the last three years have been above 27,000, which means there are that many job seekers every year. This figure should be even higher bearing in mind that not all job-seekers register themselves in these Exchanges. In fact other computations indicate that about 45,000 persons enter the job market every year.

Of these, at most 5000 will get employment during the year through the existing channels mainly in Govt. establishments where vacancies will be available mainly through the annual attrition. (If anything, Govt. organisations are grossly overstaffed, and should actually be reduced).

A total of about Rs.2632.42 crores has been invested since the Fourth Plan during which period, the state of Meghalaya was created. Unfortunately, the economic growth rate has not shown the desirable results.

It will be seen that if any impact is to be made in the area of economic development much will have to be done in activities that maximise job creation and those that provide value addition. It should also be realised that these extra jobs must lead to greater economic productivity for the State if economic progress is to be achieved. Management specialists have estimated that an investment of Rs.70,000 is required to create one job. On this basis an annual investment of Rs.280 crores is required to cater to 40,000 persons who enter the job market each year. This figure of 40,000 job-seekers is incremental to the work force.

It is clear from the above economic projections that a vast amount of investment is necessary each year just to keep abreast of incremental demand. The scope of obtaining this level from within the resources of the state, both public and private, is remote. The bulk of the requirement will have to be obtained from sources external to the state. This will need a review of a number of restrictive provisions, and requires urgent thought and action as it has long-term implications on security and stability. It is not that resources are not available. The problem is to attract these resources so that we can avail and utilise them to produce the maximum returns. This has implications on our commitment, honesty and the productivity of our manpower. Naturally, the investor will also expect a minimum return, which means a sharing of the pie with him. This should be accepted if we are to obtain capital from outside.

In the light of these facts, it is therefore important to look at the prospect of job creation, and the resources we have. Here again, Meghalaya has rather limited resources. For example, in agriculture we can boast of four types of fruits, viz (i) Oranges, (ii) Pineapple, (iii) Bananas, (iv) Papaya. Fruit processing and canning, especially of these varieties on a large scale, with the intention of export outside the state is a distinct possibility. This industry if developed has the prospect of creating an appreciable number of jobs.

Unfortunately, we have also been responsible for large scale destruction of an important resource-fisheries. A combination of selfishness, thoughtlessness for the future pettiness and an unreadiness to enforce the law have contributed to the damage to fisheries in lakes and rivers. Until there is a realisation that wanton destruction of piscicultural wealth does more harm than good, and there is a general realisation that the laws must be enforced strictly and without discrimination, this situation is not going to improve. A strategy to develop pisciculture in lakes, ponds and river systems in a phased manner, combined with educating and creating a mass awareness of the damage caused by wanton destruction through use of explosives, chemicals, has the prospect of creating a vast impact, changing the present mindset and opening avenues for obtaining economic well-being for the individual, as also increasing the economic wealth of the State. (entrepreneurs can look at these).

Remaining in the area of agriculture, mention must be made of the prospects for tea cultivation. Experiments were conducted in the early 1970's on tea cultivation. These experiments showed that tea, especially that cultivated in the Bhoi area was of very high quality-having attributes of both colour and flavour, which are not available in Assam and Darjeeling Teas. Twenty five years have passed since the demonstration was made. Had tea cultivation been taken up 20 years back, the whole economic face of Meghalaya would have changed. The opportunity to take up this promising activity still exists. What is needed is the will and a professionalised, business-oriented approach. There are reservations on adopting the plantation method as it is labour intensive. The fear of importing labour with its concommitant impact on the demographic structure is more apparent than real. Considering the high incidence of unemployment and underemployment in our labour force, what will be required is a certain input of skilled workmen to impart the requisite skills for gainful employment to the local labour in care, maintenance and processing of tea production. A fresh look needs to be taken as the prospects are too promising to be ignored or deferred. Time is of the essence.

While the number of mineral resources are limited, we are fortunate in the vast reserves and the high quality of coal, limestone and uranium. Stress must be laid on the importance of scientific exploitation in order not to cause damage to the ecology and environment. This is especially so in respect of coal, the exploitation of which is done privately and in a manner we all know. Limestone, being of more limited use is mined largely in a controlled manner.

The exploitation of Uranium has raised much controversy. Suffice it to say that uranium extraction is not more dangerous than the ore which is lying on the ground. Enrichment of the ore has to be done under strict scientific control and regulation. The Indian track record in respect of safety of their various plants is second to none. The fact that no accidents have occurred in them since the first nuclear reactor was operated over 40 years ago is eloquent testimony to their safety and reliability. If anything there is a ground for demanding that the uranium ore should be enriched in Meghalaya, and hence we should have an enrichment plant. This will provide many opportunities for developing skilled scientific manpower among the local population which can only be beneficial to the state in the long-term.

Coming to the area of Human Resource Development and Manpower Planning, a fresh in depth look is called for here also. Apart from certain professions (agriculture, some fields of engineering, law), Meghalaya is deficient in almost all skilled and semi-skilled areas. It will be necessary to create a skilled pool of manpower through training programmes. An effort has been made in some fields through vocational training (computer, etc.). Much still remains to be done. Needless to say that the need for skilled manpower cannot be over-stressed. It takes time to create this pool (5-10 years). It takes even longer to create the appropriate and experienced manpower to man the top levels of an organisation (at least 20 years). If we start today we will need that much time for obtaining the skilled and appropriate manpower from the local market. They will not be available overnight.

The implication for the entrepreneur is that while the desire for economic advancement of the state is laudable, and should be initiated as early as possible, a two-pronged approach seems to be most practicable :

1. Training opportunities for the local youth to acquire requisite skills.
2. To obtain some proportion of skilled manpower if not all for a start-up from outside.

It is time to take a fresh look at the prospects and options for economic development in Meghalaya. This means that we should have a perspective of a minimum period of 10 years-preferably longer. The economic Planning in Malaysia was launched 10 years ago with a perspective of 25 years/The benchline is already known to us. We all know where we are today. Objectives, strategies, targets have to be set for next 10-25 years. There is need to open up the economy of the state. That includes removing any law or policy that impedes economic development. 25 years have been lost if we consider the poor growth rate and per capita income growth as indicators. While other parts of the country have been galloping forward, Meghalaya has, at best, been marking time. This has only widened the economic gap between Meghalaya, the North East and developed states. Accusations of neglect are not wholly valid, when we have ourselves adopted the present restrictive approach, which have tended to dissuade economic investment, and economic development which has left us in the present situation. Local investors have not come forward. Most probably they do not have the skill nor the requisite financial resources. If anything they have exploited the opportunity for personal benefit without creating such benefits on a macro scale. A fresh approach to attract the desired large-scale investment is vitally important. This need has to be realised and accepted.

The indicator of health development present a disturbing feature of development society indicators in respect of control factors like infant mortality (50 per thousand life births) and death rate (6.8). On the other hand, the birth rate is alarmingly high at 128 per thousand population. This may explain for the unacceptably high population growth rate of about 3.3% per annum. In this present economic position, the state cannot sustain this high growth rate. It is, therefore, necessary to look at measures that will aim at checking the population growth. This will help ease the demand on employment, education and other services which are a strain on the states resources.

A brief mention has been made on the need for manpower planning. This has implications on the educational system. The present needs are for professionally trained youth who can contribute to economic growth and development. Our education should therefore lay more emphasis on the professionalised aspect of education rather than the abstract and open needed University Education as it exists, as this is not likely to lead us anywhere. No doubt, such education needs to be maintained and should be maintained. A policy has to be adopted however, to curb the mass production that is taking place in the system, bearing in mind their employability and the employment opportunities as they exist.

Following the visit of the then Prime Minister, Mr Deve Gowda and others, a number of Committees etc. were set up to look at the problems of infrastructure requirements etc. The Shukla Committee set up by the Planning Commission has identified an infrastructural gap for the North East amounting to Rs.93,000 crores. While some of this is being proposed to be included in the Ninth Five Year Plan (about Rs.17,000 crores) nothing has been forthcoming in the first year. The Shukla Committee has also identified a need for investing about Rs.434 crores for Basic Minimum Services for Meghalaya alone. Similarly, it has recommended about Rs.1200 crores for infrastructural development over and above what has been envisaged in the 9th Plan. This only emphasises the backwardness of the region and how far we have to go to even reach the minimum acceptable standard of living at the All India level.

Some ideas have been expressed about creating a regional economic development bloc which will include the North East Region of India, Bangladesh, Nepal, Bhutan and possibly Myanmar. The concept is based on the European common market system. While these are still only in the thinking stage, they need to be pursued suitably as the economic benefits would be of great help to this region itself. It must be borne in mind that prior to partition, much of the trade and commerce as well as educational and other interaction especially for Meghalaya had been in the direction of what is now a Bangladesh. The river route which is the cheapest form of transportation also goes through Bangladesh. If this can be opened, the advantage by way of cost of commodities imported as well as exported will soon be felt in the region.

CONCLUSION

Much has been said about the need for social and economic development of the region and the implications of various approaches. It is also important that there should be development in the minds of the people. What is necessary is an open mind and realisation that there is a need to change attitudes and thinking processes. The problem of socio-economic change must be looked at in a balanced manner. Economic development entails costs. The costs have to be looked at in a most objective manner and a balance has to be struck between the profits (benefits) and the losses. It is also important to realise that a society cannot exist in isolation, especially in the present context. There must be interaction, exchange of views and readiness to accept the sharing of both the efforts and the fruits of the development process. This is necessary as no one person or group can bring about benefits or profits without interacting with other groups. Hence, what is needed is a realisation that the North East Region and its people must reach out to the other parts so that it can clasp the hand of social and economic development and interaction with the rest of the country. It is only on the basis of constructive engagement that one can go forward. The effort must be forthcoming from the side of the North East as much as it is necessary for the rest of the country if economic improvement is to be brought about in this region.

SCIENCE & TECHNOLOGY SCENARIO OF ASSAM – IN THE LAST 50 YEARS

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ABSTRACT

Science and Technology influence all activities of man, and all governmental efforts for development of the society. These efforts need adequate man power educated and trained in different disciplines of science and technology. At the time of gaining independence fifty years ago, the strength of this man power in Assam was extremely poor. So, after independence the Govt. of Assam gave top priority to building educational and training institutions of various categories for creating adequate man power. The results are seen to-day in the form of a large number of schools and colleges, two engineering colleges, one regional engineering college, three medical colleges, several polytechnics and industrial Training Institutes, three State Universities including an Agricultural University, two Central Universities, one Indian Institute of Technology, one Regional Research Institute, and so on. Products of these institutions have been manning various developmental and social service departments of the Government like Agriculture, Industries, Forests, Public Works, Flood Control, Irrigation, Power, Soil Conservation, Sericulture and Weaving, Health & Family Welfare, Veterinary and Animal Husbandry, Town and Country Planning etc.

In 1982 the Government of Assam created the Department of Science and Technology and Environment to formulate S&T policies of the State, and also to implement various S&T programmes. In 1986 the Assam Science Technology and Environment Council was set up as an autonomous body under the STE department. This council through its four divisions, viz. S&T, Energy, Environment and Remote Sensing Applications, has been implementing various schemes and programmes for extending S&T services to the people of the state as the institutional arm of the STE department.

INTRODUCTION

Science & Technology plays a pivotal role for the development of a country. So, after gaining independence from foreign rule fifty years ago the Govt. of India under the enlightened leadership of Pandit Jawaharlal Nehru started building a huge network of scientific and technological institutions including research laboratories, universities, varieties of autonomous and semi-autonomous councils and other organisations of national importance under different Govt. departments like Departments of Science & Technology, Atomic Energy, Space, Electronics, and Biotechnology, and Ministries of Environment & Forests, and Non-conventional Energy Sources etc.

In India there are now more than 225 universities including 38 Deemed Universities, and also several institutions of national importance. Total number of colleges stand at about 9,278 including several recognised Medical and Engineering colleges.

Today the country has over 300 technology institutions of the First Degree level, and about 750 polytechnics of the Diploma level with annual admission capacities of 65,000 and 90,000 respectively. Facilities for Post Graduate and Ph.D research have been created for an annual intake capacity of about 11,000 students.

No wonder, India today has the third largest number of scientific personnel in the world.

Explosions of nuclear and thermonuclear devices on 11th and 13th May 1998, development of Nag and Agni missiles, and launching of several satellites into space are testimonies of the high level of development in science & technology in our country, in recognition of which Govt. of India has declared the Eleventh of May as the Technology Day.

The state of Assam also has its due share of educational and research institutions for human resource development. Besides the two state universities of Gauhati and Dibrugarh established in 1947 and 1965 respectively, there are the two central universities, viz. Assam University and Tezpur University, established in 1989 and 1994 respectively. There is also the state Agricultural University with its agricultural campus at Jorhat and veterinary campus at Guwahati.

Three Engineering Colleges, viz. Assam Engineering College at Guwahati, Jorhat Engineering College at Jorhat and Regional Engineering College at Silchar were set up in 1956, 1960 and 1977 respectively. The Assam Textile Institute at Guwahati and the Prince of Wales Polytechnic at Jorhat had already been established in 1920 and 1927 respectively. After independence the Govt. of Assam established seven more polytechnics including a Girl's Polytechnic.

Assam has three Medical Colleges at Guwahati, Dibrugarh and Silchar.

The state has also a good number of affiliated colleges, around 200, imparting science education up to the Degree level.

In addition to the universities and colleges, Assam has one Regional Research Laboratory under the Council of Scientific & Industrial Research, and also a Tea Research Institute, both at Jorhat.

There are also two research institutes at Guwahati. The Institute of Advanced Study in Science & Technology, set up by the Assam Science Society in 1979, is now an autonomous body receiving grants-in-aid from the Department of Science Technology & Environment, Govt. of Assam, and the centre of Plasma Physics, an autonomous body receiving grants-in-aid from the Department of Education, Govt. of Assam. Both the above institutes get substantial project grants from various departments and agencies of the Govt. of India.

Products of all these institutions mentioned above have been manning various developmental and social service departments of the Assam Govt., like Agriculture, Industries, Forests, Public Works, Flood Control, Irrigation, Power, Soil Conservation, Sericulture & Weaving, Health & Family Welfare, Veterinary & Animal Husbandry, Town & Country Planning etc. and also other institutions, organisations, agencies etc., besides taking up in some cases measures for self-employment.

EMPLOYMENT SCENARIO

Employment scenario for products of the above scientific and technical institutions is far from satisfactory. There is, of course, no question of unemployment in respect of Medical Graduates and Post Graduates. In respect of qualified personnel in other technical disciplines, the following represents a general scenario :

The out-turn of Degree Holders in technical disciplines during the period from 1986 and 1996 was 5,111 (Approx). Out-turn of Diploma Holders during the same period was 8,607 (approx). Out-turn of Post Graduate Degree Holders during the period from 1987 to 1996 was 403, and that of Post Graduate Diploma Holders during the same period was 151.

Many of the above engineering graduates and diploma holders are found to remain unemployed for 3-4 years or even more years. Degree holders remaining unemployed for 2 or more years after passing out in the years 1987, 1988, 1991, 1993 and 1994 were 25,139,157,183,206 and 127 respectively. The corresponding figures for Diploma Holders are 383, 486, 346, 604, 513 and 309 respectively.

The primary reason for the above bleak scenario is unsatisfactory development of the state in the areas of agriculture, horticulture and industry, unwillingness to seek employment outside the state, failure to compete successfully for jobs in national level organisations, and lack of proper mind-set to go for entrepreneurship which may provide self-employment.

INDUSTRIAL DEVELOPMENT

The whole of N.E. Region including Assam has remained underdeveloped even after 50 years of independence of our country. It is claimed that Assam is gifted with abundant natural resources like fertile land, forest resources, ground and surface water, high concentration of bio-diversity, both flora and fauna, including medicinal and ornamental plants, and minerals like oil, coal, limestone, refractory clay, dolomite, natural gas, and so on. Yet, except for tea and oil, and to some extent paper and cement, no remarkable contributions have been made by industries of other sectors towards economic development of the state.

In Assam about 50 state enterprises in the small and medium sectors were set up after independence, out of which only four or five could show economic viability by earning profit. A few of these enterprises were : (1) Assam Conductors and Tubes Ltd., (2) Fertichem Ltd. (3) Assam State Fertilizer & Chemicals Ltd., (4) Cachar Sugar Mills Ltd. (5) Assam Petrochemicals Ltd., (6) Assam Syntex Ltd., (7) Assam Electronics Development Corporation Ltd., (8) Assam State Text Book Corporation Ltd., (9) Assam Spun Silk Mill Ltd., (10) Assam Polytex Ltd., (11) Ashok Paper Mills Ltd., (12) Industrial Papers (Assam) Ltd. and (13) Assam Gas Company. A few of the non-viable enterprises have been sold out to private parties, a few practically closed down, and the rest are being kept alive somehow.

Some of the reasons for this sorry state of affairs are : (1) Transport bottleneck isolating the NE Region from the mainland of the country, resulting in increased cost on transportation of materials and chemicals brought from outside the region, and on transportation of finished products to outside the region for marketing.

(2) Non-professional management headed by beaurocrats and politicians, (3) Inadequate local markets for finished products, (4) Disturbed conditions due to insurgency etc.

Power :

Installed capacity for power generation is Assam in 534.4 MW. But due to break down of machineries for various reasons the effective installed capacity of the Assam State Electricity Board is only around 275 MW. Peak hour short fall of power at present is about 100 MW, in spite of the fact that the Board purchases power from Meghalaya, from NEEPCO and Eastern India Power Grid. The Board, however, has to export some power to neighbouring states of Arunachal Pradesh and Tripura, and also to Bhutan.

The Board has electrified 21,845 villages of the state with loan from the Govt. of India, but fails to supply power at the peak hours, and get little revenue from the villages.

The Board is running through severe financial constraints. Its generation cost is Rs.2.70 (approx.) per unit, which is the commercial rate of electricity tariff. But domestic rate of tariff is only Rs.1.00 per unit.

Revenue earned by ASEB is only Rs.30 crore (approx.), whereas its monthly expenditure amounts to about Rs.35 crore.

Tea :

Assam has about 750 tea plantations. It produces 15.6% of world's total tea and 55% of India's tea output. Production in 1997 was 811 million kg, which is expected to be 830 million kg in 1998.

Oil :

Assam is the first state in the country where oil was struck near Jaipur in Upper Assam. In 1989 oil was discovered at Digboi, and a small refinery was set up at Margherita. In 1889 Assam Oil Company was born, and a refinery capable of refining 500 barrels of oil was set up in Digboi in 1901. The refinery at Digboi now refines more than 0.25 million tonnes of oil per annum with natural gas as fuel.

The Guwahati Refinery was set up in 1960 and has a refining capacity of 1 million tonne per annum.

The Bongaigaon Refinery and Petrochemicals Ltd., incorporated in 1974, is a business organisation with a capacity of processing 2.7 million tonnes of crude oil per annum. BRPL exports its quality fibre outside India. Its most prestigious product is Polyester Staple Fibre. In 1995-96 the Company made a pre-tax profit of Rs.120.2 crore.

The fourth refinery coming up in Assam is Numaligarh Refinery. Undertaken by the Company named "Numaligarh Refinery Ltd." it is a project of Rs.2724 crore with refining capacity of 3 million tonnes of crude oil. Construction is scheduled to be completed in Dec/98 and production started in March '99.

Oil India Ltd :

OIL was born in 1959 as a joint venture of the Govt. of India and the Burma Oil Company. OIL explores hydrocarbons in Assam, Arunachal Pradesh, Rajasthan, Orissa, Bay of Bengal and the Andaman Islands. Production is confined to the North East only. It also operates a pipeline and produces LPG at Duliajan.

OIL delivers a total of 5.2 million tonnes of OIL and ONGC crude oil through its trunk pipe line system to the refineries of the Indian Oil Corporation at Digboi, Guwahati and Barauni, and also to BRPL. It has an LPG plant of 60,000 tonnes per annum capacity.

Oil & Natural Gas Corporation :

The Oil & Natural Gas Corporation started exploration in the N.E. Region in 1957. Till date, by exploring 37 prospects, 14 oil fields and 2 gas fields, including one in Nagaland and two in Tripura, has been established. Indications of oil/gas are known from 9 more structures.

Gross annual production of crude oil is 2.3 million tonnes, and associated gas production is 2221 standard cubic metre.

Hindusthan Paper Corporation :

The Nagaon Paper Mill, Jagiroad, started commercial production in Oct., 1985. Its production capacity is 1 lakh tonnes per annum, actual production being greater than 80% of installed capacity.

The Cachar Paper Mill, Panchgram, started production in 1988. Its production capacity is 1 lakh tonne per annum, actual production being more than 66% of installed capacity.

Both mills are entirely dependent on bamboo. Captive plantation of bamboo has not been possible for not getting land on lease.

Except lime and bamboo all other materials and chemicals are brought from outside the state, and marketing has also to be done outside to the extent of 126.00 tonnes per annum against 20,000 tonnes per annum within the state. Transportation cost increases paper price. But still the mills running at profit.

THE ASSAM SCIENCE TECHNOLOGY & ENVIRONMENT COUNCIL

The Assam Science Technology & Environment Council (ASTEC) was constituted by the Government of Assam in 1986-87 as an autonomous society. It became functional from 1988-89, and is now the instrumental arm of the Department of Science Technology and Environment, Govt. of Assam. Its prime objectives are to formulate policies and programmes on various aspects of science, technology and environment for the State, and to executive relevant schemes of the Govt. of India, Govt. of Assam, North Eastern Council and other funding agencies. The Council acts as a focal point of interaction among different development departments and agencies, scientific research organisations and educational institutions for identification of the areas of development and resources, where science and technology inputs can be fruitfully applied. Another role of the Council is to build and catalyse the formation of necessary institutional infrastructure and facilities which are not covered by conventional departments or agencies, and thus fill up gap areas in the interest of removing regional disparities and imbalances.

The Council implements its programmes and schemes under its four divisions : (i) Science & Technology (ii) Energy (iii) Environment, and (iv) Remote Sensing Application.

The Science & Technology Division bears the responsibilities for communication of science and technology to the people, and for promotion of goal oriented R&D programmes including studies on location specific problems relating to natural resources etc. The Division has taken up the development of a Rural Technology Centre, an S&T Entrepreneurship Development Centre, a Mushroom spawn culture centre, and an Instrumentation (Repair and Development) Centre, a Centre for Radio Astronomy Studies, a Training Centre for Leather Goods Making, and a Training Centre for Modern Rice Milling.

The Energy Division has been playing a significant role in popularisation and implementation of renewable energy programmes in the state. Thrust is on use of Photovoltaics, Solar Cooker, Solar hot water system and wind energy. Other important projects are setting up of Urjagrams (Rural Energy Centre), Biogas research and evaluation, energy plantation, energy conservation and energy audit. The Division has set up a Centre for Energy Research, Application and Development, and has taken up the work of setting up of an Energy Park.

The Environment Division has taken up a few ambitious schemes, notably, setting up of a Bio-Resource Centre to conserve and propagate economically important species including medicinal, ornamental and endangered species of plants. Another important scheme is preparation of Environmental Atlas of Assam in the form of data-books with maps and write-ups on all environmental aspects of the state of Assam.

Assam Remote Sensing Application Centre (ARSAC), the fourth division of the Council, has by now established itself as one of the leading State Remote Sensing Centres of the Country. Its diverse activities include execution of the following projects :

A. National level projects coordinated by the Dept. of Space, Govt. of India, being implemented by ARSAC are :

1. Integrated Mission for Sustainable Development (IMSD) of parts of Kamrup and Karbi-Anglong Districts.
2. Crop Acreage and Production Estimate for Assam at district level.
3. Wetland Mapping of Assam.
4. National Natural Resource Information System (NRIS).

B. Projects sponsored by Central Govt. Agencies and implemented by ARSAC are :

1. Waste land Mapping of Wokha District of Nagaland.
2. Drainage conjested, flood inundated and erosion prone areas Mapping of Barak, Subansiri and Pagladiya river Watersheds.

3. Land use/land cover analysis with special reference to shifting cultivation in Karbi-Anglong and North Cachar Hills.

C. Projects sponsored by State Govt. Departments / Agencies :

1. Waste land Mapping of Sonitpur District.
2. Land utilisation Mapping around Deepar Beel, Guwahati.
3. Delineation of water-spread areas and changing Land use pattern around Deepar Beel.
4. Land use/Land cover Mapping of Dhemaji District.
5. Land use/Land cover Mapping of Majuli Sub-division.

D. Projects sponsored by private agencies :

1. Ground Water survey of Terai region of West Bengal sponsored by Tea Research Association, Calcutta.
2. Ground water survey for parts of Darrang, Sonitpur, Cachar, Hailakandi and Karimganj Districts, sponsored by Tea Research Association, Calcutta.

E. Inhouse Projects :

1. Land use Mapping and Monitoring of urban changes in Guwahati.
2. Satellite Mapping of Channel migration of Brahmaputra river near Palasbari.
3. Channel Migration study of Pagladia river.
4. Detailed Land cover Mapping of Kaziranga National Park.

ASTEC at present is functioning from three rented premises located at Silpukhuri, R.G. Baruah Road, and Narikalbasti, Guwahati. It proposes to build its own office building at Guwahati - Shillong Road near Dispur, and hopes to set up a few regional offices in selected district headquarters in near future to facilitate expansion of its areas of activities.

AGRICULTURE BY 2000 AD IN MEGHALAYA

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ABSTRACT

Although Agriculture is playing a predominant role in the state's economy and the main stay of the people, the net cropped area is only about 9% of the total geographical area of the state. Meghalaya is yet to touch the national level in economic and Agricultural growth rate. The state is running in deficit in foodgrains by 1.14 lakh tonnes annually to feed 1.77 m. people. On the other hand, horticultural crop have registered a significant increase in production and productivity with an annual production of 2.15 lakh tonnes and given a good marketable surplus.

In the context of the given topography and Agroclimatic regime, Meghalaya does not permit significant increase in net area shown under foodgrain crops, the alternative is to go for large scale cultivation of various horticultural crop through land development, water management, post-harvest management, economic development and priority shift from foodgrains to horticulture.

INTRODUCTION

Although Agriculture is playing a predominant role of the state's economy and the main stay of the people, the net cropped area is only about 9% of the total geographical area of the state. Meghalaya is yet to touch the National level in economic and agricultural growth rate. The state is running in deficit in foodgrains by 1.14 lakh tonnes annually to feed 1.77 million people. On the other hand, horticultural crops have registered a significant increase in production and productivity with an annual production 2.15 lakh tonnes and given a good marketable surplus.

In the context of the given topography and agro-climatic regime, Meghalaya does not permit significant increase in net area shown under foodgrain crops, the only alternative is to go for large scale cultivation of various horticultural crop by providing efficient marketing and processing support. It is therefore, emphasised that the Horticulture Sector is given priority in the coming years. The second place may, however, go to Foodgrains Sector.

Meghalaya agriculture faces major challenges which may be summed up as follows :

1. Increasing agricultural/horticultural production and productivity, to ensure food security for the rising population and generating surplus for export;
2. Addressing problems of underemployment, unemployment poverty and malnutrition in the rural areas;
3. Focussing the agricultural/horticultural research system on the development of economically viable and location - specific technologies in rainfed, flood-prone and irrigated areas;
4. Utilising research findings in the priority areas for the benefit of all sections of the farming community;
5. Addressing technology, training and input needs of farmers, specially women farmers living in tribal areas and other disadvantaged sections of the rural society, with a view to remove the drudgery and burden of their lives and augmenting their income;
6. Increasing the utilisation of irrigation potential, promoting water conservation and efficient water management and expansion of irrigation facilities, specially in the long dry spell and for rabi crops cultivation;
7. Providing critical inputs to the farmers in or near their villages through authorised retail outlets and service co-operative societies;
8. Revitalizing and democratizing the cooperatives for providing credit, inputs, extension support and marketing and processing facilities;
9. Increasing the involvement of NGOs, cooperative and local institutions of the farming community as legitimate instruments of decentralised agricultural planning with full participation of the local community. NGOs can play an important role in agricultural development and village upliftment programmes;
10. Reducing post harvest losses and promoting value addition in agriculture;
11. Correcting and relaxing the terms of trade to make them favourable for Agriculture, thereby increasing the flow of resources, etc.

12. Diversification of Agriculture and accelerating the development of Horticulture including Floriculture, Planting Crops, aromatic and Medicinal Plants, Mushroom and so on with necessary Processing and Marketing back up;
13. Checking the large scale deforestation of the hills which has seriously disturbed the ecological balance which had, hitherto, been supporting rice culture in the valley bottom land;
14. Introduction of degree against free grazing of all animals, particularly the cattle, in all seasons, which is a serious constraint to go for rabi crops as a standard operation;
15. Restricting diversion and transfer of productive pockets of Agricultural land to Non-Agricultural purposes;
16. Arresting degradation of land and pollution of environment since been caused by open Coal mining in some specific areas;
17. Developing areas of untapped potential, thereby correcting uneven development and production in hilly, rainfed areas; and reducing regional imbalance;
18. Removing the problem of absence of land-documentation acceptable to the financial institutions which has stood on the way of flow of credit to the farmers and encouraging efficient use of marginal lands and augmentation of biomass production and their use in Agricultural practices to maintain soil fertility and Productivity.

APPROACH

To meet the foregoing challenges innovatives and new initiatives are envisaged to accelerate all round development and economic viability of agriculture. The approach will aim at infusing new ideas and dynamism through public investment in infrastructural development and much greater impetus for private investment. These would lead to enhance agricultural growth and generating higher income in the rural areas which would result in improving the quality of life in the villages. The gap that exists in access to education, health and other services between the rural and the urban areas create gainful employment on self-sustaining basis. Farming will be given the necessary support encouragement and thrust so that the rural people look to this noble occupation for all round development and well being. Agricultural research and development would be dovetailed to the challenges to achieve these objective.

ECONOMIC UPLIFTMENT

Economic upliftment of the farming community, specially agricultural labourers, small and marginal farmers, women and members of SCs and STs and other backward classes will receive high priority through promotion of wage employment and credit linked self employment and increase in productivity level. The focus will be on reducing unemployment and underemployment of the farmers and agricultural labourers through diversification of agriculture by promoting horticulture, livestock husbandry and other allied sectors.

INVESTMENT

Realisation of a prosperous and sustainable agricultural economy will require some new area orientation. The resource allocation regime in agriculture sector will be reviewed with a view to rechannelizing the available resources from current support measures towards capital formation and infrastructure building. Public investment will be stepped up to accelerate development of supportive infrastructure for agriculture and rural development. The focus of investment will be on removing regional imbalances in the State and generating more value added exportable surplus. An economic climate will be created for increasing farmer's own investment through a favourable price and marketing system.

RESEARCH AND EDUCATION

The existing research stations and laboratories and farmers training centres will be reorganised for building an efficient and result-oriented, location-specific research and education system by covering all districts for the development of a vibrant and modern agriculture. Development of suitable pest-harvest technologies will be given particular attention. Emphasis will be given to the development of effective system for the transfer of technology to the field and development of human resources. Use of electronic media and computerisation of agriculture for agricultural extension and education will be promoted. Increased private investment in these sectors will be encouraged.

LAND DEVELOPMENT

Reclamation of degraded and follow land will be given high priority to improve quality and maximize productive use. Faculty agricultural practices, methods will be corrected through introduction of recommended

systems of cultivation to arrest soil erosion and further degradation of land. With a view to ensuring sustainability of agricultural production and food security for all in the rain-fed areas. Meghalaya being as such ***in Situ***, moisture conservation on watershed basis, shall continue to be a major thrust area. Increasing agricultural production in shifting cultivation areas of the state will receive high priority. Mechanised Agriculture is prepared to be taken up in a large scale in jhum areas and reshaped lands to be given to Jhum cultivators.

SUSTAINABLE AGRICULTURE

Conservation of land and water resources and agro-biodiversity will be given due importance through proper natural resource management. Application of chemical will be minimised and eco-friendly nutrient management technique like integrated Pest Management and use of bio-fertilizer will be encouraged. Use of plastics for growing vegetables and flowers during off-season and also for weed control will be promoted for generating income of the farmers.

CREDIT SUPPORT

Although the basic support for agricultural development is being provided by the credit structure, Meghalaya is not getting that to the extent desired. Institutional credit flows to the agriculture sector will be enhanced by simplifying the procedure with due consultation of NABARD to suit the prevailing situation. An important objective of agricultural development will be to ensure easy, adequate and timely availability of credit at reasonable rates of interest. Adequate coverage of bank services in rural areas will be stressed upon.

INSURANCE

Failure of crops specially in rainfed areas, like in Meghalaya, inability of the farmers to absorb the risks of instability in production levels and damages caused by natural disasters result in poor investment. Crop insurance schemes need to be redesigned and made more comprehensive with built-in provisions of insulating farmers from financial distress, caused by the failure of rain or by natural disasters.

INPUTS SUPPLY

Adequate and timely supply of quality inputs such as seeds fertilizers and agricultural implements and machinery at reasonable rate and proximity to the farmers will be the endeavour of the department. Balanced and optimum use of inputs will be promoted. Seed farms in different agro-climatic regions/sub-regions will be established for seed multiplication of suitable varieties of crops to meet the requirement of the farmers. At present the state is depending on sources from outside for supply of HYV seeds. A seed certification agency is to be established in the state.

MECHANISATION

Selective and eco-friendly mechanisation will be given due emphasis with special reference to rainfed farming so as to make agriculture efficient and competitive, to increase productivity and to make farming activity more remunerative. It will provide job opportunities to the rural youths too. Hence, an idea of setting up of an 'Agro-Industries Development Corporation' in the state may be materialised.

PROCESSING

Agro-processing units will be set up in the rural areas for generating employment opportunities. The thrust will be on effective utilisation of Agricultural produce and creation of value addition facilities close to the production base so as to ensure a better value to the actual producer. Human Resource development in processing industries will be given due emphasis.

POST-HARVEST MANAGEMENT AND MARKETING

Considering the importance of post-harvest management of agricultural produce, due emphasis will be laid on development of infrastructure and techniques of preservation, storage, transportation and marketing, with a view to reduce post-harvest losses. Specific efforts will be made to provide to the farmers unrestricted access to domestic markets through a regulated system. Setting up of more regulated markets and development of rural markets will be given due emphasis.

REMUNERATIVE PRICES

The government will continue to discharge its responsibility of ensuring remunerative prices for the agricultural produce. Support price will be extended in case of necessity to protect the interest of the farmers.

LAND REFORMS

In the context of prevailing land tenure system in the state, question of land reforms does not practically hold good. Here, the land is generally belonged to the community. However, considering the significant contribution of small and marginal farmers and women farmers to the state agriculture, land reforms will be so pursued as to channelise their energies for achieving greater production. Conferring ownership rights of land on small and marginal farmers, women farmers and tenants will receive particular attention.

STRENGTHENING OF EXTENSION WING

Extension wing is proposed to be strengthened to disseminate the latest technologies to the farmers of the state. Monitoring and Evaluation needs to be strengthened from grass root level for effective monitoring and evaluation on implementation of various schemes.

In the light of the fact that Meghalaya has great potential in development and improvement in Agricultural Systems with a view to increase the overall agricultural productivity in the state, the following measures/steps are suggested for adoption and implementation during the next fifteen years.

1. To realise the full potentials of the agricultural sector, marginal efficiency of labour and capital has to be raised. This can be done by introducing a crop-mix which, on the one hand, utilises and stabilises the Agro-climatic profile and, on the other optimises revenue returns to the farmers. In the context of changes in the economy of the state, the concept of 'food security' in contrast to 'foodgrains security' is to be kept in mind.

   In order to attain the goal of 'Food security' the department has proposed to create few new schemes during the Ninth Plan period.
2. Substantial increase in the irrigation potential and availability to facilitate growing more number of crops i.e. higher cropping intensity, particularly in the rabi season in a cropping cycle and also to cover additional area under crops with assured irrigation. The foodgrains crops like wheat, rabi pulses, spring rice, even rabi maize could be given in the warm region in an extensive scale with irrigation.
3. In order to act immediately with the forecast & IMD and also likely deviation in monsoon behaviour, the State Department of Agriculture is taking up preparation of 'Contingent Plan' for crop production.
4. Increasing the productivity in dry land agriculture by adopting modern dry farming techniques, viz. minimum tillage, water harvesting, mulching and other soil conservation techniques and by efficient use of fertilizers, manures and agro-chemicals with need base for crop production.
5. Taking appropriate soil and water conservation measures to minimise loss of plant nutrients and development of catchment areas in the river valley projects for increasing irrigation potential and providing support to take up agro-horticultural activities.
6. Stabilising the yield in 'Jhum' areas by adopting a package of low-cost technologies and making available much needed agricultural inputs to jhumias in the hilly areas.
7. Setting up of seed multiplication farms in the high, middle and low altitude regions to meet the demand for good quality seeds in those areas without depending on outside agencies.
8. Taking up compact area cultivation of maize, millets in and around the cattle and poultry feed Mills to provide raw materials for processing of animal and poultry feed locally.
9. In case of oilseeds, it is proposed to step up further area under rape and mustard crop through utilisation of additional areas after harvest of the main Kharif paddy (Autumn rice) for growing rape and mustard crop. Irrigation is being advocated, only at the critical stage. More area coverage under soyabean, sesamum groundnut will be emphasised during the coming years. Cultivation of recommended varieties of sunflower will receive due attention. The physical target and achievement of production of important foodgrain crop and other Horticultural crop for the 8^{th} plan and projection for 9^{th} plan are shown in Table I.

HORTICULTURE PRODUCTION PROGRAMME

Basically Meghalaya is a Horticultural State having enough potential for development of Horticulture. The state with a variety of Agro-climatic condition soil and rainfall provides opportunities for growing varied range of horticultural and plantation crop. Seeing the situation as it stands today, the State Govt. has created a separate Directorate of Horticulture and it started functioning.

During the year 1996-97 the target and anticipated achievement of production of Horticultural crop are given below :

TABLE – I
SEASON-WISE Production (000MT), 1996-97

Sl.No.	Crop	Target			Achievement		
		Kharif	Rabi	Total	Kharif	Rabi	Total
1.	Banana	99	–	99	80	–	80
2.	Pineapple	110	–	110	90	–	90
3.	Citrus	–	65	65	–	53	53
4.	Other Misc. Fruits	55	–	55	45	–	45
	Total	264	65	329	215	53	268
	Vegetables (excluding potato)	37	35	72	30	36	66

TABLE – II
CROP-WISE PRODUCTION – (000 T), 1997-98

Sl.No.	Crop	Kharif	Rabi	Total
1.	Banana	80	–	80
2.	Pineapple	125	–	125
3.	Citrus	–	60	60
4.	Other Misc. Fruits	40	–	40
	Total	245	60	305
5.	Vegetables (excluding potatoes)	30	40	70

The targetted area for the above crop during the year 1997-98 is 36540 ha.

VEGETABLE DEVELOPMENT

Diverse climatic conditions suitable for Vegetable cultivation including off season vegetable is gaining momentum year by year. Vegetable cultivation is one of the major crop included in the Multiple Cropping Scheme which gives not only nutritional security but socio-economic development of the state. Every year a target of 500 Ha. is fixed each for Kharif and Rabi under this Sector. Hence, the total production is estimated to be 78,000 MT under Vegetable Production. Hybrid tomato cultivation in Ri-Bhoi district has shown a profitable crop combination and getting remunerative profit by the farmers.

FUTURE STRATEGY FOR HORTICULTURE DEVELOPMENT

While significant headway has been made in fruit and vegetable and plantation crop, many serious problems still remain to be solved. Concerted efforts are, therefore, required to tackle important problems of fruit industry still defying solution. The following thrusts for future has been proposed to be implemented in the schemes under Horticulture Sector in a planned manner :

- Extension of area under fruits, vegetable, flowers and plantation crops according to agro-climatic zones
- Supply of genuine planting materials.
- Optimisation of production per unit areas.
- Strengthening of transfer of orchard management technology.
- Availability of credit at concessional rate of interest for fruits and plantation crop because of long gestation period.
- Creation of major fruit growing belts to provide necessary facilities, such as cold storage, preservation processing and marketing etc. in future.

In order to meet the growing challenges of the State Economy, attempts have been made to assign greater role for the Horticulture during the Ninth Plan period. Accordingly Horticulture Development during the period will primarily centre around the following objective :

1. Increased generation of employment in the rural areas.
2. Economic resurgence by way of boosting production and productivity of all major Horticultural crops.
3. To provide 'nutritional security' to the state population.
4. Strong market support for marketable surplus of fruits, vegetables and flowers.

TABLE - I

PHYSICAL TARGETS AND ACHIEVEMENTS

Sl. No.	Item	Unit	Eight Plan (1992-97) Target	Annual Plans (1992-93 to 1994-95 Actual Achieve-ment	Annual Plan 1995-96 Antici-pated	Annual Target	1996-97 Antici-pated Achieve-ment	Ninth Plan 1997-02	Annual Plan 1997-98
I : AGRICULTURE & ALLIED ACTIVITIES :									
1. PRODUCTION OF FOOD GRAINS :									
i) Rice		'000 Tonnes	175.00	111.49	136.00	175.00	136.00	140.00	125.00
ii) Wheat		"	7.20	6.36	6.40	7.20	6.40	10.40	7.30
iii) Maize		"	25.50	20.55	24.00	25.50	24.00	55.50	40.00
iv) Other Cereals		"	3.20	2.24	3.10	3.20	3.10	10.00	5.00
v) Pulses		"	5.70	2.39	4.50	5.70	4.50	10.00	5.00
TOTAL FOODGRAINS :		"	216.60	143.03	174.00	216.60	174.00	225.90	183.30
2. OILSEEDS :									
i) Rape & Mustard		"	9.50	4.22	8.77	9.50	8.77	7.47	5.00
ii) Sesamum		"	1.06	0.67	0.83	1.06	0.83	1.82	1.10
iii) Soyabean		"	2.60	0.88	1.94	2.60	1.94	1.41	1.00
iv) Castor		"	0.05	0.02	0.03	6.65	0.03	0.02	0.02
v) Sunflower		"	0.17	0.04	0.10	0.15	0.10	0.52	0.30
vi) Groundnut		"	0.12	0.06	0.08	0.14	0.08	1.55	1.00
TOTAL OILSEEDS :		"	13.50	5.89	11.75	13.50	11.75	12.79	8.42
3. POTATO :		"	176.00	121.24	170.00	176.00	171.00	239.86	200.00
4. COTTON :		'000 Bales	5.45	5.32	5.50	5.45	5.00	5.67	5.40
5. JUTE & MESTA :		"	71.20	56.70	60.00	71.20	60.00	60.13	60.00
6. GINGER :		'000 Tonnes	42.50	43.34	39.00	42.50	39.00	77.03	50.00
7. TURMERIC		"	3.10	1.76	2.80	3.10	2.80	36.39	18.00
8. PRODUCTION OF MAJOR HORT. CROPS :			(FRUITS)						
i) Pineapple		'000 Tonnes	111.00	76.89	90.00	110.00	90.00	192.83	125.00
ii) Banana		"	99.00	60.85	75.00	99.00	80.00	88.07	30.00
iii) Otanges (Citrus)		"	65.00	32.84	53.00	65.00	53.00	44.90	40.00
iv) Others (Temp. Fruits & Misac. Fruits)		"	55.00	45.03	45.00	55.00	45.00	47.00	40.00
TOTAL HORTICULTURE (FRUITS)		"	329.00	215.31	263.00	329.00	268.00	372.80	285.00
9. VEGETABLES		"	72.00	68.00	70.00	72.00	71.00	146.25	90.00

(Contd.)

PHYSICAL TARGETS AND ACHIEVEMENTS

Sl. No. Item	Unit	Eight Plan (1992-97) Target	Annual Plans (1992-93 to 1994-95 Actual Achievement	Annual Plan 1995-96 Anticipated	Annual Target	1996-97 Anticipated Achievement	Ninth Plan 1997-02	Annual Plan 1997-98
10. MUSHROOMS	'000 Tonnes	1.00	0.50	0.60	1.00	0.80	1.20	1.00
11. SEEDS :								
i) Production (T.L.)	"	1.00	0.59	0.61	1.00	0.85	2.00	0.85
ii) Distribution	"	3.823	0.60	1.364	3.823	3.60	6.00	3.70
12. CHEMICALS FERTILIZERS :								
i) Nitrogeneous (N)	"	5.00	2.58	4.00	5.00	4.00	6.00	2.75
ii) Phosphatic (P)	"	3.00	1.71	2.24	3.00	2.24	3.25	1.80
iii) Potassic (K)	"	1.00	0.55	0.60	1.00	0.60	0.89	0.95
(TOTAL N + P + K)	"	9.00	4.84	6.84.	9.00	6.84	10.14	5.50
13. PLANT PROTECTION :								
i) Pesticides consumption (Tech. Gr. materials)	"	20.00	16.00	15.29	20.00	15.00	12.00	20.00
ii) Area Covered under Pesticides	'000 Ha	20.00	16.00	15.29	20.00	15.00	16.00	16.00
14. High Yielding Varieties : (HYV)								
i) Rice Total Area	"	103.50	106.55	105.00	108.50	105.00	104.00	103.00
Area under HYV	"	50.00	43.00	40.00	50.00	42.00	47.00	41.20
ii) Wheat Total Area	"	5.75	5.40	5.60	5.75	5.61	6.50	5.50
Area under HYV	"	5.75	5.40	5.60	5.75	5.61	6.50	5.50
iii) Maize Total Area	"	20.50	20.00	19.65	20.50	19.65	37.00	20.90
Area under HYV	"	16.50	14.00	14.00	16.50	14.00	30.00	14.80
TOTAL AREA UNDER ABOVE THREE CEREALS	"134.75	131.95	130.25	134.75	130.26	147.50	129.40	
TOTAL AREA UNDER HYV		72.25	62.40	59.60	72.25	61.61	83.50	61.50
15. CROPPED AREA :								
i) Gross Area	"	249.00	238.68	243.00	249.00	243.00	376.00	277.50
ii) Net Area	"	201.00	201.29	199.00	201.00	199.00	304.00	233.00
iii) Area shown more than once	"	48.00	37.39	44.00	48.00	44.00	72.00	44.50

ROLE OF UNDER-GRADUATE COLLEGES IN THE DEVELOPMENT OF SCIENCE IN MEGHALAYA – A PERSPECTIVE

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ABSTRACT

The paper tries to assess the role and contribution of the under-graduate colleges of Meghalaya towards the growth and development of science in the state. It further examines the pace, pattern and status of education on science at the collegiate level in the State and explores the possibilities and prospects of making it more responsive to the needs of research and various other social and economic needs.

INTRODUCTION

Colleges in our country have rather an intermediate role in formal science education. While School Science prepares a learner to understand his environment, sharpen his mind and sensibilities with reasoning capacity, opens up the threshold of newer areas of study, the science education at the collegiate level allows a learner to formally choose a subject area with systematic study at the end of which he can either opt for more specialised higher education on the subject or look for a gainful employment befitting his qualification.

The degree-level science education in a college therefore is a vital link between the School and University-level science study of formal nature. Research, technology and development are obviously the stages which come next but can be reached mostly through the formal levels of Science-Study in a School, College and University.

Collegiate education in general today is being questioned and examined for its incapacity to equip a student with such professional knowledge as needed for employment and also for its lack of being socially relevant and fruitful. This is a tricky area of priorities and perceptions. Some experts find it paradoxical that the country spends much more on higher education than on primary education. As a result, while almost half the Indian population still remain illiterate, the country has one of the largest higher educated population in the world. Notwithstanding the contradiction, India is acknowledged to have a substantial scientific manpower of global repute and level. It is therefore not easy to dismiss a more than hundred year old system of education merely on the ground of utility.

Collegiate education till today remains a vital component of Indian higher education mainly in the three traditional streams of Science, Arts and Commerce despite the introduction of semi-professional courses on Computers, Bio-technology, Microbiology, Mass-Communication and related other subject areas.

MEGHALAYA SCENARIO

The growth and development of science education in colleges vary from state to state according to its size, population and overall development. Thus the population – college ratio in Karnataka or Maharashtra is much higher than that of Assam or Meghalaya. Interestingly again, the recent growth of colleges in Meghalaya is higher than that of say, West Bengal or Rajasthan. The reason for this cannot obviously be attributed to any single factor. A multiplicity of causes including the development of people and the place, economic scenario, employment facilities available and social development are to be taken into account before a definite statement is possible to be made. The beginning of Colleges in Meghalaya has a chequered history. Christian Missionaries are the pioneers of education in the hills and the credit of setting up the first college, namely St. Edmund's College rightfully goes to one of them, the Christian Brothers. The college began Science education way back in 1923. The Salesians of Don Bosco set up St. Anthony's College in 1934 at the capital town of Shillong to be soon followed by St. Mary's College in 1937. Other missionary colleges namely Synod College in Shillong and Don Bosco College, Tura came up much later. Science education in most of these colleges began at different stages of development.

The first ever public college set up by public-spirited individuals who identified themselves with the place and its all round development came up as Lady Keane Girls' College in 1935 which is now a leading college of the region offering upto Degree Honours level education both in Science and Humanities. Shillong College, another leading coeducational college of Meghalaya which came up in 1956 is also a product of well-meaning public initiative the main concern of which was the development of collegiate education in the State. Shillong College today is a multi-stream college offering Degree Hons. and Pass level courses in Science, Commerce

and Arts. Sankar Dev College established in 1962 is another important centre of Degree Science and Arts education including facilities of Honours education.

In addition, the state has two Government Colleges, Kiang Nongbah College, Jowai and Tura Government College which also are catering to the needs of Science education upto degree level.

There are also a number of colleges and schools in Meghalaya which have introduced +2 level Science education. Some of the colleges in this category have also plans to open B.Sc Courses in their institutions in future.

Another interesting feature of the growth of educational institutions, both schools and solleges, in Meghalaya is the emergence of private enterprise on ownership basis which has already set up a good number of schools and a few colleges. Privatisation of general and technical education is not new in the country but is a recent phenomenon in the region. As such there is nothing wrong in the development against the backdrop of increasing privatisation of various sectors. But it is important to ensure through official mechanism – both governmental and academic, the proper quality and social responsiveness of the education imparted by such institutions. Profit must not be allowed to precede quality and social responsibility. Once regulated on this line, private institutions run by individuals or families may well supplement the total efforts to increase educational facilities in the state including science education.

ROLE OF NORTH-EASTERN HILL UNIVERSITY

The establishment of North-Eastern Hill University located in Shillong in 1972 gave a tremendous boost to the collegiate education in general in the region and particularly in science education to be precise. Closer monitoring, updating of course content, encouragement to research, increasing interaction among various related agencies have at least given a definite direction to collegiate science education in the state. The opening of a regional branch of University Grants Commission at Guwahati in recent years has also considerably helped the funding of colleges to develop and promote science education in general.

AN ASSESSMENT OF THE PRESENT SCENE

It is now time to look critically at the end-products of the system in terms of research, employment and social utility. A traditional science graduate today has apparently three options – he may join post-graduate education with or without research ambition, look for a job based on his general education or engage himself in self-employment not necessarily connected with his educational background. A traditional science-graduate has therefore very limited options of either career development or gainful employment.

It therefore raises the serious question of the desirability of producing more college graduates in science without a system in which their skills are utilised for social and economic development of an area. This is a fundamental question of multiple dimensions and cannot be analysed only within academic parameters.

Collegiate education in our country has a complex nature, dynamics of which cannot be judged exclusively on economic terms. The social respectability associated with a degree cannot be wished away nor can a learner be dissuaded from opting for higher education in absence of his employability in any sector of economy. Thus any radical change in the system or in the outlook towards the system is not presently possible to achieve to any great extent. The picture again varies from region to region depending upon the alternatives available or the nature of development of a particular area. Thus in the colleges of Delhi there has been a gradual decline in the enrolment of B.Sc. students whereas in Shillong no such trend is as yet visible. There is rather an increase in Degree Science enrolment in the local colleges in spite of the factors of limited scope of research and employment for science graduates.

WAYS OF MAKING COLLEGIATE SCIENCE EDUCATION MORE RESPONSIVE

Any changes envisaged in order to make collegiate science education more meaningful in the state have to be gradual by phases keeping in mind the factors which are not necessarily academic. First of all there has to be planned employment generation for scientific manpower developed locally at the collegiate level. At present teaching seems to be the only assured vocation locally available for an ordinary science graduate. But Meghalaya is rich in its natural resources. Forests, fruit, minerals, if exploited scientifically, can generate good employment opportunities for science graduates. Travel & Tourism for which Meghalaya has a vast potential should require technical manpower for their proper development. In a word, science education at collegiate level will have to be responsive to the needs of both research and other social and economic objectives.

In order to fulfil the above objectives degree level course content and structure are to be modified in such a way that they include newer subject-areas which have a direct bearing upon industry and other employment sectors. This will increase the employability of a science graduate and social utility of his knowledge and skill. Side by side, research is to be encouraged and more interaction should take place between classroom and research organisations so that a serious research-minded learner finds it easy to relate class-room education and research.

So in the ultimate analysis we have to understand that collegiate education in science has not yet outlived its utility given the present socio-economic and other psychological reasons. Then the colleges do have a definite role in shaping up manpower in still relevant areas where graduation is the minimum entry-qualification for further specialised study and training or career placement.

CONCLUSION

The development of science education in the colleges of Meghalaya has been really challenging. Most colleges had to begin without any institutional backing and support. The colleges like Lady Keane and Shillong College had to fight hard to make their Degree Science programmes what they are today. Shillong College in particular fought against all odds to begin their science stream education way back in 1963. Over the last 35 years the teachers and management of the college did everything possible to make the science stream a full-fledged Degree Course affair with Honours facilities. Science departments in most colleges are under-staffed and have still inadequate Lab facilities and funding for recurring expenses. Within these constraints of various nature the colleges of Meghalaya have been producing reasonably good and competitive science graduates for a long time now. To them, the colleges goes the credit of creating the initial infrastructural facilities to make the degree programmes in science possible and available to the aspirants of the state and neighbouring areas.

The public body-run colleges had the twin responsibility of creating facilities as well as keeping the fee-structure for science programmes well within the reach of common people of the society. This was and is still today a big hurdle on the way of promoting and diversifying science education at the collegiate level.

It is fine to say 'make higher education self-supporting'. To say so is to be blind to the fact that half of this country's population live below poverty line and they too have a right to education including higher education if they have the necessary merit and aptitude for it.

Education in general and science education in particular, in their correct format and stage, are the pre-requisites of a nation's all-round development. Collegiate education in science is an important and significant component of this package which can be modified, modernised and made more utility-oriented but certainly not ignored and side-tracked in many more coming years. Hence this middle-level education of science needs to be further strengthened and made effective in absence of other viable alternatives and direction.

GLIMPSES INTO SOME LEADING COLLEGES

OF SHILLONG

1. ST. ANTHONY'S COLLEGE
2. ST. MARY'S COLLEGE
3. ST. EDMUND'S COLLEGE

THE CONTRIBUTION OF ST. ANTHONY'S COLLEGE, SHILLONG TO THE CAUSE OF SCIENCE EDUCATION IN THE NORTH EAST

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Science Education in St. Anthony's College is about sixty years old; or should we say that it is sixty years young? What are sixty years, after all, in the life of an institute and one of her streams but like a wink in a human life? A human being perfects his faculties and grows old in the course of sixty years, while the Second-World-War-sapling of science education in St. Anthony's has taken exactly that time to sprout its myriad branches and develop into a young tree, while serving generations of students in the North-East and elsewhere in the country, with fruits of growth and fulfillment..... And the tree is still very young with potentials for further and greater expansion.

Rev. Principal Fr. Ricaldone was gardener to nurse and nourish the sapling with its two leaves of the Intermediate Science and the B.Sc. Pass courses just before, during and after the World War. It was a small beginning, indeed, and classes often had to be taken even by non-professionals like dear Rev. Fr. Kenny who would tell his Botany students, 'Boys, B for Botany, B for Beauty!'

The years of war and the constraining aftermath gave place, at last, to a period of sustained growth with Rev. Fr. D.J. Wollaston SDB. taking over as Principal in 1952, and with Fr. Kenny joining hands with him as Vice Principal in 1953. Honours classes in Science began during that time, and girl students from St. Mary's College used to come to St. Anthony's for their science classes. The college was extremely fortunate to have a number of dedicated science teachers during those years of growth to tidy up and smoothly run the departments of Biology including Botany, Physics, Mathematics and Chemistry. One of them, Prof. S.N. Paul – the colossus of a teacher – passed away only last year. Their students, scattered all over the globe, mention their names to this day with a lot of respect and affection. The high esteem in which the teachers of science were held is borne out by this amusing anecdote. The illustrious don of English, Prof. K.R. Mukherjee, was once accosted by his Rev. Fn. Principal as he was about to step into a class. Pointing out an accusing finger at the text books in Prof. Mukherjee's hands Father roared, 'Shame on you, Professor! My teachers of science never takes their books to the class!'

Science results as well as the numerical strength of the students picked up remarkably during the long tenure of Rev. Fr. Joseph Arokiaswamy SDB, as Principal of the College, from 1958. Top positions in the University Merit lists became all but a monopoly for St Anthony's College for a number of years. The very best of students were taken into the folds of the science departments, and special coaching classes were organised for them.

The tree had grown taller by the year, but was yet to spread out its branches in a big way. That spreading out and efflorescence occurred in the mid-eighties with Rev. Fr. Stephen Mavely, who epitomises the very spirit of 'Ever More and Better Ever', taking over as the Principal in 1986. The stirrings for greater growth had already been felt, though. The College shifted to the new premises in 1984-85 and, in keeping with that momentum of beginning afresh, the departments of Pisciculture and Geology budded forth in 1984 and 1985 respectively. Each received a shot in the arm with the induction of a couple of teachers in the following years. The College now maintains an experimental pond in its premise for the Pisciculture Department, and hopes to set up a hatchery for fish-breeding in the near future. The department runs a farm in Umran in collaboration with Don Bosco. The 17 ponds there and another at St Joseph's Agricultural Training Institute in the same location offer immense scope for practical training to the students in the department. A group of students was sent last year to C.I.F.A. in Bhubaneshwar, Orissa, to hone their skills further. The department of Geology has been doing exceedingly well at the Major level for a number of years now. Its Wall-Magazine 'Tethys', started in 1996 and run by its enthusiastic students and teachers, is a virtual ocean of information. Extensive field-work in the department is carried out with the help of a number of organisations. 1995, the Diamond Jubilee year of the College, saw the department putting up an excellent one-day Geological Exhibition in collaboration with the G.S.I. and the Directorate of Mineral Resources, Government of Meghalaya.

Two more departments with immense futuristic potentials started off in the nineties. Both, now, are immensely popular with the youth in the North-East. The dream of 'Ever More and Better Ever' blossomed into reality on 13 June 1992 in the shape of the 'Anthonian Computer Academy', a three-storey building housing a complete faculty of Computer Science, equipped with spacious, modern class rooms, library and, of course, the 'Sanctum Sanctorum' – the tastefully furnished computer laboratory, boasting of the best in computer hardware. The regular courses offered are Computer Education, a Graduation Programme as well as Post-Graduate Diploma Course. Besides these, the department offers a number of programmes for the beginners. College students as well as teachers from other disciplines and adult learners from all over the state derive a lot of benefit from these.

It was in 1995 – the Diamond Jubilee Year – that the Department of Botany had a unique sister bough – the Department of Biotechnology – grafted on it. This was a pioneering achievement since Biotechnology as a new independent discipline emerged only in 1970 as a result of the revolutionary progress made in the fields of Biological Science and technology. Under the able guidance of their teachers, groups of enthusiastic students are learning today how to make 'the controlled use of biological agents such as micro-organisms or cellular components for beneficial use' for mankind.

The same Department of Botany had set up a flourishing Orchidarium in 1990 where about 3000 orchids are in cultivation now. This would soon prove to be immensely beneficial for the students of the North-East in particular. The Botanical Garden behind the College buildings, too, is a veritable gold mine for the students of Botany.

The ever-enquiring spirit of science goes beyond the confines of the class-room into the world around, and queries about its future. The ever-tightening crunch on the conventional sources of energy, combined with the necessity to keep our environment clean, urged our College to host the 'All India Exhibition and Symposium on Renewable Energy Utilisation' in 1991 at the behest of the North-Eastern Council and the Government of Meghalaya. The fall out of this momentous effort was the setting up of a Non-conventional Energy Demonstration Park in the College campus. The 'Eco-friendly' solar energy is the only fuel tapped there. 1995 saw the launching of the 'Eco-Friendly Club' in the College. Scientific awareness in St Anthony's, thus, aims at ensuring a secure future for our planet by properly looking after, first, the immediate surroundings. The bottom line is that charity begins at home!

A number of worthwhile Conventions and Seminars have been conducted in the recent years by the departments of Physics and Geology, among others. These have proved to be great eye-openers for the students of science here.

Several scientific projects run by the students, teachers and research workers have been completed during the last few years, while others are nearing completion. One of these explored the flora in and around St Anthony's College. 'Project Orchid' of 1990 led to the project on Tissue Culture. A laboratory for this project was inaugurated by Dr Raja Ramanna in 1995. Eight different projects are on the anvil, at the moment, in the departments of Biotechnology, Chemistry, Geology, Pisciculture and Zoology. These would definitely enhance the spirit of enquiry which is the very essence of the scientific temper.

Science education is in bloom in St Anthony's. Let us hope that its fragrance would spread far and wide for ages to come.

PROMOTION OF SCIENCE EDUCATION IN N.E. REGION EFFORTS MADE BY ST. MARY'S COLLEGE

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Since its inception of science independently in 1966, St. Mary's College has contributed effectively in promoting Science in the North-East by producing Science Graduates of high quality and competence in the technical field.

At the beginning there were only a few students in the Pre-University classes; these have grown from strength to strength and at present there are approximately two hundred students in the classes currently known as the Higher Secondary Classes. Pre-University Science results of the College have been consistently good with one or two students securing positions among the first ten candidates, the percentage of pass being about ninety percent.

For quite sometime, the results have been so satisfactory that our students have secured admission to professional courses such as Engineering, Architecture, Medical Science, Dentistry and Veterinary Sciences. In these chosen fields also the students of St. Mary's College have always done well. Many of them have made a name for themselves on account of their undivided devotion to their respective fields, the seeds of which we may proudly say were planted in this institution, St. Mary's College.

Each science department was run by a single science teacher for a long time. The first appointments in the Science Department were in 1967 in Biology and Chemistry and then in 1968 Mathematics and Physics. More teachers were inducted from 1976 onwards. Now each department is fully fledged.

Due to the consistent academic achievement and the eagerness shown by the students, the College opened B.Sc. classes from 1978, the first batch appearing for the Final Examination in 1980. The students came out with flying colours. From then onwards there has been no looking-back, the College has made positive strides in the opening of Honours Courses in Chemistry, Botany, Zoology and Mathematics in the eighties. Botany and Zoology in 1981 and Chemistry in 1983 followed by Mathematics and Physics Major in 1993-94.

In both Honours and Major our students have had outstanding results almost always securing the first few positions in the University. While all the Departments are doing well, the performance of the Chemistry Department is the first among the best. Their achievement has been uniformly outstanding from the beginning. Not only are our students securing high positions in the degree level examinations, they have done equally well at post-graduate level. Many science students after passing out from St. Mary's College are bringing laurels to North Eastern Hill University.

Many members of the staff of the Science Departments have acquired their Doctorate degree while in service. It is a tribute to the College that the teachers have the opportunity of doing their research while teaching. Some have completed their Ph.D. while others are awaiting their results and still others are continuing their research. This is an on-going dynamic process which promotes growth and development, both in the individual and at the social level.

The Science Staff of the College are interested in taking up projects and other activities related to the promotion of Science Education.

At present the Chemistry Department is involved in two projects of the State Council of Science and Technology viz :

1. The Extraction of perfume oils from flowers of Meghalaya.
2. Mosquito repellent from Marigold extract.

Previously two other projects had been taken up :

1. Bio-diversity in the state of Meghalaya.
2. Animal infection in Lady Hydari Park, Shillong.

We look forward to being involved in other major projects. Already the Botany and Zoology Departments have undertaken a combined project under the University Grants Commission and offered by the College Development Council.

Science Exhibitions are held annually during College Week. Certificates of Merit are given to participants.

Although the Science Departments have achieved much during the past thirty two years, much is yet to be done. The rate at which scientific development is taking place in advanced countries is yet to be reflected in our achievements both within and outside the College. To meet the challenge of Science and Technology today, we need a team of dynamic, resourceful, highly devoted workers.

We are not yet able to produce "real scientists" in the true sense of the word, due to the inadequacy of infrastructure and the true spirit of approach.

The aim of science may be better realised if more open Discussions and Seminars, Exhibitions, Debates and Quiz are held more frequently.

The setting up of a fraternity where one can openly discuss one's doubts, difficulties and opinions, will also help in producing the right atmosphere for the pursuit of Science.

However, the sapling of Science Education which was planted thirty-two years ago in St. Mary's College, has taken root and has become a full grown tree. We trust that it is the beginning of greater things to come.

ST. EDMUND'S COLLEGE & SCIENCE EDUCATION – A PROFILE

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Scientific interactions in general and science education, in particular is immensely dependent upon the nature and efficiency of the propagating system. As such, educational institutes play a significant role towards contribution in the field of science education. Since a methodical, systematic and sequential approach is an utmost requirement for the effective science education, the challenge is left with the educational institutions. St. Edmund's College, Shillong is one of the pioneering educational institutions in the North-Eastern India which has introduced science education way back in 1923. The Department in the initial phase started with the pass courses and later introduced the Honours courses with the well-equipped Science Departments. National policy of education (NPE), in the mean time, emphasized the need for qualitative improvement of Science education especially in School, College and University levels. A number of steps were taken in this direction and the National Council of Educational Research and Training (NCERT), in particular was given the charge to accelerate the process. The University Grants Commission (UGC) took up certain time-framed packages and programmes for radical improvement of Science education in Indian Universities and Colleges. One such package came into existence in the name of College Science Improvement programme (COSIP), 1972. In the process, the UGC started picking up the best institution in the country where COSIP could be successfully implemented without hindering the existing system of science education. In the initial phase about twenty institutions in all, were selected from the whole country. In the entire North-Eastern region, St. Edmund's College was given the opportunity to conduct and carry out this programme. Under the able guidance of the leading personality of Rev. Bro. Vieyra, the then Principal of St. Edmund's College, a good number of teachers were involved to carry out research works in various fields. The students were also motivated to participate in various activities such as students' seminars, display of scientific models and charts, display of self-made scientific instruments etc. Resource persons/scientists were invited to deliver popular lectures on special topics. Financial support to the COSIP was intended for a period of five years during which the College proved to be successful in motivating a number of young students towards shaping their Scientific temperament for the great interest in Science.

Meghalaya Science Society, a scientific organisation whose efforts and objectives, were directed towards enhancing and channelising the enthusiasm of the young scientific minds, was the result of a handful of devoted young Scientists. A good number of teachers from St. Edmund's College was actively involved in both the administrative work as well as in uplifting the standard of Science education among young students in the State. St. Edmund's College had the opportunity of hosting the Science exhibition (model and chart display) organised by Meghalaya Science Society.

Over the years, the academic excellence in Science branch has exemplified amply the deep-rooted culture of Scientific orientation among the students and teachers of this College. The teachers are deeply involved in research studies to enhance their knowledge and use the same for the benefit of student community in general. St. Edmund's College is committed to impart quality education in science.

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