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ON
"POLLUTION, MAN & ENVIRONMENT"

WITH SPECIAL REFERENCE TO
NORTH-EAST INDIA

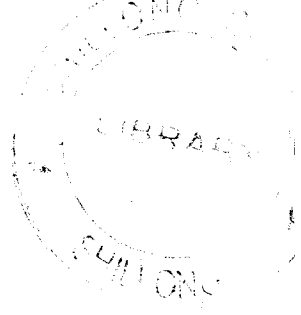
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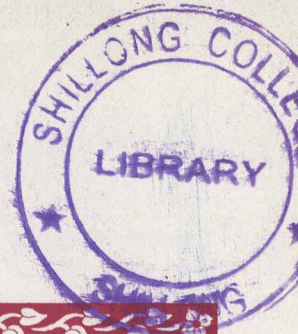
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***This Proceedings Volume
is Dedicated to
All Persons
Who Are Actively Involved in
Preservation of
Natural Resources
&
Protection of
Environment***

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ON
" POLLUTION, MAN & ENVIRONMENT "

WITH SPECIAL REFERENCE TO
NORTH-EAST INDIA

June 15 — 16, 1999

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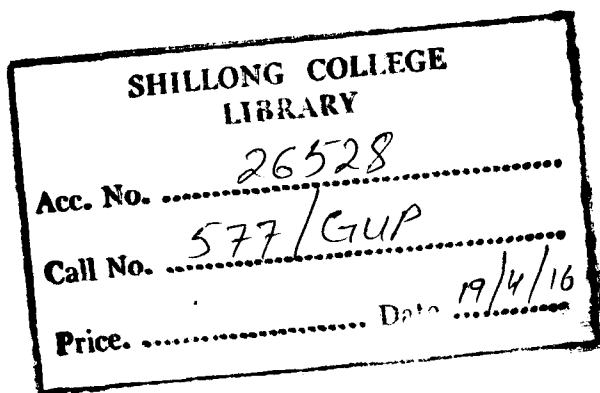
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NATIONAL CONFERENCE ON POLLUTION MAN & ENVIRONMENT

WITH SPECIAL REFERENCE TO NORTH-EAST INDIA

JUNE 15 - 16, 1999

PROGRAMME

15TH JUNE 1999 (TUESDAY)

Registration of Delegates : **Shillong College, Shillong - 793 003**
(8.15 AM to 9.15 AM)

INAUGURAL SESSION

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

Welcome Address : **Dr S. K. Gupta**
Joint Convener

Address By : **Shri R. Kharpor**
President, Governing Body
Shillong College

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

Inaugural Address : **Shri D.D. Lapang**
Deputy Chief Minister
Meghalaya

Scientific Talk : **Shri A.R. Agarwal**
Executive Director (NER)
Power Grid Corpn. Ltd.
Shillong.

Chairperson's Address : **Dr (Mrs) M.P.R. Lyngdoh**

Release of the Proceedings Volume : **Shri D.D. Lapang**
of National Conference on Deputy Chief Minister
"Development of Science & Technology" Meghalaya

Key Note Address : **Shri J.P. Singh, IAS**
Chief Secretary
Govt. of Meghalaya

Vote of Thanks : **Shri N.K. Sarkar**
Co-convener

15TH JUNE 1999 (TUESDAY)
12.30 PM

: SHILLONG COLLEGE, SHILLONG - 793 003

TECHNICAL SESSION - I

: POLLUTION & IMPACT - AN ASSESSMENT

Meghalaya Pollution Control Board, Govt. of Meghalaya
Zoology Deptt. NEHU., Oil & Natural Gas Corp. Ltd. Assam
Chemistry Deptt. NEHU, Directorate of Geology & Mining, Govt. of Assam,
Assam Pollution Control Board, Guwahati,
Public Health Engineering Deptt. Govt. of Meghalaya, Indian Council of Agricultural Research, Barapani
St. Mary's College, Shillong, Zoological Survey of India, Shillong
Botanical Survey of India, Shillong, Atomic Minerals Division, Shillong
Soil Conservation Deptt. Govt. of Meghalaya, Centre for Environmental Studies, NEHU
St. Anthony's College, Shillong, Shillong College, Shillong

Chairman : Sri B. Singh, IFS
Principal Chief Conservator of Forests, Govt. of Meghalaya.

16TH JUNE 1999 (WEDNESDAY)
9.00 AM

: SHILLONG COLLEGE, SHILLONG - 793 003

TECHNICAL SESSION - II

: ENVIRONMENT & AWARENESS

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Oil & Natural Gas Corp. Ltd., Silchar, Zoology Deptt. Meerut University, Meerut,
Oil & Natural Gas Corp. Ltd. Jorhat, Ministry of Environment & Forests, Govt. of India, Shillong
Geological Survey of India, Shillong, Meghalaya State Electricity Board, Shillong
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Central Water Commission, Shillong, Central Ground Water Board, Shillong,
National Bureau of Plant Genetic Resources, Shillong

Chairman : Dr L.N. Bora
Chairman
Assam Pollution Control Board, Guwahati

LUNCH BREAK

16TH JUNE 1999 (WEDNESDAY)
3.00 PM

VALEDICTORY FUNCTION	:	STATE CENTRAL LIBRARY AUDITORIUM
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Address by	:	Shri P. J. Bazeley, IAS Principal Secretary, Finance & Planning Deptt. Govt. of Meghalaya
Chief Guest	:	Shri Kitdor Sylem Hon'ble Minister, Forests & Environment Govt. of Meghalaya
Guests of Honour	:	Shri H.W.T. Sylem, IAS Chairman, Me.S.E.B., Shillong Dr S.K. Acharyya Director General, Geological Survey of India, Calcutta
Chairperson's Address	:	Dr (Mrs) M.P.R. Lyngdoh
Joint Convener's Remarks	:	Shri R. K. Datta
Observation by the Participants	:	Shri H. Prasad Chairman, Meghalaya Pollution Control Board, Shillong Shri R. D. West Member Secretary State Council of Science, Technology & Environment Meghalaya Dr S.N. Datta Co-convener
Prize Distribution for the Students	:	
Vote of Thanks	:	Dr S. K. Gupta Joint Convener



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MEGHALAYA

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Dated Shillong the 27th June, 2000

FOREWORD

I am grateful to the Shillong College Academic Society which organised the National Conference on "Pollution, Man & Environment" on 15-16 June, 1999 for having asked me to write a Foreword to the 'Proceedings Volume' of the Conference.

The concern for environment is universal since it is central to preservation and continuity of man's existence on planet earth. Whilst developed countries have generated considerable awareness and expertise for protection and preservation of environment for sustainable development, the developing and under-developed countries are rightly making a humble but much desired beginning in such regard.

The mindless exploitation of our land, air and water resources have reached critical proportions. These trends can only be checked and reversed by generation of mass awareness of the necessity to maintain our natural environs for sustainable development and continuance of life on earth.

I congratulate the Shillong College Academic Society for having taken leadership in organising the National Conference and for focussing attention on "Pollution, Man & Environment". I am sure the deliberations at the Conference has initiated the process of generating better all-round environmental awareness in the longer interest of our posterity.

I have gone through the 'Proceedings Volume' and am glad to note the wealth of ideas contained in the papers presented and in the summary of deliberations which took place.

With these few words, I commend the 'Proceedings Volume', for your consideration.

(E.K. Mawlong)

CONTENTS

Page Nos.

**List of Participating Organisations, Delegates
and Rapporteurs**

I

INAUGURAL SESSION

Welcome Address	: <i>S.K. Gupta</i>	IV
Inaugural Address	: <i>Hon'ble Deputy Chief Minister, Sri D.D. Lapang</i>	V
Scientific Talk	: <i>A.R. Agarwal</i>	VII
Chairperson's Address	: <i>M.P. Rina Lyngdoh</i>	XIV
Key Note Address	: <i>J.P. Singh</i>	XV
Vote of Thanks	: <i>N.K. Sarkar</i>	XVII

VALEDICTORY SESSION

Valedictory Address	: <i>H.S. Gupta</i>	XVIII
Joint Convener's Remark	: <i>R.K. Datta</i>	XXI
Participant's Remark	: <i>S.N. Datta</i>	XXIII
Vote of Thanks	: <i>S.K. Gupta</i>	XXV

TECHNICAL SESSION – I

**: POLLUTION & IMPACT —
AN ASSESSMENT**

1.	Studies on the Ambient Air Quality of the Major Towns of Meghalaya <i>B. Nongbri and S.C. Katiyar</i>	1
2.	Abiotic Environment of a Lentic Ecosystem of Cherrapunji (East Khasi Hills District), Meghalaya <i>B.K. Sharma and D. Wanswett</i>	7
3.	Man's Uses of Science and Technology — Does it Upgrade or Downgrade Human Environment <i>S. Aravamudhan</i>	13
4.	Temporal and Horizontal Variations in Abiotic Parameters of Umiarn Reservoir, Meghalaya <i>B.K. Sharma and R.M. Lyngdoh</i>	17
5.	Pollution Control Strategies in the Operations of Upper Assam <i>S.K. Sahota, K.T. John and H.C. Dhawan</i>	25
6.	A Study on the Impact of Opencast Mining on Environment of Makum Coal Field and Surrounding Areas <i>A. Bhattacharya, J.R. Borthakur and M.K. Dhar</i>	33
7.	A Study on Environmental Pollution in Guwahati in Respect of Air, Water and Solid Waste <i>L.N. Bora and A.B. Dev Choudhury</i>	39

8. Role of Public Health Engineering Department for Healthy Environment <i>B.K. Choudhury</i>	43
9. Environmental Degradation in North East India <i>B.K. Sarma and N.D. Verma</i>	45
10. Waste Management and Pollution Abatement : Turning Waste to Wealth Opportunities for Down Stream Optimisation at the Household Level <i>Ranjana Sinha Choudhury, Neerja Mishra, Catherine R. Diengdoh and Dhrupad Choudhury</i>	49
11. Investigation on Water Quality of River Umshyrpi and Its Tributaries in Shillong <i>J. Sawian and S.C. Katiyar</i>	59
12. Landslide Studies in North Eastern India with Special Reference to Mizoram State <i>M. Raju, Suresh A. Chore and D.D. Joshi</i>	65
13. Management of Radioactive Wastes – An Overview <i>S.Q. Hoda and Ragav Saran</i>	71
14. National Ambient Air Quality of India With Special Reference to Locations Having Highest Concentrations of Air Pollutants (SO ₂ , NO ₂ , SPM) <i>Z. Changsan and M.K. Choudhury</i>	75
15. Comparative Study on the Production of Biogas Using Different Slurries in a Miniature Biogas Production System <i>S.R. Joshi and R.S. Singh</i>	87
16. Fragile Geo-Environment of North East India <i>B.P. Bhattacharyya</i>	93
17. Human – Elephant Conflict in Garo Hills, Meghalaya <i>T.T.C. Marak</i>	101
18. Man and Nature <i>Sujata Miri and D. Ramseij</i>	105
19. Animal Diversity – Those Vanishing Faunal Species <i>S.J.S. Hattar</i>	107
20. The Need for Conservation and Management of Water Resources in North East India <i>D.L. Buam and S.K. Gupta</i>	111
21. Water Resources Development and Environment <i>N.K. Goyal</i>	115
22. Significance of Lichen Floristics in Assessing Air Quality <i>K.P. Singh</i>	121

TECHNICAL SESSION – II

: ENVIRONMENT & AWARENESS

23. Wildlife Conservation in Meghalaya <i>B.K. Lyngwa and B. Singh</i>	125

24. Water Quality of Three Subtropical Reservoirs of Meghalaya B.K. Sharma	127
25. Pollution - A Threat to Man and its Environment with Special Reference to North-East India N.C. Das	135
26. Parasites as Bio-Indicators in the Environmental Impact Assessments Seema Yadav	141
27. Measurement of Environmental Performance - A Key Component of Environment Management System K.T. John, B.P. Babu and S.K. Sahota	149
28. Environmental Issues of Meghalaya U.K. Mishra and S. Sen	153
29. Environmental Pollution - Can We Destroy Nature's Gifts in the Name of Development ? Anup Mahanta and Elias Lyngdoh	159
30. Powergrid Approach Towards Meeting Power Transmission's Environmental and Social Issues A.R. Agarwal and R.K. Srivastava	167
31. Environmental Pollution and its Implications on Man and the Environment H.W.T. Syiem	175
32. Plant Genetic Resources Conservation Strategies - A Security for Man and His Environment D.K. Hore	179
33. Land Degradation and its Effect on the Environment K.L. Tariat and L. Shabong	183
34. Pollution-cum-Depletion of Tribals' Ethnobotanical Knowledge Systems T.M. Hynniewta and A.A. Mao	187
35. Science Technology and Environment R.D. West	191
36. Decadal Variation in Chemical Quality of Ground Water in Meghalaya U. Gogoi and B.C. Kalita	195
37. An Idea of Environmental Legislations and Administration in India : Implications for India's North-East V.T. Darlong	203
38. Environmental Impact Assessment of Limestone Mining Project S.K. Barik and B.K. Tiwari	217
39. Environmental Pollution Management Implementation in Dhansiri Valley Project (DVP), ONGC Ltd. Jorhat (ERBC), Assam Kamal Nain, M.K. Kar, H.C. Gupta, P.K. Bora and S.C. Hazarika	233



LIST OF PARTICIPATING ORGANISATIONS TO THE NATIONAL CONFERENCE

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3 Geological Survey of India, Shillong	4 Planning Department, Govt. of Meghalaya
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97 Dr B.K. Tiwari, Centre for Environmental Education, N.E.H.U., Shillong	98 Dr Dhruvad Choudhury, G.B. Pant Institute of Himalayan Environment & Development, Itanagar, Arunachal Pradesh

RAPPORTEURS

1 Shri G.C. Saha, Central Ground Water Board, Shillong	2 Shri P. H. S. Boney, State Silviculturist, Shillong
3 Shri C.P. Shullai, Officer on Special Duty, Office of PCCF, Shillong	4 Dr (Miss) N. Sen, Zoological Survey of India, Shillong
5 Shri D. Wanswett, Zoology Deptt. N.E.H.U	6 Dr Dhruvad Choudhury, G.B. Pant Institute of Himalayan Environment & Development, Itanagar
7 Dr H.C. Gupta, Oil & Natural Gas-Corp. Ltd., Jorhat	8 Shri R. M. Lyngdoh, Zoology Deptt. NEHU
9 Smti M. Diengdoh, Meghalaya Pollution Control Board, Shillong	10 Mrs N. Deka, Meghalaya Pollution Control Board, Shillong
11 Smti A. Ahmed, Shillong College Academic Society, Shillong	12 Smti V.R. Solomon, Shillong College Academic Society, Shillong
13 Smti D. Buam, Shillong College Academic Society, Shillong	14 Smti R. Laitflang, Shillong College Academic Society, Shillong

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

Madame Chairperson, Dr (Mrs) M.P.R. Lyngdoh, Hon'ble Deputy Chief Minister Shri D.D. Lapang, Shri J.P. Singh, Chief Secretary, Govt. of Meghalaya, Shri A.R. Agarwal, Executive Director, Power Grid Corporation Ltd., Dr B.P. Bhattacharyya, Deputy Director General, Geological Survey of India (NER), Shri R. Kharpor, President, Governing Body, Shillong College, Respected Members of the Advisory Committee, Distinguished Guests and Scientists, Delegates and Participants, Beloved Students and fellow Teachers, Ladies & Gentlemen.

On behalf of Shillong College and the Shillong College Academic Society, I extend our hearty welcome to each one of you on the inaugural session of our National Conference on "Pollution, Man and Environment". We are particularly grateful to Shri D.D. Lapang, Hon'ble Deputy Chief Minister of Meghalaya, our esteemed guest Shri J.P. Singh, Chief secretary, Government of Meghalaya, Scholar-Administrators Shri A.R. Agarwal, Executive Director of power Grid Corporation Ltd., Shillong and Dr B.P. Bhattacharyya, Deputy Director General, Geological Survey of India, Shillong. We welcome you all Sirs in our midst this morning and thank you profusely for your kind presence.

This Conference on "Pollution, Man and Environment" is an outcome of our concern for an increasingly threatened environment and quality of man's life, particularly in this part of the country and our quest for a healthy balance between the demands of development and the vital conservation of environment. We are hopeful that the deliberations in our 2-day-long conference will rightly focus upon the relevant problems, perceptions, progress and solutions.

I am also happy to announce that the Proceedings Volume of the National Conference on "Development of Science and Technology in last 50 - years of India with special reference to North-East India" organised by Shillong College and the Shillong College Academic Society in 1998 will be released today by our Hon'ble Deputy Chief Minister, Shri D.D. Lapang.

We in Shillong College firmly believe that the academics have a role to play beyond the classroom in creating an awareness about problems confronting the society at large and in making efforts to find out viable alternatives of solutions. The Conference on "Science and Technology" last year and the present conference on "Pollution, Man and Environment" are our humble bit of contribution towards generating an awareness and interest in our problems, ensuring interaction among concerned groups and organisations and providing suggestions conducive to healthy development and progress of the society in the State.

We record our deep appreciation and gratitude for the ample help and co-operation received from the College Management, State Government and various other development agencies and organisations in making the conference and seminar possible and fruitful.

While once more sincerely welcoming each one of you, we look forward to the successful sessions of deliberations today and tomorrow and seek your valued encouragement and co-operation in our endeavour and pursuit.

Thank you.

11

INAUGURAL ADDRESS : SHRI D. D. LAPANG, DEPUTY CHIEF MINISTER OF MEGHALAYA

I deem it a great honour and a privilege to be invited to inaugurate today's National Conference on "Pollution, Man and Environment" organised by the Shillong college in collaboration with the Shillong college Academic Society. I am grateful to the Principal of Shillong College and its teachers 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 Environmental issues concerning the country in general and North-East in particular.

The concern for the need of environmental conservation and protection is as old as human history. As long as man lives in harmony with nature, his existence and survival were never threatened. We have in fact a long history of harmony between man and environment. Our ancient sages and thinkers had farsighted vision of the relationship between Man and Nature which fortunately was ingrained in our day to day attitudes. India ethos has always emphasised self discipline on the part of human beings to bring about the desired balance between human activities and environmental conservation. The picture in the western world is however different. They, on the other hand, wanted to solve the problems of environment with the help of technical options.

The global scene has however drastically changed over the last several decades of the rapid industrialisation, increasing gap between the rich and the poor and a booming population problem, particularly in the third-world countries.

India for example, has today the crippling problems of poverty and an ever-increasing population. Obviously speedy economic growth, including rapid industrialisation where feasible, is an urgent imperative. But should development necessarily mean destruction? No, it does not. There has to be a balance between development and the preservation of environment. It is necessary for man's very survival on earth in long term implications.

India has no doubt made a strong foundation of democratic traditions, steady economic progress and a strong scientific and technological base. But still we have not been able to remove the scourge of poverty for the millions of our people, there looms large the continuance of massive illiteracy, the absence of health care and modern medical services for the majority of our countrymen. But the most important area which has received very little attention within a policy perspective is the failure on modern India Society to preserve the environment and the enormous wealth of natural resources which our ancestors have left behind for us.

It is not to be forgotten that India has a unique environment heritage with its geographic climatic and biological diversity. But inspite of various constitutional provisions, a host of environmental legislations and planning objectives, there still remains a wide gap between environmental security and developmental advances. When I say so I don't necessarily have in mind the urban rich and the educated but the vast majority of Indians who are directly dependent on the natural resources of the country for their basic need of food, fuel, shelter and fodder for their cattle.

It is good that a lot of discussion and activities are taking place at various levels of urban population. It is welcome that environmental awareness now forms part of School and College Syllabi. But to make environment awareness programmes really effective, to bring about a change in the quality of life of the larger masses, we must reach out to the need of the poorest of the poor in villages and towns alike. The potential of modern information technology makes it possible to reach out with knowledge on these subjects to the remotest parts of the country. Policy makers, researchers and environment activist must understand that protecting the environment is not a luxury that only rich countries can afford but an imperative that even poor countries including India cannot afford to ignore.

As of now most discussions, activities, research and concern are mainly confined in a limited circle of the urban educated and concerned population. But to make environment awareness programmes really successful and effective, we have to begin from the villages and the urban poor where the need is far greater and condition more serious. The village bodies, like Durbars in Meghalaya should be involved in environment awareness and protection programmes which will on their part teach people how environment degradation directly stems from uncontrolled deforestation and excessive use of toxic products. The emissions of pollutants and the exploitation of non-renewable natural resources should be explained as acts of aggression against nature. The poor and the ignorant should be helped to identify their own resources near their dwelling and the need for their protection. The villagers, with the help of the educated among them, would be taught about the dangers their environment

11

faces and how to prevent these dangers. Elementary examples of how the Villager's land is losing fertility, how his water is becoming scarce or polluted, how the trees, animals, birds, forests are fast vanishing from near him, would go a long way to motivate him to conserve and expand environmental resources.

The task is difficult and it requires a re-defining of perspectives and priorities in the environmental awareness scenario. One thing must however be clearly understood that in a country like ours we cannot slacken the pace of development. What is needed most is that in our vast developmental programmes we must have the conditions of environment-protection strictly followed. There certainly can be some adjustment between the two needs. And to fulfil these conditions of environment conservation, a mass awareness among the vast majority of our population is a must.

I am sure this National Seminar on "Pollution, Man and Environment" will focus upon the whole gamut of environmental problems, challenges and their right solutions. And before I end I profusely thank the organiser and sponsors of this important seminar for taking up vital issue of utmost importance and urgency directly connected with the sustenance and welfare of our future generations both here and everywhere else.

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

Thank you,

Jai Hind,

Khublei,

Mithela.

11

SCIENTIFIC TALK : ECO - FRIENDLY POWER DEVELOPMENT

Shri A.R. AGARWAL, Executive Director
POWER GRID CORP. OF INDIA LTD., (N.E.R.), SHILLONG - 793 001

Respected Chairperson, Dr. (Mrs.) M.P.R. Lyngdoh, Hon'ble Deputy Chief Minister Sri D.D. Lapang, Shri J.P. Singh, Chief Secretary, Govt. of Meghalaya, Shri R.K. Datta, Dr S.K. Gupta, Distinguished Guests, Friends, Ladies and Gentleman. I express my sincere thanks to the organisers for arranging this august gathering, to ponder over the important issue before us, Pollution, Man & Environment. I also thank the organisers for providing me the opportunity to share my thoughts with all of you, in this conference.

We are a growing economy. Our endeavour is not only to meet the demand of the growing population but also to make substantial change in the living standards. We have to achieve growth in all facets of our activity, Fig. 1 and Fig. 2. It is heartening to see that the pace of growth achieved since our independence is quite spectacular, we have been able to shift from the era of deficit to the era of surplus in many fields from production of food grains to the production of infrastructural facilities. But along with development we have been confronted with the issues raised by the environmentalists world over which planning can not be ignored. The rising levels of pollution, degradation of forests, damage to natural habitats of the wild life is already having telling effect on the entire society. However, I would like to limit my discussion to the power sector with which my association is very long.

Development of Indian Power Sector has been spectacular since independence, from a meagre 1,300 MW the capacity has grown to 85,000 MW out of which around 55,000 MW is based on coal, 23,000 MW based on Hydro and about 6,000 MW based on Gas/Oil fuel. But all these sources have different environmental implications, Fig. 3 and Fig. 4. Increased consumption of electricity is an indicator of economic growth and with the projected economic growth, the demand for electricity is going to reach phenomenal proportion which has already initiated several changes in the structure of the electricity industry in the country. The government has liberalised the process of establishment of plants, regulation of the tariff mechanism, introduction of the reforms. The authorities in charge of planning have to focus on the following issues to keep pace with the development of the energy sector.

- Assessment of environmental impact of locating new projects.
- Providing policy guide line for implementing energy development projects.
- Identify the future direction and thrust for improving the environmental services.

It is extremely important, that the process of conclusion of the issues mentioned above at the regulating level become fast and transparent and economical. We are all aware that North Eastern Region has got vast hydro potential of 35,000 MW which could not be harnessed, since the requirement is much less within the region but ecological problem need a detailed but fast study, Fig. 5. These resources could be of national importance but decision regarding investment in these projects need a closer look at the environmental issues and its implication on the cost of the end product. If we go through the process of development of the hydro power generation in the country, it may be seen that the growth is not that spectacular in comparison to thermal power, because some major projects could not see the day of light because of the unresolved environmental issues. The once comfortable Hydro:Thermal mix of 40:60 has gradually eroded to poor 20:80 which need correction if we intend to maintain a healthy mix i.e. the power generation scenario. This will definitely require additional initiative at the project design level so that minimum environmental impact is resulted. It is a matter of pleasure that such an initiative has already been taken at the Subarnsee and Dehang Projects where multistage dams have been envisaged to reduce the problem of submerge.

Coal based thermal projects also have environmental problem like

- Emission of pollutant into the atmosphere.
- Water pollution due to the discharge of effluent from Power Stations.
- Fly ash disposal in the atmosphere

Apart from the above, the thermal plants are also contributing to the increases i.e. level of Green House Gases in the atmosphere which is going to become a matter of more serious concern to the environmentalists.

The Thermal Power Projects are being subjected to Environmental Impact Assessment (EIA) studies during assessment of the projects whereas Hydro Power Projects are subjected to Environmental Action plans (EAP) for selection of sites as the projects may necessitate rehabilitation of a sizeable population mainly living in the remote areas on the hills. All these issues are having major long term financial implications if left to the companies dealing with the subject. So far as the companies are concerned, the cost shall be recovered in tariff (electricity) and shall become costlier at the users end, for the people of the region having lower level of financial capacity to bear it. Hence the issue needs a closer look at the policy making level.

In the transmission sector, the environmental impact is much less, it facilitates locating power generation projects at pit heads or at the remote locality having hydel power resources but transmission of power from these remote areas to the load center in cities, it passes through hills, forest, national parks and populated areas, Fig. 6. Felling/pruning of trees falling in the transmission corridor is most commonly encountered problems. Proper selection of route to avoid forests, national parks etc. is also important at the initial stage. With the eco-conscious environmentalist, these issues some times become extremely critical if not taken care of in the policy making level.

In POWERGRID, the only central sector utility in transmission of electricity this issue has already been taken into consideration. An environment and Social Policy Guideline has already been formulated. The key principle of the policy are

- Avoidance of environmentally and socially sensitive areas while planning of transmission line routes.
- Minimisation of impacts during implementation stage in the environmentally and socially sensitive areas.
- Mitigating all unavoidable negative impacts out of execution of the project.

Though POWERGRID tries to route all its transmission lines through agricultural land, some times it becomes impossible to stop taking these through forests and hills. The classification of the land used while taking POWERGRID lines is as under

● Forest	6.0
● Agricultural Land	64.4
● Other Revenue Land	28.0
● Water Bodies	0.4
● Plantation and orchids	0.4
● Mountain/Ice caps	0.4
● Urban/residential area	0.4

Further POWERGRID has initiated actions to minimise right of way requirement while constructing transmission lines through forests. The ROW width of 27 metres of 123 KV lines in normal terrain has been reduced to 14 metres by felling of trees within the flash over distance of 4 metres and lopping of branches in the balance position. POWERGRID has further taken steps to compensate the loss of trees have been felled. Thus, we in POWERGRID have already oriented our action to address the environmental issues while constructing new lines, Fig. 7. and Fig. 8.

The existing forest conservation Act 1980, Fig. 9 and the recent Supreme Court Order on felling of tree etc. are fully complied with though the process of clearance and scrutiny take a long time. However, to meet the growing need of electricity in India matching development in transmission sector has also to take place. The generation capacity has to treble in coming 20 years as per conservative estimate and matching requirement of transmission system shall also to increase to same extent if not more for times to come. In such scenario, environmental issues shall be in the forefront. Hence, it is felt that these should be further deliberated to review the process of implementation of the policy enactment on the environmental issues.

Thanking you.

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- ◆ WE ARE A GROWING ECONOMY
- ◆ GROWTH OF POPULATION TO BE SUSTAINED THROUGH DEVELOPMENT
- ◆ LIVING STANDARDS TO BE IMPROVED
- ◆ GROWTH IN THE FIELD OF INFRASTRUCTURAL AREA SPECTULAR

Figure - 1

- ◆ GROWING CONCERN FOR ENVIRONMENTAL ISSUES
- 1. RISE IN LEVEL OF POLLUTION
- 2. DEGRADATION OF FOREST
- 3. DAMAGE TO NATURAL HABITAT OF THE WILD LIFE

Figure - 2

- ◆ DEVELOPMENT OF POWER SECTOR SPECTULAR SINCE INDEPENDENCE
- ◆ CAPACITY GROWN FROM 1,300 MW TO 85,000 MW; 55,000 MW - THERMAL, 23,000 MW - HYDRO & 6,000 MW - GAS
- ◆ FUTURE GROWTH REQUIRED IS PHENOMENAL TO SUSTAIN PROJECTED ECONOMIC DEVELOPMENT
- ◆ ENVIRONMENTAL IMPACT SHALL ALSO INCREASE

Figure - 3

- ◆ FOCUSED ATTENTION IS REQUIRED FOR
- 1. ASSESSMENT OF ENVIRONMENTAL IMPACT OF LOCATING NEW PROJECTS
- 2. POLICY GUIDE LINE FOR ENERGY DEVELOPMENT PROJECTS
- 3. IMPROVEMENT IN THE SERVICES FOR ENVIRONMENTAL CLEARANCES

Figure - 4

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- ◆ **NER HAS VAST UNHARNESSED HYDRO POTENTIAL IS ABOUT 35,000 MW**
- ◆ **HARNESSING THE SAME IS ESSENTIAL TO IMPROVE THE HYDRO: THERMAL MIZ TO 40:60 FROM PRESENT LEVEL OF 20:80**
- ◆ **IT IS CLEAN POWER BUT HAS ENVIRONMENTAL IMPACT**
 - 1. **SUBMERGENCE**
 - 2. **DISPLACEMENT OF POPULATION ETCS.**

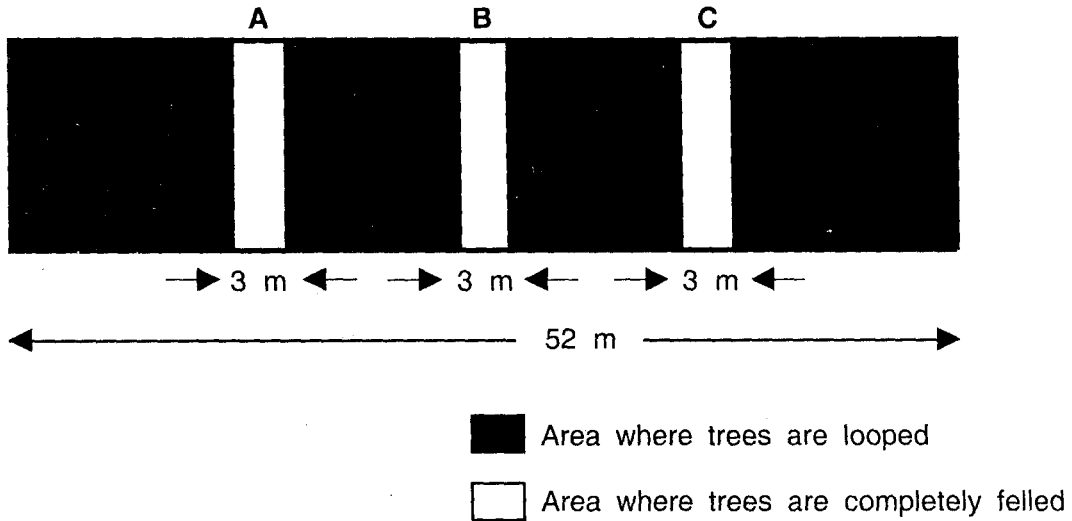
Figure – 5

- ◆ **TRANSMISSION LINE: ENVIRONMENTAL ISSUES ARE MINIMUM**
 - 1. **FELLING AND PRUNNING OF TREES TO ACHIEVE PROPER CORRIDOR WIDTH**

Figure – 6

RIGHT OF WAY IN THE FOREST : 400 KV

A. DURING CONSTRUCTION



B. AFTER CONSTRUCTION

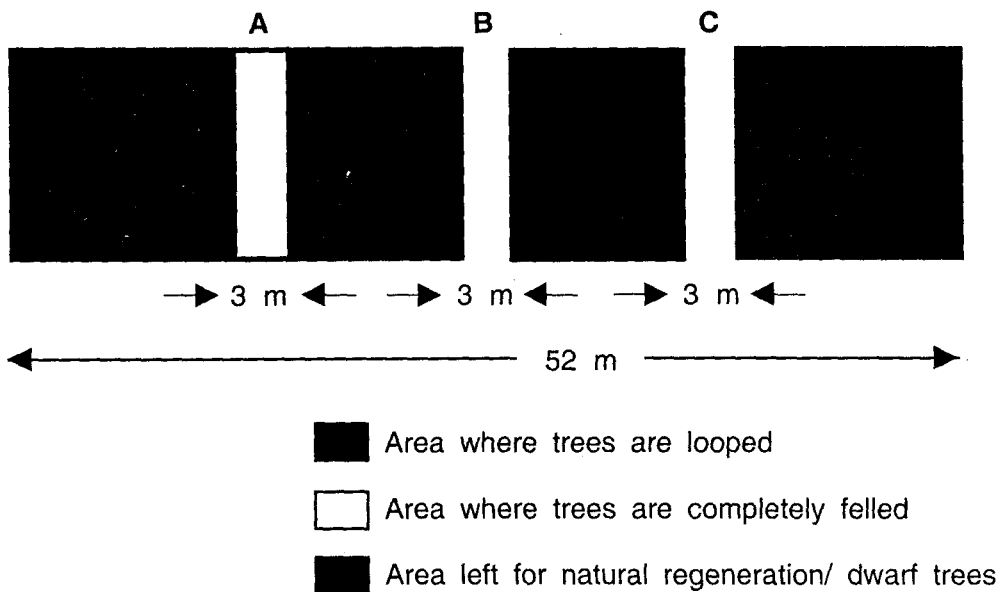
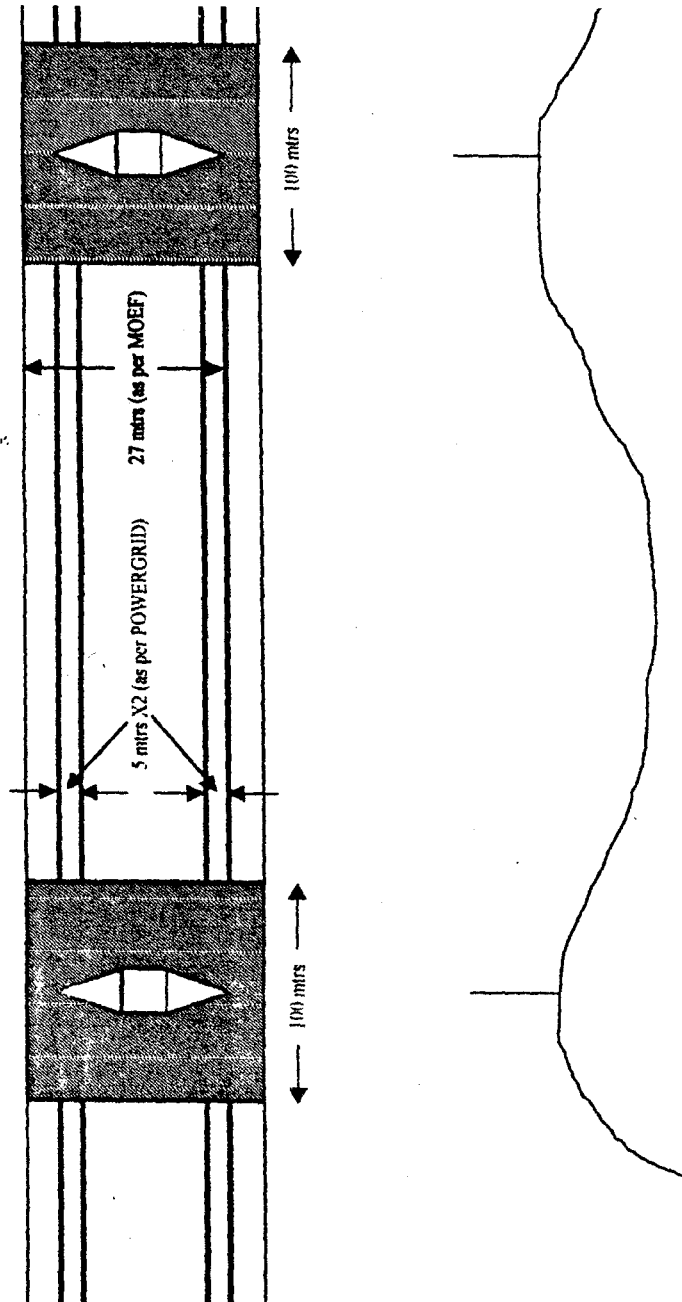


Figure - 7

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NOTE :

1. In deep Gorges where tower locates on peak, we have opted for 10 mtrs ROW against approved 27 mtrs
2. Forest damage of 36 Ha saved in 77 km line length.

Figure - 8

- ◆ **FOREST CONSERVATION ACT 1980 & SUPREME COURT ORDER**
- ◆ **FULLY COMPILED BY POWERGRID**
- ◆ **FOREST CLEARANCE - LENGTHY & TIME CONSUMING, SOMETIMES LONGER THAN PROJECT EXECUTION TIME**
- ◆ **FOREST CLEARANCE PROCESS**
 1. **NEEDS TO BE SIMPLIFIED, SHORTENED & MADE FASTER**
 2. **RED TAPEISM TO BE CURTAILED**
 3. **TRANSMISSION LINE PROJECTS TO BE ACCORDED CONSTRUCTION PERMISSION AFTER STAGE-I CLEARANCE**
- ◆ **TREE AND CROP COMPENSATION RATES AMONG STATES OF NER TO BE RATIONALISED AND UNIFORM**

Figure – 9

CHAIRPERSON'S ADDRESS AT THE INAUGURAL FUNCTION

DR (MRS) M. P. RINA LYNGDOH

On behalf of Shillong College and the Shillong Academic College Society, we would like to extend our warm welcome to our Honourable Chief Guest, Shri. D. D. Lapang, Deputy Chief Minister of Meghalaya, who has kindly consented to be with us today to grace the Inaugural session of the National Conference on "Pollution, Man and environment". We also have the pleasure to welcome Shri. J. P. Singh, IAS, Chief Secretary, Government of Meghalaya, Shri. A. R. Agarwal, Executive Director, Power Grid Corporation Ltd. Shri. B. P. Bhattacharyya, Deputy Director General, Geological Survey of India, Shillong, Shri. R. Khapor, President Governing Body, Shillong College. May we also welcome all the Resource persons, Participants, Representatives from various departments and organisations, and all our Distinguished Guests, Friends, Ladies and Gentlemen.

As we enter into the 21st century, we know for certain that we have the technical know how, the skill, the man power, to sustain us in various sectors of our everyday life but, now the question is Do we see ourselves responsible enough to keep Mother Earth alive ? or we are just going to take it, that man has been made so intelligent that the keys to planet's destruction has become truly entrusted in his hands. We may ask ourselves if we have not had enough of just discussing it inside the walls of our drawing room, or shaking our heads, when yet another news item regarding planets' slow death is mentioned.

We are organising this National Conference for two days, to show our concern with the whole world and our country, on the need of Environmental Conservation and Protection. Since time immemorial, man has lived in harmony with nature and his relationship has been on a give and take basis, where man acquires from the earth what he needs, and in time replenishes his source. Our forefathers had a farsighted vision of this relationship between man and nature. In the Khasi and Jaintia Hills till today, we have the sacred groves where the cutting of trees and other plants is forbidden. This is an ancient wisdom, to conserve the environment which is linked to their religious belief. But as man became more developed, he became less and less sensitive to this relationship. If this is the result of being developed, then the very existence of man is threatened. India has today a number of problems, the problems of an urban structure like poverty, booming population, unemployment, rapid industrialisation and expanding urban limits, which increases the burden on the natural resources in particular, and the eco-system in general. There has to be a balance between development and the preservation of environment. I believe, that these problems can be solved, if there is a motivation, and if we put our heads together. If man can explore the limit of the sky, then a solution to the problems can be sought. There should be a proper policy to preserve the environment and the enormous wealth of our natural resource. Environmental consciousness can only be spread like the word of God itself, where transformation will take place in every nook and corner of the earth. Education is one way of combating this self inflicted process of destruction. It is a welcome step, that environmental awareness now forms part of school and college syllabi. Environmental awareness programmes, must be organised to bring about a change, and the message should reach to each and every one and to every remote village.

The final solution calls for self belief, we can and we must make the world a better place to live in. I am sure that this National Conference will focus on the various issues relating to environmental problems and their solutions. I wish all of you a very pleasant day and a very fruitful deliberation.

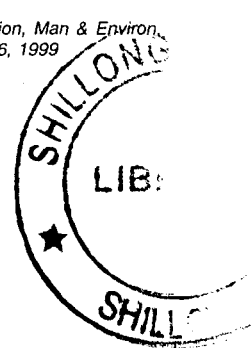
Thank you,

Khublei,

Jai Hind.

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KEY NOTE ADDRESS : POLLUTION, MAN AND ENVIRONMENT

Shri J.P. SINGH, IAS
CHIEF SECRETARY, GOVT. OF MEGHALAYA

HE WHO PLANTS TREES HAS SHADE IN THE FIRST GENERATION,
WOOD IN THE SECOND GENERATION, RAIN IN THE THIRD.

Pollution is derived from a Latin word *Polluere* meaning "to soil" or "to defile".

Pollution is an undesirable change in the physical, chemical or biological characteristics of air, land and water that may or will harmfully affect the human, animal and plant life.

Environment is the multidimensional systems of complex interrelationships in a continuing state of change. It is the sum of substances and forces external to the organism in such a way that it affects the organism's existence.

"A large percentage of drinking water provided by India's major rivers is polluted and clean air is breathed by Indians for only two hours in the morning. Over 10% of hospital patients are victims of a polluted environment."

Concern for the environment has been part of India's social and cultural heritage. This land of ours is the birthplace of sages and of religions, preaching love for every living being, a concern for life and conservation of nature. Twenty two centuries ago, the Emperor Asoka emphasized the preservation of animal life and forest trees.

The concern for environment in present time found expression in the proclamation undertaken to "Defend and improve the environment for present and future generation" by the United Nations Conference on Human environment in Stockholm in 1972. All natural eco-systems are balanced and were unaffected by man until the dawn of civilization. But the speed and nature of man-induced environmental changes have brought an increasing disharmony between him and nature at present. Living beings are dependent upon nature for their requirements. Hence the purity and depletion of resources, soil erosion, pollution, deforestation and extinction of wild animals due to increased human population have reached global levels.

Man has played a very important part in shaping his environment. He has been responsible for degrading the quality of his environment ever since he appeared on this earth. At first he contaminated the atmosphere by the use of fire which added gases, smoke and ash to it. When he came out of the cave age and began to settle into village town and cities the situation gradually worsened. The degradation of the environment was caused mostly by his activities such as burning of wood, smelting of ores, tanning of leather, primitive method of sewage disposal and so on. With the advent of Industrial revolution, coupled with urbanization, all kinds of impurities began to be added to the natural air, weather as well as soil causing almost irreparable and irrevocable damage to the environment.

In 1961, John Tindal, a scientist, brought to the knowledge of the world the green house effect of carbon dioxide.

The Green House effect is caused by the increasing levels of CO_2 in the atmosphere largely the result of burning wood and fossil fuel.

The acid rains are very dangerous to the living organism as they produce highly toxic compounds that contaminate the portable water and enter our body.

Each year 17,500 species of plants and animals are ravaged into extinction. Destabilization of the ozone layer has caused a rise of up to 1.5m in sea level which devastate coastal areas where half of the world's population presently lives. One of the world's 5 to 10 million species of wild life become extinct each day. It is estimated that the end of the century will witness the elimination of as many as one million species. The plunder of earth for short term gain and power is systematically destroying our soils, water, forest and air. The onslaught of aggressive technology is undermining the food production. Poisons ranging from toxic chemical to radio active substances are released daily into the environment. Increasingly, our bodies are degraded as our physical environment.

At the same time wild life is systematically decimated by wild life trade and deforestation. Vital life support systems are being destroyed as animals, birds and insects face extinction. Without natural biological checks and balances, agricultural pests and diseases ravage and destroy cultivated lands. Insects and other creatures which have a positive role to play in agriculture too, are becoming rare.

Another major life sustaining resource which is being sucked away is water. Ground water is currently used indiscriminately. Traditional ecological practices have been all replaced by modern technology with the capacity to draw out immense quantities of water, often to be wasted. Contamination of soils and hence water by toxic substances and other pollutants also contribute to the destruction of such non-renewable water resources. Without water the survival of human kind will undoubtedly be cut short.

The rapid depletion and destruction of global resources have serious and wide spread social implications. Already the signs are strong. There is increasing poverty and unemployment as the resource stock for economic development runs out. Millions especially in the Third World are leading barely human existence. When we move to the transformation of earth's natural wealth due to man's greed and avarice, the outcome is disastrous. Bhopal, Chernobyl, Minamata, acid rains, pesticide poisoning of food chain, contaminated and adulterated food and drinking water - the catalogue of disaster grows steadily and stealthily.

Due to unequal exchange of resource trade and commerce the Third World has 75% of population, 30% of food grains, 11% of education spending, 6% of World Health expenditure and 5% of World Science and Technology. Due to this grave imbalance the Third World surrenders most of its resources, but obtains only a small fraction of goods and services with which to fulfil its basic needs of its people. The drive for market and sales in order to obtain sufficient profits lead to proliferation of products and thus increasing use of raw materials. This includes forest products from the already deforested lands of the Third World. Since incomes are unequally distributed within the rich countries, there is a mad scramble by the firms to get the rich and the middle class to become hooked on to fashion and status products, since with their abundant income they have already long satisfied basic survival needs. The whole society joins in the craze for consumer products. The result is the production and consumption of too many products, many of which are wasted either through under utilisation or through easy and constant disposal.

"There is everything in nature for man's need, but not enough for his greed." (Gandhiji)

In India, awareness about the environment came very recently. In Bangkok, three wheelers are obliged to have four - stroke engines or to run on gas. In South Korea, more and more taxis are running on LPG. In Bangalore, recently almost 25,000 cars are plying using LPG's. The Federal Republic of Germany is the first country to adopt environmental standards in their Constitution. They adopted the method called Sustained yield method which includes :

1. Preservation of soil quality
2. Water retention
3. Clean air
4. Recreational value
5. Secondary benefits as speed production
6. Preservation and safe guarding of genetic variety
7. Timber production

The protection of environment is only possible on the basis of market mechanisms. People will only act in a manner not harmful to the environment if and when they can expect amonetary advantage by doing so, such as tax relief, incentive, certificates and recognition. Others have to be forced to change their ways by imposing tax disadvantages, fines and tax surcharges.

The principle of development must be rejected. We should abandon the totally counter-productive task of trying to build up economic wealth. Instead we should seek to rebuild social and ecological wealth, the only types of wealth that are capable of satisfying real human needs and not artificial needs generated by an aberrant and short sighted consumeristic society.

VOTE OF THANKS AT THE INAUGURAL FUNCTION : SHRI N. K. SARKAR, CO-CONVENER

It's a wonderful opportunity for me to extend our most sincere thanks to each one of this distinguished gathering on this inaugural session of the Conference on "Pollution, Man and Environment".

I, on behalf of the organisers of this National Conference profusely thank Shri D. D. Lapang, Hon'ble Deputy Chief Minister of Meghalaya who kindly released the Proceedings Volume of our earlier National Conference on "Development of Science and Technology". Your kind presence and action, Sir, have given us great encouragement and inspiration.

We remain grateful to Shri J. P. Singh, Chief Secretary of the State of Meghalaya for his well-documented and learned key-note address delivered in this inaugural session.

We are thankful to Dr B. P. Bhattachayya, Deputy Director General (NER), Geological Survey of India, Shillong and Shri A.R. Agarwal, Executive Director, Power Grid Corpn. Ltd. (NER), Shillong for their kind presence amidst us this morning and their learned deliberations highlighting various aspects of environment and its presentation.

It is heartening to note that a number of scholars, teachers, scientists and representatives of sponsoring organisations have meaningfully participated in the inaugural session of our Conference and we remain ever grateful to them for their patronage and cooperation.

Shri R. Kharpor, President of Shillong College Governing Body as a renowned educationist and Dr (Mrs) M. P. R. Lyngdoh, Principal and Chairperson of the session have always been own pillars of strength for making this Conference possible and they command our deepest gratitude and admiration.

Finally we sincerely thank the members of the media who kindly covered the proceedings, fellow teachers, students, volunteers and all members of the Shillong college Academic Society, the Shillong College management, various sponsoring agencies for making this inaugural session of our National Conference on "Pollution, Man and Environment" a heart-warming, positive reality.

Thank you all once again.

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**VALEDICTORY ADDRESS : DR H. S. GUPTA, Joint Director,
INDIAN COUNCIL OF AGRICULTURAL RESEARCH, SHILLONG**

Hon'ble Minister of Forests & Environment, Shri Kitdor Syiem, Dr (Mrs) M. P. R. Lyngdoh, Chairperson and Principal, Shillong College Dr S. K. Acharyya, Director General, Geological Survey of India, Calcutta. Shri H. W. T. Syiem, Chairman, Meghalaya State Electricity Board, Dr S. K. Gupta, Shri R. K. Dutta, Distinguished Scientists, the Delegates in the conference, Faculty Members of Shillong College, Members of Shillong College Academic Society, Students, Ladies & Gentlemen, I feel honoured for having asked to deliver the valedictory address to the august gathering here on the occasion of the National Conference on "Pollution, Man & Environment" organised by shillong college in collaboration with Shillong College Academic Society. I would 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.

During the course of the 2-day National Conference, there have been thread-bare discussions on various topics as per programme of two technical sessions. The themes had focussed attention to their relevance in North Eastern Region.

Life on earth is estimated to have evolved some three hundred million years ago and has sustained so far. However, further survival of human life depends on quality of vital components that constitute the environment. The major constituents of environment that helps support human life are –

- 1 Air
- 2 Water and
- 3 Land

Unfortunately, at present all the three are being polluted. This pollution started since the beginning of industrial revolution and now it has reached to an alarming state especially in last 15 - 20 years. If the pollution is allowed to continue with the present rate, life on earth will be threatened. I intend to discuss here the present status of pollution of air, water as well as land and suggest the remedial measures to contain this menace.

Air Pollution

The quality of air that we breathe in our cities is heavily loaded with toxins caused due to burning of fossil fuels, wood, charcoal and animal wastes. The sustained burning of fossil fuel like coal, which is carbon-intensive-green house gas emissions - not only erode the ozone layer but they are largely responsible for global warming, the haze over Indian Ocean and drastic changes in weather patterns. Burning of coal accounts for nearly one-half of annual global carbon emissions. Coal releases 29% more carbon per unit of energy than oil and 80% more than the natural gas. Although the urban air pollution has been reduced in developing countries due to strict regulations, it has been increasing in the developing countries because of increased demand of energy. It is estimated that almost more than one billion urban residents world-wide breathe air that does not meet WHO's air quality standards.

Carbondioxide is increasing in the atmosphere at the rate of more 3,000 million tonnes per year, whereas methane is increasing at the rate of 45 million tonnes/year. Chlorofluorocarbons (CFCs), widely used in household items like, air conditioners, fire extinguishers, aerosols as well as solvents and foams, are insoluble in water and mix freely and quickly into the air and ultimately reach to the stratosphere regardless of their weight. CFCs are increasing at the rate of 5-6%. Chlorine released from the break down of CFCs remains in the atmosphere for several years where it destroys ozone molecules found in the ozone layer located between 10 - 15 Km above the surface of the earth. The ozone layer protects us from the harmful effects of the ultra-violet radiation from the sun by blocking up to 95% of these rays. Any decrease in these layers would mean prolonged exposure to UV radiation that is known to result in several human ailments leading to an increase in skin cancers, weakening of immune systems and aggravated eye disorders like cataract.

If the concentrations of these green house gases continues at the present pace, the average global temperature is likely to rise by 1.5 - 4.5°C by the year 2040. This will cause the water level (of the sea) to

11

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rise by 56 - 345 cm by 2100 that will flood the low lying coastal areas as a result, the existence countries like Maldives and Bangladesh will be threatened.

The green house effect of methane is almost ten times more than carbondioxide and the cultivation wetland rice is the major cause for the emission of methane. Almost 110 million tonnes of methane is estimated to emit every year from rice cultivation. Since rice is a staple food that feeds almost 2/3rd of the global population, its cultivation can not be stopped. However, the emission of methane can be minimized by -

- i) Using compost instead of straw/fresh crop residue
- ii) Use of SSP instead of TSP or DAP
- iii) Use of varieties that emits less CH₄
- iv) Crop rotation like rice-non-rice crop

Financial assistance is available from the Multilateral Ozone Fund set up by the UNEP to help clean up industrial processes in developing countries. The Ozone layer is expected to return to normal by 2050, provided there is a concerted effort by all countries to adhere strictly to the terms and spirit of the Montreal Protocol. The UNEP's Global Environment Outlook 2000 (Geo-2000) report says, "The continued poverty of the majority and excessive consumption by the minority are the major causes of environmental degradation.

Water Pollution

Water and land provide food to the mankind and their pollution may endanger their existence. Almost two third of earth surface is covered with water by only 3 percent of this is fresh water. More than one billion people in developing countries lack access to soft water which is getting polluted by -

- (a) Human waste
- (b) Fungicide and pesticides and
- (c) Industrial wastes

Water contamination leads to contaminated food, which becomes toxic to terrestrial and aquatic animals. In fact, every year in this country five lakh deaths occur due to insecticide and almost ten thousand people die every year due to poisonous food. According to an estimate, about 80% of disease in India are caused by polluted water. The extent of water contamination has reached an alarming proportion, which is evident from worldwide consumption of about 25 lakhs tonnes of biocide every year. This ultimately cotaminates water and land. These biocides include 50 - 60% weedicides, 20-30% insecticides and 10 - 20% fungicides. Industrial pollution of water has reached an alarming proportion. The government has been trying to minimized this pollution of water has reached an alarming proportion. The government has been trying to minimized this pollution by giving incentives/subsidies to the polluting industries for installing after treatment plants.

Land Pollution

Out of 328 million hectare total geographical area of the country, 258 million hectare is subject to various kinds of soil erosion. Of this, 150 million hectare are subject to serious water and wind erosion, 69 million hectare is at critical state of deterioration due to erosion, 32 million hectare is prone to wind erosion, 3 million hectare are prone to erosion due to *jhum* cultivation whereas 4 million hectare are prone to gullies and ravines. Soil loss from unprotected land is estimated to be around 50 tonnes/acre/year to 120 tonnes/acre/year. Almost 6000 million tonnes of productive soil are lost every year from 80 million hectare of cultivated land in India. The major effects of soil erosion are degradation in physical properties and loss of plant nutrient. It is estimated that 8.4 million tonnes of plant nutrients worth 20 million rupees are lost every year.

The estimated total soil loss from crop land the world over is 25,400 million tonnes. Out of this, India contributes 18.5 per cent whereas we have only 2.4 percent of the global area. The seriousness of soil erosion can be understood by the fact that nature takes 1000 years to build 1 inch of tropical soil. In view of the serious pollution of air, water and land, human and animal life is threatened. This can. However be contained by sustainable development which meets the need of the present without compromising the availability

of the future generation to meet their own need as well as not endangering ecology and environment. At the 1992 U.N. conference on Environment and Development, Rio UNCED Principle #3 characterised sustainable development as "the right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generation." Principle #4 further states : "in order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it." In other words, the objectives of sustainable development are to provide for the economic well-being of present and future generation and to maintain a healthy environment and life support system. Ethically speaking sustainable development has two dimensions : (i) our relationship to fellow inhabitants and (ii) our relationship to land, plant and animal inhabitants. Therefore, sustainable development is not strictly a problem of science or engineering or economics or management or politics. The roots are found in values, ethics and cultures of all concerned. The elements of sustainable development are :

- Population stabilisation
- New technologies / technology transfer
- Efficient use of natural resources
- Wastes reduction and pollution prevention
- Integrated environmental system management
- Determining environmental limits
- Refining market economy
- Education
- Perception and attitude changes
- Social and cultural changes

Men's meddling with nature and the ever increasing presence of carbon dioxide, carbon monoxide and other gases in the atmosphere have resulted in an ecological imbalance and a worldwide crisis which is an enormous and impending challenge to modern civilization while environment means surrounding circumstances, environmental pollution implies the destruction of our surroundings and serene atmosphere.

The need of the hour is conservation, be it soil, water, air, plants or animals and instead of exploiting the environment for our survival, we should be frugal in meeting our needs of the present and future. The term conservation relates to the science of inter relationships between living things and their environment. Modern conservation as defined is the management of human use of the environment so that it may yield the greatest sustainable benefit to present generation, while maintaining its potential to meet the needs and aspirations of future connection. It is concerned with the quality as well as the basic support of human life. Conservation also ensures that proper consideration is given to aesthetics and recreation.

At the UN - sponsored 1992 Earth Summit in Rio de Janeiro, the largest congregation of world leaders in history agreed on the broad principles that must guide environmental policies while still encouraging economic growth. The prevention of environmental pollution from industrial, agricultural, urban and domestic sources, including toxic chemicals, radioactive wastes and elevated water temperatures, is another concern of conservation, we have to conserve natural resources, agricultural lands, biological diversity, water, non-renewable resources from more exploitation and degradation for our present and future. The goals of resource conservation for a eco-friendly environment are –

- the maintenance of essential ecological processes and life support systems, such as agricultural, coastal, fresh water and forests systems.
- the preservation of biological diversity.
- sustainable utilisation of species and ecosystems such as forests and grazing lands.

I hope every delegate will carry this message and try to spread the message of conservation of our environment. Then only the slogan like "keep your city green" will have some meaning.

Thank You
Khumblei
Mithela.

JOINT CONVENERS' REMARK AT THE VALEDICTORY FUNCTION : SHRI R. K. DATTA

Madame Chairperson, Hon'ble Minister for Forests and Shri H.W.T. Syiem, Chairman Meghalaya State Electricity Board; Dr. S.K. Acharyya, Director General, Geological Survey of India; Dr. H.S. Gupta, Principal Scientist, ICAR, Shri B. Singh I.F.S., Principal, Chief conservator of forests Govt. of Meghalaya, delegates and participants, Heads of the Institutions, teachers and students, distinguished members of the public, ladies and gentleman. We are privileged to stand before you to make an assessment of our activities in the National Conference on 'Pollution, Man and Environment'. Last year, after the 'Pokhran Implosion' in May, 1998 we hailed the achievement of our scientists and overlooked the impact on the environment. This year around the same time the Kargil situation has been thrust upon us by our neighbour and we cannot help the consequence on the environment. The NATO BOMBING in Kosobo is creating avoidable environmental hazard. At the threshold of the new millennium, the social activists, worldwide, are scrutinising development of science and technology and the environmental hazards. Throughout the globe some measures are being undertaken with a view to reducing the effect of pollution.

But certain aspects including the global warming is alarming. Climatologists are worried that the unusual floods and droughts, bitter winters and severe summers that are plaguing many parts of the world in recent years could be due to global warming caused primarily by human activities such as the emission of billions of tonnes of green house gases. Rising temperature during the last two decades and changes in seasons with prolonged summer, early spring and delayed autumns in Europe suggest global warming. India experienced severe summer in 1998 and the global temp. reached record high. Deforestation, environmentally unviable development projects, reductions of water body area, less open spaces and built up structures which produce heat islands, disturb ecological balance.

The Narmada Bachao Andolan activists are of the opinion that there is a possibility of earthquake of high magnitude in the valley due to these dams as was evidenced by recent quakes in Pandhana and Jabalpur. But we find a ray of hope to learn that Shri Vishweshar Dutt. Saklain single handedly planted more than 4 lac trees in Dehradun areas.

Again to combat pollution of air by vehicular emission, steps to enforce Euro-emission norms are being considered. Thus as there is onslaught on environment due to human activities, there are conscious opposition also. With this backdrop we considered it proper to make an attempt in the mass awareness programme through this conference.

As a part of our programme, the 'world Environment day' was observed on the 5th June through some activities including some competitions among school and college students, The overwhelming response from the students and the quality of their performance speak volumes about their concern for environment.

In the two day seminars on June 15-16, 41 papers spread over two sessions were presented and discussed. I mention some of the important revelations. Meghalaya Pollution Control Board's findings reveal that in Shillong, Jowai and Nongphoh the suspended particle matter concentration exceeds the National ambient Air Quality Standards.

The study of landslide in Mizoram by the Geological Survey of India, Shillong will act as a baseline document for planning the developmental activities.

The Atomic Minerals Division in its overview on the nuclear waste management focuses on the problem and current efforts for a solution.

On human elephant conflict in Garo Hills, the conservator of Forests suggests that preventive measures should include keeping elephants away from vulnerable areas because a complete separation of elephant and human habitat would hardly be feasible.

Most of the authors suggested mass awakening towards protection of environment and conservation of biodiversity.

The Central Water Commission gives an account of its role in the implementation of the environmental safeguards as stipulated by the ministry of Environment & Forests .

Forests deptt. of Meghalaya suggests that people's involvement and co-operation is important for successful implementation of wildlife conservation - measures, because most of the wildlife habitat fall in private hands.

'The forests which the Tribals guarded so scrupulously for centuries have now become the scene of ruthless onslaught for extracting its wealth to feed the ever increasing demand of the present materialist technology based civilisation, laments one author.

On the implications of environmental legislations and administration in N.E. India an author feels the necessity of a wide debate on the subject. Shifting cultivation, growing of pineapple along the slopes and other developmental activities have affected the land resources and at some places the land has become unfit for food production, reveals Geological survey of India in the study of environmental issues of Meghalaya.

As organisers of this conference it had been our endeavour to take the people into confidence. The attempt will be considered successful if the message reaches the people in general.

We place on record our appreciation that Hon'ble deputy Chief Minister inspite of his busy schedule in the Assembly could devote some time to inaugurate the conference and release the proceedings volume of the National Conference on the Development of Science & Technology during the last 50 years held on 27-30 May, 1998.

The scientific talk by Shri A.K. Agarwal, Executive Director, Power Grid Corp. and key note address by Shri J.P. Singh, Chief Secretary, Govt. of Meghalaya at the Inaugural function were thought provoking.

While Dr H.S. Gupta gave an account of pollution in various fields, Shri H.W.T. Syiem correctly held man responsible for pollution.

Thank you.

PARTICIPANTS' REMARK AT THE VALEDICTORY FUNCTION : Dr S. N. DUTTA, Co-Convener

Madame Chairperson, Dr S. K. Acharyya, Director General, Geological Survey of India, Calcutta, Sri H. W. T. Syiem, Chairman, Meghalaya State Electricity Board, Dr H. S. Gupta, Indian Council of Agricultural Research, Barapani, Dignitaries, Scientists, Distinguished Guests, Ladies and Gentlemen, and my Dear Students, I am privileged to share my experience as a participant in the National Conference on 'Pollution, Man and Environment'. I shall mainly focus on the seminar spreading over two Technical Sessions

The papers presented in Session-I dealt mainly with impact of pollution and environment while that of Session-II, emphasised on need to develop awareness in all sections of people of the society to protect the environment for safety and security of the planet earth. To assess the impact of pollution in a region it is most essential to know the geoenvironment of that region, as rightly pointed out by Dr. B.P. Bhattacharyya in his paper. In fact the fragile geoenvironment of North-East India is responsible for many environmental hazards. The geoenvironment of North-East India is fragile due to, (a) natural hazards like earthquake, due to subduction of Indian plate under Burmese plate, floods and land slides due to excessive rainfall and drainage congestion leading to erosion of soil and bank of rivers and changes in the river courses, and (b) anthropogenic induced hazards like Jhum cultivation, indiscriminate deforestation. The anthropogenic hazards have added more fragility in the geosystem of North-East India. It is most essential to keep in view the geoenvironment while implementing any developmental project as well as to assess the impact of pollution on environment.

Most of the investigations revealed that pollutions in general is anthropogenic contribution of mankind, such as the pollution level in the city of Guwahati (Assam). Sri L. N. Bora and Co-worker commented in their investigations that unplanned development of the city of Guwahati, with increasing population and industrialization has caused environmental pollution in respect of air, water and solid wastes. This is true for most of the cities of our country.

North-Eastern India is rich in natural resources such as crude oil, natural gas, coal, limestone, sillimanite, clay and glass stones, iron ores, fireclay and kaoline etc. Obviously oil-refineries and different industries have developed based on these available resources. By-products of these industries cause environmental pollution. All these industrial plants must adopt environmental protection and preservation programmes, such as waste minimisation, recycling i.e. reuse of wastes, treatment safe disposal of operational wastes as indicated by S.K Sahota *et al.* Opencast mining in Makum Coal field in Assam has contributed a lot to the environmental hazards, such as land degradation, loss of fertility of the surrounding agricultural land, deforestation, water, air and noise pollution in surrounding areas. Definite remedial measures are required in this field to protect environment.

Dr R. Saran and Co-worker in their paper discussed waste management in Nuclear Industry and this aspect is very much important particularly in relation to Meghalaya, because, Meghalaya is rich in radioactive minerals like Uranium which is essential for nuclear industries, he emphasised that all the nuclear industries are provided with adequate arrangement of proper disposal of wastes to prevent any possible environmental hazards.

Some papers dealt with ambient air quality and water quality, land slide hazards, man animal conflict and management of environment from household level.

Investigations on ambient air quality in national as well as in state level of Meghalaya revealed that primary pollutant like suspended particulate matter (SPM) concentration exceeds National Ambient Air quality standards (NAAS) in 69 locations out of 290 stations all over India, while it exceeds in 3 stations in Meghalaya (Shillong, Jowai and Nongpoh) out of four studied locations including Baghmara. Studies on water quality in the river Umshrypi and its tributaries in Shillong indicated its polluted nature due to solid wastes, as revealed by total coliform (TC) and Faecal coliform values. Investigations on pathogenic nematode parasite indicated prevalence of nematode eggs or larvae in soil water and vegetables of Shillong city and its surroundings, and this is due to discharge of solid wastes. Therefore attention should be given towards a mass health education programme, particularly on sanitary system and hygiene in the city. Study on water quality of Umiam Reservoir and a fresh water pond of Cherrapunji shows that the water in both the cases is soft and alkaline with high productivity of fish. Man made hazards on environment have gone to a different dimension in Garo Hills in

Meghalaya, where a regular conflict between man and wild elephant is encountered every year for safety and security of both man and elephant and this has been nicely projected by Sri Marak in his paper.

Thus most of the papers presented in session – I, tried to evaluate the impact of pollutions and man-made hazards on environment from different angles because it has affected not only human society but also has made about 650 plant species and 70 animal species endangered in north east region of the country. In Session II, different authors attempted through their presentation to develop the idea of awareness among the people in general to protect the environment and at the same time they suggested different remedial measures to avoid pollution and degradation of environment.

The outcome of deliberations and follow-up discussion during the session is summarised as following remedial measures to protect over all environment. The remedial measures may be categorised as (1) Preventive measures in industrial sectors, (2) Preservation of germplasm to protect biodiversity and (3) Legislation to protect environment.

(1) Preventive measures in industrial sectors : These measures may involve, (i) active environment management programme, (ii) environment impact and performance parameter monitoring, (iii) environmental auditing of operational facilities, (iv) recycling and waste minimisation.

(2) Preservation of Germplasm to protect biodiversity : Preservation of plant germplasm to maintain plant genetic diversity in North-East region of the country is very essential, because 43% of total florestic elements of the country are available in this region and about 650 species of plants are recorded endangered. Therefore, conservation of plant-genetic diversity is must for food security and healthy environment. This attempt should be extended to the endangered fauna of this region too, because about 70, species of animals of North-Eastern region are registered endangered. Tribals' Ethnobotanical knowledge system, studies are also to be encouraged to search new potential medicines, and their germplasms are to be conserved for human health care.

(3) Legislation to protect environment : In India there are constitutional provisions as well as legislations to protect air and water from pollution, to conserve land, wild life, forest and environment as a whole, but the existing legal provisions are not sufficient because Supreme Court is to intervane from time to time to protect the environment. Therefore some new legislations are essential to protect total environment as well as lively-hood of people depending on forest and other natural resources.

It may be concluded that with the help of Science and Technology human civilisation is progressing every moment but care is to be taken to protect environment for their own safety and security. So the concept to be propagated is that Science, Technology and Environment must go hand in hand to develop eco-friendly technologies to ensure environment-friendly development in all fronts.

Thank You.

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VOTE OF THANKS AT THE VALEDICTORY FUNCTION : DR S.K. GUPTA, JOINT CONVENER

Madame Chairperson, Dr (Mrs) M.P. Rina Lyngdoh, Shri H.W.T. Syiem, Dr S.K. Acharyya, Shri Balwinder Singh, Dr H.S. Gupta, Shri R.K. Dutta, Distinguished Guest, Delegates, Participants, Ladies and Gentlemen, on behalf of the Organisers of this Conference it is my proud privilege to sincerely thank you all for your kind presence, patronage and cooperation towards the successful completion of our Conference on "Pollution, Man and Environment".

We are extremely grateful to our Guest of Honour this afternoon, Shri H.W.T. Syiem has always been very kind to us and stood by us in any meaningful endeavour we approached him with. We are very grateful to Dr S. K. Acharyya, Director General, Geological Survey of India who took all the trouble of coming from his Head Quarters at Calcutta to grace the valedictory function as our esteemed Guest of Honour.

Shri P.J. Bazeley, IAS, Principal Secretary, Finance and Planning Department, Govt. of Meghalaya who is also an honorary member of our Advisory Committee has always inspired us with his active presence, valuable suggestions and most helpful guidance. We owe our deep gratitude to him.

Dr H.S. Gupta, Principal Scientist, Indian Council of Agricultural Research has made us greatly happy with his most illuminating Valedictory address. We are thankful to you sir.

I am also happy to announce that the long-awaited proceedings volume of the National Conference on the "Development of Science and Technology in last 50 years of India with Special Reference to North-East India" Organised by us, in 1998 was released by Hon'ble deputy Chief Minister of Meghalaya Sri D.D. Japang yesterday in our Inaugural session at Shillong College. The key note address at the session was kindly delivered by the State's Chief Secretary Sri J.P. Singh. The session was also addressed and attended by several other eminent scientists, administrators and scholars. We are all grateful to them.

We sincerely thank all our distinguished guests and delegates present on both the days representing various organisation without whose participation and cooperation, this conference would not have met the success it has.

It is our duty to gratefully acknowledge that this conference on "Pollution, Man and Environment" was sponsored by a number of key Govt. departments and important organisations. Planning and Finance Department North Eastern Council and also the Forest Department of Govt. of Meghalaya came in a big way to support the conference.

The State Council of Science Technology and Environment, Meghalaya kindly sponsored handsome prizes for the winners in various competitions held for School and College students in connection with the world Environment Day celebrations on 5th June. North Eastern Council and Power Grid Corporation Shillong also generously sponsored several of our important programmes of this Conference. We are also grateful to Meghalaya Pollution Control Board, North Eastern Hill University, North Eastern Electric Power Corporation Ltd. Shillong, I.C.A.R., Shillong and Meghalaya Electricity Board, Shillong for their steady support, cooperation and participation. We must also acknowledge with deep appreciation the help and response we received from Central Pollution Control Board and Central Ground Water Board, New Delhi, Geological Survey of India, Calcutta and Hindustan Paper Corporation Ltd., Assam. The Heads of Educational institutions in and around Shillong admirably responded to our various competitions by sending their students and helping our various programmes.

We profusely thank the media - notably the D.D.K. and A.I.R., Shillong, newspaper groups and D.I.P.R. Meghalaya for their kind and competent coverage of the conference. The D.I.P.R. also helped us with their P.A. System as before. We are grateful to still another department of Art and Culture of Meghalaya Government which allowed us to make complimentary use of the State Central Library Auditorium for our programmes.

The Shillong College management as well as the Principal & Chairperson of the main Committee Dr (Mrs) M.P.R. Lyngdoh and Vice Principal Shri T. Moitra had been a source of the constant guidance, inspiration and all types of material help. Teacher-Colleagues, Students, Office and Subordinate Staff did their best to make the conference a grand success. Members of the Shillong College Academic Society worked hard for a common cause shoulder to shoulder with others.

On behalf of the Organisers, I sincerely extend my hearty thanks and gratitude to each one of you present here and others whose help and cooperation made it possible to hold this conference meaningfully and successfully.

Thank you all.

TECHNICAL SESSION — I
POLLUTION & IMPACT
AN ASSESMENT

STUDIES ON THE AMBIENT AIR QUALITY OF THE MAJOR TOWNS OF MEGHALAYA

B. Nongbri and S.C. Katiyar
Meghalaya Pollution Control Board
Shillong - 793014

ABSTRACT

The studies on ambient air quality of Shillong, Nongstoin, Nongpoh, Tura, Jowai and Baghmara towns of Meghalaya are carried out at prime locations having substantial commercial activities during the year 1997 & 1998. The ambient air sampling is performed by using conventional High Volume sampler and the concentration of important critical pollutants like Suspended Particulate Matter (SPM), Sulphur-Di-Oxide (SO_2) and oxides of Nitrogen (NO_x) are monitored under the Ministry of Environment & Forests, Government of India sponsored study project.

It is observed that the SPM concentration exceeds the National Ambient Air Quality Standards (NAAQS) in case of monitoring stations located at Shillong and Nongpoh. The SO_2 and NO_x concentrations in Dhankheti, Shillong have been found to be ranging from low moderate to high levels. The SPM, SO_2 and NO_x for remaining towns have been found to be within the NAAQS. The results are further discussed by developing pollution indices for the monitored parameters.

INTRODUCTION

The term Air Pollution is defined as the situation in which the ambient atmosphere contains materials in concentrations harmful to man and his environment. The composition of ambient air changes continuously due to the emissions of natural and man made pollutants. The air pollutants emitted from natural processes include vegetation decay, forest fires, volcanic eruptions and bacterial activities. The anthropogenic or man made activities, which mainly contribute towards air pollution problems include, emissions from industrial processes, urbanization, automobiles, solid waste disposal etc. With increasing population, expansion in industry and growth in agriculture the problem of air pollution is also increasing with an alarming pace. Green House Effect and Ozons Layer Depletion are a few well-known examples of air pollution problems.

Meghalaya is situated in the North-Eastern Region of the country. It lies between latitude 25° and 26° N and longitude 90° E and 92° E. The state covers an area of 22,429 square kilometers. The total population of Meghalaya is 17,74,778 as per the 1991 census.

The state is having tremendous potential for agro and mineral based industrial development but the pace of the same has not been as per expectations in past due to certain bottlenecks. With the implementation of new industrial policy and announcement of a special package by the Govt. of India for overall development of the North-eastern region, the state is all geared-up to pick-up the industrial development to boost its economy.

At present, contribution of industrial emissions towards air pollution in the state is not that significant as there are only 1100 industries in operation in the State. Most of these industries are small-scale industries and are non-polluting in nature. Only about 20 number cement and limekilns industries fall under the category of air polluting industries. Mining activities and Jhum cultivation are other such practices, which contribute towards air pollution. As such, the main sources of air pollution in urban areas of the state are vehicular exhaust emissions and unscientific disposal of solid wastes.

The present paper discuss part of results obtained during investigations made for assessment of ambient air quality status of shillong, Nongstoin, Nongpoh, Tura, Jowai and baghmara towns of Meghalaya.

MATERIALS AND METHODS

Selection of sampling Locations

The sampling locations have been carefully identified, so that, the representative scenario regarding air pollution levels in urban centres of the state should be obtained. Accordingly, the sampling locations at Dhankheti, Shillong (East Khasi Hills District), Nongstoin, (West Khasi Hills District), Nongpoh, (Ri-Bhoi District), Tura, (East Garo Hills District), Jowai, (Jaintia Hills District), and Baghmara (South Garo Hills) are selected.

Selection of Air Quality Monitoring Parameters

The most critical pollutants viz. Suspended Particulate Matter (SPM) Sulphur dioxide (SO_2) Oxides of Nitrogen (NO_x) have been selected for monitoring.

Sampling Methods

The ambient air samplings have been performed using conventional high volume air samplers (Envirotech APM 410). The air borne particulates (SPM) are collected by passing air through a high efficiency glass fiber filter paper (GF/A) at a flow rate ranging between 1.0 to 1.3 cubic meters per minute. This process retains the suspended air particulates on the filter paper. The gas samples for SO_2 and NO_x have been collected by passing air through glass impingers containing specific absorbing solutions at a flow rate of 1.0 LPM. The analysis for SPM, SO_2 and NO_x has been performed as per the Methods of Air sampling and Analysis (APHA, 1977).

The sampling has been performed quarterly during day and night time for a period of two years. We are presenting average annual results for discussion in this paper.

RESULTS AND DISCUSSION

National Ambient air quality standards (24 hours average) for Suspended Particulate Matter (SPM), Sulphur-di-Oxide (SO_2) and Oxides of Nitrogen (NO_x) laid down by Central Pollution Control Board, Delhi for industrial and mixed areas, residential and commercial areas and sensitive areas that include hill stations are presented at Table-I. The air quality, with respect to Suspended Particulate Matter (SPM), Sulphur-di-Oxide (SO_2) and Oxides of Nitrogen (NO_x) at the selected sampling locations is presented at Table II, III & IV respectively. The obtained air quality results are compared with those national standards and is discussed in terms of Low (L), Moderate (M), High (H) and critical (C) based on the notified national standards (S) for different pollutants and area classes (AR, CPCB, 1999). The air quality is termed as low (L) if the value of the pollutant is less than half of the notified standard ($<0.5 \times S$), Moderate (M) if it lies between half of S and S ($0.5 \times S - 1.0 \times S$), High (H) if it lies between S and 1.5 times S ($1.0 \times S - 1.5 \times S$) and Critical (C) if more than 1.5 times S ($>1.5 \times S$).

SUSPENDED PARTICULATE MATTER (SPM)

Shillong is a hill station and, as such, falls under the category of sensitive area as per the Central Pollution Control Board's classification (Table-I). The national standard for SPM for sensitive places is $100 \mu\text{g}/\text{m}^3$. The other locations of Nongstoin, Nongpoh, Tura, Jowai and Baghmara fall under the category of residential, commercial & rural area and the national standard for SPM for these areas is $200 \mu\text{g}/\text{m}^3$.

The concentration of SPM in Dhankheti at Shillong has been found to be at Critical levels as the values obtained during 1997 & 1998 (Table-II) are 2.2S (Day, 1997), 1.7S (Night, 1997), 3.7S (Day, 1998) and 2.0S (Night, 1998) and, as such, have always been above the 1.5S concentration.

The concentration of SPM in Nongstoin has been found to be at low levels as the values obtained during 1997 & 1998 (Table - II) are 0.2S (Day, 1997), 0.2S (Night, 1997), 0.5S (Day, 1998) and 0.4S (Night, 1998) and, as such, have always been at and below 0.5S concentration.

The concentration of SPM in Nongpoh has also been found to be at Critical levels as the values obtained during 1997 & 1998 (Table-II) are 1.8S (Day, 1997), 1.7S (Night, 1997), 1.9S (Day, 1998) and 1.8S (Night, 1998) and, as such, have always been above the 1.5S concentration.

The concentration of SPM in Tura ranges from moderate to low as the values obtained during 1997 & 1998 (Table - II) are 0.7S (Day, 1997), 0.2S (Night, 1997), 0.3S (Day, 1998) and 0.3 S (Night, 1998) and, as such, have been in between 0.5S to 1.0S concentration.

The concentration of SPM in Jowai ranges from moderate to low as the values obtained during 1997 & 1998 (Table - II) are 0.6S (Day, 1997), 0.3S (Night, 1997), 0.3S (Day, 1998) and 0.2 S (Night, 1998) and, as such, have been in between 0.5S to 1.0S concentration.

The concentration of SPM in Baghmara has also been found to be at low levels as the values obtained during 1997 & 1998 (Table - II) are 0.2S (Day, 1997), 0.2S (Night, 1997), 0.5S (Day, 1998) and 0.4S (Night, 1998) and, as such, have always at and below 0.5S concentration.

SULPHUR DIOXIDE (SO₂)

The national standard for SO₂ for Shillong is 20 µg/m³ and for other locations of Nongstoin, Nongpoh, Tura, Jowai and Baghmara the national standard is 80 µg/m³ (Table - I).

The concentration of SO₂ in Dhankheti at Shillong has been found to be ranging from low, moderate to high levels as the values obtained during 1997 & 1998 (Table - III) are 1.3 S (Day, 1997), 0.6S (Night, 1997), 0.9S (Day, 1998) and 0.5S (Night, 1998) and as such, have always been in between 0.5S to 1.5S concentration.

The concentration of SO₂ in Nongstoin has been found to be at low levels as no SO₂ has been detected during the sampling periods of 1997 & 1998 (Table - III).

The concentration of SO₂ in Nongpoh has also been found to be at low levels as the values obtained during 1997 & 1998 (Table - III) are 0.1S (Day, 1997), BDL (Night, 1997), 0.2S (Day, 1998) and BDL (Night, 1998) and, as such, have always been within 0.5S concentration.

The concentration of SO₂ in Tura has also been found to be at low levels as the values obtained during 1997 & 1998 (Table III) are 0.1S (Day, 1997), 0.1S (Night, 1997), 0.1S (Day, 1998) and 0.1S (Night, 1998) and, as such, have always been within 0.5S concentration.

The concentration of SO₂ in Baghmara has also been found to be at low levels as no SO₂ has been detected during the sampling periods of 1997 & 1998 (Table - III).

OXIDES OF NITROGEN (NO_x)

The national standard for NO_x for Shillong is 30 µg/m³ and for other locations of Nongstoin, Nongpoh, Tura, Jowai and Baghmara the national standard is 80 µg/m³ (Table - I).

The concentration of NO_x in Dhankheti at Shillong has been found to be ranging from low, moderate to high levels as the values obtained during 1997 & 1998 (Table- IV) are 0.8S (Day, 1997), BDL (Night, 1997), 1.4S (Day, 1998) and 1.0S (Night, 1998) and as such, have always have been in between 0.5S to 1.5S concentration.

The concentration of NO_x in Nongstoin has been found to be at low levels as the values obtained during 1997 & 1998 (Table - IV) are 0.1S (Day, 1997), BDL (Night, 1997), 0.1S (Day, 1998) and 1.0S (Night, 1998) and as such, have always have been in between 0.5S concentration.

The concentration of NO_x in Nongpoh has been found to be ranging from low to moderate levels as the values obtained during 1997 & 1998 (Table - IV) are 0.6S (Day, 1997), 0.3S (Night, 1997), 1.0S (Day, 1997), 0.3S (Night, 1997), 1.0S (Day, 1998) and 0.7S (Night, 1998) as such, have always have been in between 0.5S 1.0S concentration.

The concentration of NO_x in Tura has also been found to be at low levels as the values obtained during 1997 & 1998 (Table - IV) are 0.3S (Day, 1997), 0.3S (Day, 1997), 0.3S (Night, 1997), 0.2S (Day, 1998) and 1.0S (Night, 1998) and as such, have always been within 0.5S concentration.

The concentration of NO_x in Jowai has also been found to be at low levels as the values obtained during 1997 & 1998 (Table - IV) are 0.2S (Day, 1997), 0.1S (Night, 1997), 0.3S (Day, 1998) and 0.1S (Night, 1998) and as such, have always been within 0.5S concentration.

The concentration of NO_x in Baghmara has also been found to be at low levels as no NO_x has been detected during the sampling periods of 1997 & 1998 (Table - IV).

CONCLUSION

The high concentrations of suspended particulate matter (SPM) and low, moderate to high concentration of Sulphur dioxide (SO₂) and Oxides of Nitrogen in Shillong and Nongpoh is a matter of great concern. The reasons for high concentration of these critical pollutants in these towns are basically the increased vehicular population. At present, the vehicular population of Shillong is 4th highest in the country. The national highway 40 passes through these towns, which is the another reason for the high pollution levels. This highway also acts as a conduit point for the other north-eastern states like parts of Assam, Mizoram and Tripura and adds to the already existing problem of vehicular pollution.

At present the pollution levels in the towns of Nongstoin, Tura, Jowai and Baghmara are within the permissible limits of national ambient air quality standards (NAAQS). But there is no place for complacency as a number of vehicles in all the urban centres of the state are rising by leaps and bounds. It is also expected that the pace of industrialization shall now take a big step forward due to economic liberalisation, implementation of new industrial policy and announcement of a special package by the Govt. of India for economic development of the area.

The need of hour is to adopt suitable development programmes for the state and take concrete steps to abate and control the problem of vehicular pollution so that the quality of ambient air may not deteriorate further and the coming generation may inherit a pollution free environment.

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TABLE - I

NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS)

Sl. No.	Category	SPM $\mu\text{g}/\text{m}^3$	SO ₂ $\mu\text{g}/\text{m}^3$	NO _x $\mu\text{g}/\text{m}^3$
1	Industrial & mixed area	500	120	120
2	Residential, Commercial & Rural	200	80	80
3	Sensitive	100	30	30

TABLE - II

SUSPENDED PARTICULATE MATTER (SPM) CONCENTRATION AT MAJOR TOWNS OF THE STATE ($\mu\text{g}/\text{m}^3$)

Sl. No.	Sampling Location	1997		1998	
		Day	Night	Day	Night
		7:00 am 7:00 pm	7:00 pm 7:00 am	7:00 am 7:00 pm	7:00 pm 7:00 am
1	Dhankheti	221.4	165.6	370.3	199.3
2	Nongstoin	43.4	41.3	91.7	75.8
3	Nongpoh	362.3	347.2	389.0	364.1
4	Tura	138.0	30.8	64.8	54.8
5	Jowai	115.0	68	52.3	36.8
6	Baghmara	29.6	24.3	38.2	29.2

TABLE - III

SULPHUR DIOXIDE (SO₂) CONCENTRATION AT MAJOR TOWNS OF THE STATE ($\mu\text{g}/\text{m}^3$)

Sl. No.	Sampling Location	1997		1998	
		Day 7:00 am 7:00 pm	Night 7:00 pm 7:00 am	Day 7:00 am 7:00 pm	Night 7:00 pm 7:00 am
1	Dhankheti, Shillong	39.2	18.4	28.2	15.3
2	Nongstoin	BDL	BDL	BDL	BDL
3	Nongpoh	10.5	BDL	15.2	BDL
4	Tura	7.2	6.0	5.9	5.1
5	Jowai	8.7	4.0	6.4	3.1
6	Baghmara	BDL	BDL	BDL	BDL

TABLE - IV

OXIDES OF NITROGEN (NO_x) CONCENTRATION AT MAJOR TOWNS OF THE STATE ($\mu\text{g}/\text{m}^3$)

Sl. No.	Sampling Location	1997		1998	
		Day 7:00 am 7:00 pm	Night 7:00 pm 7:00 am	Day 7:00 am 7:00 pm	Night 7:00 pm 7:00 am
1	Dhankheti, Shillong	23.6	BDL	42.0	30.0
2	Nongstoin	4.3	2.2	8.0	6.1
3	Nongpoh	44.5	22.5	77.5	57.5
4	Tura	22.8	21.5	12.7	10.4
5	Jowai	12.5	6.2	24.0	4.8
6	Baghmara	BDL	BDL	BDL	BDL

ABIOTIC ENVIRONMENT OF A LENTIC ECOSYSTEM OF CHERRAPUNJI (EAST KHASI HILLS DISTRICT), MEGHALAYA

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ABSTRACT

Limnological investigations undertaken (from May, 1993 - April 1995) in a freshwater pond of Cherrapunji indicated its subtropical character (Water temperature: $18.5 \pm 2.3^\circ \text{C}$), marginally acidic to alkaline nature (pH: $6.9 - 8.3$; 7.65 ± 0.43), low ionic concentration (Specific conductivity: $63.3 \pm 24.7 \mu\text{S/m}$) and distinctly soft-waters (alkalinity: $26.7 \pm 9.2 \text{ mg/l}$; hardness: $32.0 \pm 9.0 \text{ mg/l}$; $\text{Ca} > \text{Na} > \text{Mg} > \text{K}$) with bicarbonate alkalinity. This biotope registered low transparency ($0.68 \pm 0.20 \text{ m}$), moderate dissolved oxygen ($6.6 \pm 1.4 \text{ mg/l}$), low free Carbon dioxide ($7.0 \pm 2.0 \text{ mg/l}$), low Chloride content ($6.6 \pm 1.2 \text{ mg/l}$) and low concentrations of nutrients (Phosphate: $0.15 \pm 0.07 \text{ mg/l}$; Nitrate: $0.09 \pm 0.02 \text{ mg/l}$; Silicate: $0.57:1.028 \text{ mg/l}$ and Sulphate: $1.28 \pm 0.65 \text{ mg/l}$). Rainfall ($1091.9 \pm 1209.4 \text{ mm}$) exerted significant impact on majority of abiotic factors. Water temperature, pH, specific conductivity, dissolved oxygen, alkalinity and hardness are other important parameters.

INTRODUCTION

Chenapunji, the wettest place of the world, indicates serious environmental degradation due to leached nature of soils and rocks caused by excessive rainfall, deforestation, unscientific land-use patterns and mining of limestone and coal etc. The stated aspects are likely to influence structure and function of water bodies in the area but so far no attempt has been made to monitor water quality of these ecosystems or to document such an impact.

The present study, pioneering limnological investigation in the Cherra plateau, deals with temporal variations in physico-chemical parameters of a lentic biotope with an objective to assess its water quality and to evaluate ecological correlations between various parameters.

MATERIAL AND METHODS

The observations were undertaken (May, 1993 - February, 1995) in Mawmluh reservoir - a rainwater-fed pond (area: 3600 m^2 , max. depth: 1.5 m) located at Cherrapunji (Lat.: $25^\circ 17' \text{N}$; long.: $91^\circ 47' \text{E}$) in East Khasi Hills District, Meghalaya. Water samples were collected at regular monthly intervals. Air and water temperatures were recorded with a thermal probe. Transparency was recorded with a Secchi disc. pH and specific conductivity were noted with pH and conductivity meters respectively. Dissolved oxygen was estimated by modified Winkler's method and various other chemical parameters were analysed following APHA (1985). Ecological relationships were established by computing correlation coefficients (r) between the recorded parameters.

RESULTS AND DISCUSSION

Temporal variations in abiotic factors of Mawmluh reservoir are depicted in Table: I, ecological correlations between these parameters are indicated in Table: II and their salient features are discussed hereunder:

Rainfall ($1091.9 \pm 1209.4 \text{ mm}$) exhibited notable annual variations and the amount of precipitation is distinctly influenced by the Southwest monsoons. Occurrence of higher rainfall during warmer months resulted in its direct relationship with water temperature ($r = 0.599$). It, however, registered inverse correlations with transparency, specific conductivity, alkalinity, hardness, Calcium and Magnesium which, in turn, corresponded with the findings of Sharma and Hussain (1999). Further, rainfall indicated negative correlations with pH, dissolved oxygen, Nitrate, Phosphate, Sulphate and Silicate. Hence, it exercised an important influence on a majority of parameters (thirteen factors) in this study as against its limited role noticed by Sharma (1995).

Water temperature ($18.5 \pm 2.3^\circ \text{C}$) affirmed sub-tropical character of the studied pond, the documented range agreed with that reported by Sharma (1995) and is significantly influenced ($r = 0.956$) by air temperature

(19.7 ± 2.50 C). Water temperature appeared to be another notable attribute presently because it registered inverse correlations with thirteen abiotic factors namely transparency, pH, specific conductivity, dissolved oxygen, alkalinity, hardness, Calcium, Magnesium, Sodium, Chloride, Nitrate, Sulphate and Silicate and thus presented a striking contrast to its limited role recorded by Sharma (*loc cit.*).

pH (6.9 - 8.3, 7.65 ± 0.43) depicted marginally acidic to alkaline nature of the sampled pond which is in contrast to acidic character reported by Sharma (1995). The observed range is distinctly wider than the reports by Das *et al.* (1996) and Sharma and Hussain (1999). Lower hydrogen-ion concentration noticed particularly during monsoon season and higher values during rest of the study period may be attributed to influx of carbonic acid with rainwater in this rain-fed pond and are supported by an inverse correlation of pH with rainfall ($r = -0.599$); the latter aspect also concurred with the observations by Sharma and Hussain (*loc cit.*). On the other hand, pH registered positive relationships with dissolved oxygen, alkalinity, hardness, Calcium, Magnesium, Chloride, Nitrate, Phosphate, Sulphate and Silicate in the present study.

The water of Mawmluh reservoir is characterized by low transparency (0.68 ± 0.20 m) which, in tuM is adversely influenced by influx of abiosestonic material during the rainy season. Further, this generalization is supported by an inverse relationship between transparency and rainfall.

Specific conductivity (30.5 - 112.0, 63.3 ± 24.7 μ S/cm) highlighted 'soft-water' character with low electrolyte concentration; such an aspect can be attributed to weathered and leached nature of surrounding rocks and soils because of excessive rainfall (Rai and Hill, 1978; Payne, 1986) as well as the lowered buffering capacity of the demineralized waters (Steinitz-Kannan *et al.* 1983). Based on the stated feature, this biotope can be assigned to Class 1 category following Talling and Talling (1965). The present observations registered relatively wider temporal changes in conductivity but higher values are noticed particularly during the latter part of the study period. The recorded range, however, is higher in contrast to the reports by Sharma (1995) and Das *et al.* (1996). Ionic concentration is inversely influenced by rainfall in this study while it registered significant direct correlations with dissolved oxygen, alkalinity, hardness, Calcium, Magnesium, Chloride, Nitrate, Sulphate and Silicate.

Dissolved oxygen fluctuated between 4.4-8.8 mg/l, broadly corresponded with the reports of Das *et al.* (1996) and Sharma and Hussain (1999), registered inverse relationships with water temperature ($r = -0.785$) and free carbon dioxide ($r = -0.612$) while it indicated direct correlations with alkalinity, hardness, Calcium, Magnesium, Nitrate, Phosphate, Sulphate and Silicate. Percentage saturation of oxygen in the pond water ranged between 48.6 - 90.1 % and higher saturation values are evident during periods of low water temperature. Free carbon dioxide occurred throughout the study period, did not register definite pattern and its range (2.0-10.4 mg/l) broadly corresponded with the works of Sharma (1995) and Sharma and Hussain (*loc cit.*).

Alkalinity (26.7 ± 9.2 mg/l), exclusively represented by bicarbonate alkalinity, imparted distinctly 'soft-character' to the studied pond (*vide* Moyle, 1946; Phillipose, 1960). The recorded range, however, broadly coincided with that observed by Das *et al.* (1996) but is distinctly higher than the report by Sharma (1995). Alkalinity is adversely influenced by rainfall in the present study and this feature is well supported by an inverse relationship between the two factors. On the other hand, it registered significant positive correlations with specific conductivity, hardness, Calcium and Magnesium in concurrence with the results of Sharma (1995) and Sharma and Hussain (1999). Besides, it recorded direct relationships with Chloride, Nitrate, Sulphate and Silicate.

Hardness (32.0 ± 9.0 mg/l), yet another interesting feature, reaffirmed 'soft-water' nature of Mawmluh reservoir the recorded range, however, is notably higher than the report by Sharma (1995). The pond water registered poor Calcium content (*vide* Ohle, 1934). Calcium > Sodium > Magnesium > Potassium contributed to total hardness and the recorded order of dominance of alkaline earth metals corresponded with the pattern noticed by Yadav *et al.* (1987), Sinha *et al.* (1994) and Sharma and Hussain (1999). Further, hardness is inversely influenced by the rainfall while it registered significant positive correlations with conductivity, alkalinity, Calcium, Magnesium, Chloride, Sulphate, Nitrate and Silicate.

Low chloride concentration noticed in Mawmluh reservoir (6.5 ± 1.2 mg/l) is well within the limit noticed in natural freshwaters (Wetzel, 1983) and, therefore, depicted lack of organic pollution of domestic origin. The recorded range also corresponded with the report by Sharma (1995). Temporal variations observed presently affirmed conservative nature of this cation which exerted an inverse relationship with water temperature but denoted positive correlations with alkalinity, hardness, Calcium and Magnesium. On the other hand, this study

reflected very low Sulphate content (1.28 ± 0.7 mg/l) which broadly coincided with the results of Sharma (*loc cit.*) but is lower than the report by Sharma and Hussain (1999). It, however, registered relatively higher values during the latter half of the study period. Sulphate registered a negative correlation with water temperature while it indicated direct relationships with pH, specific conductivity, dissolved oxygen, alkalinity, hardness, Calcium, Magnesium, Nitrate and Phosphate.

Among the micro-nutrients, Phosphate ranged between 0.15 ± 0.07 mg/l and did not depict any definite annual pattern except for lower concentration during the rainy season which is attributed to dilution caused by rainwater. The stated mean value corresponded with that of Sharma (1995) but remained higher than the report by Das *et al.* (1996). It depicted an inverse relationship with free carbon dioxide and a direct relationship with Nitrate. Nitrate content (0.09 ± 0.02 mg/l) is apparently higher than the results of Sharma (1995), did not register any definite annual pattern, indicated inverse relationships with rainfall and water temperature, and exhibited direct correlations with dissolved oxygen, alkalinity, hardness, Calcium, Magnesium, Chloride and Silicate. In addition, Silicate exhibited low concentration but relatively wide annual range ($0.18 - 1.25$, 0.57 ± 0.28 mg/l) and recorded no definite temporal trend. Its comparison with any other water body from Meghalaya is not feasible because of lack of such published data while the observed values are lower than the findings of Sharma and Hussain (1999). It, however, denoted inverse correlations with rainfall and water temperature and direct correlations with specific conductivity, dissolved oxygen, alkalinity, hardness, Calcium and Magnesium.

To sum up, Mawmluh reservoir depicted a number of salient features of water quality namely low electrolyte concentration, distinctly 'soft-water' character marked by lower alkalinity (exclusively attributed to bicarbonate ions) and hardness and very poor Calcium content as well as marginally acidic to alkaline nature of water. This pond reflected low transparency and lower concentrations of Sulphate, Phosphate, Nitrate and Silicate. Such interesting and notable features are attributed to environmental degradation ushered in by excessive rainfall in the region. The present observations highlighted limnological importance of rainfall, water temperature, specific conductivity in particular and also depicted significant correlations between number of abiotic attributes.

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TABLE - I

ABIOTIC FACTORS OF POND (CHERRAPUNJI)

Abiotic factors	May, 93 - April, 94 1st Year	May, 94 - April, 95 2nd Year	May, 93 - April, 95 Study Period
Rainfall (mm)	8.6 - 3412.0 (1350.3 ± 1358.0)	8.4 - 3444.3 (833.4 ± 1033.6)	8.4 - 3443.3 (1091.9 ± 1209.4)
Air temp. (°C)	14.4 - 21.3 (19.5 ± 2.1)	14.8 - 22.9 (19.9 ± 3.1)	14.4 - 22.9 (19.7 ± 2.5)
Water Temp. (°C)	13.9 - 20.6 (18.4 ± 2.1)	14.1 - 21.8 (18.6 ± 2.6)	13.9 - 21.8 (18.5 ± 2.3)
Transparency (m)	0.40 - 0.95 (0.68 ± 0.16)	0.30 - 1.0 (0.69 ± 0.24)	0.30 - 1.00 (0.68 ± 0.20)
pH	6.9-8.3 (7.68 ± 0.43)	6.9-8.2 (7.61 ± 0.46)	6.9-8.3 (7.65 ± 0.43)
Sp. Cond. (μS/cm)	30.5-103.5 (60.5 ± 26.8)	39.0 - 112.0 (66.0 ± 23.2)	30.5-112.0 (63.3 ± 24.7)
D. Oxygen (mg/l)	4.4 - 8.8 (6.5 ± 1.2)	4.6 - 8.8 (6.7 ± 1.5)	4.4 - 8.8 (6.6 ± 1.4)
Free CO ₂ (mg/l)	2.0 - 8.6 (6.5 ± 2.2)	3.8 - 10.4 (7.6 ± 1.7)	2.0 - 10.4 (7.0 ± 2.0)
Alkalinity (mg/l)	12.5 - 40.1 (25.8 ± 8.8)	15.8 - 43.5 (27.7 ± 10.0)	12.5 - 43.5 (26.7 ± 9.2)
Hardness (mg/l)	21.5 - 43.1 (28.3 ± 10.6)	20.8 - 50.8 (33.5 ± 10.7)	20.8 - 50.8 (32.0 ± 9.0)
Calcium (mg/l)	3.2 - 12.7 (7.1 ± 2.4)	5.2 - 12.5 (8.1 ± 2.6)	3.7 - 12.5 (7.6 ± 2.5)
Magnesium (mg/l)	3.2 - 6.2 (4.9 ± 0.95)	2.9 - 7.0 (5.2 ± 1.2)	2.9 - 7.0 (5.0 ± 1.1)
Sodium (mg/l)	3.0 - 10.0 (5.7 ± 1.9)	2.0 - 11.0 (6.2 ± 3.0)	2.0 - 11.0 (5.9 ± 2.5)
Potassium (mg/l)	1.5 - 7.0 (3.5 ± 1.4)	1.5 - 9.0 (3.7 ± 2.0)	1.5 - 9.0 (3.6 ± 1.7)
Chloride (mg/l)	5.5 - 7.8 (6.7 ± 1.0)	3.8 - 8.3 (6.3 ± 1.4)	3.8 - 8.3 (6.5 ± 1.2)
Sulphate (mg/l)	0.35 - 2.35 (1.3 ± 0.7)	0.46 - 2.25 (1.3 ± 0.6)	0.35 - 2.35 (1.28 ± 0.7)
Phosphate (mg/l)	0.05 - 0.33 (0.14 ± 0.08)	0.07 - 0.31 (0.17 ± 0.06)	0.05 - 0.33 (0.15 ± 0.07)
Nitrate (mg/l)	0.04 - 0.13 (0.09 ± 0.03)	0.04 - 0.14 (0.09 ± 0.02)	0.04 - 0.14 (0.09 ± 0.02)
Silicate (mg/l)	0.22 - 1.25 (0.53 ± 0.32)	0.18 - 1.03 (0.62 ± 0.24)	0.18 - 1.25 (0.57 ± 0.28)

TABLE – II

SIGNIFICANT LIMNOLOGICAL CORRELATIONS

Parametres	Parametres	r-Value
Rainfall	Transparency	- 0.479 ***
	Water temperature	+ 0.599 **
	pH	- 0.599 **
	Specific Conductivity	- 0.465 ***
	Dissolved oxygen	- 0.769 *
	Alkalinity	- 0.576 **
	Hardness	- 0.594 **
	Calcium	- 0.467 ***
	Magnesium	- 0.847 *
	Nitrate	- 0.744 *
	Phosphate	- 0.765 *
	Sulphate	- 0.836 *
	Silicate	- 0.708 *
Water Temperature	Transparency	- 0.614 **
	pH	- 0.733 *
	Specific Conductivity	- 0.692 *
	Dissolved oxygen	- 0.785 *
	Alkalinity	- 0.625 **
	Hardness	- 0.776 *
	Calcium	- 0.703 *
	Magnesium	- 0.681 *
	Sodium	- 0.567 **
	Chloride	- 0.560 **
	Nitrate	- 0.584 *
	Sulphate	- 0.495 *
	Silicate	- 0.648 *
pH	Dissolved oxygen	+ 0.710 *
	Alkalinity	+ 0.629 **
	Hardness	+ 0.703 *
	Calcium	+ 0.577 **
	Magnesium	+ 0.671 *
	Chloride	+ 0.674 *
	Nitrate	+ 0.708 *
	Phosphate	+ 0.469 ***
	Sulphate	+ 0.598 **
	Silicate	+ 0.604 **

Parametres	Parametres	r-Value
Specific Conductivity	Dissolved oxygen	+ 0.567 **
	Alkalinity	+ 0.888 *
	Hardness	+ 0.889 *
	Calcium	+ 0.882 *
	Magnesium	+ 0.563 **
	Chloride	+ 0.654 *
	Nitrate	+ 0.700 *
	Sulphate	+ 0.628 **
	Silicate	+ 0.604 **
Dissolved Oxygen	Free Carbon dioxide	- 0.612 **
	Alkalinity	+ 0.654 *
	Hardness	+ 0.767 *
	Calcium	+ 0.617 **
	Magnesium	+ 0.784 *
	Nitrate	+ 0.753 *
	Phosphate	+ 0.633 *
	Sulphate	+ 0.803 *
	Silicate	+ 0.596 **
Alkalinity	Hardness	+ 0.913 *
	Calcium	+ 0.857 *
	Magnesium	+ 0.679 *
	Chloride	+ 0.732 *
	Nitrate	+ 0.708 *
	Silicate	+ 0.657 *
	Sulphate	+ 0.693 *
Hardness	Calcium	+ 0.904 *
	Magnesium	+ 0.732 *
	Chloride	+ 0.700 *
	Sulphate	+ 0.600 **
	Nitrate	+ 0.735 *
	Silicate	+ 0.691 *
Silicate	Nitrate	+ 0.597 **
	Sulphate	+ 0.611 *
Nitrate	Phosphate	+ 0.647 *
	Sulphate	+ 0.805 *
Phosphate	Sulphate	+ 0.681 *

* $P > 0.01 = 0.823$

** $P > 0.01 = 0.708$

*** $P > 0.05 = 0.576$

MAN'S USES OF SCIENCE AND TECHNOLOGY — DOES IT UPGRADE OR DOWNGRADE HUMAN ENVIRONMENT

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ABSTRACT

It is the very people who get used to the products of Science & Technology, who speak very vehemently on the platforms against industrialisation to 'protect' environment. Most often it is the convenience of the "automation" gadgets which helps people to continue to be ignorant of the very values the Science Education stands for and these gadgets provide an alternative as material possessions for preserving their superstitious habits and ways of living in the name of traditions. Hence the opponents or opponents of Environment should acquire the right attitude towards acquiring "machines" for the daily domestic use before they could speak out anything about the Science & Technology causing ill effects while rendering the benefits to the "masses" - to the many people whose living standard has to be cared for by turning out a huge productivity.

INTRODUCTION

The focus in this paper is on Environmental Education in Schools and Colleges, and for the public at large.

In the United States Public Law 91-516 the Environmental Education Act, States environmental education as

"The educational process dealing with man's relationship with his natural and man-made surroundings..... and urban and rural planning to the total human environment."

When man finds a need to have a man-made surrounding and cannot be content with the mere natural surrounding man tends to use science and technology.

According to deterministic perspectives of man-environment relationships, man is subordinate to natural environment as all aspects of human life viz. physical (health and comfort), social, economic, political, ethical and aesthetic etc., not only depend but are dominantly controlled by physical and environment, (*chapters 1 to 3, pp 26, Environmental Geography, Savindra Singh, Prayag Pushtak Bhawan, Allahabad (1995).*

As the man-made surrounding is raised and as it comes up, if it alters the natural surrounding, (by which it is implied that, to make and maintain a surrounding for man. A destructive strategy, even if it is in the remotest sense, is required to alter the prevailing natural surrounding) at some stage or the other it is bound to cause a polarisation and disharmony in the public. Since human actions are basically discretionary and insisting on restraints will be countered vociferously by the inconveniences caused hence.

The basic thesis of the growth (affluence) school is that because of economic growth is required for political, social and economic stability the 'quality of environment' normally assumes lower priority in formulating learning proposals and long term planning because the deterioration of the environment is generally protracted and socially less oblique than a deterioration in economy (*chapters 1 to 3, pp28, Environmental geography, Savindra Singh*)

It is not easy to reconcile with a destructive strategy even for making and maintaining (protecting) conveniences for human living.

What essentially it means if man-made surroundings happened to vitiate natural surroundings in the long-term, then how to compromise is all environmental education about.

This compromise required to be appreciated in the same sense as the "See-Saw" games children play. To start with the plank has to be held parallel to the ground and both the riders of both ends should move into place and position in such a way as one rider kicks to be lifted upwards the other rider reaches downward.

Even though work is done in moving up and down the energy used to work is an useful exercise and not a dissipatively polluting loss. The long-term and short-term considerations are at opposite ends moving in opposite direction.

Alternative efforts to seek non-conventional energy resources is only to reduce this opposing trends in situations while considering long-term and short-term effects of human activity.

The real quest is can we alter the present surroundings at present for better conveniences now in such a way it only make the environment better and better even in the long-run what is wasteful by-product unavoidable must be used and recycled with out further new wasteful by-products.

DISCUSSION

Most of the words used in the genetics engineering and biotechnology are words used in linguistics and communications, the latter is made faster and faster with electronic media. These media provide packages which have new and elitist words as well as common words from languages with only technical connotations. By popularising such communications media, the words used have only specialist meanings which completely override the common, usual & popular meanings prevailing earlier. It may happen that the present generation are taught only the recent specialist meanings for even common words without even referring to the colloquial meanings which might prevail in the under developed surrounding where they continue to live and hail from. The words used being the same, the grasping of these in the high-tech situation being altered and much faster, it results in discordant human actions which is an abstract form of vitiating human environment like the "NOISE POLLUTION". These can cause tensions and communication gaps for which the reasons would always remain elusive. Hence caution must be exercised while living by the ways of electronic equipments making up the media. People should not be carried away by the fact that they do not produce visible "smoke" or stinking "effluents" as the pollution causing industries! On the contrary such artificial altering of contextual meanings of common language words because of the high-tech electronic media can become lucrative alternative to cover-up the superstitions habits harmful for preserving what is good in traditions and perpetuate what is harmful by advertisicy it as has been changed into harmless. This is the discriminatory effect of thrusting end-result to developing countries and the environmental issues impedingly get compounded with development strategy. In the essence one should not be unduly worrying about chemical pollutions only and succumb for any thing and everything only not to have chemical pollution.

Hence it may be wise to consider Human nature and Human environment as different bounded phase in the totality of Nature & Environment while managing the environment and drawing up schemes for effect-monitoring and system-monitoring for Environmental Management.

All these are born out in the following definitions of Environmental Education.

"Environmental Education is the process of recognising values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate inter-relatedness among man, his culture and his biophysical surroundings. Environmental Education also entails practice in decision making and self-formulating of a code of behaviours about issues concerning environmental quality."

(NEVADA Conference of the International Union for Conservation of Nature and National Resources (1970)

"Environmental Education involves teaching about value judgements and the ability to think clearly about complex problems - about the environment which are as political, economic and philosophical as they are technical."

(Proceeding of the Organisation of American States Conference on Education and Environment in the Americas 1971.)

One of themes at the United Nations Conference on human environment in Stockholm is : Planning and Management of human settlements for environmental improvement. And it is not without relevance to mention a guiding principle as the Focus on "Current and potential environmental situations, while taking account the historical perspective" - which essentially means we must learn from history and further by extrapolation barn about the possible longterm disadvantages of the present actions.

The subjective evaluation of the Phemenenal Environment (as nature is) which surrounds the human

subject, revealing his or her consciousness of it and his or her intentionality towards the objects which constitute it, is known as Behavioural Environment. (in Human GEOGRAPHY, by Majd Hussain, page 35, Rawat Publications, 1994, New Delhi)

CONCLUSION

To conclude, the following may be quoted from INDIA - 2020, A Vision for the New Millennium (Book by A.P.J. Abdul Kalam with Y.S. Rajan page-3, Viking 1998) :

"It does not make sense to achieve a 'developed' status without a major and continuing upliftment of all Indians who exists today and of the many more millions who would be added in years to come. They should all have a secure and enjoyable "present" and also be in a position to look forward to a better 'future'. Such a developed India is what we are looking for.

The above conclusion would warrant the necessary for the realisation that when the short-term and long-term considerations are at logger-heads, the conflict arise while acting at present since the mighty posterity might present an obstacle. When one has to stop the "See-Saw" game, how and who would be on the ground first to let the other reach the ground level. Off from the "See-Saw" we tend to vascillase-not quite the soothing swinging movement.

We will have the man-made mighty automation machines, doing task which are humanely not possible on the one side and on the other, the naturally abundant flora and fauna not providing any human environment for human settlements. When man-made machine do tasks which are humanly not possible is it Sub-human or Super-human ?

When we attribute Super human qualities to it have credit for the man who made it, in the long run, it leads to a monotonous regimented way of living and the opponents of such prospect would attribute sanctity to the benevolence of nature and despise automation and resist mechanisation. Those who want to use Science and Technology would tend towards the other extreme to provide a balancing counter and might event send to decimate what is "inhuman" naturally. This is all only human conflicts and only man-made and to cover this all about the environmental pollution and degradations would be pointed out as the reason. The more men try to be reasoning out the more communication gap escalates because of those very instruments used. One may prepositiously favour "Wild Animal Protection Acts" while not really caring for and bring up the meek and docile! Even if it is a question of foregoing one's own comfort human must make sure that this does not become inconvenient to others !

*"The reasonable man adapts
himself to the world, whereas
the unreasonable man tries to
adapt the world to himself
Therefore all progress depends
on the unreasonable man"*

George Bernard Shaw

TEMPORAL AND HORIZONTAL VARIATIONS IN ABIOTIC PARAMETERS OF UMIAM RESERVOIR, MEGHALAYA

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ABSTRACT

This study deals with temporal changes (November, 1993 - October, 1995) in abiotic parameters of Umiām reservoir at four sampling stations. Air ($14.5 - 28.0^{\circ}\text{C}$) and water ($11.0 - 27.5^{\circ}\text{C}$) temperatures depicted its subtropical nature. This reservoir is characterized by soft-alkaline waters (pH: 7.0-8.5; alkalinity: 8.0-32.0 mg/l; hardness: 20.0-35.0 mg/l) with low mean concentrations of ionizable salts (Specific conductivity: 53.7 - 62.2 $\mu\text{S/cm}$), Chloride (11.4 - 15.6 mg/l) and Sulphate (14.8 - 16.6 mg/l). Different sampling stations registered moderately higher mean dissolved oxygen (8.3 - 8.9 mg/l), lower free Carbon dioxide (2.4 - 3.6 mg/l), lower mean nutrient concentrations (Total phosphorus: 22.6 - 26.4 $\mu\text{g/l}$; Phosphate: 11.2 - 13.3 $\mu\text{g/l}$; Nitrate: 0.23 - 0.33 mg/l) and relatively higher Silicate content (43.9 - 61.7 mg/l). Comments are made on the documented temporal and horizontal variations and on ecological relationships between various parameters.

INTRODUCTION

Reservoirs comprise important inland aquatic resources of India because of their role as multi-purpose water storage basins and valuable biogenic production potential (Sugunan, 1997). Investigations on abiotic environment of these biotopes are essential to evaluate their trophic status and aquatic productivity as well as to formulate strategies for effective scientific management for various purposes. Even though limnological studies in India began in early part of this century and culminated in scattered literature on reservoir limnology from its different parts, the related information from North-Eastern region is so far confined to works in tropical Gumti reservoir, Tripura (Bhattacharya and Saha, 1986, 1990) and subtropical Malse reservoir, Meghalaya (Sharma, 1995).

The present study assumes special significance in view of the stated lacuna and deals with temporal changes in abiotic factors in a subtropical reservoir of Meghalaya with special reference to its water quality, horizontal variations at various sampling stations and relationships between different abiotic parameters.

MATERIAL AND METHODS

Water samples were collected at regular monthly intervals (November, 1993 - October, 1995) from four sampling stations (I - IV) of Umiām reservoir (Lat.: $25^{\circ} 37' \text{N}$, Long.: $91^{\circ} 51' \text{E}$; maximum water spread area: 356 ha; maximum depth: 50 m) located at a distance of about 20 km from Shillong city, the capital of Meghalaya State. This reservoir was commissioned in 1960 as stage of the Umtru-Umiām hydal power project. Temporal variations in abiotic factors were recorded as per the procedure detailed by Sharma and Wanswett (1999). Ecological correlations were analysed by computing simple correlation coefficients (r) between the observed parameters.

RESULTS AND DISCUSSION

Temporal variations in abiotic factors at different sampling stations of Umiām reservoir are indicated in Tables : I - IV, their mean values are compared in Table: V and significant limnological relationships are depicted in Table: VI. The salient features of these observations are discussed hereunder:

Rainfall in the study area ranged between 0-520 (222 $\pm$ 207 mm), indicated marginal annual variations and is mainly influenced by the Southwest monsoons. Total precipitation is reasonably lower than that reported from Cherra plateau (Sharma and Wanswett, 1999) but nearly corresponded with the range recorded by Sharma (1995). An adverse impact of rainfall on transparency in Umiām reservoir is in concurrence with the results of Sharma and Wanswett (*loc cit.*) while its overall general impact on other abiotic parameters in this study is far

less than the observations by the stated authors. It, however, registered significant direct correlations with water temperature and alkalinity and also with pH (during 1st year only).

Water temperature (11.0-27.5° C) exhibited sub-tropical nature of Umiyam reservoir, concurred with the reports by Sharma (1995) and Sharma and Wanswett (1999) and is strongly influenced ($r = 0.989$) by atmospheric temperature (14.5-28.0° C). Surface water temperature exhibited little horizontal variations (mean: 20.5-21.1° C) at different sampling stations. It recorded positive relationships with pH, specific conductivity, alkalinity, hardness, dissolved oxygen (during 2nd year only) and an inverse correlation with transparency.

Transparency ranged between 0.9 - 1.74 m, registered moderate mean value of 1.34 ± 0.3 m which is nearly half than the report in Malse reservoir (Sharma, 1995). It denoted significant inverse correlations with pH, alkalinity, hardness and Magnesium and indicated direct relationship with free Carbon dioxide but is not adversely influenced by rainfall. Of these, the last feature concurred with the remarks by Sharma (*loc cit.*)

Hydrogen-ion concentration (7.0 - 8.5) reflected circum-neutral to alkaline nature of Umiyam reservoir. It is, however, in distinct contrast to typical acidic waters of Malse reservoir (Sharma, 1995) while it corresponded with the results of Sharma and Wanswett (1999). Further, mean pH (7.51 - 7.80) did not exhibit notable horizontal variations at different stations and its maximum value is noticed at Station II. Agreeing with the remarks of Sharma and Hussain (1999), pH recorded direct correlation with alkalinity but depicted an inverse relationship with free Carbon dioxide.

Specific conductivity, an interesting abiotic parameter, recorded relatively wide range (37.0-110.5 $\mu\text{S}/\text{cm}$ during this study; its mean values ranged between 53.7-62.2 $\mu\text{S}/\text{cm}$ and, hence, reflected soft-water nature of Umiyam reservoir. Mean conductivity is distinctly higher in contrast to the report in Malse reservoir (Sharma, 1995), higher than that in Tasek lake (Das *et al.* 1996) but broadly coincided with the report by Sharma and Wanswett (1999). Characteristic lower content of ionizable salts in the studied biotope is attributed to leached and weathered nature of soils and rocks in the region due to heavy rainfall (Rai and Hill, 1978, Payne, 1986) and the lowered buffering capacity of the demineralized waters (Steinitz-Kannan *et al.* 1983). This reservoir, therefore, can be assigned to Class I category following Tailing and Tailing (1965). Specific conductivity indicated highest mean value at Station I (62.2 ± 17.2 $\mu\text{S}/\text{cm}$) and, thereafter, showed a declining trend from Stations II-IV. Its significant direct correlation with hardness coincided with the report of Sharma and Wanswett (1999). Of the other abiotic factors, conductivity registered an inverse relationship with total phosphorus in the present study.

Dissolved oxygen ranged between 6.5 - 10.8 mg/l, its mean concentrations (8.3 - 8.9 mg/l) did not exhibit notable variations at different sampling stations and maximum concentration is observed at Station I. The recorded values, however, reflected well oxygenated waters of Umiyam reservoir, coincided with the results in Malse reservoir (Sharma, 1995) and are slightly higher than those recorded by Das *et al.* (1996) and Sharma and Wanswett (1999). On the other hand, free Carbon dioxide is not detected at all sampling stations throughout the present observations. Such a feature is in deviation of its report on all occasions (Sharma, 1995; Sharma and Hussain, 1999 and Sharma and Wanswett, 1999). Further, lower mean free CO_2 values observed in Umiyam reservoir (2.4-3.6 mg/l) agreed with the reports by the mentioned workers while its mean concentration is marginally higher at Stations I and II.

Alkalinity, a salient feature of water quality (Payne, 1986), fluctuated between 8.0-32.0 mg/l; its mean value (20.8 - 21.8 mg/l) did not reflect notable horizontal differences at various sampling stations. The documented range is distinctly higher than that reported by Sharma (1995) but broadly agreed with the results of Das *et al.* (1996) and Sharma and Wanswett (1999). Total alkalinity in this study is exclusively attributed to bicarbonate ions and assigned typical 'soft-water' character to Umiyam reservoir (*vide* Moyle, 1946; Phillipose, 1960; Wetzel, 1983). Its significant direct correlation with hardness corresponded with the remarks by Sharma and Wanswett (*loc cit.*) while positive relationship with rainfall is in distinct contrast to adverse impact examined by the mentioned authors. Besides, this parameter registered significant direct correlations with water temperature and pH and an inverse correlation with transparency.

Hardness (20.0-35.0 mg/l), another vital parameter of water quality, affirmed distinct 'soft-water' character of Umiyam reservoir and showed marginal horizontal variations (mean hardness: 25.4-26.5 mg/l) at different sampling stations. The hardness of water is, however, distinctly higher than that of Malse reservoir (Sharma, 1995) but broadly agreed with the report by Sharma and Wanswett (1999). It registered significant direct

correlation with water temperature and an inverse relationship with transparency. Further, its direct relationship with alkalinity indicated close interdependence of the two parameters (Payne, 1986). Calcium > Magnesium contributed to hardness in this study and the present observations indicated general poor Calcium content (*vide* Ohle, 1934).

The present observations depicted low Chloride content (7.0-19.0 mg/l) which, in turn, broadly corresponded with its range in natural freshwaters (Wetzel, 1983) and thus showed lack of direct impact of organic pollution. Further, this cation indicated nearly identical mean values (11.4 - 11.7 mg/l) at all the study sites except for its maximum mean concentration at Station II (15.6 $\pm$ 6.5 mg/l). The recorded range of Chloride affirmed its conservative nature (*vide* Wetzel, 1983) and broadly concurred with the general findings of Sharma (1995), Sharma and Hussain (1999) and Sharma and Wanswett (1999) from N. E. region

Sulphate registered relatively wider range (4.7-32.5 mg/l) which coincided with the results of Yousuf *et al.* (1986) and Sharma and Hussain (1999) but is distinctly higher the reports from Meghalaya (Sharma, 1995; Sharma and Wanswett, 1999). Its mean concentration (14.8 - 16.6 mg/l) denoted notable horizontal variations; maximum value is noticed at Station I (inlet) and, thereafter, it decreased progressively from Stations II - IV. Sulphate, however, did not exhibit significant correlation with any of the presently studied abiotic factors.

Total Phosphorus (7.7-68.7 μ g/l) and phosphate (2.9-49.4 μ g/l) reflected lower concentration but notable changes during the study period and did not confirm to any general pattern. Moreover, their mean values fluctuated between 22.6-26.6 μ g/l and 11.2-13.3 μ g/l respectively, recorded marginal horizontal variations in Umiam reservoir and both the nutrients, however, showed maximum concentrations at Station IV. Total Phosphorus depicted significant inverse relationships with specific conductivity and hardness and recorded a strong positive correlation with phosphate. On the other hand, Phosphate content of Umiam indicated distinctly lower concentration than the results of Sharma (1995) and Sharma and Wanswett (1999) while its content is higher in contrast the report from Tasek lake (Das *et al.* 1996).

Nitrate ranged between 0.08-0.80 mg/l in Umiam reservoir and depicted mean values between 0.23 - 0.33 mg/l at different sampling stations; the recorded concentrations are higher than those reported by Sharma (1995) and Sharma and Wanswett (1999) but are lower than the results of Das *et al.* (1996). This study, however, indicated higher mean nitrate concentrations at the first two stations (maximum at Station II) than the other two stations. On the other hand, Silicate content (19.0-101.0 mg/l) in this reservoir is significantly higher than the results of Sharma (*loc cit.*), Sharma and Hussain (1998) and Sharma and Wanswett (*loc cit.*). It also depicted notable horizontal variations (mean values: 43.9 - 61.7 mg/l) and maximum Silicate concentration is observed at Station I.

In conclusion, Umiam reservoir indicated sub-tropical nature and its soft waters are characterized by circum-neutral to alkaline character, bicarbonate alkalinity, distinctly low electrolyte concentrations as well as poor Calcium and Chloride contents, lower total Phosphorus, Phosphate and Nitrate concentrations and higher Silicate content. Specific conductivity, Sulphate, Chloride and Silicate exhibited relatively significant horizontal variations at different sampling stations.

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TABLE - I

ABIOTIC FACTORS OF UMIAM RESERVOIR (STATION – I)

Abiotic factors	Nov. 93-Oct. 94 (1st Yr.)	Nov. 94-Oct. 95(2nd Yr.)	Nov. 93 - Oct. 95
Rainfall (mm)	0-456 (206 ± 215)	0-520 (237 ± 199)	0-520 (222 ± 207)
Air temperature (° C)	16.0-28.0 (22.8 ± 3.6)	16.0-26.5 (22.2 ± 3.3)	16.0-28.0 (22.5 ± 3.4)
Water Temp. (° C)	15.0-26.0 (21.1 ± 3.9)	11.5-24.6 (20.0 ± 4.5)	11.5-26.0 (20.5 ± 4.2)
Transparency (m)	1.0-1.7 (1.41 ± 0.3)	0.9-2.17 (1.27 ± 0.3)	0.9-1.7 (1.34 ± 0.3)
pH	7.1-8.5 (7.96 ± 0.85)	7.1-7.8 (7.36 ± 0.24)	7.1-8.4 (7.66 ± 0.54)
Sp. cond. (μS/cm)	46.0-87.5 (60.4 ± 12.7)	37.0-101.5 (64.0 ± 21.7)	37.0-101.5(62.2 ± 17.2)
D. Oxygen (mg/l)	6.5-10.8 (9.0 ± 1.3)	7.5-10.6 (8.8 ± 1.0)	6.5-10.8 (8.9 ± 1.2)
Free CO ₂ (mg/l)	0-7.0 (3.5 ± 2.2)	0-7.0 (3.6 ± 2.0)	0-7.0 (3.6 ± 2.1)
Alkalinity (mg/l)	14.0-28.0 (21.0 ± 5.1)	14.0-32.0 (22.6 ± 6.0)	14.0-32.0 (21.8 ± 5.5)
Hardness (mg/l)	20.0-32.0 (26.3 ± 3.3)	21.0-35.0 (26.7 ± 3.8)	20.0-35.0 (26.5 ± 3.6)
Calcium (mg/l)	12.0-18.5 (15.5±1.9)	10.5-16.8 (15.2±1.7)	10.5-18.5 (15.4±1.8)
Magnesium (mg/l)	3.0-6.3 (4.7±1.0)	3.1-5.8 (4.6±0.9)	3.0-6.3 (4.7±0.98)
Chloride (mg/l)	7.0-19.0 (10.3±3.4)	10.0-18.0 (13.0±2.3)	7.0-19.0 (11.7±2.9)
Sulphate (mg/l)	5.8-26.0 (16.7±5.6)	6.2-23.5(16.5±5.3)	5.8-26.0 (16.6±5.5)
T. Phosphorus (mg/l)	14.4-57.1 (25.4±11.2)	13.1-37.2 (23.6±7.3)	13.1-57.1 (24.5±9.2)
Phosphate (ug/l)	8.2-20.1 (10.7±3.7)	7.3-19.5 (12.0±3.8)	7.3-20.1 (11.3±3.8)
Nitrate (mg/l)	0.08-0.45 (0.23±0.11)	0.17-0.67 (0.38±0.15)	0.08-0.67 (0.35±0.13)
Silicate (mg/l)	38.5-101.0 (61.1±15.5)	41.0-90.0 (62.3±14.3)	38.5-101.0 (61.7±15.0)

TABLE - II

ABIOTIC FACTORS OF UMIAM RESERVOIR (STATION – II)

Abiotic factors	Nov. 93-Oct. 94 (1st Yr.)	Nov. 94-Oct. 95(2nd Yr.)	Nov. 93 - Oct. 95
Rainfall (mm)	0-456 (206 ± 215)	0-520 (237 ± 199)	0-520 (222 ± 207)
Air temperature (° C)	16.0-27.0 (23.1 ± 3.1)	18.0-26.5 (21.4 ± 5.3)	16.0-27.0 (22.2 ± 4.2)
Water Temp. (° C)	15.0-26.0 (21.5 ± 3.5)	11.0-25.0 (20.2 ± 4.8)	11.0-26.0 (20.8 ± 4.1)
Transparency (m)	1.0-1.7 (1.41 ± 0.3)	0.9-1.7 (1.27 ± 0.3)	0.9-1.7 (1.34 ± 0.3)
pH	7.2-8.3 (8.16 ± 0.80)	7.1-8.0 (7.43 ± 0.31)	7.1-8.3 (7.8 ± 0.55)
Sp. cond. (μS/cm)	43.0-79.0 (58.2 ± 11.9)	39.0-82.0 (58.0 ± 15.0)	39.0-82.0(58.1 ± 13.5)
D. Oxygen (mg/l)	6.5-10.5 (8.6 ± 1.3)	6.5-9.6 (8.6 ± 1.0)	6.5-10.5 (8.6 ± 1.1)
Free CO ₂ (mg/l)	0-8.5 (3.6 ± 2.3)	0-6.5 (3.4 ± 2.0)	0-8.5 (3.5 ± 2.1)
Alkalinity (mg/l)	13.0-28.0 (20.4 ± 5.3)	12.5-29.0 (22.1 ± 5.4)	12.5-29.0 (21.2 ± 5.4)
Hardness (mg/l)	21.0-31.0 (26.0 ± 3.3)	20.0-30.0 (26.0 ± 3.1)	20.0-31.0 (26.0 ± 3.2)
Calcium (mg/l)	10.0-17.5 (14.6 ± 2.0)	8.8-16.5 (14.3 ± 1.9)	8.8-17.5 (14.5 ± 1.9)
Magnesium (mg/l)	2.8-5.9 (4.7 ± 0.9)	3.1-5.7 (4.4 ± 0.9)	2.8-5.9 (4.6 ± 0.9)
Chloride (mg/l)	8.0-14.5 (12.6 ± 2.6)	8.0-18.0 (15.7 ± 2.4)	8.0-18.0 (15.6 ± 2.5)
Sulphate (mg/l)	5.9-31.5 (16.0 ± 7.2)	6.0-32.5 (16.7 ± 8.1)	5.9-32.5 (16.3 ± 7.6)
T. Phosphorus (mg/l)	9.9-48.0 (22.2 ± 9.9)	12.4-52.7 (23.0 ± 10.9)	9.9-52.7 (22.6 ± 10.4)
Phosphate (mg/l)	4.2-24.0 (10.5 ± 5.0)	7.1-32.5 (11.8 ± 6.7)	4.2-32.5 (11.1± 5.8)
Nitrate (mg/l)	0.15-0.80 (0.40 ± 0.22)	0.15-0.47 (0.26 ± 0.09)	0.15-0.80 (0.33 ± 0.15)
Silicate (mg/l)	29.0-73.0 (51.2 ± 14.4)	31.6-69.5 (49.1 ± 12.5)	29.0-73.0 (50.1 ± 13.5)

TABLE - III

ABIOTIC FACTORS OF UMIAM RESERVOIR (STATION – III)

Abiotic factors	Nov. 93-Oct. 94 (1st Yr.)	Nov. 94-Oct. 95(2nd Yr.)	Nov. 93 - Oct. 95
Rainfall (mm)	0-456 (206 ± 215)	0-520 (237 ± 199)	0-520 (222 ± 207)
Air temperature (° C)	16.0-28.0 (23.6 ± 3.5)	15.0-27.0 (22.4 ± 4.0)	15.0-28.0 (23.0 ± 3.7)
Water Temp. (° C)	15.0-27.0 (21.6 ± 3.8)	11.5-25.0 (20.5 ± 5.1)	11.0-27.0 (21.1 ± 4.4)
Transparency (m)	1.0-1.7 (1.41 ± 0.3)	0.9-1.7 (1.27 ± 0.3)	0.9-1.7 (1.34 ± 0.3)
pH	7.1-8.4 (7.81 ± 0.78)	7.1-7.8 (7.41 ± 0.24)	7.1-8.4 (7.61 ± 0.51)
Sp. cond. (μS/cm)	39.0-68.5 (53.8 ± 9.4)	39.5-82.5 (58.4 ± 13.8)	39.0-82.5 (56.1 ± 11.6)
D. Oxygen (mg/l)	6.5-9.5 (8.1 ± 0.9)	7.0-10.8 (9.0 ± 1.3)	6.5-10.8 (8.6 ± 1.1)
Free CO ₂ (mg/l)	0-4.6 (2.6 ± 1.2)	0-3.5 (2.2 ± 0.6)	0-4.6 (2.4 ± 0.9)
Alkalinity (mg/l)	10.0-28.0 (19.5 ± 5.7)	10.0-30.0 (20.8 ± 7.0)	10.0-30.0 (21.2 ± 6.3)
Hardness (mg/l)	20.5-30.5 (25.4 ± 3.1)	21.0-31.0 (25.4 ± 3.0)	20.5-31.0 (25.4 ± 3.0)
Calcium (mg/l)	11.0-18.6 (15.0 ± 2.1)	10.0-22.0 (14.7 ± 2.9)	10.0- 22.0 (14.8 ± 2.5)
Magnesium (mg/l)	3.0-5.6 (4.4 ± 0.8)	3.2-5.4 (4.3 ± 0.6)	3.0-5.6 (4.4 ± 0.7)
Chloride (mg/l)	8.5-13.0 (10.9 ± 1.4)	10.2-15.5 (12.1 ± 1.4)	8.5-15.5 (11.5 ± 1.4)
Sulphate (mg/l)	4.7-26.0 (15.3 ± 6.1)	7.0-23.0 (15.0 ± 5.3)	4.7-26.0 (15.1 ± 5.7)
T. Phosphorus (mg/l)	7.7-51.0 (22.4 ± 11.9)	12.1-54.6 (25.2 ± 11.2)	7.7-54.6 (23.8 ± 11.6)
Phosphate (mg/l)	2.9-20.3 (10.0 ± 5.5)	6.9-35.7 (12.4 ± 8.0)	2.9-35.7 (11.2 ± 6.7)
Nitrate (mg/l)	0.17-0.40 (0.26 ± 0.1)	0.15-0.31 (0.19 ± 0.1)	0.15-0.40 (0.23 ± 0.1)
Silicate (mg/l)	19.0-62.0 (45.2 ± 12.0)	24.1-66.5 (42.6 ± 12.1)	19.0-66.5 (43.9 ± 12.0)

TABLE - IV

ABIOTIC FACTORS OF UMIAM RESERVOIR (STATION – IV)

Abiotic factors	Nov. 93-Oct. 94 (1st Yr.)	Nov. 94-Oct. 95(2nd Yr.)	Nov. 93 - Oct. 95
Rainfall (mm)	0-456 (206 ± 215)	0-520 (237 ± 199)	0-520 (222 ± 207)
Air temperature (° C)	15.0-29.0 (23.2 ± 4.4)	15.0-28.5 (23.6 ± 4.3)	15.0-29.0 (23.4 ± 4.3)
Water Temp. (° C)	13.0-27.0 (21.0 ± 4.7)	12.0-26.0 (21.0 ± 4.9)	12.0-27.5 (21.0 ± 4.8)
Transparency (m)	1.0-1.7 (1.41 ± 0.3)	0.9-1.7 (1.27 ± 0.3)	0.9-1.7 (1.34 ± 0.3)
pH	7.0-8.3 (7.77 ± 0.70)	7.1-7.8 (7.42 ± 0.22)	7.0-8.3 (7.59 ± 0.46)
Sp. cond. (μS/cm)	37.0-69.0 (52.3 ± 11.0)	37.5-85.0 (52.0 ± 13.5)	37.0-85.0 (53.6 ± 12.2)
D. Oxygen (mg/l)	6.5-10.0 (8.2 ± 1.0)	6.5-9.6 (8.3 ± 1.1)	6.5-10.0 (8.3 ± 1.1)
Free CO ₂ (mg/l)	0-5.0 (3.2 ± 1.6)	0-4.0 (2.4 ± 0.9)	0-5.0 (2.8 ± 1.2)
Alkalinity (mg/l)	8.0-30.0 (19.7 ± 6.3)	13.5-29.0 (21.9 ± 5.5)	8.0-30.0 (20.8 ± 5.4)
Hardness (mg/l)	21.0-30.5 (26.1 ± 3.3)	21.0-31.0 (25.5 ± 3.1)	21.0-31.0 (25.8 ± 3.2)
Calcium (mg/l)	13.0-19.0 (14.9 ± 1.7)	12.5-20.0 (15.6 ± 2.1)	12.5-20.0 (15.3 ± 1.9)
Magnesium (mg/l)	3.1-5.3 (4.4 ± 0.7)	3.2-5.9 (4.5 ± 0.8)	3.1-5.9 (4.4 ± 0.7)
Chloride (mg/l)	9.5-12.7 (11.0 ± 1.1)	8.9-16.7 (11.8 ± 2.0)	8.9-16.7 (11.4 ± 1.5)
Sulphate (mg/l)	7.3-26.5 (14.4 ± 5.5)	6.5-26.5 (15.1 ± 5.8)	6.5-26.5 (14.7 ± 5.7)
T. Phosphorus (mg/l)	17.4-66.0 (26.3 ± 14.2)	13.1-68.7 (26.4 ± 15.5)	13.1-68.7 (26.4 ± 14.8)
Phosphate (mg/l)	5.3-46.2 (12.2 ± 11.1)	5.4-49.4 (14.4 ± 11.8)	5.3-49.4 (13.2 ± 11.5)
Silicate (mg/l)	37.5-67.0 (51.2 ± 9.1)	32.0-86.5 (52.2 ± 13.4)	32.0-86.5 (51.7 ± 11.2)

TABLE - V

ABIOTIC FACTORS (MEAN VALUES) AT DIFFERENT STATIONS OF UMIAM RESERVOIR

Abiotic Factors	Station I	Station II	Station III	Station IV
Air Temperature (° C)	22.5 ± 3.4	22.2 ± 4.2	23.0 ± 3.7	23.4 ± 4.4
Water Temp. (° C)	20.5 ± 4.2	20.8 ± 4.1	21.1 ± 4.4	21.0 ± 4.8
Transparency (cm)	1.34 ± 0.3	1.34 ± 0.3	1.34 ± 0.3	1.34 ± 0.3
pH	7.66 ± 0.54	7.80 ± 0.55	7.61 ± 0.51	7.59 ± 0.46
Sp. Cond. (μS/cm)	62.2 ± 17.2	58.1 ± 13.5	56.1 ± 11.6	53.7 ± 12.2
Dissol. oxygen (mg/l)	8.9 ± 1.2	8.6 ± 1.1	8.5 ± 1.1	8.3 ± 1.1
Free CO ₂ (mg/l)	3.6 ± 2.1	3.5 ± 2.2	2.4 ± 0.9	2.8 ± 1.2
Alkalinity (mg/l)	21.8 ± 5.5	21.2 ± 5.4	21.2 ± 6.3	20.8 ± 5.9
Hardness (mg/l)	26.5 ± 3.6	26.0 ± 3.2	25.4 ± 3.0	25.8 ± 3.2
Calcium (mg/l)	15.4 ± 1.8	14.5 ± 1.9	14.8 ± 2.5	15.3 ± 1.9
Magnesium (mg/l)	4.7 ± 1.0	4.6 ± 0.9	4.4 ± 0.7	4.4 ± 0.8
Chloride (mg/l)	11.7 ± 2.8	15.6 ± 2.5	11.5 ± 1.4	11.4 ± 1.6
Sulphate (mg/l)	16.6 ± 5.5	16.3 ± 7.6	15.1 ± 5.7	14.8 ± 5.7
T. Phosphorus (mg/l)	24.5 ± 9.2	22.6 ± 10.4	23.8 ± 11.6	26.6 ± 14.8
Phosphate (mg/l)	11.3 ± 3.8	11.2 ± 5.8	11.2 ± 6.7	13.3 ± 11.5
Silicate (mg/l)	61.7 ± 14.9	50.1 ± 13.5	43.9 ± 12.0	51.7 ± 11.3

TABLE - VI

SIGNIFICANT COEFFICIENT CORRELATIONS (R)

Parameters		First year	Second year
Rainfall	Water temper.	+ 0.880 *	+ 0.731 **
	Transparency	- 0.587 ***	- 0.686 ***
Water Temp.	pH	+ 0.714 **	-
	Alkalinity	+ 0.811 **	+ 0.622 ***
	Transparency	- 0.724 **	- 0.639 ***
	pH	+ 0.739 **	+ 0.686 ***
	Conductivity	+ 0.658 ***	+ 0.864 *
	Alkalinity	+ 0.750 **	+ 0.591 ***
	Hardness	+ 0.778 **	+ 0.659 ***
	D.Oxygen	-	+ 0.835 *
Transparency	pH	- 0.731 **	- 0.841 *
	Free CO ₂	+ 0.701 ***	+ 0.909 *
	Alkalinity	- 0.687 ***	- 0.627 ***
	Hardness	- 0.820 *	- 0.680 ***
	Magnesium	- 0.603 ***	- 0.607 ***
pH	Free CO ₂	- 0.684 ***	- 0.797 **
	Akalinity	+ 0.645 ***	+ 0.548 ***
Conductivity	Hardness	+ 0.599 ***	+ 0.686 ***
	T. Phosphorus	- 0.577 ***	- 0.715 **
Alkalinity	Hardness	+ 0.614 ***	+ 0.760 **
Hardness	T. Phosphorus	- 0.581 ***	- 0.601 ***
Phosphate	T. Phosphorus	+ 0.956 *	+ 0.911 *

* P > 0.001 = 0.823

** P > 0.01 = 0.708

*** P > 0.01 = 0.576

01

02
03
04
05

POLLUTION CONTROL STRATEGIES IN THE OPERATIONS OF UPPER ASSAM

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ABSTRACT

Oil & gas exploration and exploitation activities normally generate various waste by-products, which can be broadly categorised as gaseous emissions, liquid effluents and solid wastes. These waste may impart air, water or land pollution, if adequate pollution control/prevention programmes are not adopted. Pollution control strategies undertaken in the two broad categories of upstream oil industry viz. drilling and production operation in the oil fields of Upper Assam have been discussed. The pollution prevention approach such as waste minimisation, recycling, reuse of waste, treatment safe disposal of operational wastes as well as environment management practices are presented in this paper. Environment monitoring studies indicate that ambient air quality parameters and the effluent water quality are within the permissible limit set by the statutory agencies.

INTRODUCTION

The world petroleum industry is under tremendous economic pressure due to the decline in petroleum prices and increasing cost of finding and extraction of petroleum. Still the share of oil and gas as a key energy source to fuel the economic progress, will continue for few more decades. Aggressive exploration and exploitation strategies with inadequate care for the environment can miss the goal of sustainable development. The increasing public awareness of environmental issues, stringent statutory requirements and commitment of the organisation to environment management have been an impetus for the oil industry to continuously improve its environmental performance. This has added a significant cost to the production of oil and gas. However, the threat of this cost increase also could have a positive effect. Better application of current technology and development of new technology may provide an opportunity to reduce the amount and type of oil field waste that has to be treated, which in turn could help to contain or minimise future production costs. The pollution status of the petroleum development activity depends on the quality and quantity of waste generated, treatment methodologies adopted, reuse/recycle possibilities, mode of disposal and the quality of the receiving environment. The pollution control strategies adopted in the two broad activities of upstream oil & gas industry viz. drilling and production operation have been discussed.

SOURCES OF POLLUTION

Like any development activity, oil field operations also invariably interact with the environment. The major categories of pollution problems can be air, water and soil pollution due to gaseous emissions, effluent discharges and solid waste disposal.

Air Pollution

Hydrocarbon emission from the operational facilities, gaseous emissions from flares, engine generator exhaust heater treaters, etc. are, the primary sources of air pollution from oil field operations. The movements of heavy machineries, vehicular traffic to and from the operational sites, flares etc. can cause notable increase in the ambient noise level in the immediate vicinity of the operational sites.

Water Pollution

The prominent water pollution sources are -

- Discharges from the drilling operation viz. drilling fluid waste and drill cuttings
- Discharge of effluent water from daily operations in drilling and production installations.

- Produced water discharges
- Accidental spills
- Overflow and seepage of operational waste pits

Soil Pollution

Land pollution sources include deforestation oil spillage, solid waste disposal, effluent water discharges, drilling waste, sludge from production operation, packing materials, etc.

POLLUTION CONTROL STRATEGIES

Pollution control / prevention strategies in oil field operations include equipment and practices that reduce the volume and toxicity of the operational waste. Solid control equipments, environment friendly oil field additions, adequate effluent treatment facilities, environment management practices, etc. are various components of this strategy. Various steps towards pollution prevention are :

- Waste minimisation or reduction at source
- Recycling or reuse of waste
- Treatment of waste to eliminate or minimise its toxicity
- Safe disposal of waste

Drilling Operation

Waste water from floor washings, machinery space washings, drill cutting washings, etc. which contain spent oil & grease,, drilling fluid chemicals, other contaminants constitute the effluent water stream from the drill site. The bulk volume of waste, generated in the drilling operation consist of spent drilling fluid and drill cuttings. The spent mud contains drilling fluid additives 'Viz. clay, caustic soda, dispersants / thinners, weighting agents, lubricants, fluid loss agents, corrosion and scale inhibitors, etc.(Table-I). The drill solids are natural formation cuttings comprising of clay, claystone, shale, sand, silt coal limestone, etc., depending on the type of geological formation drilled.

Waste Minimisation

Waste minimisation emphasis on reducing both quantity of waste generated and its toxicity. Selection of material, processes and chemicals that generate low toxicity and minimise waste volume can reduce environmental problem. Generally drilling fluid chemicals used to solve technical problems such as hole enlargement thennal rheology, filtration control torque drag reduction hole stability, corrosion control etc. may impart some pollution risk as well as solution. Chromium based additives (e.g. chrome lignosulphonates), which contain 2-4 % by weight chromium pose an environmental problem when spent drilling fluids are disposed. However chrome free lignosulphonates have replaced this toxic compound and this is slowly phasing out in drilling fluids. Chrome free deflocculents are already in use in the oil fields of Upper Assam.

Solid control equipments play a major role in the volume reduction of drilling fluid waste. The effluent water from daily operation and collected storm water pose a critical challenge for waste management. The volume of rain that falls within the location boundaries can often exceed both the rig and drilling fluid waste volume. These add to the total volume of the waste to be handled. This problem is grim especially in the monsoon season. Effort to divert the rain water/ storm water from join the waste pit can minimise the overall waste management effort. The rig can be cleaned effectively with high pressure low-volume cleaners thereby reduce the rig wash effluent volume. Use of drip pans, drilling fluid buckets, drill string floats, etc. can minimise the cleaning frequency. Additionally this effluent can be reused if properly collected and treated . Uncontaminated storm water can be directed / collected separately without mixing with the drilling waste.

Recycle/ Reuse

The, effluent water and spent drilling fluid collected in the waste pit, is allowed to settle. The segmented waste pit with a facility for effluents to overflow from one compartment to another, facilitate sedimentation and separation of floating oil. The supernatant effluent is treated in a mobile effluent treatment plant and is reused in drilling fluid system or for washing.

Disposal

No waste is disposed outside the premises of the drillsite. Since the oil wells in Upper Assam are drilled with non-toxic fresh water based drilling fluid, the pit closure method is generally used as an accepted disposal technique. The pit is covered with a layer of top soil and allowed to dry.

Other disposal methods that are in use include land farming, solidification bacterial degradation, downhole injection, etc. The non-hazardous oil field waste (NOW) can be reused for landfill or as road bed material successfully.

PRODUCTION OPERATION

The produced water associated with the oil & gas form the largest volume of effluent generated in the petroleum industry. The quantity and quality of produced water depends on the formation characteristics, age of the oil well, production strategy, etc.. Produced water typically contain varying concentration of organic hydrocarbons, salts, heavy metals and sometimes radioactivity. Due to this, the waste generally require treatment and responsible methods of disposal. In Upper Assam project about 2.6 lakhs M³ of produced water is generated per month.

Treatment and disposal

The produced water collected along with oil & gas in the Group Gathering Stations (GGS) and Central Tank Farm (CTF) are separated and sent to effluent treatment plants. The effluent is subjected to adequate physico- chemical and biological treatment at the ETP to render it suitable for disposal or reuse. The following treatments are generally given -

- Free oil separation
- Separation of emulsified oil
- Skimming of oil in API separators
- Dissolved air floatation
- Chemical treatment using alum, lime, polyelectrolytes and other additives
- Filtration
- Biological treatment

Major part of the treated effluent is disposed either to surface water bodies or through sub surface disposal wells. In Upper Assam project approximately 1.5 lakhs M³ of treated effluent is discharged to the surface water bodies per month, which meet the standards and guidelines set by the State Pollution Control Board and other regulatory bodies. Since effluent generated in Rudrasagar oil field contain high concentration of dissolved solids, it is disposed subsurface through disposal wells. Approximately 0.5 lakhs M³ of effluent is injected per month through the disposal wells.

Reuse / Recycle

The effluent water generated in the production operation are partially injected back to formation for reservoir pressure maintenance, after adequate treatment for optimum injectivity and minimum corrosion problems.

In the, Upper Assam project approximately 20 % of the produced water is recycled for water flooding in the various water injection schemes .

Solid Waste

Sludge from the crude oil storage tanks and effluent treatment plants are the major sources of operational solid waste. The crude oil are desludged at regular intervals. The tank bottom drains are routed to the effluent treatment plants along with other sludge from processing and transportation of crude oil. The sludge contain generally hydrocarbon, sediments, heavy metals, etc. along with water. Characteristics of a sludge sample is depicted in Table-III.

The sludge from the effluent treatment plants are, transported to the disposal facility after thickening/dewatering to reduce the volume. Normally lagoons or ponds are made to contain the sludge. Oil field sludge is subjected to biodegradation and adequately protected to prevent direct or indirect pollution to the surrounding environment.

AIR POLLUTION MANAGEMENT

Flare system is provided to burn any gas that cannot be utilised in-house or by the consumer or that need to be released due to process requirement. The location, height and design of the flare stacks ensure complete combustion of the natural gas and safe disposal of the combustion products. This will assure that minimum quantity of unburned hydrocarbon, nitrogen oxides and sulphur dioxide, etc. are released to the environment. The ambient air quality monitoring conducted around the oil field installations in Upper Assam reveals that the concentration of all the air pollutants are within the permissible limit set by the Central Pollution Control Board (Table-IV). In some cases the flare is rendered smokeless by steam injection as well as box flares are used to minimise heat and light effect on the surrounding vegetation.

Though all efforts are taken to minimise gas flaring to zero level, due to some reasons flaring is continued at low rate in almost all the oil fields. The following schemes are introduced to minimise the, flaring of gas -

- Increasing gas marketing
- Establishment of gas compressing stations
- Installation of captive power plants for power generation
- Domestic distribution of gas
- Gas lift for enhanced oil recovery

Air pollution prevention measures such as -

- Construction of ground level multiple flare tips
- Providing enclosure to flares
- Developing green belt around flares stacks
- Commissioning of box flares for total burning of hydrocarbons without illumination

are being implemented in various oil fields.

CONCLUSION

Oil exploration and production operations in Upper Assam are being conducted with full regard for preservation of environment in such a diverse geographic climatological and social conditions. ONGC incorporates the environment friendly technologies and industry practices to meet the statutory requirements as well as, comply with internal performance criteria. Changing environmental requirements have been an impetus to revalidate the approach to environmental strategies so that operations are executed in harmony with the environment. A qualitative improvement in the environmental performance

has become vital for maintaining the ecological balance and to attain sustainable development in the oil field operations.

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TABLE - I

CHEMICAL CONSUMPTION FOR AN OIL WELL DRILLING IN UPPER ASSAM OIL FIELD

Sl. No.	Chemical	Consumption (Average)	
		Exploratory Well	Development Well
1	Bentonite(MT)	430	303
2	Baryte(MT)	613	239
3	Carboxy methyl cellulose (MT)	19	11
4	Chromeligno sulphonate (MT)	27	16
5	Caustic soda (MT)	16	10
6	EP Lube (MT)	9	5.5
7	Drilling Detergent(M ³)	1.5	0.8
8	Spotting fluid (M ³)	4.4	10
9	Sulphonated asphalt(MT)	14	20
10	Chrome lignite(MT)	12	18
11	Sodium chloride(MT)	30	-
12	Poly anionic cellulose (MT)	1	0.2
13	Aluminium stearate (MT)	0.1	0.1
14	Potassium chloride (MT)	0.3	-
15	Resinex (MT)	0.15	6
16	Soda ash (MT)	1	0.15
17	Mica (MT)	0.3	-
18	Potassium hydroxide (MT)	3.4	3
19	Lime(MT)	3.5	4.5

TABLE - II

EFFLUENT WATER QUALITY FROM EFFLUENT TREATMENT PLANTS

Sl. No.	Parameter	ETP Lakwa	ETP * RDS	APCB Limits
1	pH	7.5	8.5	5.5-9.0
2	Total Hardness	40	100	-
3	Salinity	877	6727	-
4	Chloride	532	4082	600
5	Carbonate	nil	300	-
6	Bicarbonate	610	3202	-
7	Sulphate	81	35	1000
8	Calcium	10	24	-
9	Magnesium	4	10	-
10	Sodium (Calculated)	802	4052	-
11	Total dissolved Iron	nil	nil	-
12	Total dissolved solids	2039	11705	2100
13	Total suspended solids	11	12	100
14	Chromium	BDL	0.21	1.0
15	Nickel	BDL	BDL	3.0
16	Zinc	0.03	0.05	2.0
17	Oil & grease	4	nil	10
18	Turbidity	1.2	2.0	-

All units are in mg/l except pH * disposed subsurface.

TABLE - III

SLUDGE QUALITY FROM EFFLUENT TREATMENT TREATMENT PLANT

Sl. No.	Parameter	ETP Lakwa
1	Density (gm/cc)	1.02
2	Salinity (gm/l)	0.51
3	Total hardness (mg/l)	150
4	Carbonate (mg/l)	75
5	Bicarbonate (mg/l)	49
6	Sulphate (mg/l)	125
7	Calcium (mg/l)	28
8	Magnesium (mg/l)	20
9	Iron	2200
10	Chromium	0.22
11	Nickel	0.48
12	Zinc	0.25
13	Total Solids	3.08%
14	Total suspended solids	2.89%
15	Oil & grease (mg/l)	1100

TABLE - IV

AIR QUALITY DATA AROUND OIL FIELD INSTALLATIONS OF UPPER ASSAM

	SPM	NO ₂ μg/m ³	SO ₂ μg/m ³	CO ₂ μg/m ³	H ₂ S μg/m ³
Geleky GGS - II	55	16	3	BDL	BDL
Geleky GGS - III	47	16	3	BDL	BDL
Lakwa GGS - VII	59	14	3	BDL	BDL
Lakwa GGS - VIII	50	12	3	BDL	BDL
RDS GGS - I	82	21	4	BDL	BDL
RDS GGS - II	71	14	3	BDL	BDL
CPCB limits	200	80	80		-

Detectable limit of H₂S is 1 μg/m³ and CO-1 ppm

Results shown are the arithmetic mean of 12 observations at 4 locations each.

100

100

100

A STUDY ON THE IMPACT OF OPENCAST MINING ON ENVIRONMENT OF MAKUM COAL FIELD AND SURROUNDING AREAS

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ABSTRACT

Opencast mining at the Makum Coal Field in the district of Tinsukia, Assam have been done since a long time. Initial impact was not felt but gradually it is increasing and now it has reached to a serious environmental problem in and around the surrounding areas. Land degradation, loss of fertility of the surrounding agricultural land, deforestation, water air and noise pollution are some of the affects of open cast mining. Field study was made, soil and water samples of the surrounding area were collected and analyzed, and it is observed that pollution impact is very high. Some remedial measures are suggested to lower the impact of pollution and way to environment friendly mining activities.

INTRODUCTION

The Makum Coal Field is 80 km. long and about 5 km. wide tract over the Patkai foothills along the southern border of the Lakhimpur district, between the Tirap river (27° 17' - 95° 58') on the east and Dirak river (27° 15' - 98° 35') on the west. The Makum Coal is superior in quality and it is considered as the best Coal in Assam.

The Baragolai: Tirak Collieries of the Coalfield, is industrially developed since long ago and are well communicated both by roads and railways. The National Highway No. 38 runs along the northern extremity of the Coal field connecting Margherita, Ledo and Lekhapani, the important trading centres of the area. After the nationalisation of the coalfields in 1973, the Coal India Ltd. done opencast Mining with modern machinery to increase the production from 0.5 m tones to 1 m tones. In this way environmental hazard occurred in the area from that time.

ENVIRONMENTAL POLLUTION DUE TO OPENCAST MINING

For the mining activities in the Makum area following environmental pollution has occurred -

- 1 Land degradation
- 2 Lost of fertility of the surrounding agricultural land.
- 3 Deforestation.
- 4 Water Pollution
- 5 Air Pollution
- 6 Noise Pollution

Land Degradation

Due to the dumping of vast Coal mine particles, large area around the mines become wasteland, infertile and unproductive.

Mine talling are dumped surrounding the low laying areas of Tikok and Tirap and destroying the crops and Vegetation of the area as Assam Coal contains large amount of the sulphur which is injurious to vegetations.

Lost of fertility of the agricultural Land

Assam Coal contains high amount sulphur (2-7%), chemical oxidation and microbial processes change the sulphur into sulphuric acid. As Assam experience high rainfall they wash away the sulphuric acid and loose debris to the low lying areas and thereby drastic chemical and physical change occurred in the area.

2000 bighas of rice crop was affected by Siltation/acidic effluent during 1988-1989 crop season (Barthakur). The mine effluent containing sulphuric acid unadulterated the rice fields in Tirap, Dihing and Namdung rice field. The water was stagnant for a long time. As the effluent is acidic in character they change the pH of soil to abnormal lower value. But sometimes it is seen that natural dilution brings the (SO_4^{2-}) content upto safe level. The chemical analysis of water sample shows that at the junction of Tirap river and Dihing river, the pH, electrical conductivity and (SO_4^{2-}) content of the river was within safe limit. But in future indiscriminate disposal of effluent from mine will not protect the environment.

Degradation Land due to Siltation

About 120 bighas of land was affected near Namdung Nalla by I) Siltation, II) contamination with acidic effluent from coal mine. The depth of siltation in some paddy fields varies from 0.5m. to 1.0m (H. C. Barthakur). Analysis (Table-I) of soil samples in some rice fields is as follows –

Electrical conductivity - 0.43 - 1.66 m mho/cm (SO_4^{2-}) - 419.3-988.4 ppm. But in some rice field like Numdung Babhari gaon, the siltation is not so heavy. But the mine effluent containing sulphuric acid decrease the pH to 2.98. This low pH value have adverse effect on plant growth. Moreover deposition of coal particles and loses earth at the fertile paddy field reduces the normal plant growth of paddy field. Information getting from the local people reveals that about 100 bighas of rice crop was affected during the main crop season of 1988-89. If the adequate measure is not taken the condition of the fertile paddy field would deteriorated.

Ledo spot study in Chipe Basti area near Railway station shows the depth of siltation varies 0.9 - .2 m and therefore the paddy field become unproductive. About 100 bighas of rice field was affected during 1988-89 as per information getting from the local people. Chemical analysis of soil sample in the paddy field show that pH at soil decreases with the increase of electrical conductivity and SO_4^{2-} content of the soil.

The village Chipe Basti is most affected by the deposition of silt. The Chipe nalla is a natural water course which carrier rain water from the adjoining hilly area. But due to the open cast mining, the siltation deposited in the shipenalla and the carrying capacity of such natural water become reduced. As a result, this nalla water mixed with acidic affluent from coal fields submerged the low-laying rice fields. Moreover Dihing and Tirap rivers also fed up with water and at the same time and the acidic nalla water entered in the rice fields and remains stagnated for a long period. Therefore the acidity of the soil increases with the stagnant acid water. Hence the acidity of soil increases with loss of fertility of the productive soil.

It is observed from spot study the Tikak hill site, overburden from coal mines were deposited at the site. The area have high relief and the overburden composed of loose earth debris and coal particles were carried down to the rice field situation at lowers elevation by the natural transportation. Here also Chemical analysis shows increase SO_4^{2-} content with maximum decrease of pH in the soil.

Deforestation

Before the mining activities in Makum Coal Field, the area was covered by green valuable trees like Hollong (*Diptercaspus pilosus*), Nahor, Dimal etc. But now due to mining the area became barren. The forest was cleared for the ex fraction of coal. But proper attraction will improve the barren condition of the land. For the deforestation the average annual rainfall was 88.57 inches in 1986-87 in comparison to 134.12 inches in 1982-83.

Water Pollution

The pH of mine water at Ledo varies from (4.23-5.99) and so they are acidic in nature Jeypore coal field shows pH between (2.25 - 2.99). Which are acidic in nature. The mine water of Baragolai and Tipong are alkaline in nature that is pH varies from 7.33 - 8.26.

Specific Conductance

The specific conductant of mine water at Ledo and Jeypore coal field is very high i.e. they range from 0.410×10^{-2} to 0.882×10^{-2} mhos cm^{-1}

Chloride & Sulphate

Chloride ion and Sulphate ion in mine water of Makum coal field varies from 10.20 to 10.68 mg/l and 24.1 to 245.90 mg/l (Rawat and Viswanathan).

Iron

Iron varies from 12.82 to 644.0 mg/l (Rawat & Viswanathan).

Sodium & Potassium

Sodium & Potassium in mine water of Ledo varies from 11.0 and 124.0 mg/l (Rawat & Viswanathan).

Calcium and magnesium

Calcium & Magnesium varies from 24.0 to 210.6 mg/l and 5.8 to 211.4 mg/l (Rawat & Viswanathan).

Copper & Zinc

Copper & Zinc concentration mine water of Makum varies from 2.05 mg/l to 0.92 mg/l (Rawat & Viswanathan).

Air Pollution

Assam Coal is high in a sulphur content (2-7%). From the dumping coal, sulphur of the Coal after conversion by natural processes release SO_2 in the atmosphere. Again burning from Coal and preparation of coke from Coal high amount of SO_2 and carbon monoxide are released into the air. Therefore the air become polluted. If this will continue for long time acid rain may occur in Assam.

Dust and Coal Particles

Huge amount of dust released during open cast mining, from dumping of takings and transportation of coal. This becomes the serious health hazard for the people of neighbouring coal mine area. This dust particles also affected the plant growth.

Noise Pollution

In the Makum coal field considerable noise pollution has occurred from blasting operation and for use of bulldozer and generator etc. This becomes the serious health problem of the area.

DISCUSSION AND POSSIBLE REMEDIAL MEASURE

The above study shows that open cast mining in Makum area has got extremely harmful affect on the health of the local people together with the harmful effect on rice field of the surrounding area. To control the paddy field from loss of fertility, the effluent discharged from the mine should be treated and for this concerned mining Law must be adopted. The Assam soil is acidic in nature and available nutrient content of this soil is limited. The open cast mining will further increase the acidity of soil if improved mining technique is not adopted instead of old process.

The dumping of the Coal should be avoided to control the air pollution due to spotneous combustion of Coal. Sulphar absorbing plant may be planted near the coal mining area. There should be water spraying measure for controlling the dust particles. The Coal may be transported in closed railway wagon for reducing dust.

To control water pollution dumping of mine tallings in the river or river courses should be avoided and failing may be so used as back filling of abandoned open cast mines. The effluent of mine water should be treated before releasing in to the water course.

To reduce the soil erosion and to maintain the ecological balance, afforestation programme may be taken.

For reducing noise in the mine area, noise reducing apparatus may be used. For this also green hedges may be planted.

CONCLUSION

The mine water of collieries of Makum coal field is highly acidic; water contains free sulphuric acid and ferric sulphate along with other salt.

The nature of mine water reflects the geo-chemical nature of the surrounding area, Assam coal contains pyritic material, corrosive action may take place due to the presence of free sulphuric acid. This water has intense corrosive action which increase with the decrease of pH of water.

India being a developing country, Industry is necessary for its development. For this development mining is to opt the modern technology and proper planning should be necessary for maintaining the ecological balance of the area. Moreover, the concerning mining authority must abide by the rules framed by the competent authority. Then only we can enjoy the benefit of industry along with the natural ecological balance.

The existing level of water pollution of Makum coal field is considerably high. The acidic mine water may cause rapid corrosion of mining equipment, adversely effect land, vegetation crops and the health of mine workers along with the neighbouring people. If the mine water could be treated properly it would also reduce the water pollution of the surrounding rivers.

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TABLE - I

CHEMICAL ANALYSIS OF SOIL SAMPLES COLLECTED FROM MAKUM COAL FIELDS OF ASSAM

Sample No.	pH	Electrical Conductivity mho cm ⁻¹	SO ₄ ²⁻ (ppm)
1	2.98	0.66	988.4
2	2.67	1.66	449.3
3	3.69	0.43	419.3
4	2.25	0.53	429.5
5	2.99	0.46	528.00
6	5.18	0.56	629.22

MAP OF MAKUM COAL FIELD MARGHERITA, ASSAM

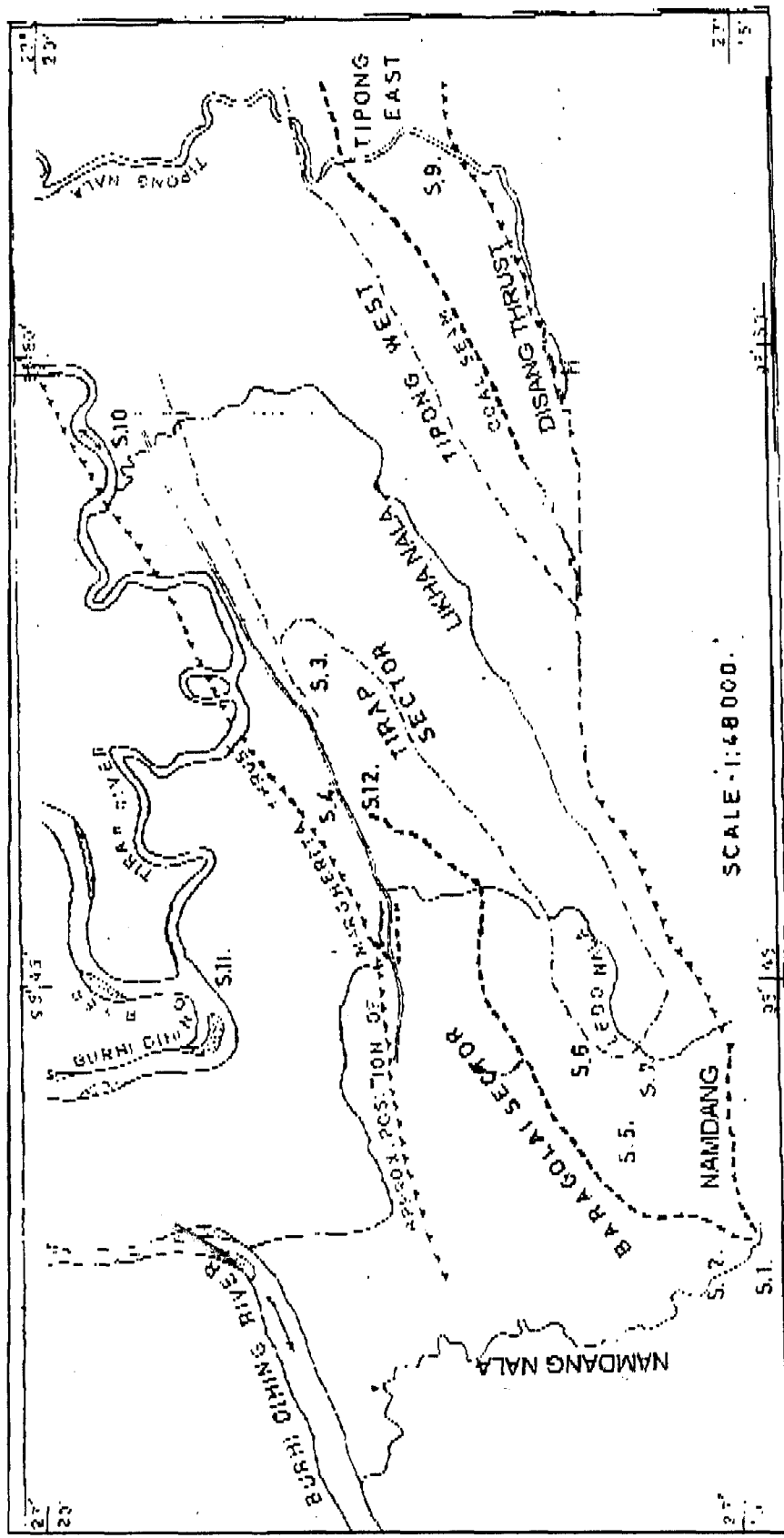


Figure - 1

A STUDY ON ENVIRONMENTAL POLLUTION IN GUWAHATI IN RESPECT OF AIR, WATER AND SOLID WASTE

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ABSTRACT

With lush green hilly belts on three sides and the mighty Brahmaputra to the north, Guwahati, the premier city of North-East India, once presented a resplendent scenic beauty and a bracing climate. But ever since the shifting of the capital from Shillong to Dispur, previously an outskirt, its administrative and commercial activities increased incredibly and population has reached a new high at about 1.2 million now against two hundred thousand in 1971 although, to cope with the emerging situation, the city planning has been virtually non-existent. So the city witnessed the emergence of huts, building and industrial units anywhere without discrimination spoiling its scenic beauty and causing adverse climatic variations. In the hilly region of the city, there are human settlements. The physical features of the city underwent a sea-change. Lack of proper drainage and sewage systems has been responsible for inundation of many parts of the city during heavy rainfall and spreading water-borne and vector-borne diseases. Heaps of solid waste are to be seen everywhere. Proliferation of the number of automobiles plying along limited number of narrow roads and lack of co-ordination among government departments concerned with environment have made environmental problems more acute.

The present investigation endeavoured to show to what extent Guwahati's environment had been degraded. The pollution of the environment in respect of air, water and solid waste was dealt with separately. The data of pollutants had been analysed, throwing light on their overall impact on the environment with remedial measures.

INTRODUCTION

With the shifting of the capital from Shillong human activities in Guwahati increased manifold. Moreover, due to its advantageous situation and transportation facilities, it has become the gateway to the north-eastern states of the country. As a result, there has been an unprecedented rise in population which now stands at 1.2 million against 200 thousand in 1971. Moreover, the floating population of the city is also about 200 thousand. Number of buildings for various purposes increased incredibly owing to ever-increasing population, expansion of trade, commerce and education and administrative activities. Even people settled on the surrounding hills spoiling the green belt upsetting ecological balance. All cropped up the problems of environmental degradation of the city, which needs intense study.

CLIMATE

Guwahati is situated on an undulating plain with varying altitudes of about 55 m on the average above the mean sea (level $26^{\circ}11'$ latitude and $91^{\circ}45'$ E longitude). It is surrounded on the three sides by hill and hillocks with scanty vegetation. It experiences a moderately cold and foggy winter, the spring is very pleasant and the summer hot and humid. The Nor 'wester' thunderstorms and South-West Monsoon bring copious rainfall during premonsoon (March to May) and monsoon seasons (June to September) respectively. The prevailing wind direction of the city is from north-east to south-west during winter from south-west to north-east during summer.

AIR POLLUTION

The physiography of Guwahati favours air pollution for it is uneven with hills, hillocks and marshy lands which hinder air to be blown away. The air pollution in the city has been increasing every year as a result of burning of fossil fuels for domestic and industrial purposes, incredible increase in the number of all sorts of motor vehicles consuming fossil fuel and rapid growth of population resulting in the depletion of the green cover. In 1988 the number of registered vehicles in Guwahati was 62,387 but at present (1999) it is 1,50,000. Air pollution accentuates because of roads criss-crossing the city as they are narrow and uneven. In spite of growing number of vehicles, there is no rise in the number of roads. This results in traffic congestion creating more air pollution.

The burning of fossil fuels in factories and vehicles is associated with emission of harmful gases like CO, SO₂, NO_x, lead, cadmium, polycyclic aromatic hydrocarbon and significant amount of suspended particulate matter (SPM).

Some of these gases produce green house effect on the atmosphere warming the place. Guwahati's intolerable summer temperature and reduced winter period may be attributed to such warming. The main culprits are CO₂, CO and CH₄. Moreover CO reduces the oxygen in the blood, produces dizziness and headache and affects visibility. Sulphur dioxide (SO₂) provokes temporary spasms in lungs, causes coughing and a sore throat and shortness of breath. Inhalation of this gas runs the risk of bronchitis and lung cancer. Nitrogen oxides (NO_x) are associated with eye irritation, nasal irritation and breathing discomfort. Lead leads to reduced appetite, weariness and learning disability. It affects blood circulation, nervous system, kidney and liver. Suspended particulate matter leads to bronchial tendency. Metals like cadmium, nickel etc. are also no less harmful.

TABLE - I

24 HOURS AVERAGE OF SPM, SO₂, AND NO_x AT VARIOUS PLACES IN GUWAHATI

Place	SPM	SO ₂	NO _x
Amingaon	118.3	9.8	23.7
Adabari	234.2	5.6	22.6
Noonmati	165.4	8.2	31.2
Fatasil	178.3	21.7	29.5
Bamunimaidan	196.8	5.4	23.5
Panbazar	155.4	6.1	23.1
Dispur	192.6	5.8	21.8
Beltola-Lokhra	247.7	16.9	31.4

Unit = $\mu\text{g}/\text{m}^3$, Tolerable limit of SPM = $200 \mu\text{m}/\text{m}^3$, SO₂ = $80 \mu\text{m}/\text{m}^3$, NO₂ = $80 \mu\text{m}/\text{m}^3$

Table - I, shows that Beltola-Lokhra area possessed the highest value of SPM much above the tolerable limit ($200 \mu\text{m}/\text{m}^3$). The limit is crossed at Adabari too. The significant amount of SPM ($196.8 \mu\text{m}/\text{m}^3$) at Bamunimaidan is contributed by dusts from the roads. The values of SO₂ and NO₂ are within the prescribed limit at all the stations but higher values of SO₂ at Fatasil ($21.7 \mu\text{m}/\text{m}^3$) is due to silicate industries there. In the eastern and western parts of the city, the brick fields create the problem of air pollution. The brick industries generally function from November to March.

TABLE - II

SPM, SO₂ AND NO₂ IN BRICKFIELDS SEASONWISE (1998)

Place	Monsoon Season			Winter Season		
	SPM	SO ₂	NO ₂	SPM	SO ₂	NO ₂
Dharapur	126.5	6	336	336	28	39
Panikhathi - Chandrapur	79	BDL	10.5	464.5	34.5	32

Unit = $\mu\text{g}/\text{m}^3$

Table - II shows that in winter values of all the parameters were much higher than those during the monsoon season, proving that air pollution in these parts of the city is mainly due to brick industry. The SPM values there (336 and 464 $\mu\text{m}/\text{m}^3$) were much higher than the prescribed limit ($200 \mu\text{m}/\text{m}^3$).

In connection with air pollution it is essential to mention here that the average concentration of lead in the SPM in Guwahati was found to be below $1 \mu\text{m}/\text{m}^3$.

WATER POLLUTION

Ground water and surface water are the main sources of water in the Guwahati city. The master plan area of the city covers 262 Sq. Km with a population more than one million. Against the estimated requirement of 67 million litres per day only 42 million litres of water supply is available. A large number of people are still dependent on ring wells, tube wells, natural streams etc. About 70-90% of the total consumption of the water is discharged as waste water. Most of the city's waste water in the form of sanitary sewage and domestic sewage together with the liquid wastes from commercial establishments like hotels, restaurants and hospitals and health care units flow to the river Brahmaputra through drains, small tributaries like Bharalu and Basistha, the later via the Deepar Beel and the Khanajan river. The treated effluent from the refinery is directly discharged into the river Brahmaputra through an underground pipe.

The Bharalu stream flows through the heart of the city and carries municipal waste water. After carrying out several rounds of monitoring, it was found that the BOD and COD values were high during the dry season than those during the monsoon season. The BOD and COD values ranged from 4.0 mg/l to 25.0 mg/l and 24.0 mg/l to 70.0 mg/l respectively.

TABLE - III

CONCENTRATIONS OF COMMON INORGANIC PARAMETERS OF WASTE WATER AT VARIOUS SOURCES

Parameters	Concentration (mg/l)
Chloride as Cl	10.00 - 16.00
Total Hardness as CaCO_3	80.00 - 140.00
Calcium as CaCO_3	50.00 - 95.00
Sulphate as SO_4	7.00 - 30.00
Nitrate as NO_3	0.04 - 0.34
Total Dissolved Solid (TDS)	280.00 - 560.00
Total Kjeldahl Nitrogen (TKN)	1.50 - 7.00
Dissolved Oxygen (DO)	0.2 - 200

From Table - III, it is evident that the concentration of Chloride and TKN are due to contamination from sewage.

Table - IV, furnishes the ground water analysis at different places of Guwahati. It reveals that the presence of minerals are moderate excepting that iron concentration is high. Toxic elements like As, Hg and Cr were below the detectable limit, COD values and Chloride level showed a higher trend indicating seepage of polluted water from the surface to the shallow level. Bacteriological analysis reveals that total coliform in many cases was found high and faecal coliform was present in a few cases.

TABLE - IV

GROUND WATER ANALYSIS OF A FEW PLACES IN GUWAHATI

Place	TC/MPN	FC/MPN	pH	Total Hardness as CaCO_3	Phosphate (mg/l)	Toxic Elements
Gotanagar - Maligaon	460	15	6.9	204	0.6	As, Cr and Hg were below detectable Limit
Paltan Bazar	210	nil	6.8	290	1.8	
Chandmari	288	5	6.4	235	0.08	
Hatigaon	nil	nil	7.0	160	0.61	
Panbazar	730	nil	6.7	240	2.2	

SOLID WASTE

Municipal solid waste (MSW) is highly heterogenous and difficult to characterise due to diversity of its components. Depending upon food habits, cultural traditions, socio-economic and climatic conditions from place to place and from time to time, it varies in quantity, quality and size. Garbage being a multi-dimensional and multisource waste product is extremely difficult to tackle in a developing country like India. Day by day the gravity of the problem is increasing and the natural environment and public health are at stake. With rapid urbanization and rise in population, the amount of generated solid waste will definitely increase.

Most of the city dwellers are not well aware of environmental issues and they dump waste materials near the house or in front of the house. The municipal authorities are also unable to provide sufficient numbers of dustbins as per requirement in proportion to population in a specific area. In some areas it has become the normal practice of the people to dump their domestic waste near the road side or drains. Rains carry these wastes to the drains, get accumulated and block the flow of drains.

In Guwahati about 190 metric tonnes of solid wastes are generated daily. Transportation of the city solid waste of about 60-90 truck loads is done through contractors. Dumping of solid waste is made in a lowlying area near Adabari bus terminus on a temporary basis. Previously used dumping ground in south-west direction of the city now has been prohibited. The present system of disposal of MSW is not proper and scientific at all. There is maximum possibility of contamination of ground water is not proper and scientific at all. There is maximum possibility of contamination of ground water by the leachate of MSW. More than 50% of the solid waste being organic (Table - V) in nature and with high moisture content, this kind of dumping may become the breeding place for germs of deadly disease. The present system of disposal and the existing infrastructure would not be effective to manage garbage problem.

The physical composition of MSW is as shown below :

Paper	-	18%
Plastics	-	9%
Glass	-	7%
Organic	-	66%

TABLE - V

COMPOSITION OF MUNICIPAL WASTE IN GUWAHATI

Place	Organic %	Paper	Plastic %	Glass %	Metal %
Hengrabari	77	16	6	0.6	0.4
Professor Coloney	75	18	5	2	0
Mathuranagar	85	9	3	2	1
Beltola	90	5	5	0	0
Chenikuthi	73	10	14	3	0
Kamakhya Gate	67	26	5	2	0
Karnachal	76	13	11	0	0
Pensionpara	63	17	20	0	0

CONCLUSION

To avoid the air pollution problem the vehicles are to be properly checked to bring the emission down to the prescribed limit. Traffic network system is to be geared up with improved road condition. There should be more diversion roads. The existing roads should be widened. More flyovers are also suggested. The municipal authority should pay heed to the treatment of municipal waste water before it mixes with natural streams or any other natural water bodies. Scientific disposal of garbage is a must as scattered garbage has been instrumental in producing vector-borne disease.

ROLE OF PUBLIC HEALTH ENGINEERING DEPARTMENT FOR HEALTHY ENVIRONMENT

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ABSTRACT

The paper envisages to give an account of the activities of the P.H.E. Department and the difficulties confronting the implementation of the different plans. The main thrust however, is on water supply in rural & urban areas.

INTRODUCTION

Providing safe drinking water facilities to all rural areas of the State continues to be the important objective of the Govt. All main and other habitations are to be provided with at least one safe source of drinking water and all towns are also to be provided with drinking water facilities.

The MVIP latrines/pour flush water seal latrines are constructed in the rural areas to solve sanitation problems of rural communities.

RURAL WATER SUPPLY SCHEME

There are 5522 nos. of main habitations and 2354 other habitations in the State of Meghalaya as per 1991 Census. There are also 763 nos. of newly grown-up habitations which have grown-up after 1.4.91. As on 1.4.99 the habitations yet to be covered with safe drinking water are 34 main habitations, 107 other habitations and 733 newly grown-up habitations.

Cost effectiveness, adoption of appropriate technology and sustainability are the basic factors considered for taking up rural water supply scheme. Priorities have been set accordingly which are as follows :

- 1 S.T.C.
- 2 Ring Well.
- 3 Hand Pump.
- 4 Gravity Piped Water Supply Scheme.
- 5 Pumping WISIS (Ground water pumping/river pumping).

For all rural piped water supply scheme, per capita supply @ 40 lpcd is considered for designing and framing an estimate.

Source of water selected for community water supply should be pollution free and proper care has to be taken for the preservation of catchment area of the sources.

URBAN WATER SUPPLY SCHEME

Main urban towns viz. Tura, Jowai and Shillong have been covered partially. Water is supplied to the consumers after pumping river water and after proper treatment. Necessary treatment is done in a conventional treatment plant to remove turbidity, excess chemical substances and Alteration and bacteria by use of chlorine gas or bleaching powder and to make fit for human consumption. Supply @ 70 to 150 lpcd is considered as per capita supply under urban water supply scheme. •

WATER QUALITY PROBLEM

Water quality problem mostly the presence of excess iron (more than 1 mg/l) in the ground water has been causing concern in this State. The problem is mostly present in those habitations where deep tube-well / hand

pump have been installed. 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.

To tackle the problem of excess iron in drinking water, Govt. of India has launched Submission Programme under RGNDWM to be funded on 75:25 basis. The total nos. of iron affected habitations in the State are 413 nos. The affected habitations are mostly in West Garo Hills District, West Khasi Hills District and in Jaintia Hills District. So far 131 habitations have already been provided with safe drinking water.

The principles governing the construction of iron removal plants involves transformation of iron present in dissolved Fe^{2+} form in the ground water. When the water comes in contact with air precipitation takes place (Fe^{3+}) and the same is removed from sedimentation and filtration process. Simply put, it comprises of aeration, sedimentation and filtration.

WATER QUALITY MONITORING AND SURVEILLANCE

The Deptt. has taken steps of setting up District level laboratories in all the District Head Quarters for regular analysis of water quality.

PROTECTION OF CATCHMENT AREA

To have safe drinking water it is essential that source of water which will be tapped for public water supply is free from any pollution, and not subjected to deforestation and consequent depletion.

As regards GSWSS, the water is pumped for the river "Umiew" for treatment and distribution. The catchment area of Umiew river is spread over 115 sq. km area which needs to be protected.

LOW COST SANITARY LATRINES

It is well known that a direct relationship exists between water, sanitation and health. Consumption of unsafe drinking water, improper disposal of human excreta have been the major causes of many diseases.

The MVIP latrines/Pour flush latrines are constructed in the rural areas on 80:20 funding pattern. The State/Central Govt. provides 80 per cent of the cost of each individual household latrines where the beneficiary is required to bear 20% of the cost.

Altogether 19,340 nos. of latrines have been constructed so far upto March, 1 999 but a long way is to go to have sanitation facility for every person of the State.

The task ahead, being herculian in respect of finance, massive awareness campaign is being launched to motivate the rural masses to come up of their own in owning and construction of individual latrines and not to depend on Government.

ACTIVITY

A Human Resource Development Programme has been launched recently. The aim is at capacity building of local communities by giving requisite training to the village level workers specially women to operate and maintain handpumps and the components of other water supply systems as well as to generate demand for adequate sanitation facilities.

CONCLUSION

The Public Health Engineering Department is aware of the fact that a lot has to be done to meet the growing need of the people. To ensure public co-operation in implementing various programmes mass awareness programmes have been launched. But finance, still remains a big hurdle.

ENVIRONMENTAL DEGRADATION IN NORTH EAST INDIA

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ABSTRACT

With increasing conversion of the life supporting systems into our own use, the natural ecological relationship has vastly changed. Through overuse, misuse and management of resources to meet human needs and to satisfy man's unending greed, irreversible degradation and depletion of resources have taken place in India's north east also. Degradation of land and water resources is a serious problem in the north east India comprising seven states of Arunachal, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. Shifting cultivation (a primitive form of agricultural practice), excessive exploitation of forest wealth, expansion of development activities without paying heed to environmental care have affected land and water resources. The adverse effects of increasing human interference on forest ecosystems have now been a major concern in NE India. The devastation caused to the forest cover leading loss of valuable biodiversity of the region, faulty land rise systems, shifting cultivation practices leading soil erosion in the hills and flood in the plains, open mining and quarries coupled with rapid unplanned urbanization are some of the management factors responsible for depletion of flora and fauna and also for creating vast area into unproductive wasteland. The paper discusses some of factors which are responsible for environmental degradation in NE India and suggests a few remedial measures.

INTRODUCTION

The controversy prevailing among planners with regard to development *vis-a-vis* environment and later between development versus environment has been a matter of confusion. The call for maintaining balance among environment, nature and man cannot stop depletion of natural resources leading to environmental degradation. The north eastern region (NER) of India comprising the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura is situated in a unique environmental zone. Nature's gift to this part of the country has been diverse with enormous biodiversity. But NER is now in the threshold of acute environmental degradation. Environmental problems in North Eastern Region may be attributed to two major reasons : (i) due to negative effects of the process of economic growth and development and ii) due to conditions of poverty, overpopulation, demographic change and underdevelopment. The impact of degradation of our natural resources such as land, soil, water, forest, wild life etc. is chiefly due to overpopulation, underdevelopment, poverty and lack of awareness to environment conservation. Increasing population coupled with widespread poverty has generated pressure on our natural resources and led to the degradation of land, water and forest. The forest resources are threatened due to overgrazing, commercial household needs, encroachment, unsustainable agricultural practices like shifting cultivation (*jhum*), bun cultivation etc. and development activities. Degradation of environment has become a serious problem in north eastern region. It is assuming a serious threat to normal living habitat consequently posing an alarming situation in conservation of biodiversity.

ACTIVITIES LEADING TO ENVIRONMENTAL DEGRADATION IN NER

Land Use Systems

The entire resource degradation process in the region is closely linked up with the land use systems. Forestry is the most dominant land use system followed by agriculture, horticulture, animal husbandry and non-agricultural uses such as urbanisation, commercial establishment etc. Many of the land use systems are found to be hazardous to resources and not conducive to sustained production.

Shifting Cultivation in Hills

Shifting cultivation is the chief means of livelihood and way of life of the tribal people of the hill states of north eastern region, who have evolved this mode of cultivation in response to the most difficult terrain and topography. This type of farming system (also known as *jhuming* or slash and burn agriculture or swidden

agriculture) is regarded as the transitional stage between nomadic hunting and food gathering and this sedentary agriculture is believed to have originated in Neolithic period around 7000 BC. Land degradation or erosion of soil is the concomitant result of shifting cultivation especially with increase of population, more demand for food and fuel production and reduced shifting (*jhum*) cycle to 3-5 years with consequent diminution in the supporting capacity of a unit of land. Shifting cultivation is a predatory system of agriculture involving indiscriminate cutting and burning of forests, improper land use leading to resource degradation, ecological imbalance as well as adverse socio-economic effects. It is associated with poor crop yield and rapid soil degradation.

The burning results in the loss of precious biomass and release of many harmful gases. Deforestation in the north eastern region has reached an alarming stage owing to the practice of shifting cultivation which is one of the major damage causing factors. In the Forest Survey Reports of 1993, 1995 and 1997, it was clearly mentioned that among other factors shifting cultivation played a pivotal role in the loss of forest cover of north eastern region. An area of 1875 sq. km forest cover is lost due to shifting cultivation only. Shifting cultivation in humid tropics is the greatest constraint not only for the immediate increase of agricultural production but also to the conservation of future production potential of soil and forest. Studies at ICAR Research Complex for NER Region, Barapani, Meghalaya have indicated that the soil loss to the tune of 40.9 tonnes/ha and corresponding nutrient losses /ha area are 702.9 kg organic carbon (OC), 145.5 kg phosphorus (P_4O_{10}) and 7.1 kg potassium (K_2O). The soil erosion from 60 -70% hill slopes under first, second and third years abandoned *jhum* was estimated to be 147, 170 and 30 t/ha/year.

Urbanisation

With increased shifting of man's activities from rural agriculture based occupation to modern diversified and specialised enterprises, including white coloured jobs, there has been rise of townships and cities. With rise of towns and cities with conglomeration of people, there is increase of congestion, urban wastes, problem of disposal of garbage, sewage, drainage, harmful smoke, vehicular traffic, noise and so on. There has been a result of unclean and unhealthy condition of land, water and air polluting the environment.

Mining and Quarries

Unscientific and unsystematic mining operations of coal and quarrying of limestone, sand and stone for industries and combustion materials result the destruction and degradation of land resources.

Population Emission

The population explosion in north eastern region could be well imagined if we analyse the population trend from 1951 to 1991. The total population of north eastern hill states was 22,32,000 in 1951 whereas it was 9,134,000 in 1991, the increase being 75.56% as against national average of 57.33%.

EFFECT OF DEGRADATION

Depletion in Forest Resources

Forest resources in north eastern region are subjected increasingly into two kinds of activities : (i) deforestation and ii) degradation.

The region is a repository of biodiversity with richness in species of flora and fauna. The richness of biological diversity can be easily imagined because of its having number of species of orchid (650), grasses (450) bamboo (61) rhododendrons (65 taxa), impatiens (42), angiosperms (7500) citrus (64) gymnosperms (28), bryophytes (500), pteridophytes (700), lichens (728) besides a large number of canes and other species. That is why, the region has been recognised as one of the 12 megabiodiversity region. However, the region is also one of the 18 hot spots. In addition to plant species, the region possesses large number of species of insects (3624), mollusca (50), amphibia (64), reptilia (127), aries (541) and mammals (160). In all, the region possesses 41% plant species and 6% faunal species of the country.

Forest is a vital component to sustain the life support system on the earth. Forest is an important source of subsistence, employment, revenue earnings and raw materials to various industries. Their role in ecological balance, environmental stability, biodiversity conservation, food security, and sustainable developments been widely recognised. But this important component of the life support system has been dwindled increasingly due to rampant illicit felling of trees and mercilessly cutting of forest resources for a variety of reasons including all quick-paced human economic activities. Large scale deforestations in north eastern region are due to (i) encroachment on forest land for raising crops, human settlement and for fuel and fodder because of population pressure, (ii) land requirement for development projects such as introduction of new railway lines, roads, industrial factories, establishment of hydro-electric power projects, irrigation channels etc., (iii) over exploitation of forests for industrial and construction raw materials, (iv) overgrazing by cattle, (v) shifting cultivation and (vi) forest fire.

According to the State of Forest Report 1997, the north eastern region has recorded a major loss in forest cover. The total loss of forest cover in north eastern region was 316 sq. km in 1997 of which Assam recorded 237 sq. km followed by Nagaland (70 sq. km).

THREATS TO BIODIVERSITY

Threats to biological diversity or causes of loss of biodiversity in the north eastern region may be listed as follows :-

- Flood, siltation in river bed
- Development activities such as communication network (road, railways, airports), construction, industries, mining, oil-drilling, hydro projects, irrigation and embankments, etc.
- Encroachment (new settlement, village expansion)
- Agriculture (shifting cultivation, fishing, teak, rubber and coffee plantation)
- Exploitation (overgrazing, poaching, illegal hunting, firewood collection, collection of medicinal and aromatic plants/orchids, smuggling of timber/forest products)
- Human induced destruction (major oil spills/leakage, epidemic, intentional forest fire)
- Management of natural resources (introduction of exotic species, lack of care for preservation of local/native species, apathy towards wild life)
- Population pressure and demographic change
- Management of human resources (lack of awareness, lack of trained man powerful biodiversity conservation, increasing demands, human harassment, change in people's life style, dilution of traditional value, generation gap, erosion of indigenous knowledge)
- Political and policy issues (insurgency, inter community conflict, political pressure, military activities, lack of interdepartmental co-ordination, lack of clear policy implementation)
- Deforestation (diversion of forest land for non-forest activities)
- Denotification of forest areas
- Loss of natural habitat

DEPLETION OF FAUNA

The main reason for the depletion of wild life in north eastern region has been due to the loss of natural habitat conditions arising from population explosion, deforestation, encroachment, reduction in forest cover, poaching, hunting, diversification of forest lands to nonforestry activities. The rare one horned rhinos of Assam, the brow-antlered deer Sangai and Siroilily of Manipur, varied species of rare orchids and medicinal plants, Phayrer's languor of Tripura, Dcohanh of Assam, sturdy and swift ponies of Manipur, Masher fish of Meghalava are either endangered or facing extinction and enlisted as 'endangered' in the Red Book of World Wild Life Fund (WWF) and International Union for Conservation of Nature (IUCN). The drying up of water resources,

problem of drinking water, depletion of aquatic life etc. are also results of environmental degradation in north eastern region due to various reasons.

CONSERVATION OF BIODIVERSITY

Conservation of biodiversity is the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generation while maintaining its potential to meet the needs and aspirations of future generations. Conservation includes elements of both preservation and sustainable use, restoration and enhancement. The conservation of biological diversity has rightfully received an impetus as a consequence of the Convention of Biological Diversity held in December 1993. The Convention, which was signed by majority of the Nations during the UNCED Earth Summit held in Rhio de Jeneiro in June 1992 is now an international law. The World Conservation Strategy clearly defines three global objectives of living resources conservation -

- 1 to maintain essential ecological process and life support system
- 2 to preserve genetic diversity
- 3 to ensure the sustainable utilisation of species and eco-systems.

CONCLUSION

In order to preserve environment from further degradation, we must adopt such measures which will create ecological balance, environmental stability, biological conservation and aesthetic significance. Some of the conservation measures to check environmental degradation in the North East are listed hereunder :

- *In situ and ex situ* conservation of forest genetic resources through establishment of more biosphere reserves, national parks and sanctuaries
- Creation of public awareness to cheek degradation and pollution in the environment
- Vigorous community participation in environment safety
- Massive tree planting
- Adoption of alternative farming systems to replace *jhuming*
- Environmentally education, awareness building and motivation to preserve a healthy and decent environment in all walks of life

While on one side we are proud of rich natural resources and heritage of the North East, we have to feel sorry for the severe degradation of the natural resources and environment especially in urban conglomeration of the region on the other side. Human interference's have greatly threatened the enviromnent of the North East. But we have to do something. To quote Henry Van Dy Ka -

But the glory of trees is more than their gifts

It is a beautiful wonder of life that lifts.

From a wrinkled seed in an earth bound clod

A column, an arch - in the temple of God.

A filler of power, a dome of delight

A shrine of song, a joy of sight."

WASTE MANAGEMENT AND POLLUTION ABATEMENT : TURNING WASTE TO WEALTH - OPPORTUNITIES FOR DOWNSTREAM OPTIMISATION AT THE HOUSEHOLD LEVEL

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ABSTRACT

Notwithstanding the widespread realisation that unplanned development and changing lifestyles have contributed in a major way to resource depletion and increased pollution, not much seems to have been done in terms of resource use optimisation as a strategic management approach in pollution abatement, especially in Northeast India. In Shillong, the concept seems to be present only on paper or perhaps the drawing boards of the concerned authorities, and if there is any attempt on these lines, the initiative seems to be from individuals, the community or non-government organisations. This paper outlines simple, low cost, techniques and some necessary attitudinal changes for resource use optimisation which can enhance pollution abatement while offering opportunities for income generation, applicable at different scales, from the household to larger landscapes. Waste generation and the resultant pollution has already become a major problem for most hill-stations; the need of the day is for every citizen to realise their responsibilities and contribute their share in arresting the trend and for the authorities to nurture a participatory approach so that waste generation can be managed and in the process help pollution abatement thereby ensuring a cleaner environment.

INTRODUCTION

The last two decades has witnessed a steady depreciation in environmental quality brought about by a surge in population growth as well as changing lifestyles, resulting in increased pressures on natural resources on the one hand and a parallel mushrooming of waste generation on the other. Both lay heavy demands on national and global economies and have tremendous significance, not only for economic growth of nations, but also the well being and very survival of Humankind. Consumeristic lifestyles and the consumption patterns that they encourage, demand sophisticated and expensive technologies to take care of waste generation resultant of such lifestyles. In the Indian context, lifestyles have changed rapidly to consumeristic modes, but unfortunately, technological and infrastructural development have not kept a complimentary pace. The country lacks the sophisticated technologies and infrastructure required for waste management, nor can we afford the rapidly increasing costs of importing such technologies or setting up infrastructures to cater to waste management and pollution abatement, given the more urgent requirements of the country. Industry and commerce, the major sources of pollution, have not taken their part of the responsibility seriously either, and have focussed more on profits, than on clean manufacturing technologies. In addition, in the process of adopting Western consumeristic lifestyle patterns, we have alienated ourselves from the wisdom of our traditional knowledge and philosophy and are in a sorry state of affairs in so far as management of resources are concerned. The need, therefore, is of introspection and finding ways which are well within the country's economic means.

Although there is widespread realisation about the seriousness of the situation, concrete measures to contain the growth of consumerism or set in place appropriate waste management mechanisms seem lacking. Not surprising, therefore, the correct attitudinal approaches seem totally absent. Such a situation is typical in the developing countries. India, and in particular, the northeast, is no exception. Shillong, over the last few decades, is symptomatic of this syndrome. Unplanned urbanisation, a steadily increasing volume of rural-urban migration (exemplifying the so called Pull-Push Syndrome) and the inadequateness of existing amenities and resources have pressurised the urban environment and its life support system to the limits of its carrying capacity. The malaise is symbolised by the decaying streams and disappearance of springs, once vibrant and abundant in the landscape of the city. Several reports about the rapid degradation of Shillong's streams have been voiced by scientists of the city, both in the media as well as scientific forums and publications. However, no concrete steps seem to have been adopted by the concerned authorities as evident from the present state of the waterbodies. The streams today, are no better than open sewage disposal channels, choked with solid waste, plastic and putrid water. Their degradation as well as the contamination and drying up of the city's springs have robbed the populace of alternate sources of potable and drinking water, adding to the difficulties,

especially during the frequent dry spells witnessed of late. The contribution of such polluted waterways to frequent gastro-intestinal disorders in the city is obvious even without scientific studies.

This paper does not attempt to give statistics or scientific data about the status of pollution in the city. Several organisations and technical experts, notably the Pollution Control Board, the University and similar learned bodies exist to execute the required studies to generate the relevant data. The attempt of this paper, however, is to suggest a few practical measures, easily adoptable at different scales - the household, community and the Government - which will contribute towards downstream recycling of waste, thereby promote optimisation of resource utilisation and thus contain waste generation, finally, helping in pollution abatement.

WASTE : CATEGORIES AND SOURCES

The fundamentals of pollution control and management, particularly waste management, entails categorisation of types of waste and identification of sources. It is superfluous in the context of this paper to go into details. However, one needs to emphasise that for several categories of waste (and subsequently, pollution), the household is the primary point source of waste generation. Further, for pollution abatement measures and waste disposal and management, it is the household which should be the fundamental unit for all pollution control efforts. Major control-measure efforts tend to completely overlook this basic fact and instead start at the community level. By ignoring the household, a critical opportunity is missed. Taking the household as the basic unit ensures participation of the family and in waste recycling and downstream product generation measures, the benefits accrue directly to target families, thus offering immediate incentives for waste containment. Further, such management initiatives involve little investments on the part of the managers but at the same time guarantee containment of waste generation right at the source. In addition, the household as a unit in attitude moulding efforts is much more amenable, effective and manageable than larger social units such as local groups or the community.

With the point source identified, it is relatively easy to categorise and manage waste. Waste can be solid or liquid, biologically degradable, or recalcitrant. Both types are generated by a household, but in general, households normally generate both solid and liquid biodegradable waste in the course of their day to day activities. Once the source and categories are identified, it is easy to formulate management options and solutions. This paper lays more emphasis on solid biodegradable waste for the singular reason that opportunities for downstream product generation using low cost, simple technologies with very little infrastructural needs are far greater with such waste as raw material than any other waste. Non-biodegradable solid waste, as well as liquid waste, require both technologies (often sophisticated and expensive) and infrastructure, which are not practically accessible to the individual household and therefore, does not form the focus of attention of this paper.

MANAGEMENT OPTIONS AND THE DIFFERENT PLAYERS

The first step in management should be to explore possibilities for economising use. The basic principle involved here is optimisation of use per unit resource. This involves developing multiple usage for different parts of the resource. In other words, explore possibilities for 'downstream resource use'; put simply, this involves finding multiple uses for the waste products. Such an approach has the twin advantage of generating more products out of the same resource while simultaneously reducing the waste that remains. The tables provided at the end of this paper list the management options for common household waste. Table II also summarises the role for different players in the business of waste management, starting from the household to the government agencies.

Common household waste are, as mentioned earlier, mostly biodegradable. The most common waste generated by households is kitchen and domestic waste. Such waste is easily biodegradable, but if allowed to enter waterways, cause eutrophication and purification, thus contaminating waters. Left exposed in garbage dumps, they encourage breeding of flies which are important vectors of several diseases. The easiest disposal method is to utilise such waste as raw material for biocomposting and vermiculture. Both these methods help in conversion of such waste to useful products and can also contribute to biofertiliser production, thus providing an income generation avenue and at larger scales, can contribute substantially in boosting agricultural production and ensuring the development of sustainable agriculture while simultaneously providing opportunities for generating energy from a non-conventional alternate energy source.

Biodegradable vegetable and animal waste, paper and similar material are also generated on large scales everyday in the city's market places. Management of such waste in a manner which promotes downstream product generation is the responsibility of local and state authorities. Such resources offer ample opportunity for resource optimisation and multiple product generation. Biowaste gathered from the markets can be utilised profitably for generating energy for burning, heating and lighting while the residue can further be utilised as biofertilisers. Technologies for such utilisation are easily available and with a little effort, Shillong's biowaste can provide energy to her citizens and biofertilisers to the farmers in her hinterland, while simultaneously helping in waste disposal and pollution abatement.

In addition to biocomposting and vermiculture, green waste such as weeds, hedge cuttings and twigs can be utilised for the manufacture of briquets. Briquets are basically fuelcakes made of weeds, branches and soil. Such briquets are extremely efficient fuel sources and can provide a viable alternate to fuelwood, especially for the lower income groups and the rural populace, thus easing the pressure from fuelwood during the winter months. The briquets can also be used for cooking and can thus provide a cheap alternate to kerosene for the poor families. This technology has great potential for the rural areas and the concerned authorities need to seriously explore the possibilities for spreading it, especially in the rural areas. Betel nut chewing is a common practice in rural Meghalaya as well as many other parts of the Northeast. The husks of the nut are normally discarded as waste, but in some areas, sometimes used as fuel for burning. Utilising the husks as an ingredient in briquetting enhances its fuel value per unit. The husks are known sources of a dye; even after extraction of the dye, the residue can still be used in briquetting. Thus, the downstream value of betelnut husks can be further enhanced.

As evident, management options are many, but the need is to identify appropriate technologies and actors and streamline waste disposal. Ample opportunities exist whereby waste can be turned into profitable ventures while ensuring pollution abatement and control. The role of the government is important, but what is necessary is an attitudinal change where waste management becomes everybody's concern and efforts start at individual households rather than at the government level. Communities, educational institutions and non-government voluntary organisations, each have their own role to play in monitoring, managing, educating and moulding attitudes, lifestyles and the general outlook and perception on resource utilisation, consumption patterns and waste generation and disposal.

It may not be out of context here to point out a gradual degradation that has overtaken us at all levels - this transformation is the almost complete lack of self confidence and the absolute dependence on external aid which has overtaken today's society. Such dependency or the Aid Syndrome has completely eroded our sense of self dependency and forms, in our opinion, the most serious form of pollution in today's society. The only solution to this pollutant is a determined attitudinal change, a rejuvenation of our confidence in ourselves; and to do that, we need to infuse the sense of self confidence into our households through small, simple steps such as those of biocomposting, vermiculture and briquetting. By themselves these techniques are unimpressive but their contribution in boosting production and making a household self sufficient in day to day vegetable needs, in energy requirements and in income generation cumulatively adds up in confidence building and play a major role in changing attitudes and thus, in the long run, in optimisation of resource use.

The authorities, on their part, need to streamline collection points, encourage disposal according to type, and ensure sufficient waste disposal and collection points so that citizens do not require to dump waste on roadsides, drains and streams. The government can adopt several of the techniques available as management options, whereby they can ensure waste management, pollution abatement, product development, entrepreneurship and income generation and long-term sustainable development and environmental conservation. The northeast region may be under developed in conventional economic terms, but the plethora of opportunities available for sustainable development of the region in ways that are in harmony with conservation concerns must be the envy of many developed nations. It is up to the citizens of the region, the government and the scientific community to work in harmony in realising this end and providing an example to the nation and the world to emulate.

TABLE - I

THE ROLE OF HOUSEHOLDS, COMMUNITIES, NGOS AND THE AUTHORITIES IN WASTE MANAGEMENT

Waste Category	Household	Community	NGOs	Government
Biodegradable * Green waste (including vegetable and kitchen waste)	Use in biocomposting/ Vermiculture. Use products in gardens and for potted plants	Actively encourage green manuring, biocomposting, vermiculture and production of biofertilisers and organic farming	Organise Community level Demonstration/ Training Programmes. Organise Community Biofertiliser Production Units. Link with farmers, nurseries to establish market linkages and encourage entrepreneurship	Develop largescale grassroot level programmes on Biofertiliser Production; simultaneously encourage bio- organic farming for sustainable agriculture. Facilitate linkages between production and consumer groups. Ease transfer of technologies between Tech- nology envelopment Organisations (RRU, GBPIHED, TERI, Development Alternatives, Universities) and technology user groups. Provide Forums for exchange of ideas between different user groups. Generate incentives for waste management and product multiplication efforts.
* Green Weeds, Prunings, Twigs (Garden waste)	Biocomposting/ Biobriquetting	Encourage establishment of biobriquet manufacturing and marketing groups	Organise Awareness/ Demonstration/ Training Programmes	Establish Community Groups for biobriquet production, provide financial assistance particularly encouraging unemployed youth and women of the

Waste Category	Household	Community	NGOs	Government
				low income and disadvantages categories. Encourage non-conventional energy alternatives, especially for lower income categories. Establish linkages between technology development agencies and user groups. Facilitate Community participation in such schemes.
* Waste Paper	Economise on paper use, encourage recycling	Encourage recycling, reuse	Organise paper recycling awareness campaigns. Facilitate transfer of technology for handmade paper, carrier bag making, packaging material, corrugated package sheets, hardboard, create attitudinal	Gradually switch to electronic data filing and retrieval systems. Encourage inhouse recycling of paper, Facilitate access to information/ technology transfer for multiple recycling of waste paper.
* Clothes	Donate unused clothes to less fortunate members of society, Reuse as cushion fillings, bedding material, packaging or use in biocomposting.	Collect unused clothes for donation to orphanages, hospitals, etc.; Encourage community groups for manufacture of cushions, packing material, bedding etc.	Awareness generation, organise groups, help in market linkages.	Provide infrastructural and financial help in establishment of such units.

Waste Category	Household	Community	NGOs	Government
Non Biodegradable				
* Plastic Bottles	Reuse/recycle	Discourage dumping; promote recycling, reuse	Organise Collections by reuser firms/ generate appropriate reuse technologies	Identify downstream reuse avenues and facilitate transfer of technologies
* Plastic bags	Avoid usage; find alternatives; refuse plastic carrier bags, especially coloured. Do not carry edibles in coloured plastic bags - they are carcinogenic and poisonous. Do not burn plastic bags - the fumes are deadly poisonous and can cause fatal injuries.	Enforce severe strictures on the use, disposal and dumping of plastics, especially burning and dumping in drains, water channels, streams. Promote paper carrier bags and cloth shopping bags. Educate about dangers of plastic carrier bags.	Vigorous Awareness campaigns against plastic carrier bags and the dangers of such material. Generate Public opinion against the use of plastics. Pressurize authorities to enforce ban on plastic usage. Simultaneously explore and encourage collection and safe disposal, or link with commercial houses for recycling.	Enforce existing legislation for total ban. Promote taxation to discourage usage and recycle revenue generated for encouraging alternative biodegradable material. Enforce legal action against shops providing plastic bags; use appropriate legal provisions for actions against individuals, localities, communities dumping plastic into drainage channels and ensure strict enforcement.
* Biomedical/ Hospital waste	Ensure safe disposal by burning. Do not dispose of in open dumps or drainage channels as such material can potentially give rise to infectious diseases.	Discourage disposal/dumping in public places. Ensure incineration of such waste by the household/ clinic/dispensary/ hospital.	Vigorous Awareness campaigns for educating the public against unsafe biomedical/ hospital waste disposal. Create Public opinion and pressure on authorities for strict enforcement of disposal methods. Educate on the health hazards of such waste.	Enforce existing legislations on Biomedical/ Hospital waste disposal. Ensure strict adherence by all groups. Encourage Awareness campaigns, initiate public awareness campaigns, particularly on health hazards, existing legislation and the dangers of epidemics due to unsafe disposal methods.

Table - II

THE ROLE OF DIFFERENT PLAYERS IN WASTE MANAGEMENT

Households	Community	Educational Institutions	Non-Governmental Organisations	Government
• Economise resource use • Maximise resource usage • Explore ways for utilising waste • Practise biocomposting/ Vermiculture/ green manuring • Promote organic farming • Initiate neighbours and friends into such ways • Imbibe proper waste disposal methods and correct waste management ethos • Discourage using neighbour's compound as waste dumps • Discourage use of roadside drains/footpaths outside your compound as your garbage dump • Always sort waste into biodegradable and non-degradable categories and dispose separately • Encourage use of designated areas for	• Imbibe locality cleanliness ethos • Encourage waste recycling • Strictly discourage dumping/ burning of plastic • Designate areas for dumping to help community members know where they can dump waste • Ensure separation of dumping sites for biodegradable and non-biodegradable waste • Pressurise civic authorities for regular collection or handing over to private waste disposal firms • Promote organic farming, biocomposting vermiculture • Facilitate information accessibility, transfer of technologies, demonstration	• Create awareness among students and teaching community about correct consumption ethics • Educate on resource use patterns, resource management and optimisation principles • Create awareness of traditional waste management practices and technologies • Create respect for indigenous knowledge and traditional wisdom • Encourage proper ethics and the sense of sharing, community values. • Educate on shallowness of consumeristic lifestyles.	• Carry out large scale awareness campaigns to generate correct public attitudes and opinions • Create pressure on authorities to enforce existing regulations on proper waste disposal, pollution abatement measures. • Organise awareness camps, demonstration and training of waste disposal and downstream product development technologies, ensuring community participation. • Facilitate linkages between community, government, development agencies, technology developers, academia for participatory exchanges and capacity building • Establish market linkages for community	• Increase waste collection points to ease citizens attempts at keeping the city clean • Encourage waste sorting • Establish separate dumping/ collection points for biodegradable waste • Strictly enforce regular waste collection • Explore ways for privatisation of waste disposal and management • Encourage technical, trained unemployed youth to set up private waste management entrepreneurship enterprises • Ensure adherence to existing legal provisions on waste disposal and pollution abatement • Explore ways for introducing environmental levies,

Households	Community	Educational Institutions	Non-Governmental Organisations	Government
waste disposal • Discourage plastic bags - say NO to plastics • Make your family members, friends and neighbours do the same • Explore innovative re-use methods • Use all available opportunities to educate others	and trainings • Organise talks, discussions and debates among youth to imbibe correct attitudes to consumption patterns, lifestyles and waste management		produces • Encourage local gender/youth groups for participation in waste management efforts • Encourage entrepreneurship among such groups, especially in product development from waste • Promote biocomposting, vermiculture, organic farming.	particularly for pollution of waterbodies. • Utilise revenue collected from such taxes to introduce technologies for waste management and downstream product multiplication • Encourage and promote people's participation in waste management • Facilitate transfer of technologies and explore ways for easy accessibility of such technologies even at the grassroot level • Establish mechanisms for regular interaction between Technology Development Agencies, NGOs and community users of such technologies • Strengthen market linkages for local populace • Import clean technologies for production processes.

Households	Community	Educational Institutions	Non-Governmental Organisations	Government
				• Encourage organic agriculture • Promote respect for Indigenous knowledge and Resource Management Technologies

100

INVESTIGATION ON WATER QUALITY OF RIVER UMSHYRPI AND ITS TRIBUTARIES IN SHILLONG

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ABSTRACT

The water quality of river Umshyrpi from its origin point upto the stretch where it confluences with river Umkhrah along with its tributaries is investigated during 1997 from several selected sampling locations for their physico-chemical and bacteriological properties.

The low dissolved oxygen (DO), high nitrite-N ($\text{NO}_2\text{-N}$), chemical oxygen demand (COD), Bio-chemical oxygen demand (BOD), total coliform (TC) and faecal coliform (FC) values obtained for river Umshyrpi and some of its tributaries clearly indicate the polluted nature of these waterbodies. The results obtained for parameters like DO, $\text{NO}_2\text{-N}$, COD, BOD, TC and FC with the Primary Water Quality Criteria for surface waterbodies notified by Central Pollution Control Board. Some remedial measures are also suggested to reduce organic pollution load on these waterbodies.

INTRODUCTION

River Umshyrpi is an important river of Shillong (Latitude $25^\circ 35'\text{N}$ and longitude $91^\circ 53'\text{E}$) flowing across the city. It originates from the forests near Risa Colony and travels through the areas of Dhankheti, Malki, Laban and Rilbong before joining with Wah Umkhrah near Mawprem in the north-eastern direction of the city. During its course seven streams namely, Motinagar, Dhankheti, Malki, Wah Risa, Umkynrud, Wah Sohkhur and Umjasai streams joins this river. The confluence of Wah Umshyrpi and Wah Umkhrah creates Wah Ro-Ro which runs some distance through difficult and inaccessible hilly terrain and ultimately joins with Wah Umiam. The main river feeding water to the Umiam reservoir constructed in the year 1965 for generation of hydro-electric power in the state. At present the Umiam hydro-electric power project is having the capacity to generate 174 MW of power.

The last few decades have witnessed a phenomenal growth in the population of Shillong which has increased from a mere 10,000 in 1901 to more than 2, 20, 000 in 1991. This unprecedented growth in population has not only put tremendous pressure on the available natural resources but has also resulted in increased generation of sullage, solid waste and municipal wastewater in the city. But correspondingly, proper facilities for treatment of sewage, municipal wastewater and solid waste could not be created. As a result, most of the untreated municipal wastewater and solid waste of the city is directly discharged into the Umshyrpi. The existence of dry-latrines along the river Umshyrpi and some of its tributaries further pollutes these waterbodies.

The present study is an attempt to systematically assess the water quality of the river Umshyrpi and its tributaries.

MATERIALS AND METHOD

Selection of sampling locations have been done after performing a preliminary survey along the Umshyrpi river stretch from its origin point at foothills of Risa Colony upto the point at Mawprem where it confluences with river Umkhrah. Simultaneously, its tributaries are also surveyed for proper selection of sampling location to get representative results. The use of river water and its tributaries is also carefully recorded during the survey work.

For river Umshyrpi all the major localities along its course are selected for sampling. The details of these sampling location is provided in Table - I.

TABLE - I

WATER SAMPLING LOCATION OF RIVER UMSHYRPI

Sl.No.	Sampling Location	Use of Water
1	Risa Colony	drinking, washing cloths etc.
2	Dhankheti	wastewater and solid wastes discharge
3	Malki	wastewater, solid wastes and dry latrines discharge
4	Crinoline	wastewater and solid wastes discharge
5	Laban	wastewater and solid wastes discharge
6	Idgah	wastewater, solid wastes, and wastewater from garages
7	Kench's Trace	wastewater and solid wastes discharge
8	Rilbong	Washing cloths
9	Umshyrpi Bridge	discharge of dry latrines and garbage dumping
10	Mawprem	washing cloths and wastewater discharge

The water samples from tributaries are collected prior to their joining of the river Umkhrah. The details of these locations are provided in Table - II

TABLE - II

WATER SAMPLING LOCATION OF STREAMS

Sl.No.	Sampling Location	Use of Water
1	Motinagar Stream	washing cloths
2	Dhankheti Stream	wastewater, solid wastes and dry latrines discharge
3	Malki Stream	wastewater, solid wastes and dry latrines discharge
4	Wah Risa Stream	drinking
5	Umkynrud Stream	wastewater and solid wastes discharge
6	Woh Sohklar Stream	wastewater and solid wastes discharge
7	Umjasai Stream	washing cloths, wastewater and solid wastes discharge

The water sampling was performed using grab sampling technique. The water samples were collected at day time during Jan and Feb, 1997 thus eliminating the chances of wash out affects of the rainy season. The physico-chemical and bacteriological analysis was performed as per the Standard Methods (1).

RESULTS AND DISCUSSION

The water analysis result of the selected locations of river Umshyrpi is given in Table - III.

TABLE - III

WATER QUALITY OF RIVER UMSHYRPI

Sampling Location	pH	DO mg/L	CON umho/cm	TDS mg/L	NO ₂ mg/L	NO ₃ mg/L	BOD mg/L	COD mg/L	TC MPN/100m	FC MPN/100ml
Risa Colony	7.3	10.5	39.0	25.3	0.04	0.10	8.5	15.6	34	18
Dhankheti	7.1	3.3	136.0	120.5	0.08	1.40	20.8	70.5	63000	27000
Malki	7.4	3.2	210.0	167.0	2.00	3.50	40.0	58.8	100000	70000
Crinoline	7.5	5.0	145.0	120.0	0.85	1.80	30.0	84.0	80000	420000
Laban	7.5	5.3	147.0	115.6	1.00	2.60	90.0	156.0	120000	94000
Idgah	5.3	5.0	239.0	192.5	1.80	3.00	40.9	99.6	180000	100000
Kench's Trace	7.6	4.8	244.0	215.0	2.10	4.00	50.0	80.5	195000	110000
Rilbang	7.8	5.6	184.0	150.6	1.00	2.50	63.0	97.4	94000	43000
Umshyrpi Bridge	7.5	5.7	198.0	165.8	1.20	2.70	130.8	172.0	200000	120000
Mawprem	7.8	6.2	235.0	180.5	1.40	3.00	152.1	291.9	24000	154000

It can be observed from this table that low dissolved oxygen (DO) and very high biochemical oxygen demand (BOD) and chemical oxygen demand (COD) values were obtained for all the locations except Risa Colony which was the origin point of the river. The exceptionally high total coliform (TC) and faecal coliform (FC) values obtained for said locations are the clear indication of the contamination of river water with raw sewage and municipal solid and liquid wastes. It can also be observed that the TC and FC bacterial count is continuously increasing from the origin point to the location at Mawprem where the river confluences with wah Umkhras. At this location the bacterial count was found to be in the highest detectable limits which demonstrates the seriousness of the situation.

Table-IV provides the water analysis results obtained for the streams joining with river Umshyrpi.

TABLE - IV

WATER QUALITY OF THE TRIBUTARIES OF RIVER UMSHYRPI

Sampling Location	pH	DO mg/L	CON umho/cm	TDS mg/L	NO ₂ mg/L	NO ₃ mg/L	BOD mg/L	COD mg/L	TC MPN/100m	FC MPN/100ml
Motinagar	7.1	6.9	50.0	35.5	0.05	0.08	20.0	31.5	70	27
Dhankheti	7.2	1.3	172.0	145.6	0.10	1.50	28.0	53.8	54000	23000
Malki	7.1	4.5	190.0	155.8	1.00	4.50	30.0	78.4	50000	27000
Wah Risa	7.6	9.0	50.0	35.5	BDL*	1.00	0.5	2.0	10	2
Umkynrud	7.2	3.6	136.0	115.8	0.08	2.00	7.0	15.8	91000	54000
Wah Sohklur	7.5	3.8	159.0	120.0	0.05	1.50	60.0	94.0	23000	15000
Umjasai	7.6	6.0	144.0	115.5	0.10	1.20	50.0	78.4	94000	26000

BDL* = Beyond Detectable Limits

The result (Table-IV) indicates that except the Wah Risa stream all other streams are showing low DO and high BOD, COD and nitrite-N values. The TC and FC bacteria were also found to be in quite high number. The water of these streams is also found to be equally contaminated as found at the various sampling locations of river Umshyrpi and the reason for the degradation of streams water quality were also same.

The Central Pollution Control Board have notified the Primary Water Quality Criteria for surface waterbodies with designated best use (Table-V).

TABLE - V

PRIMARY WATER QUALITY CRITERIA

Designated Best Use	Class of Water	Criteria
Drinking water source without conventional treatment but after disinfection	A	1 Total Coliform Organism MPN/100 ml shall be 50 or less. 2 pH between 6.5 and 8.5 3 DO 6 mg/l or more. 4 BOD (5 days at 20oc) 2mg/l or less
Outdoor Bathing (Organised)	B	1 Total Coliform Organism MPN/100ml shall be 500 or less. 2 pH between 6.5 and 8.5 3 DO 5mg/l or more 4 BOD (5days at 20oc) 3 mg/l or less
Drinking Water Source	C	1 Total Coliform Organism MPN/100 ml shall be 5000 or less. 2 pH between 6 to 9 3 DO 4mg/l or more 4 BOD (5 days) at 20°C) 3mg/l or less
Propagation of Wildlife and Fisheries	D	1 pH between 6.5 and 8.5 2 DO 4mg/l or more 3 Free Ammonia (as N) 1.2 mg or less.
Irrigation, Industrial, Cooling	E	1 pH between 6.0 to 8.5 2 Electrical Conductivity at 25°C micro mmo/cm max 2250. 3 Sodium Absorption Ratio max 36 4 Boron max 2 mg/l

As per this classification, the river Umshyrpi falls under Category 'E' which indicates that the water of river Umshyrpi and its tributaries (except Wah Risa) should be of use only for irrigation, industrial cooling and controlled waste disposal.

CONCLUSION

It is evident from the above results that river Umshyrpi and its tributaries have become heavily polluted due to the indiscriminate discharge of municipal wastewater, solid wastes and raw sewage into these water courses which is much beyond their assimilative capacities. As the water of these waterbodies ultimately reaches to Umiam lake, the lake water is also polluted to great extent.

The situation requires immediate corrective measure to contain the further water pollution of these waterbodies. Some measures are suggested here for reduction in the organic pollution load on river Umshyrpi and its tributaries.

- I. To prepare an inventory of the owners of the drylatrines along the water courses of river Umshyrpi and its adjoining streams. So that, these owners may be encouraged for conversion of their dry-latrines into septic tank latrines etc. This will check the flow of the raw sewage into the waterbodies.
- II. Dumping of the garbage and other solid wastes into these waterbodies should be banned. Suitable number of dust bins should be provided along these water courses. The timely collection of the garbage for disposal in suitable manner should be ensured.
- III. The owners of garages and restaurants, Nursing Homes, Slaughter Houses situated along these waterbodies should be asked to release wastewater only after providing necessary treatment.
- IV. The NGO's should be encouraged to take-up the mass awareness campaigns to educate the masses about the harmful effects of indiscriminate disposal of wastewater and solid wastes into surface waterbodies.
- V. The water quality of these waterbodies should be regularly monitored by the appropriate agency to observe the changes brought in due to the above measures.

REFERENCE

- 1 Standard Methods for the Examination of Water and Wastewater, 16th Edn. American Public Health Association (APHA). Water Pollution Control Federation and American Water Works Association, Washington, D.C. (1985).

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LANDSLIDE STUDIES IN NORTH EASTERN INDIA WITH SPECIAL REFERENCE TO MIZORAM STATE

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ABSTRACT

It is emphasized the increasing need of systematic study of landslides as the hazards are progressively increasing in recent times, effecting the environment of the hilly terrain of North East India.

Various approaches of landslides studies are discussed. It is highlighted that the studies should be need based and oriented to met the requirement. While every approach has its own merits, it is suggested to adopt the best suitable method of study for each individual case with due consideration of prominent causative factors, scale of study, area to be covered and the time schedule to be adhered.

A preliminary landslide hazard zonation has been carried out in southern part of Mizoram. In order to cover a vast area of about 6,700 sq. km. in a short span of two years, a unique strategy was adopted for rapid assessment of the terrain. Geocoded IRS imageries have been utilised for the purpose along with the help of toposheets on 1,50,000 scale. The study helps to delineate the entire region into three categories - Low Hazard Zone, Medium Hazard Zone and High Hazard Zone. It also helped to identify the critical portions within the high hazard zone where detailed studies have been carried out by inducing further input parameter of causative factors. The studies are helpful to the end users and can be used as, a baseline document for planning their development activities in the area.

INTRODUCTION

Landslides are recurring natural hazards, causing extensive damage to road network and townships in most of the hill states of the North Eastern Region. It has been assessed that around 4.5 million sq. km. or 15 percent of India's land area is landslide prone, out of which around one fifth is located in North Eastern Region.

Downward and outward movement of slope forming materials composed of natural rock, soils or combination of these materials is generally accepted as a landslide. There are many factors such as geology, topography, vegetation, rainfall and land use pattern etc., which contribute to the formation of landslides. Since the North Eastern Region possesses inherent fragile rock conditions, geologically active tectonic set-up, sensitive seismicity and high rainfall, the region experiences frequent landslide incidences. Though all the factors, excepting the intensive land use patterns have been continuing for ages, the problem of landslides has been increased recently or gained much attention during recent times. It is expected that the importance of landslide hazards is going to be increasingly felt in the years to come, mostly because of the aggressive human interference with the nature by laying roads, especially in the mountainous terrain and increased awareness of the importance of hazards.

It is recorded that about 56 landslide investigations have so far been carried out by GSI, NER for the last two and half decades, since the NER, GSI was in operation w.e.f. 1974. Statewise particulars of the studies carried out are given in Table - I.

In addition to the umpteen number of piece-meal studies, a preliminary landslide hazard zonation map of North East India on 1:1 million scale was prepared way back in 1980. (Majumdar, 1980).

TABLE - I

STATE	YEAR (FROM-TO)	NO. OF INVESTI-GATIONS	REMARKS
Assam	1974-98	5	Landslide and slope stability studies along road sections in Cachar, Karbi Anglong and N. Lakhimpur districts.
Arunachal Pradesh	1975-98	15	Landslide studies along road sections and selection of bridge sites in different parts of the state.
Meghalaya	1974-98	11	Slope stability and subsidence studies in different parts of the state.
Tripura	1988	1	Landslides studies at Gumti hydroelectric Project.
Mizoram	1974-97	11	Landslide and slope stability along road sections, townships and at bridge sites. Also landslide hazard zonation studies in south Mizoram.
Nagaland	1976-93	8	Landslides along road sections in different parts of the state.
Manipur	1978-91	5	Landslides and subsidence studies along road sections and at Handung cement plant site.

TYPES OF APPROACHES

Depending on the causative factors, the landslides also vary from one to, 'another in intensity and extensiveness. The identification of crucial factor responsible for sliding will be immensely useful for adopting the measures to contain slides and to protect potential slope failures..

Each landslide problem has to be studied on its own merits. It is not advisable to extrapolate the results of study of landslides of one area to that of another area. Several approaches of landslide studies have been developed by various workers In the field during the last few decades. All these techniques need not be applied to the same area. But the methodology to be adopted may be decided after considering the requirement of the situation and should be need based.

Detailed study of individual landslides is an important aspect for understanding causes of failure and possible measures to contain it. Individual landslides may extend in area from a few square meters to even a few tens of square kilometers. If the slide is within the overburden soil, a tentative slip circle may be worked out by established procedures (Edwin B. Eckel, 1958) 2. If the slide is within the bedrock, the orientation of discontinuities present in rock types vis-@-vis the ground slope are to be studied.

Slope Mass Rating (SMR) technique developed by Romana (1988) involves application of the Rock Mass Rating (RMR) of Bieniawski, which is substracted by Factorial Adjustment Factor (FAF) which again depends on the joints - slope relationship and by adding a factor of safety depending on the method of excavation. The study requires Estimation of RMR, which needs detailed study at very close intervals. The approach may be adopted in the development of safe quarries, which cover a very small area.

Landslide Hazard Evaluation Factors (LHEF) rating scheme of Anbalagan (1992) is a numerical system based on the main causative factors of slope instability viz. lithology, structure, slope morphometry, relative relief, land use and ground water conditions. It involves a detailed study at close intervals. The study may be useful to assign certain value to potential instability of the slope. This approach may be adopted for terrain evaluation, which covers reasonably a small area.

Surface area ratio between surface area and its horizontal plane component / projection of the same area gives an idea of ruggedness of topography. This involves close study of toposheets, where slope

facets are to be marked, having uniform slope. As the study totally ignores geological aspect, by adding geological in-put parameters, it is possible to evaluate the terrain to delineate certain pockets, which require special attention. It is time consuming and such studies can be carried out within a reasonable time frame over limited areas only.

Landslide area percent is done in widespread and extensive landslide affected terrain where the percent of area of landslide affected in each square kilometre has to be where computed (Sharma, R.P., 1996)3. Based on the percentages obtained, equal slide area contours can be drawn to decipher the zones of varying grades of landslide potentiality. The procedure may be adopted to delineate the high potential zones in an area covering a few hundred square kilometres. The main disadvantage in the approach is that it concentrates on landslides that already occurred, ignoring the possible potential and vulnerable zones of landslides where preventive measures are called for. It is to be mentioned here the comprehensive study of landslides made at Nilgiris (Seshagiri, D.N and Badrinarayanan, S., 1982)4 considered the effects of many natural and man made factors which contributed to the extensive landslides in the area and recommended certain immediate and long term remedial measures to improve the stability of the terrain.

Aerial photostudy is also immensely useful for landslide studies especially, in a large and inaccessible terrain. Aerial, photographs present a complete map and a three dimensional picture of any terrain. When they are properly studied and interpreted, they reveal topography and landslides as well. The aerial photostudy can be done within a short@ period. It should be kept in mind that aerial photostudy cannot replace ground investigations entirely. However, the study with proper planning can profitably reduce the field checks to a minimum. Landslide hazard zonation maps of parts of Himalayas and North Eastern Region (Majumdar, 1980) prepared earlier have a good backing of aerial photostudy. The approach is also suitable for studying unstable slopes and landslides around the periphery of large reservoirs.

LANDSLIDE HAZARD ZONATION STUDIES IN MIZORAM

The Mizoram was rocked with such severe and extensive landslides almost throughout the state during 1993 and again in May, 1995. Following that, the Government of Mizoram requested the Geological Survey of India to take up the study of landslides in south Mizoram on priority basis to meet the immediate and long-term requirements for planning preventive and relocative measures. In accordance with the request, the item of rapid preparation of preliminary landslide hazard zonation map of south Mizoram of the area bounded by Lat. 22° N and 22° N and Long. 92°20' E and 93°10' E, a total of 6,700 sq km area in Chhimtuipui and part of Lunglei districts has been taken up on. 1:50,000 scale, (Aloke Sen, et.al., 1995-97)s followed by detailed studies of critical areas selected thereon. (M.Raju et.al., 1997-98)6.

PRELIMINARY STUDIES

A strategy has been devised for rapid assessment of landslide hazard zonation and also to cover a vast inaccessible area within a short span of time it is mainly a qualitative approach, involving preparation of three types of thematic maps:

Map Showing Landslide Incidences

IRS-LISS 11 imagery, in the false colour composite mode, geocoded on 1:50,000 scale was used for visual interpretation of landslides. By studying the imageries taken during both pre- and post- monsoon periods the incidences of landslides were marked on an overlay, (a). The landslides were identified by the tonal variation in the imagery. Where there was an element of doubt aerial photos of that particular spot were also consulted. Since there are quite a large number of slides present in the hilly state and most of the locations are inaccessible, the study of the imageries greatly helped to mark them. Thus the landslide incidence maps have been prepared for the entire southern Mizoram.

There are certain limitations in the study, for, the imagery is having a resolution of 36.50m, it is very difficult to pick up small landslides which are having plan width of less than that and there is a possibility of wrong interpretation of jhoom cultivation as landslide. Since the state is thinly populated and highly inaccessible,

such areas are very less, limiting the errors to the minimum. Besides consultation of aerial photos further reduces such interpretation errors.

Map Depicting Different Types Of Slopes

The Survey of India toposheets on 1:50,000 scale were used to prepare the maps depicting a three-tier classification of the slopes. Generally it is considered that the valley bed and stream bed portions are "low slope zones" and the crest lines of the ridges and hill tops are "medium slope zones". The sloping segment between the crest and the bed is considered "high slope zone". Wherever it is feasible, such classification is based on measuring the angle of the slope. If the number of contours (contour interval 20m) are 10 or less than 10 in a span of 1 cm on a toposheet (500m) i.e. 200 m vertical to 500 m horizontal, the slope angle is maximum of 22° and the slope is considered "low slope zone". When the number of contours per centimetre length on toposheet are more than 10 but less than 20, the angle will be between 22° and 38°, the slope is considered "medium slope zone". If the number of contours are 20 or more than 20 in a centimetre length on toposheet, the slope angle will be 38° or above and the slope is considered "high slope zone". By making such differentiation, the entire toposheet was divided into 3 types of slopes, demarcating low slope zone, medium slope zone and high slope zone. Then these were transferred on to an overlay, (b). Such three-tier slope classification has been prepared for all the toposheets in south Mizoram.

Preliminary Landslide Hazard Zonation Map

By superimposing the landslide incidence map over the slope type map of a Particular toposheet, the composite map of preliminary landslide hazard zonation map was prepared, bringing out three categories, viz., High Hazard Zone, Medium Hazard Zone and Low Hazard Zone. The specifications adopted to demarcate the zones are mentioned below. By considering these factors, preliminary landslide hazard zonation map was prepared on 1:50,000 scale for the entire south Mizoram.

TYPE OF SLOPE	PRESENCE OF LANDSLIDES	LANDSLIDE HAZARD ZONATIION
High slope zone	Landslides present	High Hazard zone
High slope zone	No Landslides	Medium Hazard zone
Medium slope zone	Landslides present	
Low slope zone		
Medium slope zone	No landslides	Low Hazard zone
Low slope zone		

Out of the total area of 6,700 sq km. studied, it is estimated approximately that about 10% of area is in high hazard zone, 60% of area is in medium hazard zone and the rest 30% of area falls in low hazard zone.

DETAILED STUDIES

By the preliminary appraisal, certain areas have been identified for detailed study based on the high hazardous conditions prevailed, previous history of the sites and relative importance of the locations.

The detailed studies include field checks of selective places, making inventory of landslides within the areas identified, detailing of some of the prominent landslides and an in-depth study of causative factors of the landslides, such as - geology, rainfall, seismicity and land use patterns and collecting rock and soil samples to know engineering properties of slope forming materials. A general set of treatment measures are also suggested for protection and stabilisation of slopes.

CONCLUSION

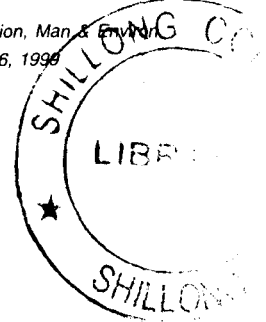
Several approaches to study the landslide are developed by various workers during the past few decades. The studies depend on their causative factors, extensiveness and latest scientific advancements. Out of various

approaches of study as discussed, the approach best suited to the requirement and terrain may be adopted in each case.

Since the traditional landslide hazard zonation takes a very long time and it is impracticable to cover a vast area in a short span of time, a rapid assessment strategy has been adopted to prepare qualitative preliminary landslide hazard zonation map for the southern Mizoram, using high resolution satellite imageries and toposheets. The landslide hazard zonation has relevance in overall regional planning of developmental activities in the hilly region, since the areas having high instability risks could be identified well in advance and treated accordingly. The information will be immensely useful to the Mizoram State Government and other concerned agencies as an important document for planning their developmental activities at appropriate places.

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MANAGEMENT OF RADIOACTIVE WASTES – AN OVERVIEW

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ABSTRACT

The wastes are undesirable but unavoidable products of an industry. Nuclear industry is no exception. Nuclear fuel cycle in the industry though produces smaller quantities of wastes, the management of wastes means care to prevent harm to men and the environment in present as well as in future as the wastes are either radioactive or contain radioactive substances.

The waste management is essentially based on principles of either concentration and containment or dilution and disposal. The former approach is more emphasised and nuclear operations are designed with inbuilt provisions to achieve the same. The approach of dilution and dispersion is mainly applied to small quantities of residual radioactivity present in the effluent arising from the concentrations and containment process.

The paper attempts to focus the problem of radioactive waste management and the current efforts in approaching a solution to the problem.

INTRODUCTION

India has an ambitious programme in the development of nuclear power. Towards the attainment of this objective, a full fledged nuclear fuel cycle has been established which include uranium exploration, mining, milling, fabrication of fuel elements & finally reprocessing and storage/disposal of spent fuel. Like any other power generation programme, the nuclear electricity generation programme also brings with it the problem of waste. However, unlike other industrial wastes, radioactive waste has an additional harmful characteristic, i.e. radiation. The radiation protection principles of time-distance-shielding are used to protect man and environment from radiation hazards which means minimising the duration of exposure, maximising the distance from the source and used protective shielding to block radiation. Therefore, management of radioactive waste requires additional safety measures. This paper attempts to analyse the efforts being made in solving the problems of radioactive wastes coming from nuclear fuel cycle.

SOURCES OF WASTE AND ITS CLASSIFICATION

Wastes generated in various steps of nuclear fuel cycle are :

No.	OPERATION	WASTE	CLASSIFICATION
(i)	Exploration	Gamma Radiation, Dust from drilling, exploratory excavation	Low level
(ii)	Mining	Radioactive dust & Radon gas	Low level
(iii)	Milling	Radium in liquid waste	Low level
(iv)	Fuel Fabrication	Solid waste as metal scrap, liquid waste.	Low level
(v)	Reactor Operation	Liquid waste, gaseous waste, spent fuel	Low & Intermediate level
(vi)	Spent Fuel - reprocessing	Solid, liquid & gaseous	High level

Radioactive waste may be solid, liquid or gaseous in nature. The classification of waste is done based on radioactivity as low, intermediate & high level. Radioactivity in low level wastes varies from 10^{-6} to 10^{-3} microcuries/ml and are discharged into environment under controlled conditions. In intermediate level wastes, the activity varies from 10^{-2} to 1 microcuries/ml. This needs some treatment before being discharged. The wastes with activity more than 10 microcuries/ml are classified as high level and are normally chemically treated and stored for long times in near surface engineered storages before final disposal in deep geological formations.

EXPLORATION

Atomic minerals are one of the main sources of natural environmental radiation. Exploration of atomic minerals normally include radiometric surveys followed by trenching, test pitting and drilling. Radioactive minerals are locked within the rocks in diluted form with limited surface exposures. The uraniferous belts recognised in India possess low grade uranium deposits and therefore has insignificant radiation impact on man & environment.

MINING

Mining of uranium is done both by open cast and underground methods. The principal sources of radiation in mines are mine dust and radon gas. They are controlled by spray of water to suppress dusts, use of dust protective mask and proper ventilation system. About 60% of total radiation dose in mine is due to inhalation of radon gas.

MILLING

Milling of uranium ore produces radioactive dust and radium (Ra-226 with half life of 1620 days) in the liquid barren liquor, produced from extraction process. It is treated with lime and barite to precipitate out radium and disposed into tailing ponds along with mill tailings. Part of the mill tailings forming solid waste is used as backfill in the mine. The overflow water from the tailing pond is monitored and released into environment with permissible limit of radium and metal ions like magnese etc. which do not pose any hazard.

FUEL FABRICATION

Fuel fabrication involves both chemical and metallurgical processes and gives rise to negligible atmospheric and aquatic discharge. Liquid chemical effluents containing mainly nitrates of ammonium and sodium are evaporated in solar ponds for recovery of salts. Wastages from the plants are stored in settling tanks, adjusted for pH and clarified water can be utilised for horti-culture purpose within the site.

REACTOR OPERATION

Radioactive waste as a result of reactor operation is small, as most of the fission products and actinides are contained in fuel pellets within the zircoloy tubes. Short lived nuclides are allowed to decay through online storage and particulate/gaseous effluents are air filtered and discharged into atmosphere through tall stacks. Liquid wastes arising from coolant leakage, resins, filters, floor washings etc, are subjected to chemical treatment and filtration. The radioactive substance is contained and converted to an inert solid using cement, bitumen etc. The Supernatants containing traces of radioactivity is discharged to nearby water body after dilution with cooling water, following the principle of dilute and disperse.

SPENT FUEL REPROCESSING

The function of fuel reprocessing is to separate residual fissile materials from the burnt fuel for possible recycling. The spent fuel has four components viz. (i) the zircaloy tubes as cladding material, housing the fuel pellets (ii) residual U-235 and U-238 (iii) Pu-239 and other transuranic products and (iv) fission products like cesium-137, strontium-90, cobalt-60, iodine-131 etc. Segregation of these highly radioactive waste constitute the

most important step of reprocessing of spent fuel. The basic philosophy in the treatment method is to concentrate and contain as much radioactivity as possible. The spent fuel along with zipcoloy tubes are dissolved in nitric acid and subjected to a series of chemical steps to separate out, purify and concentrate uranium, plutonium and fission products. The uranium and plutonium fractions are converted to fuel for re-use in the reactors. The fission products which are essentially Ra-226 and PU-239 are stored in special stainless steel tanks as conc. nitric acid solution. It is converted into an inert solid glass or ceramic matrix and retained in engineered storage for an interim period of about 25 years before ultimate disposal in deep geological formations.

ULTIMATE DISPOSAL

Underground disposal of high level radioactive waste appears to be the most viable option for permanent isolation from the biosphere. A number of geological formations like mine tunnels, deep holes, salt domes, shales, granites etc. having non porous and non-permeable characteristics are under investigation to assess their suitability as repository for final disposal of wastes. Factors to be considered for suitability of a geological formation for repository are (i) Hydrological (ii) Geochemical and Mineralogical (iii) thermo-mechanical and (iv) seismo-tectonocial. The rationale for selecting geological formations as the final disposal system are based on the following considerations :

- (i) It is an entirely passive disposal system.
- (ii) It can be abandoned with confidence after disposal and requires no continuous surveillance or monitoring.
- (iii) Deep burial below 600 to 1000 mts. Provide adequate shielding against radiation leakage.
- (iv) The geological environment has the inherent ability to absorb & dispose the heat generated by the radionuclides without any external cooling system.

CONCLUSION

India has so far accumulated sufficient experience in the management of radioactive wastes through operation of nuclear power plants over a period of about 40 years. Much of our future programme on the treatment of wastes will be directed towards management of high level wastes & investigations on deep geological disposal system. The experience to date clearly demonstrates that it is entirely possible for a developing country like India to harness the benefit of nuclear power for sustainable development.

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NATIONAL AMBIENT AIR QUALITY OF INDIA WITH SPECIAL REFERENCE TO LOCATIONS HAVING HIGHEST CONCENTRATION OF AIR POLLUTANTS (SO₂, NO₂, SPM)

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ABSTRACT

Under the Air (Prevention and Control of Pollution) Act 1981, the Central Pollution Control Board is operating the National Ambient Air Quality Monitoring Programme at 290 stations all over India. The Annual Mean Standards of Sulphur Dioxide was exceeded at 2 locations in 1992, at 4 locations in 1993, at 6 locations in 1994 and at 11 locations in 1995. The Annual Mean Standards for Nitrogen Dioxide was exceeded at 8 locations in 1992, at 7 locations in 1993, at 9 locations in 1994 and at 11 locations in 1995. Whereas, the Annual Mean Standards for SPM was exceeded at 50 locations in 1992, at 62 locations in 1993, at 51 locations in 1994 and at 69 locations in 1995.

INTRODUCTION

The Ambient Air Quality in India is degrading due to the pollutants generated from different sources. To check and control this Air Quality degradation, an Air (Prevention and Control of Pollution) Act, 1981 was passed.

Under the Air Act the Central Pollution Control Board initiated National Ambient Air Quality Monitoring (NAAQM) programme in 1984, with 7 stations in Agra and Annapara and the number of Air Monitoring stations by the end of March 1993, spreading over 24 states and 4 Union territories covering 92 Cities/towns. The Air qualities in some locations having highest concentration of Pollutants like, Sulphur dioxide, Nitrogen dioxide and Suspended Particulate Matters (SPM) are selected in this paper to represent the National Ambient Air quality/Air qualities of the 92 cities/towns monitored by the Central Pollution Control Board.

To start the National Ambient Air Quality Monitoring programme three pollutants i.e. Sulphur dioxide, Nitrogen dioxide and Suspended particulate Matter (SPM) are selected to be determined. Presently, at some locations Hydrogen Sulphide (H₂S) and Ammonia (NH₃) are also determined, besides the meteorological parameters like wind direction, temperature and relative humidity.

RESULTS & DISCUSSION

The target frequency of monitoring was twice a week i.e. 104 days in a year. This was not followed at all the locations. Therefore, the locations with less than 50 monitoring days in a year are considered as locations with inadequate data reporting, so for listing major findings, the locations with adequate data reporting have been considered. The target frequency was not strictly followed at all locations, therefore, to have uniformity more than 16 hours values in a day is considered as representative of the Air quality for that particular day. The data may be treated as indicative rather than absolute.

To maintain uniformity in determining the National Ambient Air Quality, the National Ambient Air Quality Standards have been laid down and the following Table - I presents the Air quality Standards notified in 11th April 1994 –

TABLE - I.

NATIONAL AMBIENT AIR QUALITY STANDARDS

Parameters	Time weighted Average	Concentration in Ambient Air				Method of Measurements
		Industrial Area	Residential & other Area	Sensitive Area		
Sulphur dioxide	Annual* 24 hours**	80 µg/m³ 120 µg/m³	60 µg/m³ 80 µg/m³	15 µg/m³ 30 µg/m³	1. Improved West and Geake Method 2. Ultraviolet fluorescence	
Oxide of Nitrogen NO ₂	Annual* 24 hours**	80 µg/m³ 120 µg/m³	60 µg/m³ 80 µg/m³	15 µg/m³ 30 µg/m³	1. Jacob & Hoiheiser modified (Na-Arsenite) Method 2. Gas Phase Chemiluminescence	
SPM	Annual* 24 hours**	360 µg/m³ 500 µg/m³	140 µg/m³ 200 µg/m³	70 µg/m³ 100 µg/m³	Average flow rate not less than 1.1m³ /minute	
Respirable particulate matter (size less than 10 µm (RPM))	Annual* 24 hours**	160 µg/m³ 150 µg/m³	100 µg/m³ 100 µg/m³	70 µg/m³ 75 µg/m³		
Lead	Annual* 24 hours**	1.0 µg/m³ 1.5 µg/m³	0.75 µg/m³ 1.00 µg/m³	0.50 µg/m³ 0.75 µg/m³	AAS Method after Sampling using EPM 2000 or equivalent filter paper	
Carbon Monoxide	8 hours** 1 hour	5.0 µg/m³ 10.0 µg/m³	2.0 µg/m³ 4.0 µg/m³	1.0 µg/m³ 2.0 µg/m³	Non dispersive Infrared Spectroscopy	

* Annual Arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.

** 24 hourly/8 hourly values should be met 98% of the time in a year. However, 2% of the time, it may exceed but not on two consecutive days.

MAJOR FINDINGS OF NAAQM STATIONS (Extracted from CPCB Publications)

SULPHUR DIOXIDE

The ten locations with highest concentration of Sulphur Dioxide in last few years 1992 are listed in Table II. The Annual Mean Concentration of Sulphur Dioxide violated the standards monitored at both the locations monitored in the city of Gajroula. At all other locations the Annual Mean concentrations conformed the respective standards.

TABLE - II.1

TEN LOCATIONS HAVING HIGHEST CONCENTRATION OF SULPHUR DIOXIDE DURING THE YEAR 1992

Sl. No.	Location	Annual Mean Conc. ($\mu\text{g}/\text{m}^3$)	Area class
1	Raunaq Ltd. Gajroula (U.P.)	131*	I
2	Indra Chowk Gajroula (U.P.)	141**	R
3	N.P. House, Howrah, West Bengal	58	R
4	Chemical Division Labour Club Nagda, Madhya Pradesh	51	I
5	Cossipore, Calcutta, West Bengal	47	I
6	Howrah M. Corp., Howrah, West Bengal	42	I
7	Lal Bazar, Calcutta, West Bengal	39	R
8	Kothi No. 63, Sec. 9. Faridabad, Haryana	38	R
9	Municipal Office. Rourkela, Orissa	37	I
10	RSP, Jharia, Bihar	37	I

Note : I = Industrial Area and R = Residential Area Locations where Annual Mean Concentration exceeded the Standard of $80 \mu\text{g}/\text{m}_3$ for industrial and $60 \mu\text{g}/\text{m}_2$ for residential areas.

TABLE - II.2

**TEN LOCATIONS HAVING HIGHEST CONCENTRATION OF SULPHUR DIOXIDE DURING
THE YEAR 1993**

Sl. No.	Location	Annual Mean Conc. ($\mu\text{g}/\text{m}^3$)	Area Class
1	N.P. House, Howrah, West Bengal	139*	R
2	Raunaq Ltd., Gajroula U.P.	129*	I
3	Howrah Muni. Corp. Howrah, West Bengal	119*	R
4	Indra Chowk., Gajroula, U.P.	90*	R
5	Chem. Division Lab. Club Nagda, M.P.	77	I
6	B.R.C. Udhna, Surat, Gujarat	59	I
7	Air India Bldg., Surat, Gujarat	53	R
8	Bandhaghat, Howrah, West Bengal	53	R
9	IDL OUT-Post, Rourkela, Orissa	49	I
10	S.V.R.E. College, Surat, Gujarat	48	R

Note : I = Industrial and R = Residential

* Locations where Annual mean concentration exceeded the National Ambient Air Quality Standards.

TABLE - II.3

**TEN LOCATIONS HAVING HIGHEST CONCENTRATION OF SULPHUR DIOXIDE DURING
THE YEAR 1994**

Sl. No.	Location	Annual Mean Conc. ($\mu\text{g}/\text{m}^3$)	Area Class
1	N.P. House, Howrah, West Bengal	114*	R
2	Howrah Muni. Corp. Howrah, West Bengal	102*	R
3	Raunaq Ltd., Gajroula U.P.	84*	I
4	Rallis (I) Ltd. Gajroula, U.P.	82*	I
5	Durga Traders, Ankleswar, Gujarat	68*	R
6	Cadilla Nalor Ahmedabad, Gujarat	61*	R
7	Cossipore, Calcutta, West Bengal	59	I
8	Lal Bazar Calcutta, West Bengal	57	R
9	PIDC Ind. Estate, Pondicherry	56	I
10	Town Hall, Delhi	53	R

Note : I = Industrial and R = Residential

* Locations where Annual Mean Concentration of SO_2 exceeded the Standards.

TABLE - II.4

**TEN LOCATIONS HAVING HIGHEST CONCENTRATION OF SULPHUR DIOXIDE DURING
THE YEAR 1995**

Industrial Location		Annual Mean Conc. ($\mu\text{g}/\text{m}^3$)	Residential Location		Annual Mean Conc. ($\mu\text{g}/\text{m}^3$)
01	Rallis (I) Ltd. (Pharma) Ankleswar, Gujarat	96*	Nakasipara Pump House Ghuseri, Howrah, West Bengal		105*
02	B.R.C. Udhana, Surat, Gujarat	89*	Air India Building, Surat, Gujarat		97*
03	PIPDIC Ind. Estate, Mettupalayan, Pondicherry	82*	Muni. Corp. Howrah, West Bengal		88*
04	I.P.C.L. Baroda, Gujarat	77	Cadill Narol, Ahmedabad, Gujarat		84*
05	Chem. Div. Labour Club Nagda, M.P.	59	D. Traders, Bhavana Farms, Ankleswar, Gujarat		78*
06	Basni Indl. Area, Jodhpur, Rajasthan	51	S.V.R. Engg. College Surat, Gujarat		72*
07	Renusagar Colony, Anpara, U.P.	51	Nyaymandir, Baroda, Gujarat		72*
08	Cossipore, Calcutta, West Bengal	47	G.P.C.B., Baroda, Gujarat		61*
09	Anpara Colony, Anpara, U.P.	46	Bandhaghat, Howrah, West Bengal		60
10	Parel, Bombay, Maharashtra	42	Nagda, Bhilai, M.P.		53

* Locations where Annual Mean Concentration of SO_2 exceeded the Standards of $80 \mu\text{g}/\text{m}^3$ for Industrial and $60 \mu\text{g}/\text{m}^3$ for Residential areas.

NITROGEN DIOXIDE

Ten locations having highest concentration of Nitrogen Dioxide in last few years are listed in Table - III. The ten locations with highest annual mean concentration of Nitrogen dioxide violated the standard at one Industrial location Viz. Raunaq Ltd. Gajroula and 12 Residential locations.

TABLE - III.1

TEN LOCATIONS HAVING HIGHEST CONCENTRATION OF NITROGEN DIOXIDE DURING THE YEAR 1992

Sl. No.	Locations	Annual Mean Conc. ($\mu\text{g}/\text{m}^3$)	Area Class
1	Raunaq Ltd. Gajroula (U.P.)	107*	I
2	Indra Chowk Gajroula (U.P.)	85*	R
3	N.P. House, Howrah, West Bengal	81*	R
4	Nepier, Jabalpur, Madhya Pradesh	75*	R
5	Howrah M. Corp., West Bengal	74	I
6	Kesia Lab., Alwar, Rajasthan	72*	R
7	Head Office, Bamunimaidan, Guwahati, Assam	68*	R
8	M.I.A. Alwar, Rajasthan	67*	R
9	Anantpura, Kota, Rajasthan	66*	I
10	Beat All Sport, Jalandar, Punjab	62*	R

Note : I = Industrial Area and R = Residential

* Locations where Annual Mean Concentration exceeded the national Ambient Air Quality Standards for Nitrogen Dioxide.

At three Industrial locations, fourteen residential locations and one sensitive location exceeded the respective standards in 1992.

TABLE - III.2

TEN LOCATIONS HAVING HIGHEST CONCENTRATION OF NITROGEN DIOXIDE DURING THE YEARS 1993 AND 1994

1993			1994		
Location	Annual Mean Conc. ($\mu\text{g}/\text{m}^3$)	Area Class	Location	Annual Mean Conc. ($\mu\text{g}/\text{m}^3$)	Area Class
Howrah Mun. Cor. Howrah, West Bengal	171	R	N.P. House Howrah, West Bengal	273	R
N.P. House, Howrah West Bengal	164	R	Howrah Mun. Cor. Howrah, West Bengal	218	R
Belur, Howrah West Bengal	114	I	Balor Howrah, West Bengal	186	I
Bandhaghat, Howrah West Bengal	113	R	Bandhaghat, Howrah, West Bengal	161	R
Raunaq Ltd., Gajroula, U.P.	85	I	Town Hall, Delhi	78	R
Kesla Lab., Alwar, Rajasthan	82	R	Ajanta Chemicals, Alwar, Rajasthan	75	R
Indra Chowk, Gajroula, U.P.	63	R	M.L.A, Alwar, Rajasthan	74	R
Anantpura, Kota, Rajasthan	61	I	Kesla Lab., Alwar, Rajasthan	73	R
Panbazar, Guwahati, Assam	58	R	Anantpura, Kota, Rajasthan	66	I
Nepier, Jabalpur, M.P.	57	R	Barkhera, Kota, Rajasthan	64	S

Note : I = Industrial, R = Residential and S = Sensitive

- * Locations where the Annual Mean Concentration exceeded the Standards.
- In 1993 two locations in industrial areas and 5 locations in residential area exceeded the Standard. Whereas, in 1994 one location in industrial area, seven locations in residential areas and one location in sensitive area exceeded the Standard.

TABLE - III.3

TEN LOCATIONS HAVING HIGHEST CONCENTRATION OF NITROGEN DIOXIDE DURING THE YEAR 1995

Industrial		Residential	
Location	Annual Mean Area Conc. ($\mu\text{g}/\text{m}^3$)	Location	Annual Mean Conc. ($\mu\text{g}/\text{m}^3$)
Belur, Howrah, West Bengal	181*	Municipal Corpn., Howrah, West Bengal	252*
PIPDIC Ind. Estste Mettupalayam, Pondichery	91*	N.P. House, Howrah, West Bengal	207*
Anantpura, Kota, Rajasthan	66	Bandhaghat, Howrah, West Bengal	177*
Chingavanam, Kerala	55	Town Hall, Delhi	111*
R.S.P. College, Jharia, Bihar	54	R.O., Alwar, Rajasthan	74
E.S.I. Dispensary, Najafgarh Road, Delhi	52	RIICO Pump House, Alwar, Rajasthan	74*
B.C.I. Labour Club, Nagda, M.P.	49	Nepier, Jabalpur, M.P.	65*
Near Police Station (FCI Main Hospital), Sindri, Bihar	46	Vetrinary Hospital, Kota, Rajasthan	64*
WBIIDC, Haldia, West Bengal	46	Sectional Office, Pondichery	63*
Anapara Colony, Anapara, U.P.	46	Vijay Nagar, Jabalpur, M.P.	58

* Locations where the Annual Mean Concentration of NO_2 exceeded the respective standards of $80 \mu\text{g}/\text{m}^3$ Industrial and $50 \mu\text{g}/\text{m}^3$ for Residential.

SUSPENDED PARTICULATE MATTER (SPM)

Ten locations with the highest concentration of Suspended Particulate Matter (SPM) are listed in Table - IV.1. The Annual mean concentration of Suspended Particulate Matter violated the respective standards at three Industrial, forty five Residential and two Sensitive locations in 1992.

TABLE - IV.1

TEN LOCATIONS HAVING HIGHEST CONCENTRATION OF S.P.M. DURING THE YEAR 1992

Sl. No.	Location	Annual Mean Conc. ($\mu\text{g}/\text{m}^3$)	Area Class
1	Raipur Road, Dehradun, U.P.	886*	I
2	Clock Tower, Dehradun, U.P.	596*	R
3	Shahzada Bagh, Delhi	498*	I
4	Deputy Ka Parao, Kanpur U.P.	491*	R
5	Kesla Lab, Anwar, Rajasthan	488*	R
6	Raunaq Ltd. Gajroula, U.P.	481*	I
7	SP Engg. Works, Kanpur, U.P.	472*	R
8	Nepier, Jabalpur, Madhya Pradesh	464*	R
9	Tajmahal, Ag. Uttar Pradesh	438*	S
10	Saket Bhawan, Sada Office, Korba, M.P.	417*	R

Note : I = Industrial, R = Residential and S = Sensitive

* Locations where Annual Mean Concentration of SPM exceeded the Annual Mean Standards of $360 \mu\text{g}/\text{m}^3$ for industrial, $140 \mu\text{g}/\text{m}^3$ for residential and $70 \mu\text{g}/\text{m}^3$ for sensitive areas.

TABLE - IV.2

TEN LOCATIONS HAVING HIGHEST CONCENTRATION OF SPM DURING
THE YEARS 1993 AND 1994

1993			1994		
Location	Annual Mean Conc. ($\mu\text{g}/\text{m}^3$)	Area Class	Location	Annual Mean Conc. ($\mu\text{g}/\text{m}^3$)	Area Class
Clock Tower, Dehradoon, U.P.	599	R	S. Indl. Corpn., Rajkot, Gujarat	621	I
Raunaq Ltd., Gajroula, U.P.	598	I	Air India Bldg., Surat, Gujarat	559	R
Raipur Road, Dehradoon, U.P.	585	I	Raunaq Ltd., Gajroula, U.P.	543	I
Deputy Ka Parao, Kanpur, U.P.	572	R	Clock Tower, Dehradoon, U.P.	500	R
Kesla Lab., Alwar, Rajasthan	556	R	Amausi Air Port, Lucknow, U.P.	498	I
Air India Bldg., Surat Gujarat	519	R	Kesla Lab., Alwar, Rajasthan	495	R
S.P. Engg. Works, Kanpur, U.P.	517	R	S.P. Engg. Works, Fazalgaon, Kanpur	492	R
F. & Training Centre, Kanpur, U.P.	495	R	Raipur Road, Dehradoon, U.P.	482	I
R.S.P. College, Jharia, Bihar	465	I	B.R.C. Udhna, Surat, Gujarat	480	I
Rita Sewing Machine, Ludhiana, Punjab	446	I	Deputy Ka Parao, Kanpur, U.P.	476	R

Note : I = Industrial, R = Residential and S = Sensitive areas.

- During 1993 the Annual Mean Standards were violated at 12 industrial, 48 residential and 2 sensitive areas, whereas, in 1994, 10 industrial, 39 residential and 2 sensitive areas exceeded the Annual Mean Standards.

TABLE - IV.3

TEN LOCATIONS HAVING HIGHEST CONCENTRATION OF SPM IN THE YEAR 1995

Industrial		Residential	
Location	Annual Mean Area Conc. ($\mu\text{g}/\text{m}^3$)	Location	Annual Mean Conc. ($\mu\text{g}/\text{m}^3$)
S. Indl. Corpn, 80 Ft. Road, Rajkot, Gujarat	885	S.P. Engg. Works Fazalganj, Kanpur, U.P.	565
Amausi Airport, Lucknow, U.P.	531	Deputy Ka Parao, Kanpur, U.P.	539
L. Udyod Nigam, Bhilai, M.P.	513	F. & Tra Centre, Kanpur, U.P.	526
R.S.P. College, Jharia, Bihar	496	Sojati Gate, Jodhpur, Rajasthan	436
Pologround, Indore, M.P.	478	Janakpuri, Delhi	422
Cossipore, Calcutta, West Bengal	447	Cadilla Narol, Ahmedabad, Gujarat	419
Shahdara, Delhi	437	Municipal Corpn., Howrah, West Bengal	417
Basni Indl. Area, Jodhpur, Rajasthan	435	R.O., Alwar, Rajasthan	416
Ashok Vihar, Delhi	406	Siri Fort, Delhi	408
Nizamuddin, Delhi	398	RPCB, Jodhpur, Rajasthan	368

Note : – 12 industrial, 54 residential and 3 sensitive areas exceeded the Annual Mean Standard during the year 1995.

CONCLUSION

Number of locations exceeding Annual Mean Standards for Sulphur Dioxide was found increasing from 2 locations in 1992 to 6 locations in 1995.

The number of locations exceeding the Annual Mean Standards for Nitrogen Dioxide was also found increasing from 8 locations in 1992 to 11 locations in 1995.

The number of locations exceeding Annual Mean Standards for SPM was also found increasing from 50 locations in 1992 to 69 locations in 1995.

These increases in the number of the locations exceeding the Annual Mean Standards of Pollutants signify that the National Ambient Air Quality is degrading year by year, timely control of the pollution is necessary.

COMPARATIVE STUDY ON THE PRODUCTION OF BIOGAS USING DIFFERENT SLURRIES IN A MINIATURE BIOGAS PRODUCTION SYSTEM

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ABSTRACT

There are two sources of biomass i.e. plant and animal which are potential agents for production of biogas. Biogas which contains 60% methane and 40% carbon dioxide has become an important source of non-conventional energy, an alternative to the traditional and conventional sources like fossil fuel, firewood etc. Biomass obtained from animals includes cattle dung from poultry, goat, pig, sheep and slaughter houses, fisheries waste etc. Cattle dung is most potent for biogas production. This work made a comparative study on the potency of various cattle dungs and their mixture. The result obtained from a devised miniature biogas production system revealed that pigdung was most efficient in biogas production as compared to mixture slurry, poultry litter slurry, and cowdung slurry. This suggests that the anaerobic bacteria responsible for methanogenic activities were more active in pigdung slurry than of the slurry. This envisages that in place like Meghalaya, pigdung, which is found in plenty can be used as a potential source of alternative energy even at low temperature, although biogas production is better achieved at temperature above 300°C. This would serve a dual purpose - production of fuel and manure from waste slurry.

INTRODUCTION

Biogas is a mixture of gases produced by anaerobic bacterial digestion of organic matter. Biogas consists mainly of methane (ca.60%) and CO₂ (ca.40%) plus traces of and other gases. It is produced by anaerobic degradation of a variety of organic materials, ranging from simple sugars to polymers like cellulose and nucleic acids by a community of organisms. Anaerobic digestion occurs in nature in the sediments of lakes and ponds, and in the rumen of cattle; it is carried out by man by a variety of reactors called digesters and even in land-fill sites under nonseptic conditions. A landfill site is a location at which a pit was filled with, usually, domestic refuse, covered with soil and generally landscaped. The substrate usually employed for biogas generation is a waste product of agricultural, animal husbandry or domestic origin. The organic wastes of animal origin are the most commonly used feedstock material for biogas production and these require no special treatment as they have already undergone mechanical and biochemical treatments in the animals gut.

The present paper presents the results obtained from an experiment performed to study relative amounts of biogas produced from various animal wastes using a devised miniature biogas production system.

MATERIAL & METHODS

SUB-STRATE

Four different types of organic wastes of a origin was taken. These cowdung, pigdung, poultry litter and the fourth one was a mixture slurry of the three dungs.

APPARATUS

A simple apparatus a miniature biogas producing system was designed for the experiment. A 5 kg metallic cylindrical container was taken which was provided with two outlets opposite to one another at the upper region of the container. One of the outlets was connected with a rubber tube which was again connected with a graduated glass tube. The other outlet was also connected with a rubber tube provided with a stopper. The latter system could serve as a safety system in case the gas production was more than expected. The metallic container served as the digester and the two rubber tube provided outlets for the gas produced. The graduated tube was fitted with a improvised manometer in order to measure the pressure of the gas produced in the digester (Fig - 1). A set of four such apparatus were designed exactly in the same manner taking the same type of materials, each one serving as a "MINIATURE BIOGAS PRODUCING SYSTEM".

Making of the slurry

Four different types of slurries were prepared from the three types of organic wastes. The slurries were i) Cow Dung slurry ii) Poultry Litter slurry iii) Pig Dung slurry iv) A mixture slurry

The individual slurry was prepared by taking 1 kg each of the three different organic wastes separately and then mixing thoroughly with 1 litre of warm water. The mixture slurry was prepared by taking equal amounts of the three different organic wastes, together weighing 1 kg and then mixing with 1 litre of warm water.

The four slurries thus prepared were introduced in the four digesters, one slurry to each digester. After the four digesters were loaded with the slurries. They were sealed and made airtight. This was done in order to establish anaerobic condition inside the digester and to avoid unwanted escape of the biogas produced.

MAKING OF THE MEASURING SYSTEM (MANOMETER)

The graduated tube was then filled with a little amount of mercury. On top of the mercury was added a layer of water followed by a thin layer olive oil. These three liquids (mercury + water + oil) served as kind of manometer to measure the pressure of the biogas produced inside the digester (Fig - 2). Each of the digesters had the equal amount of liquids in the graduated tubes.

The whole system was then fixed with the help of stands and fasteners so that there was no mechanical disturbances to the whole system. The four sets were then left undisturbed after recording the initial level oil in the tube and the readings were taken after 48 and 96 hours of the installation of the system.

OBSERVATION

As the biogas was by the anaerobic fermentation of the slurry in the digester, the produced gas was collected by itself in the upper region of the digester. The biogas after certain concentration started exerting pressure in the outlets. As a result of the pressure, the level of oil in the graduated tube in the designed manometer increased, which is proportional to the amount of gas produced in the digester. The final reading of the oil level in the tube was recorded after a period of 48 hours and 96 hours (Table. I).

TABLE I

TABLE SHOWING THE LEVEL OF RISE IN OIL IN THE GRADUATED TUBE

Slurries in the MBPS	Initial Reading of oil level at) Hours (cm)	Reading at 47 Hours (cm)	Net Rise in 48 Hours (cm)	Reading at 96 Hours (cm)	Net Rise in 96 Hours (cm)
Pig Dung Slurry	5.0	5.4	0.4	6.2	1.2
Poultry Litter Slurry	5.0	5.3	0.3	5.8	0.8
CowDung Slurry	5.0	5.2	0.2	5.6	0.6
Mixture Slurry	5.0	5.3	0.3	6.0	1.0

RESULTS

From the observation made, it is clear that each of the slurries biogas is being produced. The maximum amount of gas pressure was in the case of pig dung slurry which showed a net rise of 1.2 cm after 48 hours and the minimum was in the case of cowdung slurry indicating a net rise of 0.6 cm.

DISCUSSION

The production of biogas depends on the activity of anaerobic bacteria like Methanogens which undertake anaerobic degradation of organic wastes. The optimum temperature for their activity ranges from 30°C to 40°C for mesophilic digestion and 50°C to 60°C for thermophilic digestion. However, the experiment was performed when the ambient temperature was around 18-20°C. So only the psychrophilic bacteria could have been active resulting in less production of biogas.

The usage of pig dung as source of biogas production can be an effective means of renewable energy source in this part of the country. This method has already been adopted as an alternative source of energy in many parts of the country, although cowdung is mainly used as a slurry. Thus, it could be possible that by using certain activators the biogas could be produced for household use and commercial purposes even in cold places like Meghalaya even in cold seasons where pigdung is found in plenty as compared to cowdung.

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DIAGRAMMATICAL PRESENTATION OF THE DESIGNED BIOGAS PRODUCTS SYSTEM (MBPS) SHOWING ITS WORKING PRINCIPLE

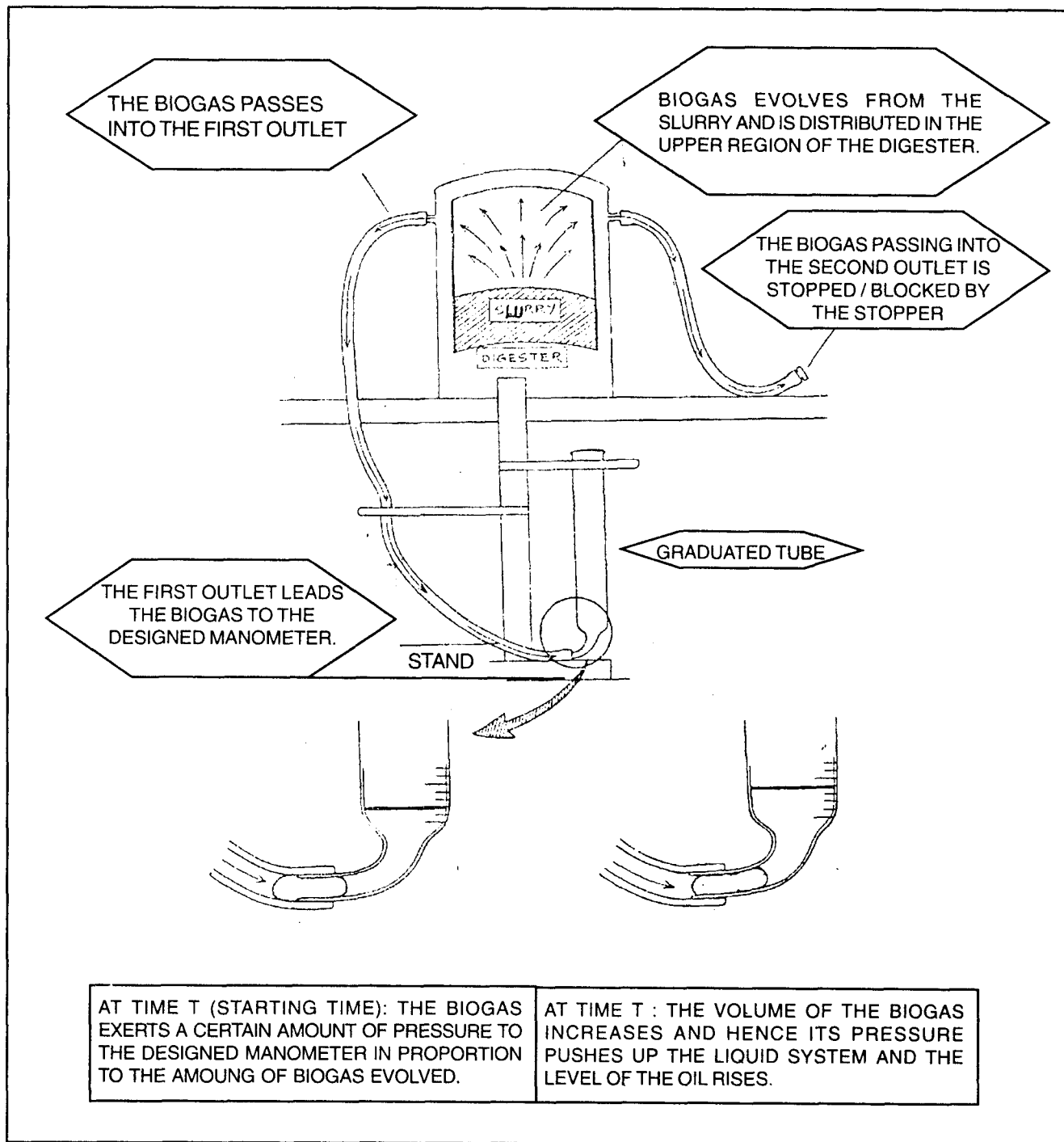


Figure - 1

DIAGRAMMATIC PRESENTATION OF THE DESIGNED MEASURING LIQUID SYSTEM
(OIL + WATER + MERCUR) WHICH ACTS AS A KIND OF MANOMETER

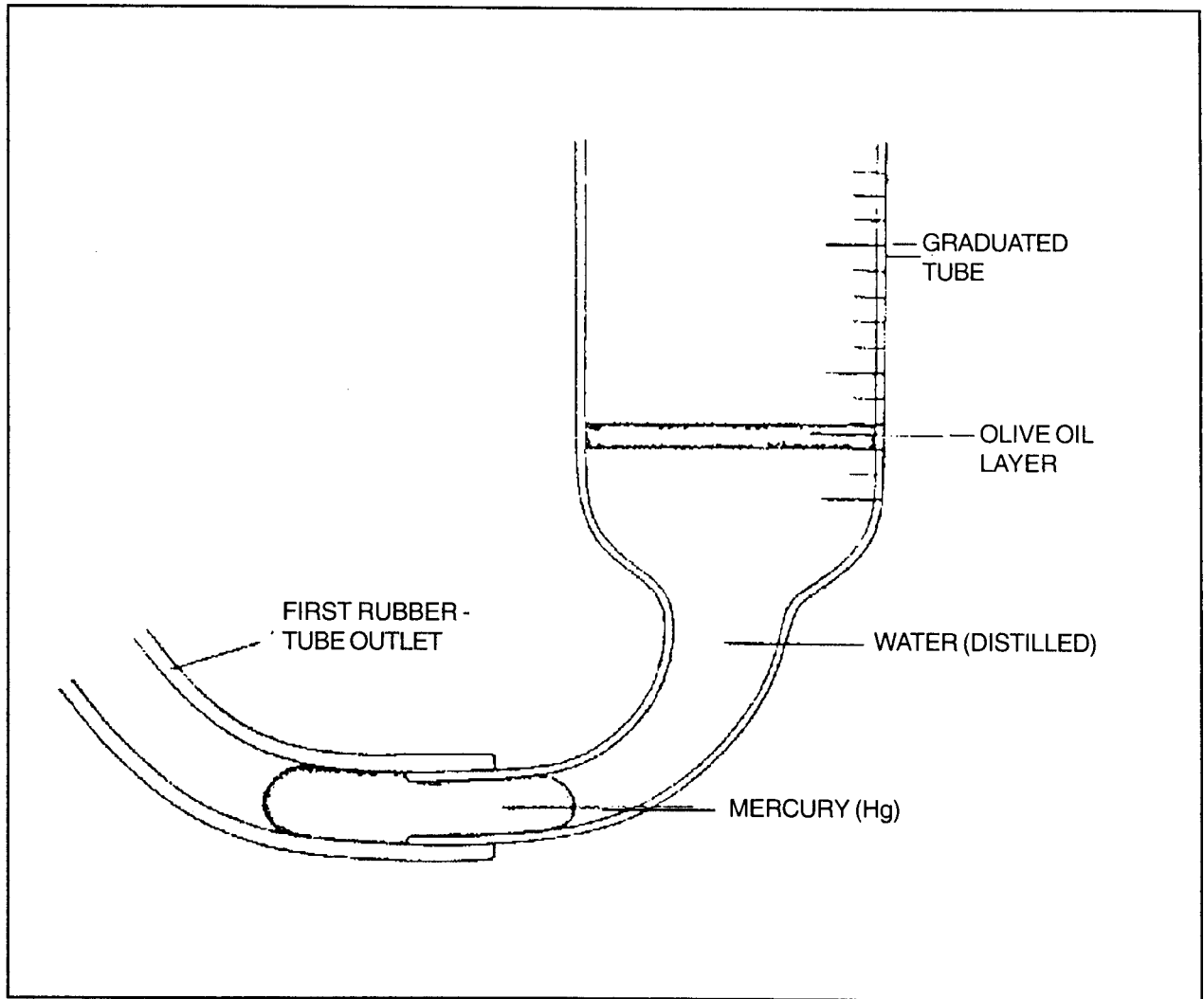


Figure - 2

FRAGILE GEOENVIRONMENT OF NORTH EAST INDIA

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ABSTRACT

North East India, bounded by three mobile belts, viz., (1) Himalayan Orogenic Belt in the north (2) Naga-Arakan part of Indo-Burmese Arc extending upto Andaman Nicobar islands in the east and (3) Sylhet trough in the south, is geoenvironmentally fragile because of (a) extreme tectonic instability (b) enormous hydrodynamics due to huge riverine systems and (c) abundant rainfall in the region with highest precipitation in Meghalaya Plateau in particular.

Factors responsible for aggravation for fragility in this region are (1) Natural hazard like earthquake due to subduction of Indian plate under Burmese plate, floods and landslides due to excessive rainfall and drainage congestion leading to erosion of soil and bank of the rivers and changes in the river courses (2) Anthropogenic induced hazard such as landslides at the site of Jhum cultivation and developing the roads in hilly tracks, and (3) indiscriminate deforestation causing sheet erosion, and river chocking (4) unplanned growth done to sediment load in the flood plains. Anthropogenic interference has acted as catalyst in inducing more fragility in the already fragile geo-system of North East India.

Many of the hazards created by anthropogenic activities and even to certain extent natural hazards can be considerably reduced if geological knowledge is properly utilised while implementing the development schemes in the region. Planned development keeping geoparameters in view, ecofriendly behaviour and environmental awareness are some of the remedial measures suggested.

INTRODUCTION

North East India, as the name signifies, forms the north eastern part of the continental mass of India, comprising Arunachal Pradesh, Assam, Manipur, Mizoram, Meghalaya, Nagaland and Tripura states. The entire region is unique in its physiographic characteristic land and varied agro-climatic condition not only in Indian sub-continent but is unique in the world because of (1) its topographical situation, where extra-Peninsular, Fore Deep and Peninsula are represented in a miniature form (2) Traditional culture (3) Socio-economic condition and (4) Proneness to natural calamities like rain, floods, earthquakes etc.

The north east has 46% of nation's valuable surface water resources. The rivers of the region is fed by the heavy precipitation and to a lesser extent by snow of Himalayan range. Brahmaputra river is the biggest catchment of the region of 5.8 lakh sq. km i.e. 75% of the total NE geographical area, drainage 51000m³ to 70,000m³ of water annually. The average run off the Brahmaputra basin is estimated 537240m³ which is the highest in India. It is estimated that Brahmaputra alone can generate 30 million KW of power if proper planning is done.

Barak river system is situated in the southern part of the NE region and is only rainfed having a drainage area of 78150 sq. km and average annual run off 59800 m³ against the country's average annual run off per hectare of cultivable area as 53680m³.

About 70% of the total area of North East India constitute hilly terrain. In Manipur 90% area are hilly supports 35% of the population while its rest 10% of the valley area has to support 65% of the population. Similarly, Arunachal Pradesh has 92.8% area occupied by hills. Mizoram, Nagaland and Tripura has 60%, 52% and 42% of the total area respectively are reported to be occupied by hills. Assam is the only exception where about 80% area is an alluvial plain.

Population density in the valley is high and has resulted in the small size operation land holding and the galloping population has increased pressure on the land resource in the hilly areas in the absence of other means of livelihood.

Geologically, the area is occupied by the rocks ranging in age from Archaean period to Pleistocene period. But the major area is covered by the soft formation belonging to Tertiary period which themselves under heavy rainfall are highly prone to weathering and erosion.

The north east region receives annual rainfall of about 200cm. However, the place like Cherapunjee located in Meghalaya Plateau where annual rainfall exceeds 1100 cms. There are certain areas where the annual rainfall is about 80 cm showing uneven distribution of precipitation in this area. Intensive rainfall leads to adequate recharge of ground water which is not only the source of water during dry season of the year but has led to the growth of luxuriant lush green forest the precious gift of nature to this region where all sorts of fauna and flora flourish and the region was once known for butterflies, non-human primates, and other wild life and orchids.

GEOTECHNICS OF NORTH EAST INDIA

North East India, is characterised by four diverse geotectonic zones viz., extra-Peninsular/Himalayan orogenic belt, Assam fore deep, Shillong Plateau and Naga-Arakan Hills, present fascinating panorama with distinct inherent geohazards constituting a fragile geosystem in the area. The unique physiographic setting of the Brahmaputra valley within a constricted foredeep in between the Extra-Peninsula and the Peninsula has added to fragility in the geosystem of the region Fig. 1.

Himalayan Orogenic Belt

Himalayan orogenic belt is bounded by Tibetan Plateau in the north and Assam foredeep in the south. It is the youngest orogenic belt in the world and is formed due to subduction of Indian Plate below Burmese Plate about 65 million years age. The subduction is still continuing which has made the belt highly prone to seismic activity. The Orogenic belt is separated into smaller parts by thrust planes and transverse faults which are still active. Extreme eastern parts of this Orogenic takes a ninety degree turn forming systaxial bend and merges into Naga-Arakan Yoma Hills. Himalayan Orogenic Belt is known for its diversity and is characterised by lush green valleys, rugged topography with snow clad peaks.

Assam Fore Deep

Consequent upon the formation of Himalaya Organic belt a depression was developed in the southern side bounded by a fault plane is known Assam Foredeep. Alluviation of foredeep by mighty Brahmaputra river system since the beginning of Quaternary period onward has given rise to a long, narrow stretch of fluvial plain bounded by Himalayan Orogenic belt in the north and Shillong Massif in the south. Its origin and development is linked with the phases of uplift, glaciation and erosion of Himalaya, basement tectonics affecting the Shillong massif and the basin, and eustatic changes of sea level during the glacial and interglacial phases. The Brahmaputra valley, with its near tropical climate, is a fertile alluvial plain, dominated and continually reshaped by hydrodynamic one of the world great river and geodynamics of the region. Brahmaputra valley is the most populated area of North East India and is undergoing rapid urbanisation and Industrial growth.

Shillong Plateau

East-west trending Khasi, Jaintia and Garo Hills ranges occupying the central part of the Plateau, located south-west of North East India, forms the watershed for Brahmaputra basin in the north and Meghna Basin in the south. The top of the plateau is at 1500 m.s.l. The western and northern slopes of this plateau are gentler as compared to eastern and southern slope. The southern face of the Plateau is deeply dissected by gorges while its northern portion is dotted with numerous hills and gradually merges with the plains of Assam.

Naga-Arakan Hills

Naga-Arakan hills, located in the eastern part of North East India trending N-S,NNE-SSW direction in Nagaland, Mizoram, Manipur along Indo-Burma border. These hills are comprised of thick sediments of soft formations of Tertiary period. The main interesting structural feature of the range is the belt of Schuppen consisting of a number of thrust sheets i.e. weak planes, limited to NW by naga thrust and to SE by Disang thrust associated with other thrusts which are all overthrust with some overlap. Presence of soft rock formation over larger area and presence of so many thrust planes (weak planes) coupled with heavy rainfall have made the area prone to landslides, and land erosion.

FACTORS INFLUENCING FRAGILE GEOENVIRONMENTAL SYSTEM IN NORTH EAST INDIA

North East Region is unique in its physiography and each physiographic zone has its inherent and distinct hazards. There are two types of geohazards identified in this region viz. (1) Natural Hazards (2) Anthropogenic induced hazards.

Natural Hazard

Natural hazards identified are the earthquake, landslides, floods. Million of years back Indian Plate drifted from main Gondwana land and moved north easterly direction and collided with Burmese Plate in this region making an arc i.e. Indo-Burmese Arc extending upto Andaman Nicobar Islands. Indian Plate is being slowly subducted under Burmese Plate along Indo-Burmese Range which is the cause of earthquakes in the region. These earthquakes have made the area more instable.

Earthquake

The entire North East India falls under high seismic zone and has recorded many earthquakes and is acclaimed as one of the most active seismic belt and one of the sixth earthquake prone area of the world. It has been locale of a number of major earthquakes, Fig. 2. Most of the earthquake in this area is generated at a shallow to intermediate depths along these slab boundaries owing to release of the energy. The Assam earthquake of 1897 where severe damage was noticed over 0.4 million sq. km area and was felt over an area of 3.9 million sq. km and in the year 1950 severe damage was observed over 0.2 million sq. km area and was felt on over an area of 2.9 million sq. km, (Ramchandran et.al, 1981) are amongst the five greatest earthquakes which had affected the communication system, hill slopes were cast down in landslides and vast alluvial tract was fissured and riddled with vents from which sand and water poured out in most astounding quantity. Tributaries of the rivers were blocked due to landslide and created burst resulting in considerable loss of life and property. These earthquakes also affected the Brahmaputra river which since then has been changing its course and is engulfing lot of fertile land in the alluvial tract - the most populated & productive putting lot of constraints in the development.

Flood And Landslide

Enormous surface water run off due to heavy precipitation in short duration cause floods as manifested by overflows and submergence of vast area, erosion of soil and bank of rivers, landslides, and changes in river courses. The high rainfall coupled with the mighty drainage system of Brahmaputra and Barak rivers imparts not only weakening of rock but also are responsible for large scale erosion and toe cutting of the valley slopes, triggering landslides. Induced landslide occurs whenever the area experiences earthquakes. At times, it has led to creation of artificial lakes along the river course and later on subjected to blast leading to vast devastation downstream as happened in 1897 earthquakes in this region.

Anthropogenic Induced Hazard

With the spread of civilisation, the interference of human/anthropogenic activities in the region also has increased. It is rather amazing that in 80 years between 1891 and 1971, the number of villages in Assam have increased from 9807 to 21,995. The average population per settlement has exactly doubled from 350 to 700. The average area of revenue village has shrunk from 1100 hact. to a mere 300 hact. And during the same period the average distance between two villages is shortened from 4 km to 1.5 km leaving little aerial room to breathe. On the top of these, Science and Technology urbanisation and industrialisation of late has accelerated in destabilising the ecological balance in the Assam State in particular and in the entire region.

With the result already existed hazards have been aggravated due to misuse and abuse of natural resources by the human beings and top of its disregards to the geo inputs in the planning and development. This has added more fragility in the geo-system of North Eastern Region and has resulted in (A) Deforestation (B) Landslides (C) Flood (D) Water-logging and (E) Drainage congestion.

Deforestation

North East India was endowed with rich heritage of forest cover where all types of forest including the rain forest is available. Importance of forest needs no emphasis. It controls the climate and rainfall. It protects the soil and prevent the soil erosion, attenuates floods, augment the ground water recharge. In addition it provides fuel, wood and other forest products required for developmental activities and maintain balance of the eco-system of the area. Heavy precipitation has helped in the growth of such rich forest where varied types of flora & fauna could exist/survive. But prolonged intensity of human interference and other biotic activities have resulted in indiscriminate deforestation causing drastic ecological imbalance endangering the wild life and has led to the extinction of some of the flora & fauna which were only known in this forest and / or shrinking in numbers e.g. Gibbon reduced from 80,000 (1971-72) to 5,000 today.

The large scale deforestation has taken place because of two reasons :-

(1) Paucity of plain area (2) Galloping population pressure (3 times since 1951). These two factors have increased the pressure on land resource in the hilly terrain which constitute about 70% of the total area of the region. This has forced the people to clear the forest for Jhum cultivation in the absence of other means of livelihood. Vast stretch of forest land has been converted to cultivated lands used for agriculture purposes & tea garden. Million tons of timber plywood, cane and other forest resources are being extricated for raising tea garden and for the use in development activities.

Indiscriminate deforestation has resulted in :

Change in the weather condition : Conversion of forest land into farm land by setting fire to under growths, mostly grasses and climber i.e. unchecked forest fire. 200 km stretch between Tuensang from Tizit bordering Assam in Nagaland was observed air with heavy smoke billowing from burning forest recently. Depletion of forest cover leads to increase in the temperature. This can be observed or seen in Shillong also. As compared to early times now the temperature of Shillong has gone up.

Decrease in rainfall : It has been observed that degradation of forest has a direct relationship with the precipitation in the area. As the degradation of forest increased there has been decrease in the amount of rainfall as much as number of days of rains. With the result prolonged dry season is now witnessed. This prolonged dry season has manifold adverse impacts on environment, viz. (1) It increases the temperature, (2) There is no control on forest fire because of undergrowth mostly grasses and climbers remain dry, (3) Less groundwater recharge in the area results in drying up of rivers and streams which causes acute drinking water shortage as witnessed in Tuensang area of Phek district in Nagaland.

Acceleration of soil erosion : In absence of forest cover heavy precipitation coupled with rapid run-off has resulted in the loss of top soil in Meghalaya during monsoon, the stream water become red. Tons of lateritic soil is washed down the streams.

Affect on the fauna and flora : Not long ago there used to be vast stretches of rain forest in Upper Assam, thickly inhabited by tigers, elephants and many other wild animals which have now shrunk due to industrialisation, population increase and influx of people from other areas beyond the limit of natural replenishment. Rare species, once known, are at the verge of extinction.

Landslides

Entire region is prone to landslides particularly the areas having soft sediments, immature topography and complex structural disposition e.g. in Mizoram and in the foothills of Arunachal Pradesh. Any developmental activities like construction of road, railway line and establishing urban agglomeration leads to landslides in these areas. Landslides are categorised as mud flow, debris flow, subsidence, slump slides, rock fall/slide.

It has been seen that any fossil landslide area utilised for development activities like Tezu-Hayliang road in Arunachal Pradesh, Huidung Cement Plant in Manipur, Mawmynkhong Village in Meghalaya were subjected to the creep movement resulting in ground distress.

Kohima town in Nagaland and Aizawl in Mizoram are good illustration of demographic pressure which mobilised the critical slope in soft formation under heavy rainfall.

Floods

Increase in population pressure and quest for reclaiming more and more riverine tract has led to encroachment of the flood plain i.e. the domain of the river and acts as flood cushion during the floods, has resulted in water-logging and drainage congestion and submergence of vast area for longer duration.

CONCLUSION

Excess of rainwater coupled with the paucity of plain area and punctuated by three mobile belts in the northern and south-western part of North East India, together with constricted Brahmaputra valley due to prolongation of Peninsular shield area and migration of Brahmaputra river channel due to earthquakes of 1897 and 1950 in particular are the factors responsible for fragile geoenvironmental system in the north eastern part of this continent mass. The factors which have aggravated the fragility to the geo-environment in the area are (1) indiscriminate degradation of forests due to population pressure for their own survival in absence of other means of livelihood added by their illiteracy (2) peculiar land holding system, which makes villages, communities or clan owner of the forests where law enforcing agencies do not have control over natural resources nor can force them to adopt measures and (3) industrial and development activities taken up during the last five decades. These activities have degraded the forest. Wild life has been destroyed beyond the limit of natural replenishment and human habitation has been expanded to the natural habitat of the indigenous plants and animals creating ecological imbalance in the area.

If forest denudation at present scale is continued, the people of north east India would experience major environmental changes like change in climatic condition, drastic reshaping of land forms due to landslides, floods, bank erosion, extinction of fauna and flora etc. in the next millenium.

There is thus a constant need for new appraisal and a new research and more widespread knowledge of all aspects of life in North East India. A lot of this region remains yet to be explored scientifically. Suitable areas may be identified for specific purposes.

Like other sciences, geological science too has great role in day to day life of man and socio-economic development of society. However, due to lack of awareness of the subject its significance has not been properly appreciated. Any anthropogenic activity, if undertaken without due consideration of geo-parameters often lead to disastrous consequences resulting in depletion of life supporting material resources, increasing health hazards and direct economic loss.

Geo-scientists has specific role in the present day society and geoscience can solve the conflict between two type of landuses, minimising the possible adverse environmental degradation or maximising possible advantageous condition resulting from the use of natural and modified environment.

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MAP SHOWING HARD ROCKS AND SOFT ROCKS IN NORTH EAST, INDIA

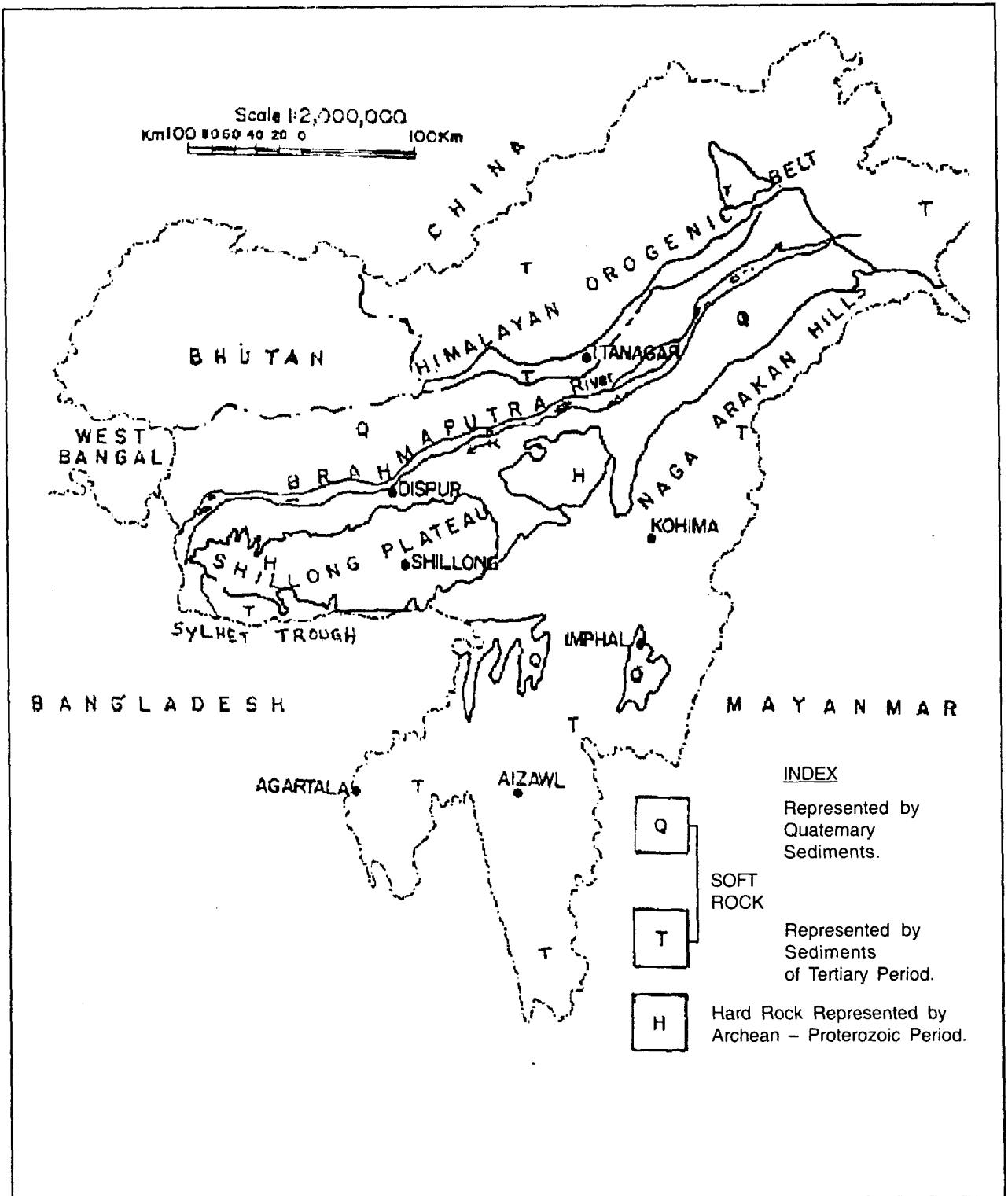
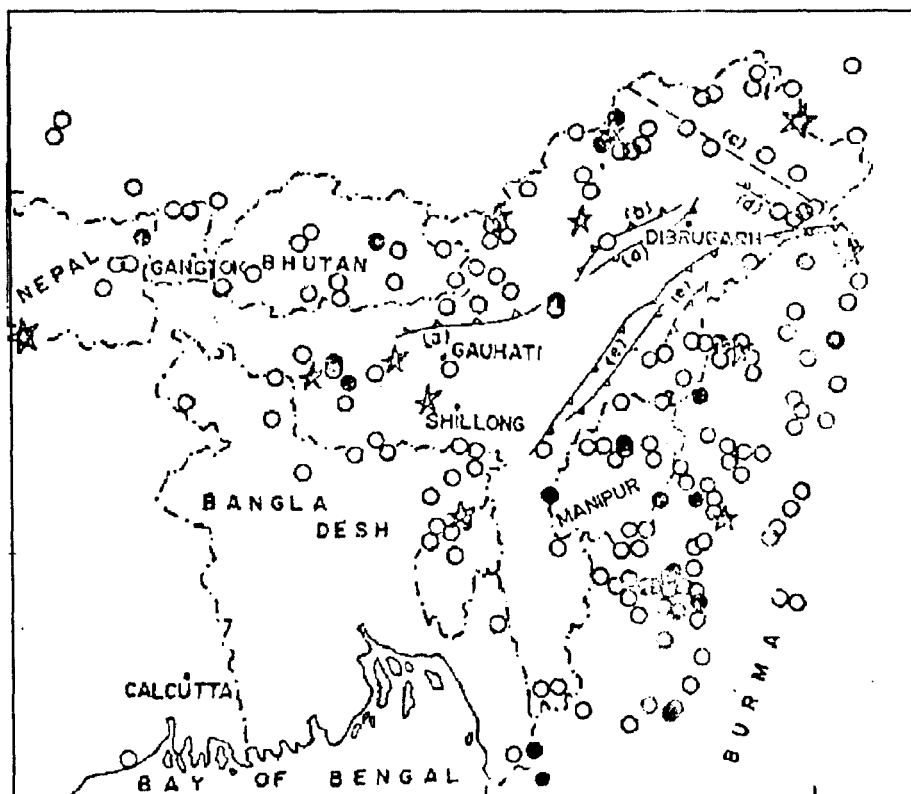


Figure - 1

MAP SHOWING EARTHQUAKE EPICENTRES AND PRINCIPAL TECTONIC FEATURES OF EASTERN HIMALAYA



LEGEND

(a) Main boundary fault	(c) Belt of schuppen thrusts
(b) Thrust between Gondwana & Daling	○ Magnitude < 6.0
(c) Lohit thrust	● Magnitude 6.0 to < 7.0
(d) Mishimi thrust	★ Magnitude 7.0 above

Figure - 2

HUMAN - ELEPHANT CONFLICT IN GARO HILLS, MEGHALAYA

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ABSTRACT

Human - elephant conflict goes on a sad tale of habitat destruction and conflicts emanating out of human need and greed. This paper deals with various aspects of the conflict like, seasonal movement and habitat preference of elephants, crop raiding by elephants and also different factors responsible for the conflict in the Garo Hills. However, preventive measures should include keeping elephants away from vulnerable areas, because a complete separation of elephant and human habitat would hardly be feasible.

INTRODUCTION

The Asian Elephant *Elephas maximus* is one animal which has caused major problems to the lives of villagers in the Garo Hills. Frequent crop raiding and even of people are scenes which are heart rendering for the people of who are basically slash and burn agriculturists (Jhumias). Elephants have also become victims by way of poaching for commercial purposes as well as through retaliatory measures of affected villagers. Thus, human elephant conflict goes on - a sad tale of habitat destruction and conflicts emanating out of human need and greed.

Garo Hills is a region of very high elephant density and high human elephant conflict. An estimated 1400 elephants occur over an area of 31 50 sq. Millimeters out of which a little more 600 have been found on clan, community or private lands. The geographical area lies between 25° 9' and 26° 1' N and 84° 49' and 91° 2' E and comprising of three districts of East West and South Garo Hills having a total area of 8197 Sq. KM. Surrounded in the west and north by the plains of Assam, on the South by the Bangladesh while on the east, the hills merge with the Khasi Hills. The population density in the elephant bearing area ranges from 24 to 80 persons per square kilometer

THE VEGETATION

Haridasan and Rao (1985) classified the vegetation types occurring in the area into following four types:

- 1 **Tropical evergreen forests:** - Occurring in the high rainfall and catchment areas of major rivers. They have a closed canopy with thick underworth.
- 2 **Tropical moist deciduous forests :-** dominated by Sal forests, these forests are characterized by the seasonal leaf shedding.
- 3 **Degraded secondary forests :-** these forests are dominant in Garo Hills and are resultant vegetation due to repeated jhuming. These forests are totally degraded and are mostly degraded by the weeds like Eupatorium, Mikania etc. with occasional sprinkling of trees.
- 4 **Bamboo forests :-** these occur as pure stands or as secondary vegetation on jhum fallows.

SEASONAL MOVEMENTS AND HABITAT PREFERENCE

To ensure they get choicest food item available and adequate water, elephants move long distances. These movements become obvious as the seasons change. They are however found to prefer *jhum* fallows of less than 10 years. (Williams and Johnsingh, 1996). It is speculated that elephants could be attracted to secondary forests due to greater diversity of food plants. These areas which will also have some agricultural crop plants like tapioca, rice, maize etc. definitely attract elephants, as they are voracious feeders. However, the loss of their regular habitat affects their seasonal movements, which covers a lot of area, ultimately leading to change in their behavior resulting in human-elephant conflicts.

CROP RAIDING BY ELEPHANTS AND CONFLICTS WITH HUMANS

Elephants have the habit of cultivated fields much to the consternation of farmers and people have sleepless nights trying to contain them. Driving elephant herds by drums, beating of sticks, bursting of crackers, use of guns etc. have little effect. There have been cases where people have been killed as they came face to face with marauding elephants. In Rongmat-chokgri village one girl was killed as the elephant threw her to ground. In 1997 three forest personnel were killed as they went to Anchenggri village to help the villagers to chase away the elephants which were raiding crops.

For many farmers, crop raiding means the loss of their entire crop and even starvation. They also face the risk of being killed if they attempt to chase away the elephants.

Most cases of depredation were found to occur between the months of June and December, peaking in July and August as well as in November and December. Ripening of paddy in July - August as well as the availability of cottons flower buds in November coincides with the peak depredations.

Crops raided include paddy (41%), ginger (41%), and cotton (9%) as well as tapioca, maize, arecanut and pineapple (Williams and Johnsingh 1996). Paddy, maize and tapioca are eaten while cotton and others were trampled. Hutnrent in the village was also observed to have been destroyed on a number of occasions.

Presently, the State Government gives an ex-gratia payment of Rs. 10,000 for the death of a person and Rs. 3,000 for grievous injury. Compensation for crop damage depends on the field assessment. Although the requirement of funds for the payment of Compensation is approximately Rs. 10- 15 lakhs per year for the entire State, the Government sanctions Rs. 2-3 lakhs every year. Thus, as of today, payment of compensation has been completed only till 1993 and there has been an arrears of more than Rupees 55 lakhs.

During 1996-98, 37 cases of poaching, illegal possession of animals and animal trophies were detected. This is the other side of the story of human attack on wildlife. Poachers are mostly outsiders who come with sophisticated weapons for elephant tusks and meat.

FACTORS RESPONSIBLE FOR HUMAN ELEPHANT CONFLICT

Human population growth has created enormous demand for land by way of agricultural needs as well as for human habitation in Garo Hills that today almost every conceivable land has been used for either of these two demands. The Sixth Schedule of the Constitution of India has become a tool for utilizing the land recklessly and there seem to be no enforcement machinery on proper land use based on proper agro-climatic considerations. With the present land use, more than 800% of the land in the Garo Hills is used for slash and burn agriculture. The problem is compounded by the fact that although the major forest areas of the State (90%) are under the clan, community or private lands under the management of the District Council, wildlife problems have to be tackled by the State Government. The State Forest Department is expected to do fire fighting caused by the reckless destruction of forests by the people. In 2 year's time alone, 57 sq. kilometers of forests was converted to non-forest land in Meghalaya (Forest survey of India Report-1997). This change was attributed to shifting cultivation and the major affected areas were West Garo Hills and West Khasi Hills.

This loss of forest results in habitat fragmentation and compression of elephant herds, finally leading to human elephant conflicts.

DISCUSSION

It is obvious that human elephant conflicts cannot be taken lightly. However the efforts that are being made by the State Government even in compensation not being paid for a number of years shows its complacency. It also shows that the compensation scheme has not achieved the purpose for which it was introduced and to treat poor villagers in this casual manner is criminal.

The elephants due to easy accessibility to high quality food raid the jhum fields with extremely palatable and nutritious crops. Thus, crop raiding by elephants is bound to continue. Critical elephant corridors will have to be identified and acquired to see that habitations and cultivation do not take place in these elephant movement

areas. People should also be provided with financial and/or technical assistance to see that they go in for a permanent and income generating cash crops and that they do not increase their areas under jhum cultivation..

Although elephant habitats and human habitations are generally taken to be incompatible human and elephants will have to live together by mutual adjustment.

The International Workshop held in the year 1982 on 'Management of elephants in the wild and in captivity' reportedly devoted a whole session to the demonstration of preventive measures which would help reduce human elephant conflicts (Lahiri-Choudhary, 1991). 'Mese are combat measures which deals with elephants actually raiding crops and preventive measures designed to prevent elephants from such raiding. Among the combative measures used against elephants are power car battery operated searchlights. Koonkies which are domestically trained elephants can be used to chase away herds in forests. Phandies who are trained elephant locators have also used to drive away elephants through their way of understanding elephant behaviour. Experiments with crackers, tape recorded tiger calls etc. have been found to be useful for a limited period of time and their effectiveness gets reduced as the elephants get habituated with them.

Preventive measures should include keeping elephants away from the vulnerable areas. This involves changing the human land use pattern, for example not planting food crops on fringes of elephant habitats. Developing chemical repellant is a line of research worth pursuing.

Constructions/objects, which are white or glittering, are found to attract elephant's attention while black or dark green painted structures enjoy immunity.

Physical barriers including elephant proof trenches, dry walls of boulders held together by galvanized wire nettings, spikes embedded in concrete slabs and low voltage electrified fences have been tried with varying degree of success. Capturing and translocation of elephants is also suggested as a viable alternative in reducing human - elephant conflict. Identified small isolated herds in perpetual conflict with humans should definitely be removed.

However, the basic idea underlying any experiment in measures to prevent elephant depredation is to try to evolve a modus operandi for man and elephant to co-exist together. A complete separation of elephant and human habitat would hardly be feasible.

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MAN AND NATURE

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ABSTRACT

One of the most important ethical issues raised in the past few decades has been whether nature has an order, a pattern. The paper examines this issue from all possible angles including the philosophical aspect of the problem of pollution and this spiritual alienation of women and men from nature. The paper concludes with an optimistic note that our democratic system is flexible enough to further the economic growth in an environmentally sustainable fashion.

INTRODUCTION

One of the most important ethical issues raised in the past few decades has been whether nature has an order, a pattern, that we humans must understand, respect and preserve. Those who have answered yes to this question have also believed that such an order has an intrinsic value, that is to say, not all values come from humans; that value can exist independently of us, it is not merely something we bestow.

Those who have answered "no" to the question (the instrumentalists for example) look on nature as a store-house of resources to be organised and used by people, as having no other value than the value some humans give it. There has been a tendency in the powerful tradition of western science to promote such instrumental thinking about nature through a drive to achieve scientific mastery over the non-human world.

With Galileo, Descartes and Newton there emerged this figure of a vast celestial contrivance set in operation by an omniscient mechanic - mathematician. The old account of creation in a way submerged with the new scientific world view. In trying to rationalize natural phenomena on the one hand and the human productive apparatus on the other, scientists and engineers alike were attracted to the mechanistic image of detachable replaceable parts made to move smoothly together by the external skill of an artisan. "It was not in the least unusual in the seventeenth or eighteenth century for leading scientists to first explain that nature was simply another machine, and then go on to draw from this larger model, mechanical inventions by which man might better his condition".

What is significant in these views is that they gave a mechanistic answer to the question of what nature is and what it ought to be. They chose to ignore any aspect of nature that could not fit into this mechanical picture. The mechanization of the modern world view did not remain restricted to physics and astronomy. Biologists too (on the authority of Isaac Newton) were encouraged to take its philosophy along with its utilitarian bias toward nature. By reducing plants and animals to insensate matter, mere conglomerates of atomic particles devoid of internal purposes, they (naturalists) removed the last barriers to unrestrained economic exploitation. Rene Descartes declared for example that animals are no more than machines, totally incapable of feeling pain or pleasure, not suitable for any emotional investment by men and women.

Eighteenth century western thought has been confronted with two contradictory stances - two ways of reasoning, two moral allegiances. There is on one side, a dedication to freeing the human mind from its self-constructed mental prison to search for intrinsic value, order, ultimate purposes, the ends of life. The opposite side is the drive for the domination of nature beginning with the desacralization of the world, its reduction to a quantitative mechanistic "mass of miscellaneous stuff". This turns reason into a merely instrumental mode; a reasoning about means, not ends. It leads to the spiritual alienation of women and men from nature, and from there to the commodification and industrialization of the living world.

In the west the environmental philosophy of domination has been defended for it is regarded as necessary to carry out the law of progress. Darwinian emphasis on the struggle for existence led to a philosophy of might makes right and hence self-assertion and aggrandizement became the highest virtues. Between man and nature too the law of competition came to be seen as the only foundation on which an advanced technological civilization could be built.

"The logic in this outlook was neatly circular and complete : nature's economy is a world of self-seeming aggression; such a system has produced remarkable evolutionary progress; it must work for the human economy too, since man is a part of nature; man's increasing technological dominion over nature is proof of the survival of the fittest and of the reality of progress in the scheme of things".

The euphoria over the success of mechanistic materialism, however, did not last long. By the next century there were protests from various directions (The romantic philosophy of vitalism for instance) against science which was now being seen as responsible for the alienation of men from nature as well as God. There started open talk against the unpleasant aspects of modernity such as pollution and industrialism and slowly science along with uncontrolled technology became one of the discomforts of civilization. There was felt again the need to recover a personal relation of every man with the world around him.

This has been brought to the forefront by the ecology movement. Ecologists have insisted that scientists are in danger of ignoring the whole complex of nature, the quality of inter-relatedness that defies analysis by the physicist or chemist. Consequently the ethical question has come to be posed most emphatically and today we are acquainted with the idea of an ecological ethic. The conservationist movement also is grounded not only in science but in a moral philosophy of interdependence and tolerance. The modern man appears to be realising that the norms of technological modernity not only promote biospheric catastrophe but are also inconsistent with the ultimate norms of most spiritual and philosophic traditions. This calls for major changes, both personal and socio-economic, regarding how humans treat each other and the natural world. What is needed they claim, is an ecosophy, a philosophy of ecological harmony or equilibrium which can "provide a single motivating force for all the activities and movements aimed at saving the planet from human exploitation and domination". (Arne Naess) unabiding concern for nature can develop only once we reject dualism (man vrs. nature) and its corollary anthropocentrism.

Unfortunately, it is not only the west but more so, the so-called developing countries whose traditions provided such an ecosophy, who have been bitten by the bug of modernity's anthropocentrism. The individual traditions of the different communities been pushed to the background, if not totally rejected. They have ceased to provide the ideal framework for progress and self-advancement and have since long been only matters of historical interest.

CONCLUSION

We must note at this juncture that none of the ancient systems of Indian thought, tribal as well as non-tribal, elevate man above the rest of the earth, nor do they claim for him any unique rights. For instance, tribal thought is seamless, free from the divides of the kind (man vrs. nature, cultural vrs. natural) that modern western thought is driven by. Man, animal, nature, the earth, sun and the moon belong to a continuum and form natural - if cosmic - moral community which they must all sustain. If such a world view were to prevail there would be no motivation for man's exploiting of nature. Sadly the aggressive, dualistic and anthropocentric attitude has come to stay in this part of the world. Use nature but do so intelligently is the slogan. What we need is not earth worship but a sane environmentalism which must be entirely anthropocentric and must declare unashamedly that nature is here to serve man. In line with their western counterparts, reformists in India too feel that our democratic system is flexible enough to further economic growth in an environmentally sustainable fashion.

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ANIMAL DIVERSITY – THOSE VANISHING FAUNAL SPECIES

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ABSTRACT

India's biological diversity is one of the most significant in the world. As many as 45,000 species of wild plants and over 81000 species of wild animals have so far been recorded, together comprising about 6.5 percent of the world's known wildlife. More than 10% of our wild fauna are on the list of the threatened species, many on the verge of extinction. For in the last few decades India has lost at least 60% of its forests, polluted over 75% of its water bodies, built on or cultivated much of its grasslands and degraded most of its coasts.

The North-East Scenario is no good. The region is facing problems of over populations, causing decimation of natural resource base for economic and technological development alongwith demand for land, energy and water supply together has brought environmental pollution. About 650 species of plants and 70 species of animals occurring in this region have been listed as endangered.

Therefore there is immediate need for an awakening among the masses towards the cause of protection of Environmental pollution and conservation of biodiversity.

INTRODUCTION

Biological diversity indicates variations and abundance of species and their living environment. Species diversity is represented by morphological, physiological and genetic features, whereas ecosystem diversity shows the difference in habitats and biological communities.

The process of species diversification started soon after the origin of life on the planet. It is a gradual process, influenced by various geo-physical and climatic factors, resulting in the emergence of new strains and sub-species. Species which are not able to adjust themselves with the changing condition gradually become extinct as evidenced in the case of the giant dinosaurs and other large mammals and birds in the past, who had once ruled over the animal kingdom.

Biological diversity plays a significant role in the nature. It provides major clues to the scientists about the origin and the evolution and the speciation process of species. It also acts as a major tool for assessing the impact of various factors in influencing the process of species diversification. Rich biodiversity is an indicator of the health of a particular habitat and its potential to sustain life.

In ecology, biodiversity plays a significant role of enriching soil, maintaining water and climate cycle, humidity precipitation and recycling and conversion of waste material into nutrients. All the living creatures, from unicellular organisms and planktons to higher species help maintain equilibrium within various components. Ecological diversity is of great significance to human society. Food, medicine and raw material for industry and household purposes are obtained from various living resources.

During the past few centuries with the increase in human population biodiversity has come under tremendous pressure. Biological extinction which led to the disappearance of one species in several hundred years has now been replaced by accelerated rate of extinction of the species. Today, we are probably losing one species every year. The industrial growth oriented culture has diminished further scope for the survival of many plant and animal species. Loss of species has direct implications on various factors which in turn affect human society.

India has great biodiversity mainly because of its unique biogeographical composition, comprising living components of three different realms, namely Palearctic, Indomalayan and Ethiopian. With just two percent of the world's landmass, the country has about five percent of living resources, one third of which are land bound. Therefore it has been designated as one of the 12 mega-diversity states in the world.

DISCUSSION

Our country has diverse faunal wealth. The total number of animal species is estimated at 81,000, which represents about 6.4 percent of the world's fauna. India's animal diversity includes over 5,000 molluscs and about 57,000 insects, besides other invertebrates. There are 2,546 fish; 204 amphibians, 428 reptiles; 1,228 birds and 372 mammals. The extent of endemism is about 62 percent.

More than 10% of our wild fauna are on the list of the threatened species, many more on the verge of extinction. For in the last few decades India has lost at least 60% of its forests, polluted over 75% of its water bodies, built on or cultivated much of its grasslands and degraded most of its coasts.

The country faces problems such as overpopulation, large number of cattleheads, growing demand for land, energy and water supply. Unplanned developmental works and overexploitation of resources have made its living resources most vulnerable. Of the world's 12 top priority biodiversity hot spots, India has two within its boundaries. Overexploitation has not only resulted in shortages of various materials but also left our biodiversity exposed to various ecological threats.

Over emphasis on timber logging has affected many animal species. Today, our forests and various species found within them are highly threatened. Various species found in different parts of the country need to be protected. A few examples are coconut crab from Andaman and Nicobar Islands, lion-tailed macaque and malabar large spotted civet from Western Ghats, musk deer, snow leopard, hangul and mouse deer from Himalayas. Out of 19 species of primates, 12 are endangered. Similar is the condition of various other animals too. In various parts of Western Himalayas, large scale tree felling of the 60s and the 70s coupled with hunting have affected the forest ecology to a great extent.

Even in every remote areas where population has not grown much to exert pressure on forests, the state of wildlife and biodiversity is very bad. The Kalli-Kumaon region famous for Jim Corbett's activities has lost more than 80 per cent of its wildlife in the last 30 years. The large groups of animals and birds such as sloth bear, ghoral, wild boars, porcupine, koklas and cher pheasants have almost vanished from the area.

In fact, none can say for sure how many species we have already lost. The cheetah (*Acinonyx jubatus*) and the pink-headed duck (*Rhodonessa caryophyllacea*) are amongst the few conspicuous ones everyone talks about. But there must be hundreds, perhaps, thousands of species which have gone forever, unsung and unrecorded either because they were not "glamorous" enough, or because we simply did not know them.

The case of the high altitude fish is no different. Their breeding grounds have been severely hit by siltation following road laying in hilly areas, and consequent heavy soil erosion. Certain high altitude variety such as pseudocheneis, glyptothorax, garra schizothorax, etc., which are found in fast running streams and rivulets face other problems like reduction of area for movement, less amount of dissolved oxygen, loss of algal food etc. due to siltation. Species like tortor, the famous mahaseer, considered most delicious and the king of fishes, is on the verge of extinction due to habitat destruction and food shortage.

Poaching and illegal activities have been responsible for most of our fauna loss. The disappearance of several herbivorous species has resulted in man-animal conflict in various parts of the country. Predators such as tiger and leopards have started preying upon domestic animals-cattles found in nearby villages.

One of the main threats to vanishing faunal species in north-east India is increasing pollution due to developmental pressure in the region. Further the encroachments, exploitation, human induced disasters, improper management of natural resources and human resources and political and policy issues are further aggravating the situation. The human population explosion in the last few decades, demanding development in various spheres, has resulted directly or indirectly in the sudden and often far reaching disturbances in the several natural ecosystems of North-East India. The rapid growth of urban areas, construction of dams and hydroelectric projects, buildings and road and encroachment on vast areas of forest lands for extension of Agriculture and mining operations oil drilling, jhum cultivation etc. are some examples of direct disturbances on the natural ecosystems. These imbalances in nature have posed problems for survival of wildlife. The North-East which used to be haven for Animal life a few decades ago has been fast dwindling to the extent that more than 70 animal species have been listed as endangered. The numbers of migratory birds to the region is also fast decreasing leave aside the number of invertebrates which are more susceptible to the increasing environmental pollution.

CONCLUSION

It may appear paradoxical if not wasteful to the average citizen to spend so much energy and money in conservation of biodiversity when the country is struggling for economic independence. What difference does it make, one may ask, if Sangai deer and white winged wood duck have disappeared and the clouded leopard or elephant would vanish tomorrow ? Like all other aspects, this attitude has its appeals and oppositions and for which we should have wider visions of recreational, educational and ecological value of totally undisturbed areas of wilderness. The only permanent solution to the problems of conservation of biodiversity is the protection of biospheres and its component ecosystems, for species once lost or ecosystems once destroyed can never be restored and conservation of biodiversity is the only hope for human survival. Conservation is also an ethical imperative, expressed in belief that "we have not inherited the Earth from our parents, we have borrowed it from our children".

THE NEED FOR CONSERVATION AND MANAGEMENT OF WATER RESOURCES IN NORTH EAST INDIA

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ABSTRACT

One does not have to look far to see that the very survival of human, animal and plant life depends on both quality and quantity of water. Our current approach to conservation and management of water resources in the North Eastern Region is based on this concept that the demand of qualitative and quantitative adequacy of water in a modern developed society is increasing and will continue to do so in the near future. To solve this issue one has to be aware of the dangers and hazards of the pollutants. The need of the hour is the cooperation and network of the various departments with the public.

INTRODUCTION

Water is a vital part of the environment, a basic need to sustain all forms of life. It is a natural resource that is needed for the survival of human, animal and plant life. Globally no resources can be more strategic than water. The demand for water is steadily increasing and will continue to do so in the near future. This underscores the need for public awareness of the importance of its conservation because its availability is at the mercy of nature over which we have no control. As we enter the 21st century, we need to see the efforts being made to develop, conserve and manage this important resource on an integrated and environmentally sound basis.

DISCUSSION

The North Eastern Region comprising of seven states-Assam, Meghalaya, Manipur, Tripura, Nagaland, Arunachal Pradesh and Mizoram is endowed with bounty of water resources accounting for about 40% of the total water resources of the country. Unfortunately, this vast resource has been exploited in many ways. As we know the region has abundance of trees and forests yet deforestation has started and degraded the water resources and the environment. The growth of industrialisation and urbanisation is also another factor. Agricultural pollutants also play a role in deteriorating the water resources and the environment. These factors contribute to degradation of the resources and detrimental effects on the environment. The issue of pollution and quality of water forms an element of conflict in the Brahmaputra and other river basins. The increasing upstream withdrawals of water from the river for irrigation and supply to the urban industrial areas including the newly built tea gardens and settlements have left the rivers with much reduced flows unable to flush out pollutants. On the other hand, growing load of urban industrial and agricultural pollution has led to fast decline in the quality of both surface and ground water. The migration of rural population to urban areas because of employment opportunities, better living conditions is at present an increasing trend in most of the states of the country. This continuous migration of people constitutes a social problem which may eventually impair the quality of life. It is indeed a blessing to see such abundant supply of clear water, streams, rivers but it is also a curse that with urbanisation, we see one after another of these beautiful resources polluted by the waste products of urban civilisation. Shillong, the capital of Meghalaya, at one time showed safe water samples examined but lately were reported unfit for human consumption. This basic problem of safe water supply is yet to be solved.

Meghalaya is situated in the north eastern region of India, covers an area of 22,429 sq. kms with a population of 17,74,778 according to 1991 census. It is a hill state with an elevation ranging from 300 metres to over 1900 metres above sea level. In the western part of the state, the Nokrek peak in the Garo Hills rises up to a height of 1418 metres while in the stream part, the Shillong peak stands at a height of 1965 metres. Based on the topography, geology, soil, rainfall, temperature, forest areas, the state has been divided into the following districts - East Khasi Hills District, West Khasi Hills District, Jaintia Hills District, Ri Bhoi District, East Garo Hills District, West Garo Hills District and South Garo Hills District. Each of the districts is drained by the rivers and their tributaries. The drainage system of Meghalaya is greatly controlled by its geological

structure and the physiographic features and occasionally by rainfall. In particular, East Khasi Hills District has an area of 3305.55 sq. kms and is drained by the rivers Umiam, Umngi, Umiew. Umiam is a river in Khasi Hills which emerges in the neighbourhood of Shillong Peak and meets the Brahmaputra in the north. The river Umiam is being dammed near Mawphlang to create a reservoir for the proposed Greater Shillong Water Supply Scheme. This river comes out in the plains and is called the Bogra river or Bogapani. The Main tributaries of this river are Umshyrpi, Umjasai and Umkhrah. The river Umtrew emerges near Sohpetbneng Hill and takes a westerly course after crossing the Guwahati-Shillong Highway. In the plains of Assam this river is known as the Digaru. Umiam and Umtrew are north-flowing rivers which meet the Brahmaputra.

Meghalaya is employed to regulate the uses of water for the benefit of community provided such uses do not cause harm to water resources. Circumstances, however, make necessary to exercise choices, so priority is given to drinking water supplies followed by water supplies for agriculture, hydro and thermal power, industries, cleaning and finally recreational purposes. In urban areas, efforts are made to ensure that population is continuously supplied with drinking water unlike in the rural areas where the population is continuously supplied with drinking water unlike in the rural areas where the population obtain its water supplies from springs, rivers, dug wells. The National Water policy gives highest priority to drinking water. The policy recommends that in all water resources development projects provision for drinking water should be of prime importance. The State Government of Meghalaya is committed to providing safe drinking water to all by the year 2003. Both surface and ground water should be regularly monitored for quality to ensure health and safety to the community. We often hear of various types of water borne infections and diseases mostly in children and also in adults. Water contaminated by faeces remains one of the biggest killers worldwide. Lack of adequate water, sanitation and hygiene is responsible for an estimated 17 percent of all deaths and diseases globally with diarrhoea alone claiming the lives of some 2.5 million children a year, according to a recent estimate.

The quantity of water is in great demand in hydro and thermal power projects. The North Eastern region has a great hydro power potential. On the hydro power front the region is said to have a potential of 32000 MW. At present only 591 MW has been harnessed through the various micro, mini and major projects. In all, the region has ten completed projects with total installed capacity of 559.7 MW. At present the region has three ongoing projects in Nagaland, Arunachal Pradesh and Mizoram, which when completed would have an installed capacity of 540 MW. Meghalaya has a great potential for hydro and thermal power. The main hydel projects are Umtrew and Umiam. The Umtrew project was set up with the Canadian help under the Colombo Plan and the generation of hydro-electricity started in 1957. Originally, it had an installed capacity of 8,400 KW but later on the installed capacity was raised to 11,200 KW and till 1992 the capacity was further raised to 16 MW. The first stage of the Umiam hydel project with the installed capacity of 36,000 KW was commissioned in 1965 and the second stage with the installed capacity of 18,000 KW in 1970. The third stage of this project, Kyrdemkulai Hydel project has an installed capacity of 60,000 KW. It was commissioned in 1979. The total capacity of five power plants now stands at 185.2 MW. The State Government is making intensified efforts to tap the hydel power potential of the State which can generate power not only for domestic needs but for the economic development of the region.

The demand for quantity of water in cleaning purposes is also very high. In Shillong, Tura and other places, the Municipal Boards are operating to carry out the responsibility of cleaning the streets and public places, for the disposal of sewage, drainage and maintenance of public latrines, water closets and for transport means to carry wastes away in such a way as to avoid any possible detrimental effects to citizens. The Municipal Board on its own cannot make much headway unless participation of the community is attained. So the Board cannot stop people from throwing garbage on the roads and in open drains, it requires the cooperation and concern of the community as a whole. On the other hand, it is imperative to see that in the cleaning process the discharges of waste water do not degrade surface or ground water resources.

The other important aspect that needs proper attention is recycling and reuse of water. The reuse of water is highly desirable in quantitative and economic terms but it also presents the most difficult problems as there is very little likelihood to reuse water in our state. The use of water is usually accompanied by deterioration in quality, so the quality of water that returns to the environment is of crucial importance. We see lot of improvements in strategies and techniques to control pollution of surface and ground water resources, to improve quality of water but the steps to recycle and reuse of water could also be the means to conserve

water and to avoid the deterioration of the fragile environment. With these techniques the water used for domestic and industrial purposes is to be discharged to a sewer and treated before it returns to the surface or ground.

CONCLUSION

The above facts clearly indicate that with availability of water must be coupled quality in order to meet the various domestic and industrial needs. The ready availability of water is important in various fields. Water is used to take away man of our waste products yet this same water eventually returns to our environment. We are now making considerable efforts to keep our environment clean. The cleanliness of our environment is important not just for the practical purpose of staying alive but also for enjoying life. Our rivers and lakes afford much enjoyment in terms of boating and fishing. Thus the steps to quality control of water should ensure that rivers are clean enough to support aquatic life. It is therefore a call for the public in general and the leaders in particulars to step up such means to make our environment pollution free and to conserve water resources.

WATER RESOURCES DEVELOPMENT AND ENVIRONMENT

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ABSTRACT

The paper gives in brief the role of Central Water Commission (CWC) in the implementation of the environmental safeguards stipulated by the Ministry of Environment and Forests while clearing the water resources development projects. For proper implementation of these safeguards at each project, effective monitoring system is essential. For this purpose a three tier monitoring system viz; at national, state and project level has been devised by Ministry of Water Resources. The objective of environmental management is to optimise the benefits while minimising the adverse impacts. Safeguards are stipulated keeping this in view, which are necessary not only for a particular project but also in overall interest of water resources sector. Eighty five (85) water resources projects have been selected by the Environmental Monitoring Committee (EMC) for monitoring from the environmental angle, out of which 17 are being closely monitored by the EMC. Director, Monitoring and Appraisal Date., CWC, Guwahati is represented on the Project Level Monitoring Committee in North Eastern Region.

INTRODUCTION

Water resources development has been receiving due priority in the successive five year plans initiated since independence. As a result, a number of major and medium river valley projects have been constructed during the past four decades. Besides contributing to the increase in agricultural production, these projects have also provided various other benefits such as drinking water, power production, navigational facilities and industrial water needs etc. However, all developmental activities have got certain environmental impacts and water resources projects are no exception.

The attention was focussed on the environmental issues during the 1972 UN Conference held at Stockholm. This, in fact, brought an awakening towards environmental impacts of various developmental activities including Water Resources Development Projects. Various environmental impacts of these projects which came to be noticed included the degradation of land, effect on flora and fauna and the displacement of people, the last one having led to some resentment among the people as it affected them directly. In fact, the environmental impacts of water resources projects are being experienced and observed carefully in many developed as well as developing countries. This led to the realisation that there was a need to make an in-depth study of these impacts. Steps were also initiated to evolve various measures so as to minimise the negative impacts while maximising the benefits. The UN Conference on Environment and Development held at Rio during 1992 was a culmination of the growing concern of the international community towards sustainable development.

ROLE OF CENTRAL WATER COMMISSION

The Central Water Commission created in 1945, has come a long way in its march towards achievement of the goal of furthering and providing measures for control, conservation and utilisation of water resources throughout the country in the areas of beneficial uses, irrigation and hydro power generation, flood management and river conservation. As the national premier organisation in the field of water resources development, the CWC with its vast experience gained in its strides towards progress in more than five decades has developed considerable technical knowhow in planning, investigation, management and design of water resources development schemes.

The Central Water Commission, which is headed by Chairman who also holds the status of Ex-officio Secretary to the Govt. of India, with three technical wings namely Designs & Research Wing, Water Planning and Projects Wing and River Management Wing. Central Water Commission had taken a land mark decision in 1992 by opening a regional field organisation headed by a Chief Engineer at Shillong for overseeing the entire activities in the North Eastern Region concerning water resources development as well as maintaining close interaction with the State Government concerned.

Other such organisations are functioning at Bangalore, Bhopal, Bhubaneswar, Chandigarh, Coimbatore, Delhi, Hyderabad, Lucknow, Nagpur, Patna, Siliguri and Vadodara.

CLEARANCE OF PROJECTS FROM ENVIRONMENTAL ANGLE

Prior to 1978, all major and medium river valley projects were examined at the Centre by Central Water Commission in respect of their technical feasibility and economic viability, before their acceptance by the Planning Commission in the development plans of various states. However, with the constitution of Department of Environment and Forests during 1978, the clearance of all major irrigation, multipurpose and flood control projects from the environmental angle became obligatory.

The project authorities are required to furnish the detailed project report along with other requisite information in the specified proforma and furnish the Environmental Impact Assessment (EIA) Studies, Environmental Impact Statements (EIS) and the Environmental Management Plans (EMP) etc. to the Ministry of Environment & Forests for scrutiny. The project is considered by an Environmental Appraisal Committee (EAC) consisting of experts of various disciplines from different Departments of Government of India which decides about the acceptance of the project from the environmental angle and certain environmental safeguards are stipulated, wherever necessary. These safeguards need to be implemented pari-pasu with the construction activities by the project authorities. It is also mandatory to get clearance from forest angle (if forest land is involved in the project) in addition to environmental clearance.

CONSTITUTION OF ENVIRONMENTAL MONITORING COMMITTEE

With a view to integrate the environmental concern into water resources development, initially a Directorate named Environment Management Directorate was created in CWC during 1987. With increase in activities at present, a full fledged Environment Management Organisation is functioning in CWC headed by a Chief Engineer. This organisation functions as a link between the State authorities who are executing water resources projects and the Ministry of Environment & Forests who are vested with the powers of clearing the projects from environmental angle.

A multidisciplinary Environmental Monitoring Committee (EMC) was constituted by the Ministry of Water Resources during February, 1990 for overseeing the implementation of environmental safeguards stipulated by the Ministry of Environment & Forests while clearing the Water Resources Projects. The Committee is headed by the Member (WP&P), CWC with Director (Environmental Management) CWC as its Member Secretary. It comprises members from Ministries of Environment & Forests, Agriculture & Co-operation, Welfare and Water Resources besides Planning Commission. The Committee is entrusted with the work of review of the mechanism established by the project authorities to monitor the ecology of the project areas and to suggest additional compensatory measures/facilities wherever necessary. It is also required to bring to the notice of the Government important cases of default, which may lead to the review of project's clearance for the funding arrangement.

SELECTION OF PROJECTS FOR MONITORING

In its first meeting held in April 1990, the Environmental Monitoring Committee selected 78 irrigation, multipurpose and flood control projects which had already been cleared from the environmental angle by the Ministry of Environment & Forests subject to certain environmental safeguards to be monitored. As there were limited infrastructural facilities with the EMC, it was decided to closely monitor 10 such projects by visiting the projects and holding meetings with the State/Project authorities. Subsequently, on the request of the Planning Commission and Ministry of Environment and Forests this list was increased to 85 and the number of project to be closely monitored by the EMC had been increased to 17.

For the remaining 68 projects, it was decided to monitor the progress of implementation of the environmental safeguard stipulations through the three-tier system i.e. Project Level Environmental Management Committee; State Level Environmental Monitoring Committee and National Level Environmental Management Committee. The Project Level Environmental Management Committees will review the progress of implementation at their level and submit its reports to the State Level Environmental Monitoring Committee which, after review, will forward the same to the National Level Environmental Monitoring Committee for further deliberations and to suggest modifications for improvement.

The organisational structure of National Level/State Level and Project Level Environmental Monitoring Committee is given at Figure-1, 2 & 3.

So far as North Eastern Region is concerned, Puthimari Project in Assam, Khuga Multipurpose Project in Manipur and Gumti Uprating Scheme in Tripura have been selected by the Environmental Monitoring Committee for monitoring. Out of this Khuga Multipurpose Project has been selected for close monitoring by National Level Environment Monitoring Committee and the remaining projects are being monitored at Project Level Monitoring Committee, Director, Monitoring & Appraisal Directorate, CWC located at Guwahati under the direction and guidance of Chief Engineer (Brahmaputra & Barak Basin Organisation, Shillong) is represented on the Project Level Environmental Monitoring Committee.

CONCLUSION

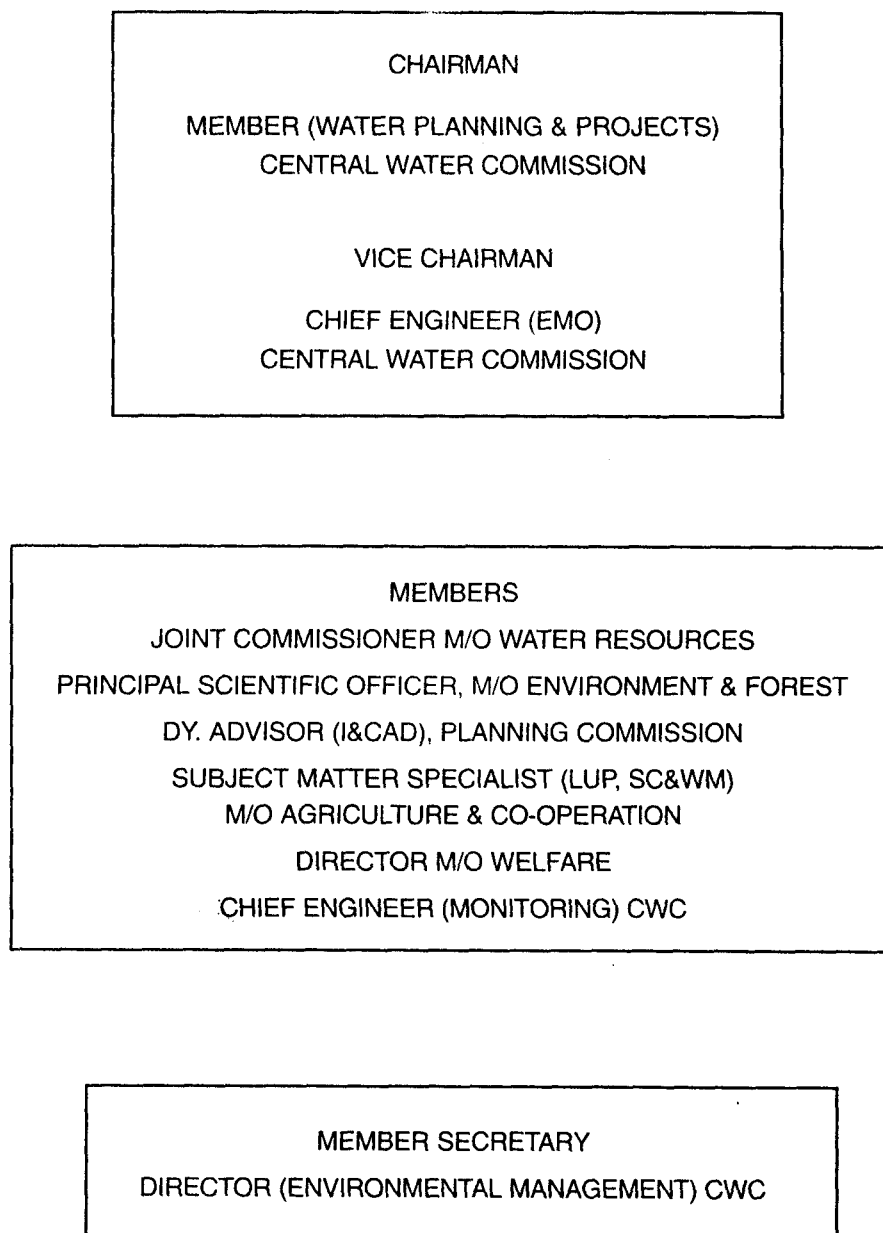
Like all other developmental activities, water resources projects have also got both beneficial and adverse environmental impacts. The objective of environmental management is to optimise the benefits while minimising the adverse impacts. Various environmental safeguards are stipulated keeping this in view. The proper implementation of these safeguards is not only necessary for the particular project but also in the overall interest of the Water Resources Sector. It is, therefore, imperative that these safeguards are followed in letter and spirit.

Monitoring is a very effective tool in ensuring the implementation of environmental safeguards. Effective monitoring should thus form an integral part of sustainable water resources development.

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NATIONAL LEVEL ENVIRONMENTAL MONITORING COMMITTEE



ORGANISATIONAL STRUCTURE OF NATIONAL LEVEL MONITORING COMMITTEE

Figure - 1

STATE LEVEL ENVIRONMENTAL MONITORING COMMITTEE

CHAIRMAN

SECRETARY
WATER RESOURCES/IRRIGATION DEPARTMENT
OF THE STATE GOVERNMENT

MEMBERS

CHIEF ENGINEER (EMO), CWC
(ALTERNATE : DIRECTOR (EM), CWC)

ADDL. SECRETARY/JOINT SECRETARY, M/O ENVIRONMENT AND FORESTS
OF THE STATE GOVERNMENT

ADD. SECRETARY/JOINT SECRETARY, DEPARTMENT OF REVENUE/REHABILITATION

ADD. SECRETARY/JOINT SECRETARY, M/O WELFARE OF THE STATE GOVERNMENT

ADD. SECRETARY/JOINT SECRETARY, M/O AGRICULTURE OF THE STATE
GOVERNMENT

ADDL. SECRETARY/JOINT SECRETARY, PLANNING DEPARTMENT/BOARD
OF THE STATE GOVERNMENT

ENGINEER-IN-CHIEF, WATER RESOURCES/IRRIGATION DEPARTMENT
OF THE STATE GOVERNMENT

CHAIRMAN OF THE ENVIRONMENTAL MANAGEMENT COMMITTEE OF EACH PROJECT
IN THE STATE FOR WHICH COMMITTEES HAVE BEEN SET UP

REPRESENTATIVES FROM TWO NON-GOVERNMENTAL ORGANISATIONS
OF REPUTE IN THE STATE

CHIEF ENGINEER/DIRECTOR OF THE GROUND WATER DEPARTMENT
OF THE STATE GOVERNMENT

ADDL. SECRETARY/JOINT SECRETARY, DEPARTMENT OF HEALTH/PUBLIC HEALTH
OF THE STATE GOVERNMENT

MEMBER SECRETARY

CHIEF ENGINEER AT THE STATE CAPITAL CONCERNED WITH ALL THE
PROJECTS OR MOST OF THE PROJECTS

ORGANISATIONAL STRUCTURE OF STATE LEVEL MONITORING COMMITTEE

Figure - 2

PROJECT LEVEL ENVIRONMENTAL MANAGEMENT COMMITTEE

CHAIRMAN

CHIEF ENGINEER OF THE PROJECT

Chief Engineer connected with maximum environmental works
of the project when compared with other Chief Engineers,
if there are more than one Chief Engineer for this Project.

MEMBERS

OFFICERS OF THE LEVEL OF

SUPERINTENDING ENGINEERS/EXECUTIVE ENGINEERS

REPRESENTATIVES FROM THE DEPARTMENT OF ENVIRONMENT AND FORESTS

REPRESENTATIVES FROM THE DEPARTMENT OF REVENUE/REHABILITATION

REPRESENTATIVES FROM THE DEPARTMENT OF WELFARE

REPRESENTATIVES FROM THE DEPARTMENT OF AGRICULTURE

REPRESENTATIVES FROM THE DEPARTMENT OF GROUND WATER

REPRESENTATIVES FROM THE DEPARTMENT OF HEALTH/PUBLIC HEALTH

TWO REPRESENTATIVES FROM THE NON-GOVERNMENTAL ORGANISATIONS
DIRECTLY

LOOKING AFTER THE WELFARE OF THE MAJORITY OF THE PROJECT AFFECTED
PERSONS IN THIS PROJECT

DIRECTOR (APPRAISAL & MONITORING/APPRAISAL) OF THE REGION CWC

MEMBER SECRETARY

SUPERINTENDING ENGINEER CONNECTED WITH THE MOST OF THE
MATTERS AT THE HEADQUARTERS OF THE CHAIRMAN

ORGANISATION STRUCTURE OF PROJECT LEVEL ENVIRONMENTAL MANAGEMENT COMMITTEE

Figure - 3

SIGNIFICANCE OF LICHEN FLORISTICS IN ASSESSING AIR QUALITY

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ABSTRACT

Lichens, the symbiotic organisms of fungi and algae/ or cyanobacteria are recognised as very sensitive to air pollution. This high sensitivity of lichens is related to their biology as they are exposed to air pollutants all year.

The lichens are sensitive to air pollution is of course, a generalisation that required cautious interpretation and limited extrapolation. For example, all lichen species are not equally sensitive to all air pollutants. Rather, different lichens are well considered as biological indicators for monitoring environmental quality.

During the last two decades in developed countries, numerous studies have been devoted to assessing the effect of air pollution on lichens. However, in developing countries like in India, such studies are almost lacking. Various techniques have been employed to study the air quality of the area. One such method is the floristic method of studying air quality with lichens. This is based on using the entire lichen flora for evaluation. All species of lichens are collected at many sites, observations are made on the lichen healths and reproduction of species, species sensitive to SO₂ are mapped, species compared with historical lists, and elemental analysis are done on a few species. The causes of lichen decline are discussed. The need for initiating such studies in India is emphasised as pollution level is gradually increasing.

INTRODUCTION

Lichens, the symbiotic organisms of fungi and algae/or cyanobacteria are recognised as very sensitive to air pollution. This high degree of sensitivity in lichens is related to their biology as thalli are exposed to air pollutants throughout the year. Alternation of the symbiotic balance between the two constituents - the photobiont and the mycobiont may lead to a break down of the association.

Lichens are especially sensitive to Sulphur dioxide (SO₂), Fluoride and strongly oxidising compounds like Ozone. Drastic losses of species occur in areas where heavy air pollution prevails. Therefore, in recent past lichens have been used as bioindicators of air pollution. Biomonitoring with lichens has advantage of not needing expensive equipments, but one must accept several areas of uncertainty.

Various techniques have been employed in European and American countries to study the air quality using lichens. However, in the developing countries like India, such studies are yet to be initiated. It is important to create base for such studies as pollution level in Indian cities is increasing day by day on account of various factors such as industrialisation, urbanisation, increase in vehicular traffic etc.

Wetmore (1988) has reviewed the use of lichens in assessing air quality. Based on his observations the following account is presented briefly on presumption that such studies will be initiated in many developing countries including India, where lichens are found both in abundance and species diversity.

Of many methods, one such method is the floristic method where total lichen flora of an area is considered for air quality. Here one has to look for species presence or absence because more sensitive species are injured or killed by low level of some air pollutants and disappear from the substrate (Wetmore, 1982). In some studies distribution maps of the species are used to find out the reduction of the natural distribution of the species (Showman, 1988). In the absence of any other ecological changes in an area, one attempts to substantiate the case for air pollution. Air pollution study other than the death can also be detected by studying the reduction in fertility, disappearing of young stages of growth, reduction of cover of species, etc. These studies are usually conducted in smaller to moderate size of areas, usually near the source of pollution.

Besides, mapping techniques (Turk, 1982), by establishing permanent plots and to follow changes there after, transplantation of lichens into an area and observing their growth and deaths (Brodo, 1968), quantitative or semi quantitative methods (Nash, 1975, Marsh & Nash, 1979) etc. are also used to study air quality effect with lichens.

All species do not die or disappear in polluted area. Certain species show resistance to a particular pollution level. These studies are required to be carried out in the Indian cities like Calcutta, Bangalore and their suburban areas.

It is well known that lichens accumulate mineral elements in excess of their metabolic requirements. The analysis of these elements present in thalli can provide a sensitive indication of the pollution level in the environment (Puckett, 1988). The elemental contents of lichens strongly co-relate with the results obtained by the instruments recording pollution level in the air (Laaksovirta & Olkkonen, 1979). Similarly multi elemental analysis and comparison of ratios of different elements can also be used to indicate the type of pollution (Nieboer et al, 1978).

CAUSES OF LICHEN DEATH

The cause of lichen death or reduction in lichen communities in a particular area have been discussed in past by various workers. When a healthy lichen is transplanted from a natural environment to a polluted atmosphere, it is observed that green algae layer fades away within few months and the lichen dies. The atmosphere has numerous complex pollutants, but one Sulphur dioxide (SO_2) is considered the main agent, responsible for changing the metabolic activities of photobiont and mycobiont. The deleterious effect of SO_2 has already been demonstrated in the laboratory conditions by Leblanck & Rao (1973) by using corticolous lichens to controlled amount of SO_2 at various conditions of humidity and found that algal cells were sensitive to sulphurous acid and sulphates. Chlorophyll-a was converted in to Phaeophytin-a by displacing Magnesium (Mg^{++}) atom. Since lichens possess less chlorophyll as compared to other green plants, even small amount of SO_2 may break the symbiotic association and thereby causing the death of lichen thalli or reduction in lichen communities in polluted environment. Therefore, lichen vegetation of an area is a clear indicator of the atmospheric pollution. Indicator species are assigned numerical values corresponding to their known resistance. A comparison of degree of toxiphoby (sensitivity) to pollution of epiphytic species of lichens reveals the degree of pollution level in a particular area and by the use of appropriate formulae an index of pollution can be computed (de Sloover & LeBlanc, 1968).

METHODOLOGY

The floristic method has been discussed in detail by Wetmore (1988). He has identified 6 basic parts which are as follows :

- 1 Collection of voucher of all lichen species found in all vegetation types throughout a specified area.
- 2 Collection of bulk samples of several common lichens for base line elemental analysis.
- 3 Notation of the presence or absence of symptoms likely due to air pollution injury in the field: discoloured parts of the thalli due to death, dead thalli of sensitive species, frequency of fertile thalli, abnormal growth pattern of thalli.
- 4 Preparation of a lichen flora for the area and its comparison with historical records or with a flora occurring within the same region having clean air.
- 5 Mapping the distribution of sensitive species in the area to look for voids in the distribution.
- 6 Comparison of elemental analyses of thalli with reports from other studies and between localities to determine if sublethal accumulation of pollutants is occurring.

The method involves thorough collection from the area. While selecting numerous localities within an area, the following points may also be taken into consideration for better results.

- 1 Initially many tentative localities are selected throughout the area to give a broad general coverage.
- 2 Tentative localities are selected that include all vegetational types.
- 3 The actual collection sites are selected which are likely to have good lichen floras.
- 4 At each site all species found are collected even though they might have been collected at a previous site.
- 5 Observations are made on the healths of the lichens at each site studied.
- 6 Observations are also made on habitat disturbance, such as fires or lumbering etc.

Later all specimens are identified according to well established lichenological methods and prepared into permanent herbarium specimens incorporating all field data for use in future.

DISCUSSION

In analysing the flora of an area for air quality degradation, the most accurate method is to compare the present flora with the historical records for the same area. When comparing modern collections in the herbarium from historical collections, the quality of the historical collections may be better than the recent specimens. Historical collections may be frequently more fertile or better in condition. If no historical records are available for the area being studied, comparisons must be made with near by comparable areas that are either presumed or known to be free of air pollution. Comparison of areas should be as near as possible geographically to avoid differences in climate and as similar in topography as possible and with a similar vascular plant flora.

When evaluating the lichen flora of an area considerations must be given to the geographic distribution patterns of the lichens beings used as indicators. The species that would normally occur in the study area but which are absent, should then be compared with the pollution sensitivity lists found in the literature. Maps of the distribution of the most sensitive species are then prepared for the study area and evaluated with respect to potential sources of air pollution as was done by Showman (1981).

The specimens collected for floristic study, selected species are also collected for analysis of chemical elements. Species selected for elemental analysis should be abundant enough for analysis also and should be relatively easy to clean.

The floristic method has certain advantages and dis-advantages, of which some are as follows :

ADVANTAGES

- 1 Rapid assessment of air quality using lichens-the most sensitive group of plants.
- 2 Field work can be accomplished by one person and without using expensive instruments.
- 3 Where flora is not known, this kind of study provides the base lichen flora and also significant ecological information.
- 4 Useful in screening many large areas rapidly to determine which should be studied in more detail later.
- 5 Advantages of using the whole lichen flora than a smaller set of species.

DISADVANTAGES

- 1 These methods give a general idea of air pollution.
- 2 Need for historical records or well known comparable areas to determine which species might be absent due to air quality effect.
- 3 The sensitivity of species may vary depending on pH of the substrate. With air pollution, species growing on basic substrate will persist longer than the lichens growing on acidic substrate.
- 4 The elemental accumulation in one species of different substrate may vary. Therefore, all species for elemental analysis should be collected from one kind of substrate to reduce this problem.

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TECHNICAL SESSION — II

ENVIRONMENT

&

AWARENESS

WILDLIFE CONSERVATION IN MEGHALAYA

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ABSTRACT

The North East of which Meghalaya forms a part is endowed with a rich flora & fauna. Of late, however, there has been extensive and rapid depletion of this wealth.

The major cause for this depletion is due to loss and destruction of wildlife habitat. Illegal trade in wildlife products, practices like community hunting, killing of crop-raiding animals by farmers and hunting for sport are other reasons.

In order to ensure survival and propagation of the remaining wildlife these existing habitat will have to be well protected. At the same time they should be made suitable to contain wildlife so that they do not stray into human habitations and expose themselves to danger. This can be done by well-planned habitat development works. At the same time corridors linking these areas should be made to allow free and safe movement of wildlife. If possible extension of Government protected areas to suitable areas should be done.

Since most of the wildlife habitat fall in private hands and as most of the wildlife live in private areas people's involvement and cooperation is vital to ensure success of wildlife conservation measures.

INTRODUCTION

INDIA is one of the twelve Mega Biodiversity countries in the world. Though it comprises only about 2% of the geographical area of the world it is estimated to contain about 7.5% of the World's Biodiversity. Meghalaya possesses abundant wildlife heritage. Wanton destruction of habitat hunting and gathering of forest fauna and flora over a long period of time, have however, taken its toll, placing many species of wildlife in danger of extinction with little hope for survival unless vigorous and committed efforts are taken to save them.

DISCUSSION

The decimation of wildlife is wholly due to man's actions. Shifting cultivation, hunting and gathering of forest biota have been the way of life here since time immemorial. Initially nature was able to sustain the ravages of a limited human population. Increasing onslaughts by a growing population however have finally overwhelmed its attempts to recuperate from such destruction. At present the results of indiscriminate felling of forests for jhumming and commercial exploitation of timber are seen now in the form of a few scattered patches of forests left untouched due to their remoteness and inaccessibility. These areas now comprise the last refuge of endangered wildlife which have been reduced to this plight due to destruction of their habitat and heavy demand for wild animal and plant products throughout the world.

Almost all wildlife found here are sought after for various purposes viz. food, medicine, clothing and ornaments within this state as well as throughout the North Eastern region especially States like Mizoram and Nagaland where the wildlife population has been decimated. Outside the region, within the country, the South Eastern region and abroad in European countries and the USA there is a great demand for various animal products like ivory, rhino horns, tiger bones, skins of animal products like tigers, leopards and reptiles for their purposed medicinal values and for ornamental uses. In addition to this, certain wild animals, notably birds are often kept as pets. Parakeets and Munias found in this State fetch high market prices. The state bird the Hill Mynah (*Gracula religiosa*) is one of the most preferred species in the international markets as it can be taught to speak and also looks good because of its glossy feathers. Butterflies of Meghalaya are also extensively used for ornamental purposes. Shillong is in fact one of the major supply centres of butterflies in India. Wild flora too are sought after for various purposes mainly medicinal and ornamental. Orchids from amongst the scheduled plants found here are Lady's slippers and Blue vanda. Wild orchids are often hidden amongst exotic flowers during export. Though accurate estimation of illegal

trade in monetary terms is not accounted due to the intrinsically clandestine nature of the trade. It is however known to involve huge sums of money and is believed to be surpassed only by the illegal trade in drugs and arms.

Amidst the increasing pressure on forests and wildlife by a rapidly growing human population, the task of the forest department to protect and conserve wildlife will be difficult. Like most Government departments, it faces the problems of inadequate infrastructural facilities, shortage of manpower and paucity of funds which may never be resolved. To make matters worse only a small part of the existing wildlife habitat, covering about a thousand square kilometers is only owned by the government. Most of the areas are under private ownership which though under legal cover of the wildlife Act, practically no protection machinery as found in Govt. owned areas. Extension of the Govt. owned protected area (PA) through acquisition of crucial habitats and linking of habitats with corridors in order to facilitate free movement of animals is being carried out in the National parks and Sanctuary but this is severely limited on account of the paucity of funds. The extent of area to be acquired by the Government is still far short of requirements, hence the department should accept this fact and prepare comprehensive and practical plans for management of all the existing habitats identified for this purpose throughout the State be they Govt. owned or privately owned. These plans should facilitate competent management of those resources and of human pressures and activities that affect the resources. From the onset, people living in and around such identified areas should be taken into confidence. It should be kept in mind that good wildlife management is effective management of people's pressure on resources. If the pressure on forest based resources are not resolved to the satisfaction of the ecological requirements and the local economic realities of the people, the wildlife conservation schemes will fail. People friendly and pressure dissipating strategies which combine education with actions that bring about mutually satisfying results, should be adopted. Legal measures and protection measures are important and necessary but if applied by themselves will create confrontation - the sure-fire recipe for disaster of any conservation scheme.

On the matter of reducing biotic pressure on forests and wildlife the Forest Deptt of Meghalaya has made some headway. In 1985 the Meghalaya Eco-development Society was established in order to rehabilitate villages displaced or affected by creation of Balphokram National Park. Ecologically sustainable and economically viable programme packages are being prepared and implemented so as to reduce their dependency on the park area. At present this society is functioning only in the areas around Balphokram National Park. It is high time that it starts bringing other villages situated in and around Govt. PA's and selected non-Govt. owned habitats under its preview.

Assistance to forest dwellers can also be provided in the form of employment. Various activities are carried out, during most parts of the year by the forest department in and around their PA's (eg. Cultural operations and maintenance works) and outside them as well in social Forestry Plantations.

For such jobs local people should be employed. The National Forest Policy 1988 has emphasized this and stressed on the need to replace contractors and employ labourers directly or through labour Co-operatives or Govt. Co-operatives. Such measures will ensure that maximum benefits accrue to the people.

The task ahead of the forest department is indeed difficult. On one hand it has to enforce stringent laws and on the other hand provide beneficial schemes to people, who rightly do get confused about the actual role of the deptt. Forest dwellers remember forest personnel as guardians of Govt. Reserve and protected forests and law enforcers prohibiting them to do the things which they need to do to fulfil their requirements. Their new role as facilitators of development is yet to be accepted by the people as many of whom seriously doubt their credibility. Thankfully, solution is now available in the form of NGO's most of which are committed and voluntarily working tirelessly for the benefits of the backward and rural poor. Many of these NGO's have proven track records in motivating and organising village support and participation in Govt. schemes made for their benefit. The expertise and experience of such organizations should be taken as an advantage but most important of all they should be primarily used as an interface between the forest department and the first dwellers to create trust and build up meaningful people's participation which is the basic ingredient of success in wildlife conservation schemes.

WATER QUALITY OF THREE SUBTROPICAL RESERVOIRS OF MEGHALAYA

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ABSTRACT

Umiam, Nongmahir and Malse reservoirs of Meghalaya depicted subtropical character (mean water temperature: 17.7 - 22.4°C and several interesting abiotic parameters. Malse is characterized by distinctly acidic nature (pH: 6.1 ± 0.4), strikingly low electrolyte concentration (Specific conductivity: 8.3 ± 1.8 µs/cm) and highly soft-waters (alkaline: 8.5 ± 1.8 mg/l; hardness: 7.5 ± 3.4 mg/l). Umiam and Nongmahir indicated typical alkaline nature (pH: 7.61 - 8.15), lower mg/l conductivity (35.1-56.1 µs/cm) and soft-waters (alkalinity 20.2-27.5 mg/l; hardness: 21.5-25.4 mg/l). All these reservoirs indicated (mean values) moderate transparency (1.34-2.55 m), moderate dissolved oxygen (6.5-8.5 mg/l), lower free Carbon dioxide (2.4-6.2 mg/l) and lower Chloride contents (5.5-11.5 mg/l). Further, these depicted low Phosphate (0.01 - 0.15 mg/l) and Nitrate (0.02-0.16 mg/l) concentrations and wider temporal variations in Sulphate (2.2-51.1 mg/l) and Silicate (2.8-43.9 mg/l) contents. Comments are made on general nature of the studied biotopes and on limnological correlations noticed presently.

INTRODUCTION

Water quality (within limits of limnosaprobity) is an important index of trophic status and aquatic productivity of freshwater ecosystems and is, hence, an essential pre-requisite for their proper scientific management. This generalization holds equally true for reservoirs which are constructed for specific purposes such as hydro-electric power generation or as storage basins for drinking water supply etc. In spite of recent upsurge of investigations on Reservoir limnology in India, our knowledge of water quality of these biotopes particularly in North-Eastern India is so far confined to published reports by Bhattacharya and Saha (1986, 1990) and Sharma (1995).

The present study provides comparative account of temporal variations in physico-chemical parameters of three subtropical reservoirs of Meghalaya with an objective to evaluate general nature of their water quality as well as to comment on their salient abiotic features and ecological correlations.

MATERIAL AND METHODS

The observations were undertaken in Umiam, Nongmahir and Malse reservoirs, Meghalaya; the first two biotopes are located in the Ri-Bhoi district at a distance of about 20 and 45 kms respectively from Shillong, the capital of this state while Malse is situated (East Khasi hills district) at a distance of about 12 kms. from this city. Additional details of the sampled water bodies are given below. Of these, Umiam or

Reservoirs	Umiam	Nongmahir	Malse
Latitude	25° 37' N	25° 8' N	25° 34' N
Longitude	91° 51' E	91° 50' E	91° 50' E
Area (ha)	356	70	8
Maximum depth (m)	70	25	15
Purpose	Hydal power	Hydal power	Drinking water supply
Year of construction	1960	1965	1979

'Barapani' is the main reservoir for the Umiam-Umtru hydro-electric project (Stage I) while Nongmahir serves as a pick-up reservoir under Stage III of the mentioned project and is fed by the water flowing from the Kyrdemkulai reservoir (Stage II).

Water samples were collected, at regular monthly intervals, from all the three ecosystems. Air and water temperatures were noted with thermal probe; pH and specific conductivity were recorded with pH and conductivity meters respectively, transparency was measured with a Secchi disc; dissolved oxygen was estimated by modified Winkler's method and various other chemical parameters were analysed following

APHA (1985). Ecological relationships are based on computation of Correlation coefficients (r) between different parameters.

RESULTS AND DISCUSSION

Temporal variations in abiotic parameters of the sampled reservoirs are indicated in Tables: I-III, their mean values are compared in Table - IV and important features of water quality are discussed below:

Rainfall indicated marginal annual variations (mean: 175.2-222.0 mm), registered identical seasonal patterns and is distinctly influenced by the southwest monsoons. Its significant positive correlation with temperature in all the reservoirs concurred with the reports of Sharma (1995), Sharma and Hussain (1999), Sharma and Wanswett (1999) and Sharma and Lyngdoh (1999) but depicted less overall impact on other parameters than that reported from the Cherra plateau (Sharma and Wanswett, *loc. cit.*). Rainfall, however, exhibited negative relationship with alkalinity in Nongmahir ($r = (-) 0.568$), with hardness ($r = (-) 0.802$) and Calcium ($r = 0.662$) in Malse while it recorded positive correlation with alkalinity ($r = (-) 0.750$) in Umiam reservoir.

Mean water ($17.7-21.1^{\circ}\text{C}$) temperatures affirmed subtropical nature of three reservoirs; the recorded annual ranges agreed with other reports from Meghalaya (Sharma, 1995; Sharma and Wanswett, 1999; Sharma and Lyngdoh, 1999) and are distinctly influenced ($r = 0.982, 0.931, 0.959$) by air temperature (mean: $20.0-23.0^{\circ}\text{C}$). Further, relatively lower annual range of water temperature in Malse reservoir is due to its higher altitude (6,000 ft) than other two water bodies. The present study indicated inverse relationships between water temperature and transparency in Nongmahir ($r = -0.578$) and Umiam ($r = -0.776$) and direct correlation between them in Malse reservoir ($r = 0.683$). In addition, it indicated negative and positive correlations with pH in Nongmahir ($r = (-) 0.781$) and Umiam ($r = 0.718$) respectively.

Transparency depicted differences in the stated order: Malse ($2.55 \pm 0.35\text{ m}$) > Nongmahir ($1.9 \pm 0.4\text{ m}$) > Umiam ($1.34 \pm 0.4\text{ m}$). Its inverse correlation with rainfall in Umiam ($r = (-) 0.621$) indicated adverse effect of abioseston being flushed into the water body with rainwater as also noticed by Sharma and Wanswett (1999). No such significant impact is, however, apparent in Nongmahir while two parameters recorded direct correlation in Malse ($r = 0.563$); the last generalization is supported by forested catchment area and less environmental degradation which is particularly in contrast to the situation in Umiam. Transparency exhibited direct correlations with pH ($r = 0.601$), dissolved oxygen ($r = 0.717$) and alkalinity ($r = 0.627$) in Nongmahir; inverse relationships with specific conductivity ($r = (-) 0.709$), hardness ($r = (-) 0.715$) and Calcium ($r = -0.672$) in Malse and also negative correlations with pH ($r = (-) 0.776$), alkalinity ($r = (-) 0.652$), hardness ($r = (-) 0.750$) and Magnesium ($r = -0.605$) in Umiam reservoirs.

Hydrogen-ion concentration depicted interesting variations and showed distinct acidic character of Malse (6.1 ± 0.4), alkaline nature of Umiam (7.6 ± 0.5) and highly alkaline nature of Nongmahir (8.1 ± 0.6). Such differences may be attributed to different soil types in Ri-Bhoi and East Khasi Hills districts. Besides, higher pH in Nongmahir may also be attributed to application of lime in this reservoir for fishery purposes.

Specific conductivity, a key index of water quality, reflected vital differences in the present study. Interestingly, Malse ($6.0-12.0$; $8.2 \pm 1.8\text{ }\mu\text{S/cm}$) indicated extremely lower electrolyte concentration and very soft-water character. It, therefore, presented an unique example of lowest specific conductivity recorded from any aquatic ecosystem of India and also matched with such lower limit ($< 15.0\text{ }\mu\text{S/cm}$) so far reported in the world (Lewis and Weibezahn 1976; Arcifa *et al.*, 1981; Mosello, 1981. Johannessen *et al.*, 1984. Schanz, 1984 and Eilers *et al.*, 1988). On the other hand, Umiam ($35.5 \pm 7.7\text{ }\mu\text{S/cm}$) and Nongmahir ($56.1 \pm 11.6\text{ }\mu\text{S/cm}$) are characterized by lower specific conductivity which broadly coincided with the report from Pokhara valley, Nepal (Hickel, 1973) as well as from this country (Sreenivasan, 1968; Vass *et al.*, 1989, Das *et al.*, 1996; Sharma and Wanswett, 1999 and Sharma and Lyngdoh, 1999). Lower dissolved mineral content of all the reservoirs warranted their inclusion in Class I category of trophic classification *vide* Talling and Talling (1965) and Payne (1986). This interesting character of water quality is, however, assigned to leached and weathered nature of rocks and soils (Rai and Hill, 1968; Sharma, 1995) and the lowered buffering capacity of the demineralized waters (Steinitz - Kannan *et al.*, 1983). Specific conductivity registered significant positive correlations with alkalinity ($r = 0.833$), hardness ($r = 0.737$), Calcium ($r = 0.808$) in Nongmahir; with hardness ($r = 0.642$) in Umiam and with alkalinity ($r = 0.656$) and Sulphate ($r = 0.822$) in Malse. On the other hand, it depicted inverse relationships with transparency ($r = (-) 0.704$) and Phosphate ($r = (-) 0.667$) only in the last ecosystem.

Umiyam (8.5 ± 1.1 mg/l) > Malse (8.2 ± 0.8 mg/l) > Nongmahir (6.5 ± 0.6 mg/l) indicated well oxygenated waters, with moderately higher mean dissolved oxygen contents. The concentration of this dissolved gas is known to exhibit an inverse correlation with water temperature (Wetzel, 1983). Such a relationship is, however, evident only in Nongmahir ($r = -0.674$) while a direct correlation is noticed in Umiyam ($r = 0.853$). Hence, the mentioned general trend is not apparent in this study although higher dissolved oxygen is often noticed during cooler periods in all the biotopes. In addition, annual ranges observed in Umiyam and Malse are higher than the report by Das *et al.* (1996) while Nongmahir depicted relatively lower values. Free Carbon dioxide occurred throughout the study period except in Umiyam reservoir. It, however, recorded lower concentrations presently and followed the stated order i.e., Malse (6.2 ± 1.3 mg/l) > Nongmahir (2.8 ± 0.9 mg/l) > Umiyam (2.4 ± 0.9 mg/l).

Alkalinity, an important parameter of water quality and trophic status, reflected interesting quantitative differences but is exclusively attributed to bicarbonate ions in this study. The present observations highlighted 'highly soft-water character' of Malse ($5.6-11.8$; 8.5 ± 1.8 mg/l) which, in turn represented lowest total alkalinity ever known from inland waters of India. Umiyam (21.2 ± 6.3 mg/l) and Nongmahir (27.5 ± 5.7 mg/l) are also categorized as 'soft-water environs' *vide* Moyle (1946), Phillipose (1960), Wetzel (1983) and Payne (1986) and their recorded ranges broadly corresponded with the results of Sharma and Wanswett (1999). All the reservoirs, however, exhibited lower alkalinity than that reported in Tasek lake (Das *et al.* 1996). Alkalinity is adversely influenced by rainfall ($r = -0.568$) only in Nongmahir. On the other hand, it registered direct correlations with transparency ($r = 0.725$) and hardness ($r = 0.691$) in Umiyam; with specific conductivity ($r = 0.833$), hardness ($r = 0.632$), Calcium ($r = 0.620$) and Chloride ($r = 0.635$) in Nongmahir and with specific conductivity ($r = 0.656$) in Malse reservoir.

Hardness, another vital indicator of water quality, re-affirmed 'extremely soft- water character' of Malse (7.5 ± 3.4 mg/l), thereby, indicating lowest hardness so far known from natural freshwaters of India. Besides, Nongmahir (21.5 ± 5.7 mg/l) and Umiyam (25.4 ± 3.0 mg/l) are characterized by 'soft-waters' and their mean values corresponded with the results of Sharma and Wanswett (1999). It reflected an inverse correlation with rainfall ($r = (-) 0.802$) only in Malse; showed positive relationship with specific conductivity in Nongmahir ($r = 0.757$) and Umiyam ($r = 0.642$) as well as with alkalinity in both these biotopes ($r = 0.632, 0.691$) respectively and with Calcium ($r = 0.776$), Magnesium ($r = 0.844$) and Chloride ($r = 0.713$) in Nongmahir. Poor Calcium contents *vide* Ohle, 1934) of Umiyam (14.8 ± 3.5 mg/l) > Nongmahir (10.6 ± 3.3 mg/l) > Malse (4.7 ± 2.5 mg/l) and very low Magnesium concentrations (4.4 ± 0.7 mg/l > 2.6 ± 0.9 mg/l > 0.7 ± 0.5 mg/l respectively) ascertained their 'soft to very soft water' nature.

Distinctly low Chloride contents noticed in Umiyam (11.5 ± 1.4 mg/l) > Nongmahir (6.7 ± 1.2 mg/l) > Malse (5.5 ± 1.2 mg/l) coincided with their range expected in natural freshwaters (Wetzel, 1983) and, hence, reflected lack of organic pollution from domestic effluents. In addition, the observed temporal variations affirmed conservative nature (*vide* Wetzel *loc cit.*) of this monovalent cation. The stated generalizations agreed with the remarks by Sharma and Hussain (1999) and Sharma and Wanswett (1999).

The present observations indicated low Sulphate concentrations in Nongmahir (5.5 ± 2.2 mg/l) > Malse (2.2 ± 0.7 mg/l) followed by relatively wider variations in Umiyam ($4.7 - 26.0$; 15.1 ± 5.7 mg/l); the first two environs broadly agreed with the results of Sharma and Wanswett (1999) while mean value in Umiyam concurred with the report by Sharma and Hussain (1999). Further, the recorded ranges are well within those in natural freshwaters (Wetzel, 1983). In addition, Sulphate reflected significant inverse correlations with rainfall ($r = -0.617$), water temperature ($r = (-) 0.610$), dissolved oxygen ($r = (-) 0.717$) and specific conductivity ($r = -0.822$) only in Malse reservoir.

Phosphate concentrations in Malse (0.15 ± 0.05 mg/l) and Nongmahir (0.13 ± 0.06 mg/l) coincided with the observations by Sharma and Hussain (1999) and Sharma and Wanswett (1999) while that in Umiyam (0.011 ± 0.007 mg/l) is distinctly lower than the former two water bodies. Nitrate indicated notable variations in this study i.e., Nongmahir (1.6 ± 1.1 mg/l) > Umiyam (0.23 ± 0.10 mg/l) and very low values in Malse (0.003 ± 0.001 mg/l). In general, lower concentrations of these micro-nutrients may be attributed to leached and weathered nature of soils and rocks in catchment areas. On the other hand, Silicate content in Nongmahir (2.8 ± 0.9 mg/l) concurred with the report by Sharma and Hussain (1999) while it is not presently estimated in Malse. It, however, reflected wider

temporal variation and higher content in Umiam (19.0-66.5; 43.9 ± 12.0 mg/l) and, thereby, indicated impact of siltation in this reservoir.

To sum up, the present observations depicted certain interesting aspects of water quality of Malse, Umiam and Nongmahir reservoirs particularly with reference to their subtropical nature, acidic-alkaline-highly alkaline character, demineralized nature of water reflected in their low electrolyte contents, well oxygenated conditions, bicarbonate alkalinity, very soft to soft nature (indicated by alkalinity and hardness) and lower Chloride, Sulphate, Phosphate and Nitrate concentrations and various notable limnological correlations.

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TABLE - I

ABIOTIC FACTORS OF NONGMAHIR RESERVOIR

Parameters	Range	Mean $\pm$ S.D.
Rainfall (mm)	1.2 - 600	175.2 $\pm$ 206.8
Air Temp. (°C)	16.2 - 27.7	22.4 $\pm$ 4.2
Water Temp. (°C)	13.5 - 26.3	21.1 $\pm$ 4.4
Transparency (m)	0.98 - 2.3	1.9 $\pm$ 0.4
pH	7.2 - 9.1	8.1 $\pm$ 0.6
Specific conductivity (μ s/cm)	27.0 - 50.0	35.5 $\pm$ 7.7
Dissolved oxygen (mg/l)	5.6 - 7.6	6.5 $\pm$ 0.6
Free CO ₂ (mg/l)	1.4 - 4.0	2.8 $\pm$ 0.9
Alkalinity (mg/l)	20.0 - 38.0	27.5 $\pm$ 5.7
Hardness (mg/l)	12.0 - 32.0	21.5 $\pm$ 5.7
Calcium (mg/l)	6.3 - 16.8	10.6 $\pm$ 3.3
Magnesium (mg/l)	1.4 - 4.1	2.6 $\pm$ 0.9
Chloride (mg/l)	5.3 - 8.7	6.7 $\pm$ 1.2
Sulphate (mg/l)	1.9 -10.1	5.5 $\pm$ 2.2
Phosphate (mg/l)	0.03 - 0.20	0.13 $\pm$ 0.06
Nitrate (mg/l)	0.15 - 3.28	1.6 $\pm$ 1.1
Silicate (mg/l)	1.4 - 3.9	2.8 $\pm$ 0.9

TABLE – II

ABIOTIC FACTORS OF MALSE RESERVOIR

Parameters	Range	Mean $\pm$ S.D.
Rainfall (mm)	1.0 - 652	196 $\pm$ 206
Air Temp. (0° C)	14.0 - 23.0	20.0 $\pm$ 3.0
Water Temp. 0° C)	12.0 - 22.0	17.7 $\pm$ 3.6
Transparency (m)	2.80 - 3.25	2.55 $\pm$ 0.35
pH	5.5 - 6.0	6.1 $\pm$ 0.4
Specific conductivity (μ s/cm)	6.0 - 12.0	8.25 $\pm$ 1.8
Dissolved oxygen (mg/l)	6.7 - 10.2	8.2 $\pm$ 0.8
Free CO ₂ (mg/l)	4.0 - 9.3	6.2 $\pm$ 1.3
Alkalinity (mg/l)	5.6 - 11.8	8.5 $\pm$ 1.8
Hardness (mg/l)	4.0 - 14.0	7.5 $\pm$ 3.4
Calcium (mg/l)	1.6 - 9.5	4.7 $\pm$ 2.5
Magnesium (mg/l)	0.2 - 1.9	0.7 $\pm$ 0.5
Chloride (mg/l)	4.0 - 8.8	5.5 $\pm$ 1.2
Sulphate (mg/l)	1.0 - 3.5	2.2 $\pm$ 0.7
Phosphate (mg/l)	0.11 - 0.28	0.15 $\pm$ 0.05
Nitrate (mg/l)	0.001 - 0.004	0.023 $\pm$ 0.010
Silicate (mg/l)	—	—

TABLE – III

ABIOTIC FACTORS OF UMIAM RESERVOIR

Parameters	Range	Mean $\pm$ S.D.
Rainfall (mm)	0 - 520	222 $\pm$ 227
Air Temp. (° C)	15.0 - 28.0	23.0 $\pm$ 3.7
Water Temp. (° C)	11.0 - 27.0	21.1 $\pm$ 4.4
Transparency (m)	0.9 - 1.7	1.34 $\pm$ 0.3
pH	7.1- 8.4	7.6 $\pm$ 0.5
Specific conductivity (μ s/cm)	39.0 - 68.5	56.1 $\pm$ 11.6
Dissolved oxygen (mg/l)	6.5 - 10.8	8.5 $\pm$ 1.1
Free CO ₂ (mg/l)	0 - 4.6	2.4 $\pm$ 0.9
Alkalinity (mg/l)	10.0 - 30.0	21.2 $\pm$ 6.3
Hardness (mg/l)	20.5 - 31.0	25.4 $\pm$ 3.0
Calcium (mg/l)	10.0 - 22.0	14.8 $\pm$ 2.5
Magnesium (mg/l)	3.0 - 5.6	4.4 $\pm$ 0.7
Chloride (mg/l)	8.5 - 15.5	11.5 $\pm$ 1.4
Sulphate (mg/l)	4.7 - 26.0	15.1 $\pm$ 5.7
Phosphate (mg/l)	2.9 - 35.7	11.2 $\pm$ 6.7
Nitrate (mg/l)	0.15 - 0.40	0.23 $\pm$ 0.10
Silicate (mg/l)	19.0 - 66.5	43.9 $\pm$ 12.0

TABLE – IV

MEAN ANNUAL VARIATIONS IN WATER QUALITY IN DIFFERENT RESERVOIRS

Parameters	Malse	Nongmahir	Umiam
Rainfall (mm)	196 ± 206	175.2 ± 206.8	222 ± 227
Air Temp. (°C)	20.0 ± 3.0	22.4 ± 4.2	23.0 ± 3.7
Water Temp. (°C)	17.7 ± 3.6	21.1 ± 4.2	21.1 ± 4.4
Transparency (m)	2.55 ± 0.35	1.9 ± 0.4	1.34 ± 0.4
pH	6.1 ± 0.4	8.1 ± 0.6	7.6 ± 0.5
Sp. conductivity (μs/cm)	8.2 ± 1.8	35.5 ± 7.7	56.1 ± 11.6
Dissolved oxygen (mg/l)	8.2 ± 0.8	6.5 ± 0.6	8.5 ± 1.1
Free CO ₂ (mg/l)	6.2 ± 1.3	2.8 ± 0.9	2.4 ± 0.9
Alkalinity (mg/l)	8.5 ± 1.8	27.5 ± 5.7	21.2 ± 6.3
Hardness (mg/l)	7.5 ± 3.4	21.5 ± 5.7	25.4 ± 3.0
Calcium (mg/l)	4.7 ± 2.5	0.6 ± 3.3	14.8 ± 2.5
Magnesium (mg/l)	0.7 ± 0.5	2.6 ± 0.9	4.4 ± 0.7
Chloride (mg/l)	5.5 ± 1.2	6.7 ± 1.2	11.5 ± 1.4
Sulphate (mg/l)	2.2 ± 0.7	5.5 ± 2.2	15.1 ± 5.7
Phosphate (mg/l)	0.15 ± 0.05	0.13 ± 0.06	0.011 ± 0.007
Nitrate (mg/l)	0.003 ± 0.001	1.6 ± 1.1	0.23 ± 0.10
Silicate (mg/l)	-	2.8 ± 0.9	43.9 ± 12.0

POLLUTION - A THREAT TO MAN AND ITS ENVIRONMENT WITH SPECIAL REFERENCE TO NORTH-EAST INDIA

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ABSTRACT

The North-Eastern part of India is endowed with abundant natural resources viz. crude oil, natural gas, coal, limestone, sillimanite, clay and glass stones, iron ores, fire clay and kaoline etc. The dominant activities involved in the modern sectors are through exploration and production of hydrocarbons (i.e. crude oil and natural gas), cement factories, jute mills, fertilizer factories, petroleum refineries, petrochemical complexes, sugar mills and distilleries.

The industrialisation followed by rapid growth of population density and urbanization in this industrially and economically backward north-eastern part of India resulting in the pollution of various components of environment and causing ecological imbalance is of prime concern as it is in the other parts of the country.

But due to its peculiar geographic locations, climatic conditions and natural endowment with thick forest cover, the problem of pollution and ecological imbalance may be viewed in a different perspective than in the other urbanized centres of the country.

INTRODUCTION

The earth is possibly the only planet in the whole of the universe capable of sustaining life in its environment. Man appears to be the best creation of nature. Apart from man the earth is inhabited by animals, plants, birds, reptiles, insects etc. Many of them help us to live by supplying food and keeping the environment clean (Basu, 1994).

Environment is one of the most important beautiful gifts which nature has given us as a natural resource. Most of the natural resources are facing deterioration. The resources which are undergoing deterioration, commonly known as pollution, requires our immediate attention to safeguard further deterioration through rational use and resynthesis of natural resources.

Man in the name of technological advancement is exploiting the resources and damaging the environment at an alarming rate. Thus there has been much disruption of the functioning of natural environment. Such an influence has been greatly observed in the developed world.

The magnitude of the environmental pollution can be scaled appropriately. The people through-out the world have begun to realise the ill effects of industrialisation and urbanization in the name of technological advancement. There is a growing concern throughout the world for such harmful effects.

NECESSITY OF INDUSTRIALISATION

Industries are the major sources of pollution. But at the same time industrial growth is also an absolute necessity to keep pace with the changing world. This is particularly true in the case of industrially and economically backward north eastern part of India.

PECULIARITIES OF LOCATION AND ENVIRONMENTAL CONDITIONS

The North Eastern part of India, comprising of seven states is of uneven topography ranging from snowclad mountains and hilly terrains of marshy and swampy beels and rich forest cover. The main sources of water are rivers, lakes and surface water springs. They are used for agriculture, fish culture and in addition community water supplies.

The region falls under heavy to very heavy rainfall. Humid summer climate and foggy weather are the characteristic conditions of the North Eastern part of India.

Most of the rivers in this region originate from the hills. These rivers have a peculiar nature. During rain, the water flow of most of the rivers are abnormally high with high current. While during the dry season, the

flow of these rivers are so flow that some of them can be termed as perennial river. The main river Brahmaputra passes through the Assam Valley.

POPULATION AND ECONOMY

Majority of the people live in villages as cultivators and agricultural workers. In all the states of the North Eastern part of India there have been a large number of tribal population. Economy is not fully monetized. In such a situation, when the region is opened to market forces, the indigenous people can not derive the benefit from the expansion of the trade and commerce through industrialisation and consequently economic condition of the indigenous people in rural areas is not improved and get deteriorated.

NATURAL RESOURCES

The abundant resources of the North Eastern part of India are petroleum, natural gas, coal, limestone, sillimanite, clay and limestones. While crude oil and natural gases are mainly found in Upper Assam, coal is found in Upper Assam, Karbi Anglong district, Nagaland, Garo Hills, Khasi Jaintia hills and in Arunachal Pradesh.

Large reserve of limestones are found mainly in Khasi Jaintia Hills, Garo hills, Karbi Anglong district, Lohit district (Arunachal Pradesh) Nagaland and in Manipur. Abundant ores are found in several places. Sonapahar area of Khasi hills produces the best quality Dsillimanite.

TYPE OF INDUSTRIES

The dominant activities in the nonagricultural sector in the rural areas in the North Eastern part of India are handloom weaving, sericulture and handicrafts.

In modern sector, there are very few medium and large scale industrial units in the whole of the North Eastern part of India. Out of the modern sectors, the industrial units are cement refineries, oil exploration and production, petrochemical industries, sugar mills and distilleries etc.

STRATEGIC POINTS OVER THE INDUSTRIAL UNITS

Many of the industrial units are in the valleys or close to the large bodies of water that impose meteorological and hydrological limitation on disposal of effluents.

Due to the peculiar river flow pattern, the treatment of effluents may be different and sometimes more stringent than other places particularly during the lean periods.

The air pollution problem is also expected to be different in this region from the other parts of the country since the relative humidity of all is considerably high during most part of the year. The rich forest cover, identified as a sink, can absorb the unwanted substances to a great extent and cleanse the air.

EFFECTS OF INDUSTRIALISATION

Industrialisation and urbanization are destabilizing the fragile ecology everywhere. This rapid and uncontrolled industrialisation and urbanization are causing hazards. So, their polluting effect on the environment is of great concern in the world of today. Though in recent times, too much attention has been given to the role of pollution in environment hazards, it is also essential to assess the hazards in the ecologically fragile regions. The nature of hazards due to industrialisation and urbanization is mainly pollution of air and its relation to the growth and density of population (Sen Gupta, 1994).

Nature as such tries to maintain an ecological balance. There is always observed a state of equilibrium between all the components of environment. In recent times, man has technologically advanced to a great extent and exploited the resources and damaged the environment challenging the state of equilibrium of nature.

Consequently there will be scarcity of water due to its deterioration, scarcity of land due to urbanization and eutrophication of air due to pollution. These result in creating pollution, stress giving rise to many unknown health hazards. Such a kind of pressure and stress is likely to be a serious threat on economy and ecology and create an emergency situation identifying the nature and magnitude of conflict between ecology and economy (Varshney, 1988).

Unplanned industrial development has created many fold environmental problems concerning energy, pollution air, soil and water which are rampant throughout the industrial urban centres of the country.

SOURCES OF POLLUTION

A good number of diverse effluents are released by various industrial units. Characteristics of industrial wastes vary from unit to unit and even within the same industry, depending upon the raw materials employed, process used and various other factors which are difficult to be generalised (Trivedi, 1988).

The threat of pollution from various activities in the modern sector industrial units is summarised.

Paper Industries

In the paper industries, liquid effluents poses more water pollution than air pollution.

The pollutants are as the liquor obtained after cooking of bleaching solution of waste water from the paper making section. High alkalinity, acidity, presence of suspended or dissolved solids, high BOD and sulphur content are some of their undesirable characteristics (Somashekar and Ramaswamy, 1988).

The release of waste liquors into fresh water streams and open fields is to be totally discouraged in view of their toxicity to aquatic organisms and plant growth (Subramanyam et al, 1972, Ghosh and Konar, 1980).

The removal of sulphur dioxide, chlorine and hydrogen sulphide in the flue gases is another problem to be tackled for minimizing the atmospheric pollution.

Fertiliser Industries

The liquid effluents from the fertilizer industries containing carbon slurry, dissolved and suspended solids, ammonia in condensate, toxic metals (arsenic), fluorides and phosphates, oxides of nitrogen, urea in water and urea dust in air etc. are generally discharged (Nandan and Patel, 1985).

In addition, enormous quantities of gaseous effluents containing urea dust and acid mist are also expected to be discharged. The removal of these pollutants should be given the utmost priority.

Hydrocarbon Exploration, Production and Remaining Industries

Extensive activities on exploration and production of hydrocarbons are taking place in a very large area in the North Eastern part of India. The environmental pollution may arise during the drilling of oil wells, wherein large quantities of salt water are likely to be discharged. Serious precautions are to be taken for the disposal of this salt water which may pollute fresh surface water streams and make them unfit for irrigation, fish culture and other domestic purposes.

The main liquid pollutants from production installations and refineries/ petrochemical complexes are : oils and greases, phenolics and their derivatives, cyanides, sulphides, mercaptane, acids and caustic etc. (Wintern et al, 1976, Coffey et al, 1977).

The air pollutants are sulphur dioxide, carbon dioxide, hydrocarbons, oxides of nitrogen, ammonia, aldehydes, organic acids, suspended particulate matter etc.

Petroleum wastes are expected to be added pollutants from the extensive network of pipelines for the transportation of crude oil and natural gas. The extent of pollution has never been assessed and it is reasonable to assume that environmental effects of oil pollution could be serious in the region.

Cement Industries

Environmental pollution is due to particulate matter in the cement industries, limestone, clay, coal clikers and cement particles are the major constituents of suspended particulate matter.

Distilleries

Distilleries are likely to discharge millions of tons per annum of liquid waste causing pollution to the streams, rivers, lakes in the adjoining areas. The liquid waste is acidic in character with high BOD and high percentage of solid content (Singh & Bhargava, 1984).

Pesticides Industries

The effluents (gaseous and liquid) from pesticides manufacturing and formulation plants contain usually highly toxic substances. The disposal problem should be given due considerations at the process design stage itself in order to make them the integral functions of production.

ASSOCIATED HAZARDS OF AIR POLLUTION

Industrialisation and technological advancement has added a second dimension to pollution of the atmosphere. Air pollution is thus by no means a new problem although it is a problem of vital current interest. Variety of pollutants are expected to be emitted into the atmosphere due to the activities in the modern sector. Typical of these pollutants are carbon Monoxide (CO), carbon dioxide (CO₂), Sulphur Dioxide (SO₂), Oxides of Nitrogen (NO₂), Hydrogen sulphide (H₂S).

The toxic action of most of the pollutants is attributed to undesirable chemical reactions which they set or to their interference with vital functions in the living systems.

The nature of hazards due to these pollutants arising out of these industrialisation and urbanization to the atmosphere and its relation to the human beings is described.

CARBON MONOXIDE (CO)

It causes difficulty in breathing, causes headache and irritates the nuous membranes. It combines with haemoglobidd the blood which plays a conspicuous role in transporting the oxygen to tissues and this may culminate in the death of living beings due to suffocation.

CARBON DIOXIDE (CO₂)

The addition of excessive amounts of carbon dioxide in the air results in appreciable rise in temperature. In general, this effect of carbon dioxide in the atmospheric temperature may cause the melting of the polar ice and subsequent rise in the sea level.

High concentrations of carbon dioxide in the air is hazardous. Prolonged exposure to concentration higher than 5% may cause unconsciousness or even death.

OXIDES OF NITROGEN (NO_x)

Oxides of nitrogen are highly toxic, insidious in their action and capable of producing severe injury or death. Oxides of nitrogen causes serious lung congestion and eye irritation as well as reduce the oxygen carrying capacity of the blood. These gases may be responsible for causing chronic respiratory diseases.

SULPHUR DIOXIDE (SO₂)

Sulphur dioxide presents hazardous as its physiological action an irritating asphyxient gas, green plant life is far more sensitive to sulphur dioxide than are man and animal. Injury to vegetation occur at ground level concentration below 1 ppm.

HYDROGEN SULPHIDE (H₂S)

It is one of the most dangerous substances in the industry. Two types of hazards are associated with its handling viz its toxicity and its explosive nature.

It may partially paralyse the 01 factory nerves to a point at which the gas is no longer sensitive. Early symptoms of poisoning are slight headache, burning eyes and cloud vision.

CONCLUSION

The North Eastern part of India is abundantly endowed with special features like natural beauty and rich forest cover which should not be adversely affected by ravages of industrial and municipal pollution.

The refineries, petrochemical complexes, distilleries, fertilizer factories, paper mills, hydrocarbon exploration and production etc. are the major sources of pollution of air and water. Effluents discharged from these factories requires to be given appropriate treatment before releasing to surface water bodies and atmosphere.

Industrial managers and technologists must take greater care the effluents likely to be discharged in terms of their pollution effects to the adjoining areas.

R&D projects on the pollution problem may be taken up in the research institutes and universities in this region.

Though the industries in this North Eastern part of India is not so much competitive with the national and international spheres, it is not time to be complacent about and if proper precautionary measures are not taken up in the beginning, time may come when it would be too late to save the rich ecological heritage of this region.

The problem of pollution is not an isolated one and must be looked into a total perspective and the pollution control measures should be institutionalized in this part of India through the best use of modern technologies in this regard.

The environmental disruption through pollution of air, water and soil and neglect of ecology and related social and economic issues may create miseries and hardships in future. So, these may be averted through methodical planning and judicious management of economic and ecological problems and by lessening the gulf between ecology and economy.

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PARASITES AS BIO-INDICATORS IN THE ENVIRONMENTAL IMPACT ASSESSMENTS

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ABSTRACT

There are a number of ways in which the environmental changes may affect both the parasites and their hosts. Knowledge of these environmental changes and the response on target organisms can, therefore, facilitate the assessment of environmental conditions. The intensity of parasitic infections may increase if the impact has such an effect on host, which reduces its resistance, or increases the number of its intermediate host. In a similar manner, the parasitism may decrease if the impact has such an effect, which reduces the population of larval stages and/or intermediate hosts. These situations thus can provide possible associations between the parasite and the environmental impact. In the recent past, there have been a number of studies in which the role of parasites as environmental indicator has been emphasized. It is in the light of these facts, that the present paper examines the potentiality of parasites to act as bioindicators to detect the presence of environmental pollutants such as eutrophication, heavy metals, crude-oil, and thermal, industrial, sewage effluents, etc. in the aquatic ecosystem. The author perceives that due to the present incomplete stage of knowledge, there are many difficulties at this stage, in interpreting the precise relationship between the parasites and pollution. Further research is needed in to the effect of pollutants, particularly in the hosts other than fish, in order to derive more reliable generalizations, regarding the role of parasites as bio-indicators.

INTRODUCTION

Monitoring is a system of regular observations, both temporal and spatial, that provides information on the state of environment. For example, physical and chemical monitoring, which detect changes in the physical and chemical properties of the abiotic environment, can provide quantitative data on the presence and levels of different potentially harmful substances present in the environment. Nevertheless, the data provided by physicochemical monitoring do not indicate and/or interpret the ecological damage, i.e., the extent of damage reaching the living organisms and at the same time may be very expensive, requiring well-equipped laboratories and trained staff.

BIO-MONITORING

Of various methods available for monitoring the state of environment, many plants and a few animal species has been used as bio-indicators to indicate air, water or soil pollution (Table - I). The biological monitoring involves the examination of biological variables to detect changes in the environment. The principle is that any change taking place in the environment has a significant effect on the biota. Knowledge of these environmental changes and the response of target organisms can therefore facilitate the assessment of environmental conditions. Thus, the organisms indicate the environment, while our task is merely to interpret and understand these biological signals. A pollutant acting alone might not necessarily be harmful, but in combination of others could induce stress (Kovacs, 1992). The indirect methods of bio-monitoring by plant and animal species may replace the physical and chemical analysis in many cases in order to estimate the degree of environmental impact and its potential danger for other living organisms (e.g. man), using bio-indicators. The bio-indicators are those organisms of which their occurrence, vitality and response change under the impact of environmental conditions. Each organism responds to environment change as it would respond to a specific stimulus. The absorbed stimuli bring about reactions that provide information on both, the changes and the level of pollution of the environment. Though, there are a variety of animal and plant species which in the past has widely been used as bio-indicators to assess the impact of environment. It is desirable to further explore and identify those species that may be susceptible to changes taking place in the nature.

PARASITES AS BIO-INDICATORS

There are a number of ways in which the environmental changes may affect both the parasites and their hosts (Kennedy, 1975). Thus data on parasitism in a host can be used to indicate the environment impacts.

In the recent past, several workers have attempted to use parasites as bioindicators in the environmental impact studies, particularly in the aquatic system (Poulin, 1992; Lafferty, 1997; Mackenzie & Abanunza, 1998; Marcogliese and Scholz, 1999). In accomplishing so, the workers have observed that the intensity of infection may increase if the impact has such an effect on the host which reduces its resistance, or increases the numbers of its intermediate host. In a similar manner, the parasitism may decrease if the impact has such an effect which reduces density of definitive host or parasite itself such as a high mortality due to that particular impact. The parasites therefore can successfully be used in environment impact assessment studies, particularly in the aquatic ecosystems. The parasite species, particularly of aquatic hosts, as test organisms may be suitable for the toxicity test of a given pollutant in the laboratory or natural-like conditions, at the host may be exposed to a toxic agent and survivorship of parasites or infected hosts between treatment and control can be compared to co-relate the active reaction and/or accumulation of test agent. The data provided by studies on parasites, as indicator species, thus can be used to estimate the degree of environmental impact and its potential danger for other living organisms (e.g. man).

The present paper discusses as to how the parasites have been used and can further be used in future, as bio-indicators, to detect the presence of environmental pollutants such as eutrophication, heavy metals, crude-oil, and thermal, industrial, sewage effluents, etc. in the aquatic ecosystems.

FISH AS AN AQUATIC HOST

In the aquatic system, the fish generally harbors a wide range of ecto- and endoparasites (Mehlhorn, 1988). The host and parasite both could be affected either directly or indirectly by contaminants. Thus, pollutants might influence, directly or indirectly, the prevalence, intensity, and pathogenicity of a parasitic species. Further, fish may as a consequence of parasitization show increased susceptibility to toxic effects. Many workers in the past have attempted to co-relate their studies on fish parasites with state of aquatic environment.

The parasites can be used to assess the environmental pollutants in aquatic bodies in a number of ways which depends, by and large, upon the characteristics features of the biology of specific groups i.e., protozoa; monogenea, digenea, nematoda and acanthocephala (Figure - 1). Firstly, the nature of parasitism, i. e. the prevalence and intensity of a particular parasite species in an aquatic host may indicate the status of pollutants in surroundings due to the stress on host caused by the pollutant. Although, many enteric parasites increase in prevalence and intensity, one or more factors might influence these changes. The immune-suppression might represent one of the major underlying causes affecting the susceptibility of some parasitic infections when they are exposed to pollutants. Similarly, some parasites could serve as efficient bio-indicators if their occurrence correlates adequately with certain environmental impacts. For example, by recording the presence or absence of digenicans in fishes one can assess and co-relate the impacts such as, human disturbances and acidification of water bodies. The later factors affect the population of their intermediate hosts. Like-wise, free-living larval stages of digenican parasites, such as miracidium, cercariae, could also be used as test organisms for assessing the state of water quality. It is known from studies that the sewage and municipal discharges decrease the life-span of these stages, leading thereby to a lower prevalence.

INFLUENCE OF POLLUTANTS ON ECTOPARASITES

The gill ciliates are the common parasitic infections of fishes in the polluted water bodies (Moller and Anders, 1986). Under the natural conditions, these parasites cause little or no damage, however, the stressed fishes in crowded tanks with poor water quality are highly susceptible to infections, particularly the gill and skin parasites. Similarly, for some ectoparasites the environmental impacts, such as higher temperature, oil pollution, industrial effluents are reported to be conducive to increase the prevalence and intensity of their infections (Overstreet, 1997). This occurs primarily because of an alteration/suppression of fish defense mechanism, caused by the pollutants in the aquatic environment. Monogenicans are the common parasites of gills and skin of fishes. There are several studies, which interrelate the water quality, gill parasites and the gill pathology. In a study in USA, the fishes were found to be heavily infected with monogenicans on gills in water bodies that were degraded by discharges of agricultural, industrial and urban waste. In contrast, the intensity

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of infection was noticed to be considerably less in fishes from less polluted water bodies in an adjoining area (Skinner, 1982). The author suggested that the exposure to pollutants (ammonia, trace metals and pesticides) acted synergistically as a stressor and caused histopathological (epithelial hyperplasia, fused gill lamellae) and physiological changes (excessive mucus secretion) which altered the host resistance to parasites. The phenomenon of parasitism by monogeneans is also reported to increase with pollution of oil (Khan & Kiceniuk, 1988). There is indirect evidence from a number of studies that increased susceptibility to trichodinid parasites occurs after long-term exposure to pollutants. In contrast, some pollutants may have a negative relationship parasitism in a fish host. In a study on a myxozoan gill parasite, *Henneguya waltirensis* in *Channa punctuatus*, Narsimhamurti and Kalavati (1984) reported a moderately high prevalence of infection in fishes taken from an unpolluted tank. Infection was completely absent in fishes examined from the tank polluted by sewage. The authors believed that high salinity, low oxygen levels, and increased turbidity might have been responsible for the absence of infection from the polluted tank. The bleached pulp Kraft mill effluents have also been found to increase the phenomenon of parasitism of gill parasites. In a study, Lehtinen et al. (1984) reported more heavy infections with trichodinid gill ciliates in the flounder (*Platichthys flesus*) that was exposed for a period of 2 months to pulp Kraft mill effluent, than in controls. Couillard et al. (1988) and Anderson et al. (1988) suggested that an impaired gill function and suppression of the immune system might have resulted for the greater infection recorded in the flounder exposed to pulp effluents. Likewise, the parasite communities as a whole can also be considered as good indicators of environmental stress. In a study on American eels (*Anguilla rostrata*), Marcogliese and Cone (1997) noticed that the parasite species richness was greater and there were more multiple infections in eels from the deacidified river, compared to those from the other two rivers. Ruinyansteve (1997) in his study on effect of lake eutrophication on the fauna of fish parasites found that the lake eutrophication significantly determines the type and direction of long-term changes in the fauna. The more rapidly lake eutrophication proceeds, the more acute are these changes. The author further proposed that under the effects of eutrophication and related ecological shift, the fauna of fish parasites is restructured as the general species diversity decreases and the numbers of individual species change. During a course of study on monogenetic trematodes of fishes at Meerut, (U. P.), consistently higher infections of gill monogeneans were noticed in the fishes collected from water bodies, having polluted discharges (Yadav, 1994).

INFLUENCE OF POLLUTANTS ON ENDOPARASITES

Myxozoan protozoans parasitize the internal organs of fishes and appear to be more commonly associated with water pollution. Prevalence and intensity of infection have been reported to increase with oil-pollution (Overstreet, 1988). An exposure to oil contaminated sediment inhibits feeding and release of bile in fish, which conceivably could permit an accumulation of myxozoan spores. In contrast, a decrease in parasitism with myxozoans has been correlated with some pollutants, such as high salinity, low oxygen levels and an increased turbidity (Narsimhamurti and Kalavati, 1984). It has been reported that the pollutants tend to influence the prevalence, intensity or both of endoparasites in fish (Baker and Muller, 1991). Eure and Esch (1974) reported that the intensity of an acanthocephalan, *Ncoechinorhynchus cylindricus* in large-mouth bass was greater in a river that received thermal effluents than in an unheated area during winter. Similarly, Kussat (1989) observed that the pollutants, discharged into the Bow River, Calgary (Canada), affected the parasite fauna of a cat fish, *Catostomus commersoni*. Again, in another study, an increased susceptibility to a trematode parasite was recorded in blue gills (*Lepomis macrochirus*) exposed to an insecticide, heptachlor, whereas no infection was noticed in the controls (Andrews et al., 1966). The spiny-headed worms, acanthocephalans, are the common parasites of fishes and reptiles and complete their life-cycle with the involvement of intermediate hosts. The polluted water therefore may cause a barrier to transmission of the parasites by excluding their intermediate hosts (amphipods, ostracods), which in turn could affect the prevalence and intensity of parasites in the host. The lower prevalence of acanthocephalans has been correlated with water bodies polluted with industrial and domestic waste (Kussat, 1989). Pollutants may also influence the prevalence and intensity or both of digeneteans at many stages of their life-cycle (miracidium, cercariae and/or intermediate host). The impacts such as thermal effluent (Aho et al. 1976), eutrophication (Moler-Buchner, 1981), increase the degree of parasitism. Eutrophication may improve the conditions conducive for breeding of snails and thus can lead to an overproduced of cercariae, the infective stages of digeneteans. In contrast, the degree of habitat degradation and pulp and paper mill effluents may decrease the degree of parasitism (Valtonen & Koskivaara, 1987). The decrease in parasitism occurs due to the sensitivity of the larval stages and/or intermediate host to pollutants.

In some studies, workers have also explored the role of parasites as biological tags in the impact assessments. Mackenzie (1983) in a fish population study observed differences in the parasitism for five species of helminth parasites due to phenomenon of eutrophication in Mc Murdo Sound (USA). The author suggested that the same be related to the feeding habits of fish and the distribution of intermediate host, copepods in water bodies. Mackenzie and Abanunza (1998) in his study used parasites as biological tags for stock discrimination of marine fish in water bodies. In another study in Finland, Valtonen and Koskivaara (1987; 1989) reported that effluent from a pulp and paper mill affect the nature of parasitism in fish. They observed no infection in the fishes examined from the polluted area, whereas the infection was noticed in fishes that were sampled from three other unpolluted sites. These differences in infection were attributed to the sensitivity of the intermediate host to pulp and paper effluents, which affect the survival of intermediate host. It is worth mentioning here that a few workers have also used parasites as bio-monitors to trace out the route of migration of fishes in island water bodies (Marcogliese and Scholz, 1999). Similarly, the use of parasite biodiversity as an indicator of water pollution was investigated out using experimental data on the ecology of metazoan parasites of Chub (*Leu cephalus* L.) in one polluted site and another control site in Czech Republic. Analysis at the component community level showed a significantly small number of parasite species, with a more equal distribution of their abundance, at the polluted site, compared with the control site.

From the studies it become evident that is possible to interpret/correlate the presence of a specific pollutant in the aquatic system by examining the nature of parasitism in the host (Table - I). The differences in the nature of parasitism as a result of exposure to these pollutants can be best explained by the very factors that determine the success of infection and/or establishment in the host. These pollutants in one way or other affect the physiological, biochemical, behavioral and immunological status of host and make them conducive in favour of parasites.

In spite of a good number of studies that revealed an association of parasites with pollutants, it is difficult to derive any generalizations with regard to the specific pollutants and a parasite species (Table - II). The manner in which a particular group and/or parasite species would respond to an environmental stimulus would vary, a factor differs its effects and similarly the parasites also differ in their response to a specific pollutant. For example, the effect of sewage effluent may increase the phenomenon of parasitism in case of ciliates, whereas would decrease the same in case of digenicans. In this case, the impact i. e., sewage effluent causes a stress to host thereby increasing its susceptibility for infection by ciliates. While on the other side it reduces the survival and/or longevity of larval stages, which in turn decreases the prevalence and intensity of digenicans in the host. The various species therefore respond on a variable scale, in a most sensitive, sensitive or less sensitive (resistant) way (Table - II).

APPLICATIONS OF THE INFORMATION SUPPLIED BY PARASITES AS BIO-INDICATORS

The impact surveys, employing parasites as bio-indicators could be useful in documenting the aquatic pollutants in an area. In experimental studies, one can select a parasite species, in which the level of the pollutant and the degree of damage or change in function are correlated. This is the simplest, cheapest and less labour intensive method which can particularly be adopted in the underdeveloped and developing countries, facing a threat of aquatic pollution. The studies in this direction, if planned and interpreted in a cautious way, could provide useful information, which are routinely needed to maintain the natural state of environment.

CONCLUSION

The situations discussed as above provide ample evidences regarding the association between the parasites and the environmental impacts. During the normal course of regular faunistic studies parasites can be used as efficient bioindicators to supersede the difficult task of making physical and chemical measurements with biological effects. They may also locate those living host species of the ecosystem where the polluting and toxic agents accumulate.

Further, as it would be evident from the aforesaid account, it is difficult to find a single specific indicator species for each known or unexpected polluting agent. Consequently, in order to characterize the environment sufficiently, all species present in the study site, rather than selected indicator organisms, should be considered in order to derive more meaningful interpretations. Changes in life functions caused by environmental stress

have been studied mainly at the level of species and individuals (Table – III), whereas there have been relatively little work devoted to the similar kind of problems at the community and ecosystem level. Further, similar kind of studies need to be undertaken on hosts other than fishes in order to derive a strong and reliable deduction on impact. There exist evidences that climatic factors (e.g. temperature, rainfall and relative humidity) are important factors in regulating the species composition and population pattern of nematode parasites in terrestrial vertebrate hosts (Yadav and Tandon, 1989a; 1989b; 1991). There is no doubt in saying that the number of fundamental problems of environmental pollution can be attacked in an efficient manner through biomonitoring at the level of communities and ecosystems. The grouping of several indicator species to form a 'biotic indices' would provide a much broader reflection of impacts. However, the use of biotic indices requires a clear understanding of the associations between the indicator species and the specific impact. The field of environmental parasitology is fast growing and many more new aspects of pollution and parasites would come in to light, which would contribute towards our understanding of the precise role of parasites in biomonitoring.

It is likely that the parasites in the form of '**Para Meters**' would be recognized as one of the important parameters, to characterize the impact of pollutants on the state of environment in future.

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TABLE - I

BIO-INDICATORS AND TYPE OF ENVIRONMENTAL IMPACT

Fungi	Soil	Heavy metals, Organic matter, Acidity
Lichens	Air	SO ₂ , NO ₂ , Ozone, Pesticides, Fertilizers
Bryophytes	Air	Industrial & Vehicular Exhaust, Radio-isotopes
Rotifera	Water	Eutrophication, Physio-chemical characteristics
Flowering Plants	Air	Industrial & Vehicular Emissions, Photo-Smog
Aquatic Plants	Air	Eutrophication, Organic matter
Plants Cells & Tissues	Soil,	Heavy Metals, Acidity, Acids & Acid Gases - HF, NO ₂ , SO ₂ , O ₃

TABLE - II

THE DEGREE OF RELATIONSHIP BETWEEN THE PARASITE GROUPS AND THE TYPES OF ENVIRONMENTAL IMPACTS

Parasite Group	Eutrophication	Crude Oil	Industrial Effluent	Pulp-Mill Effluent	Sewage Discharge	Heavy Metals
Ciliophora	N	H	H	H	N	N
Monogenea	H	H	M	M	P	N
Digenea	H	H	M	M	H	H
Cestoda	H	N	M	N	H	H
Nematoda	H	H	M	M	P	N
Acanthocephala	H	H	H	N	H	H

H = High; M = Medium; P = Poor; N = No Information

TABLE - III
SOME PARASITIC SPECIES WIDELY USED IN BIO-MONITORING

Protozoa <i>Epistylis sp.</i> <i>Trichodina sp.</i> <i>Myxobolus sp.</i> <i>Ichthyophthirius sp.</i> <i>Trichodina sp.</i>	Monogenea <i>Gryodactylus sp.</i> <i>Dactylogyrus</i> <i>Paradiplozoon sp.</i> <i>Ploystomum sp.</i> <i>Diplozoon sp.</i>	Digenea <i>Diplostomum sp.</i> <i>Ornithodiplostomumsp.</i> <i>Tetracotyle sp.</i>
Cestoda <i>Bothriocephalus sp.</i> <i>Eubothrium sp.</i> <i>Schistocephalus sp.</i> <i>Proteocephalus sp.</i>	Acanthocephala <i>Neoechinorhynchus sp.</i> <i>Pompphorhynchus sp.</i> <i>Octospinifer sp.</i> <i>Dollfusentis sp.</i> <i>Echinorhynchus sp.</i>	Nematoda <i>Eustrongylides sp.</i> <i>Raphidascaris sp.</i> <i>Anisakis sp.</i>

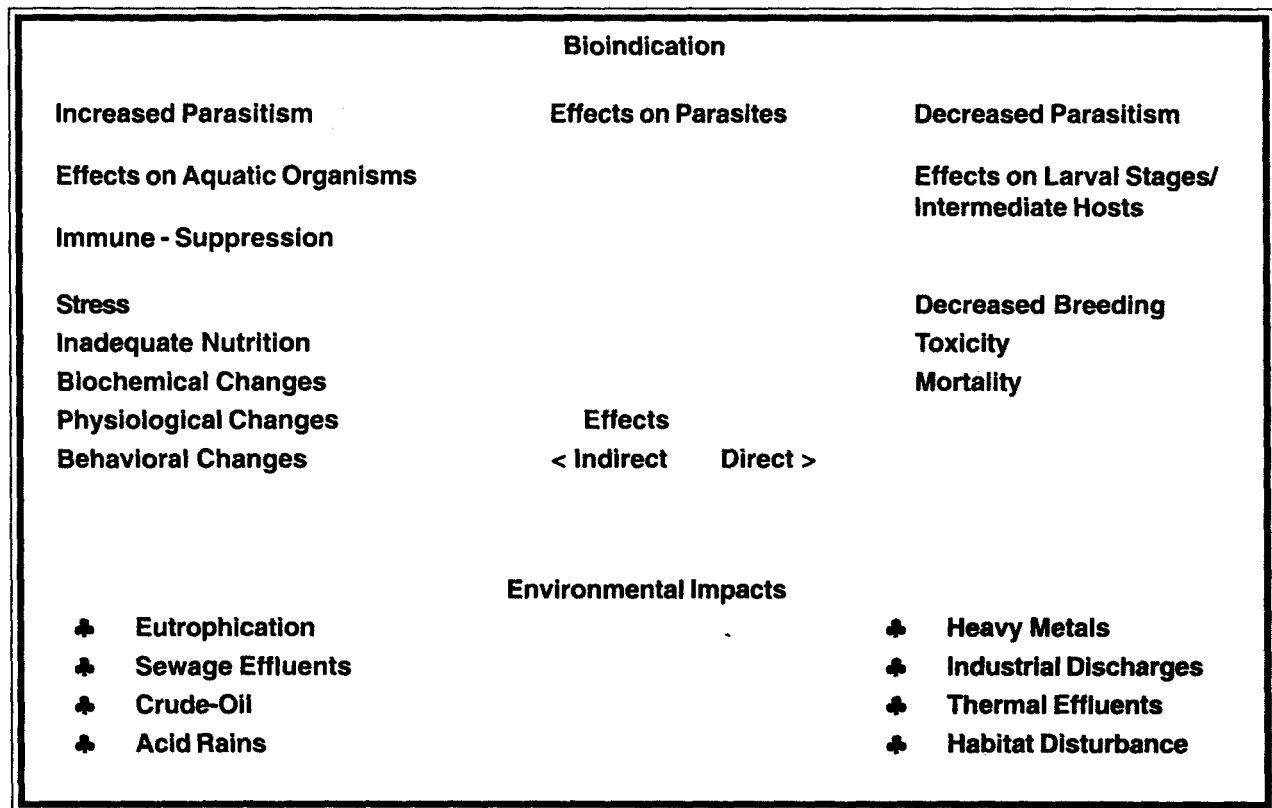


Figure - 1

MEASUREMENT OF ENVIRONMENTAL PERFORMANCE - A KEY COMPONENT OF ENVIRONMENT MANAGEMENT SYSTEM

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ABSTRACT

Measurement and evaluation is a pre-requisite for continuous improvement, in any management system. Environmental performance can be measured in three distinct levels viz. effect monitoring, control monitoring and system monitoring depending on the scope of the monitoring programme adopted. Effect monitoring measures the short and long-term changes in environmental quality due to development activities while control monitoring depicts the quality of the waste generated and disposed. System monitoring evaluates various components of environment management system as well as environmental programmes designed and implemented to achieve the environmental goals set by the organisation. The environmental monitoring parameters and the environmental programmes developed/implemented in the oil field operations are elaborated in this paper.

INTRODUCTION

'What gets measured gets done. Putting a measure on something is tantamount to getting it done. It focuses on management attention on that area'.

Thomas J. Peters (In search of Excellence)

Measuring and evaluating environmental performance is a vital function of environmental management system. No other facet of environmental discipline is more poorly recognised than the performance measurement. Generally the entire environment management programmes are evaluated periodically (perhaps once in an year) for compliance to standards. But there is a need for frequent measurement of certain aspects of critical environmental programmes/activities so that feedback of appropriate management level can be provided. This will help in changing the indicators, to verify that critical environmental objectives are achieved. The result of these measurements can evaluate performance as well as they can motivate corrective actions to get a critical program/activity back on track.

Performance measurement is applicable from working level of supervisory level to top management level. However the scope of measurement will vary with the level of the management structure. Hence it can be utilised from activity, programmes, planning, upto policy level.

Measurement of environmental performance can be classified into three distinct categories depending on the nature and approach of measurement strategy adopted.

MEASUREMENT OF CONSEQUENCE - EFFECT MONITORING

Development activities invariably interact with the surrounding environment resulting in positive and negative environmental impacts. The impacts can be short-term as well as long-term depending on the nature of input on the receiving environment. Measurement of environmental effect due to development activities is only measuring the consequence. Operational activities generally have two types of discharges to the environment.

- Daily discharges due to operational requirement. This may contain controlled pollutant level but for a long period of time. It can cause chronic pollution and sometime result in pollutant accumulation in the environmental components resulting in long-term changes in the quality of the receiving environment (e.g. produced water discharge to the environment).
- Accidental or unplanned discharges. Operational upset, environmental accidents, pollution control failures, etc. can lead to shock load of pollutants input to the environment resulting in acute pollution. This may bring about short term irreversible damage of the receiving environment (e.g oil spill, blow-out, etc). Effect monitoring of the environment around the operational activities can be helpful in assessing the impact of the development programmes/activities on the environment.

Regular measurements of selected environmental parameters can provide evidence of short term as well as long-term changes in the environment, when evaluated against baseline data or controlled system.

The strategy for measurement is generally governed by the following variables:

- Quality and sensitivity of the receiving environment
- Quality and quantity of the pollutant input from the operational activity
- Pollutant pathway to environmental components
- Probability and severity of accidental pollution
- Relevant statutory requirements on pollution control and environmental quality
- Organisation's policy on environmental protection
- Company and industry standards
- Society's aspiration and public concerns on environment.

Oil exploration and production (E&P) operation are performed both in marine and terrestrial environment. Hence the type of environmental monitoring depends on the geographical environment in which the operations are conducted. The following types of monitoring studies are generally undertaken apart from the specific studies during or after any environmental accidents.

- Ambient air quality monitoring covering various parameters viz air pollutants concentration, meteorology, noise level, etc.
- Water quality monitoring (surface and ground water quality) including physical, chemical, inorganic, organic, nutrient, biological and bacteriological characteristics.
- Soil quality covering physical, chemical, biological, bacteriological and fertility parameters.
- Ecological parameters like flora, fauna, land use, etc.
- Socio-economic survey
- Offshore monitoring - comprising of water and sediment characteristics, oceanographic and meteorological parameters as well as evaluation of pelagic and benthic flora and fauna.

MEASUREMENT OF CAUSES - CONTROL MONITORING

Monitoring of the quality and quantity of pollutants generated/disposed, is the measurement of causes or it can be termed as control monitoring. This is generally an integral part of an environmental programme in E&P operations. However this is an end-of-pipe strategy where the waste is subjected to measurement to confirm that the toxic characteristics are within the permissible limits and/or to evaluate the efficiency of the pollution control system. The scientific approach, to stipulate permissible limits, is on the basis of the carrying capacity of the receiving environment, pollution load, available technology, cost benefit analysis, international standards, public concern etc. Control monitoring includes all states of pollutant input into the environment viz gaseous emissions, liquid effluents and solid wastes. In E&P operations the control monitoring programmes include:

- Gaseous emissions through stack monitoring
- Noise level monitoring
- Produced and injection water quality monitoring
- Waste and effluent water quality monitoring
- Solid waste analysis
- Toxicity/bioassay study of the wastes and oil field additives.

MEASUREMENT OF CONTROL - SYSTEM MONITORING

Environmental performance is usually measured in terms of:

- Statutory breaches.
- Public complaints
- Pollution incidents/accidents
- Budget utilised
- Compensation paid, etc.

Measurement of causes and consequences are measurement of non-performance. The desired environmental performance should be proactive rather than reactive. The measurement of performance should focus on input parameters like environmental programmes aiming to prevent/minimise environmental damage. The approach should be preventive rather than curative. Some of the environmental programmes can be:

- Identification of environmental issues w.r.t. E&P operations
- Identification of environmental objectives, targets, programmes, for achieving short term and long-term environmental goals
- Establishing management structure, responsibility, and performance standard for personnel directly involved in environmental activities.
- Reporting, investigation and analysis of environmental accidents
- Emergency preparedness for environmental disasters
- Environmental awareness and training
- Identification and compliance of statutory requirements
- Purchase and material management catering to environments needs
- Housekeeping
- Contractual services
- Operational permits and controls
- Internal and external communication
- Measurement and assessment
- Relationship with external parties
- Land acquisition and site reclamation
- Environmental resource management
- Environmental quality maintenance

System monitoring provide quantitative measurement of the various components of the environment management system and can be evaluated against set standards. This can provide objective input into the strength and weakness of various environmental programmes of an organisation.

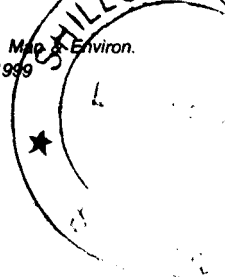
Several tools for establishing environment programmes are available globally. These include ISO-14001-International standard on environment management system, IERS-International Environment Rating System, EMAS-European Union's Eco-Management and Audit Scheme, ICC's Business Charter for Sustainable Development, BS-7750-British Standard on environment management system, etc. However ISO-14001 is today the internationally accepted standard on environment management system.

CONCLUSION

Environmental performance can be measured at three distinct levels-measuring the quality of the receiving environment, measuring the quality & quantity of the discharges, as well as objectively measuring the environmental programmes. All environmental management system tools accepted world wide stress on measurement of input into the system so that environmental damage due to development activities can be prevented.

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ENVIRONMENTAL ISSUES OF MEGHALAYA

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ABSTRACT

Meghalaya the "Abode of Clouds" having a pristine beauty with a variety of flora, fauna and other natural resources is on the verge of environmental degradation. The plateau which was formed millions of years ago is of great concern to the planners and environmentalist for sustainable development without much deterioration of environmental quality while maintaining ecological balance for prosperity.

The last few decades have witnessed tremendous growth of industries, needing increasing quantity of minerals including coal and limestone. Thus for obvious reasons the mining activity has multiplied several times in parts of Meghalaya. The acid mine water can be a cause of "serious problems in all aspects of metal enrichment ranging from the toxification of drinking water to problems concerning the growth and reproduction of aquatic organisms". Sewage of mine water through permeable formations may even pollute the underground water.

Biotic activities in the hills are responsible for land degradation in 21% of the total geographical area of Meghalaya. Food production systems viz. shifting cultivation, growing pineapple, along the slopes and developmental activities have affected the land resources and at places the land has become unfit for food production.

Meghalaya and the other sister states of North Eastern Region is highly vulnerable to a threat which is looming large over the sky of the region, is acid rain, a meteorological phenomenon which had hazardous consequences in industrially developed nations.

INTRODUCTION

The state of Meghalaya has a total geographical area of 22,489 sq. km. of which 21,585 sq. km. falls in hard rock area and which is less susceptible for environmental degradation depending upon other factors. In order to assess the environmental issues it is worthwhile to be aware about the geology, mineral resources and different geoenvironmental zones of Meghalaya.

GEOLOGY

The rock formation seen in Meghalaya are (1) Archeans, (2) Precambrians (proterozoic), (3) Cretaceous Tertiary sedimentary rocks and (4) Recent sediments.

Archean Gneissic complex is composed of biotite gneisses, granites and amphibolites. These oldest rock types date back to 3600 million years and are grouped as 'Archean'. They are represented by granite-gneiss, muscovite-quartz-biotite gneiss and schists. These are exposed over a considerable part of Meghalaya. These rocks have suffered extensive changes in composition and structure during the vast period of time since they were formed, due to crustal movements resulting in folding, faulting and partial fusion.

The shallow marine environment existed after the Archeans forming the floor over which were deposited the sediments that gave rise to another group of rocks about 2300 million years ago, which constitutes the Shillong plateau. These proterozoic rocks of Shillong group are composed of quartzites, phyllites, conglomerates, schists, intruded by greenstone, basic, ultrabasic rocks (with pyrite, pyrrhotite, calcopyrite specks-indication of copper-nickel mineralisation). Intrusive granites are also noticed in the Shillong Group of rocks.

Sylhet trap is exposed in a narrow E-W strip along the southern border of Khasi Hills.

The Shillong Group of rocks were intruded by a swarm of igneous rocks of basic to ultrabasic composition which are now of wide occurrence throughout the area. They comprise metadolerite, gabbro, peridotite, dunite and pyroxenite type of rocks.

It was followed by volcanic activity during the rock types contemporary of Deccan plateau were formed. These are known as sylhet traps. These traps are of the nature of plateau (flood) basalts, exposed in narrow E-W strip 80 km long and 4 km wide along the southern border of the Shillong plateau. They apparently overlie the eroded pre-cambrian basement and are themselves overlain non-conformably by the upper Cretaceous-Eocene sediments.

Consequent on this emplacement sedimentation ensued in the Cretaceous period about 75 million years ago and continued for nearly 70 million years resulting ultimately in a set of rocks that are now classified into three groups, viz. Khasi, Jaintia and Garo in order of antiquity (Table I).

TABLE - I

GEOLOGICAL SEQUENCE IN MEGHALAYA

Period	Group / Formation		Lithology
Quaternary	Alluvium		Sand, Silt, clay gravels and pebbles
Oligo-Miocene	Garo Group	Chengapara Formation	Sandstone and shale
		Baghmara Formation	Sandstone and shale
		Simsang Formation	Sandstone and siltstone
		Kopili Formation	Sandstone shale limestone with coals beds.
Eocene	Jaintia Group	Shella Formation	Sandstone shale limestone with coal beds.
		Langpar Formation	Sandstone shale limestone with coal beds.
	Khasi Group	Mahadek Formation	Sandstone and conglomerate
		Jadukata Formation	Sandstone and conglomerate
Jurassic	Sylhet Trap		Basalt, alkali basalt, rhyolite and tuff.
Precambrian		Acid and basic intrusives	Granite Dolerite and basalt
		Shillong Group	Quartzite
Archean		Gneissic Complex	Granite Gneiss and other gneissic rock.

MINERAL POTENTIAL

Coal, Limestone and various types of clay constitute the principal minerals that are found in parts of Meghalaya :

TABLE - II

Name of Mineral	District	Reserves	Remarks
COAL	Garo Hills	385.00 mt.	Explored by DMR, Meghalaya
	West Khasi Hills	97.61 mt.	
	Jaintia Hills	33.66 mt.	
LIMESTONE	East Khasi Hills	971.00 mt.	Cement/flux/chemical grade being utilised by Mawmluh Cherra Cement factory. Cement/SMS/Chemical grade
	Jaintia Hills	2800.00 mt.	

Name of Mineral	District	Reserves	Remark
KAOLIN	East Khasi Hills East Garo Hills	1.21 mt. 8.40 mt.	Explored by DGM-Assam and DMR - Meghalaya.
CLAYS	Garo Hills	68.00 mt	Lithomargic clay
SILLIMANITE	West Khasi Hills	0.45 mt	Refractory (mostly mined out).Used by Hindustan Steel Ltd.
BAUXITE	East Khasi Hills	1.12 mt	Titaniferous
BASEMETALS	East Khasi Hills	0.12 mt	Pb-Zn-Cu
APATITE	East Khasi Hills & Jaintia Hills	1.30 mt.	Fertilizers

GEOENVIRONMENTAL ZONES

In Meghalaya there are four different zones with different characteristics which are as follows :

TABLE – III

CHARACTERISTICS OF GEO-ENVIRONMENTAL ZONES OF MEGHALAYA

Geo-Environmental Zones	Geological Characters	Geographic Features	Hazards
UNSTABLE LAND	MOSTLY SANDSTONE, SILTSTONE, LIME-STONE GNEISSES, GRANITE AND QUARTZITES EXPOSED AT THE BOTTOM	DEEP GORGES WITH STEEP ESCARPMENT	PRONE TO HEADWARD EROSION, LANDSLIDES AND OTHER MASS WASTING PROCESSES, UNDERGOES HIGH INTENSITY RAINFALL.
POORLY STABLE LAND	SANDSTONE, SHALE SILTSTONE, MARL LIME-STONE AND THICK COAL BEDS.	HIGHLY DISSECTED PLATEAUS, DENUDATIONAL LOW AND HIGH HILLS.	IN THE STATE OF DEGRADATION DUE TO UNSCIENTIFIC MINING OF COAL, ALSO PRONE TO MASS WASTING.
MODERATELY STABLE LAND	GNEISSES, GRANITE, QUARTZITE, SANDSTONE, LIMESTONE, COLLUVIAL / DEBRIS AND ALLUVIUM	MESA/BUTTE, RESIDUAL HILLS, INTERMONTANNE VALLEYS AND ALLUVIAL PLAIN.	PRONE TO SLIDES & ROCK FALL ALONG STEEP SLOPES AND ESCARPMENTS.
MOST STABLE LAND	GNEISSES, GRANITE, SHILLONG GROUP OF QUARTZITE, ACID AND BASIC INTRUSIVE	DENUDATIONAL LOW AND HIGH HILLS, DISSECTED PLATEAUS AND DEPRESSIONS	MOSTLY UNDER STATE OF ECOLOGICAL EQUILIBRIUM, HOWEVER UNDERGOES SHEET EROSION DUE TO DEFORESTATION. ALSO PRONE TO LOCALIZED FLOODS.

Since the dawn of civilization minerals have been discriminately associated with mankind. The milestones in the growth of civilization viz. stone age, copper age, bronze age, atomic age, etc. speak of the dependence of the society on the minerals. The last few decades have witnessed tremendous growth of industries, needing increasing quantity of minerals including coal and limestones. Thus for obvious reasons, the mining activity has multiplied several times in parts of Meghalaya. The mining makes the land barren and destroys the habitat for wild life. The waste resulting from mining and treatment of ores, are invariably dumped on the ground outside in valleys or reservoirs as seen in different parts from where it is carried by running water and spread over the agricultural fields spoiling crops and affecting the fertility of soil. The acid mine waters can be a cause of "serious problems in all aspects of metal enrichment ranging from the toxification of drinking water to problems concerning the growth and reproduction of aquatic organisms". Seepage of mine water through permeable formations may even pollute the underground water.

QUARRYING

Quarrying is one of the major problems in almost all the places where hard rocks are exposed. The top soil is generally washed off leaving the hills barren. It is a common sight to see big quarries in quartzites and limestones in southern part of Meghalaya. During quarrying the limestone which preserve a variety of life of 50 - 60 million years old, which is unique to Meghalaya, is lost.

BIOTIC ACTIVITIES

Soil degradation played mankind for thousands of years. Archaeological evidences have shown that land degradation was responsible for extinction of Harappan civilization in Western India, Mesopotamia in Western Asia and the Mayan culture in Central America. Biotic activities in the hills are responsible for land degradation in 21% of the total geographical area of Meghalaya. Food production system viz. shifting cultivation, growing of pin apple, along the slopes and developmental activities have affected the land resources and at places the land has become unfit for food production. In Meghalaya sign of land degradation can be seen at several places from Khliehriat to Amlarem, the Pynursla area, the Cherrapunji-Mawsynram area and over to Garo Hills in the Siju area, Monsongiri area, Rongram, Rongchagiri and Sedengiri etc. Excess felling of forest for commercial purposes as well for shifting cultivation is greatly endangering the environment. The landuse pattern in Meghalaya has been studied and the following six types are seen along with rectification strategy for land degradation. (Table – IV & V).

TABLE – IV

LANDUSE IN MEGHALAYA

Build up land	: Urban and rural settlements
Agricultural Land	: Permanent Cultivation
Shifting Cultivation	: Jhumming to be replaced by terrace cultivation
Forest Evergreen	: Sacred Grooves
Deciduous Forest	: Southern and Northern Fringe
Water Bodies	: Main Reservoirs (Polili, Umiam)

TABLE – V

RECTIFICATION STRATEGIES FOR LAND DEGRADATION

- Proper records of land productivity status should be prepared from remote sensing.
- For each soil properties there should be a clear demarcation of boundry in order to monitor our soil which is stressed by external degrading Agencies.

- Industrial activities in the nearby areas which are hazardous to the environmental should be regulated through laws.
- Sustainable and effective land system should be followed.
- Implementation of agroforest ecosystem wherever water erosion is a serious threat.
- Adoption of integrated watershed Management system and integrated balanced nutrient Management system.

In the hazard prevention and mitigation the following general approach is suggested (Table - VI)

TABLE – VI

HAZARD PREVENTATION AND MITIGATION

Hazards	Hazard Mitigation Approach Suggested
Coal Mining and Hazards of Acidity, Pollution, Subsidence & Scarcification.	(i) Not to allow dumping of coal in areas free from coal occurrences. (ii) Trenches and Pits should be back filled with OB dump material. Top soil should be preserved and reutilised for restoration of ecology. (iii) Neutralise acidity through effluent treatment plant only at selected places. It can also be neutralised on OB dumps by using lime which is available in plenty.
Erosion and soil loss/siltation in streams and reservoirs. (i) Due to high rainfall and uncontrolled run off also resulting in floods. (ii) Due to Deforestation (iii) Due to Urbanisation (iv) Due to Jhumming	Have check dams for moderating run of and flash floods. Promote social forestry. Selective regular expansion in low and moderate slopes. Such places in Shillong and Jowai identified. Promote contour bundling and terrace cultivation also promote horticulture.

MISCELLANEOUS

Vehicular pollution is one of the major concern of the environment lovers in major towns of Meghalaya. The rising concrete jungles should be a cause of concern in Shillong, Jowai and Tura. The precise earthquake prediction is not a viable proposition scientific attention has been diverted towards "Protection" aspect by building structures in a way that they can resist earthquake without serious damages. Urgent steps are required to be taken to make the codal provisions of the Bureau of Indian standards with regard to earthquake resistant construction departments/agencies across the country to ensure safety of buildings in the event of earthquakes thereby minimising chances of human casualty. Meghalaya and the other sister states of North Eastern Region is highly vulnerable to a threat which is looming large over the sky of the region, is Acid Rain a meteorological phenomenon which has had hazardous consequences in industrially developed nations.

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ENVIRONMENTAL POLLUTION – CAN WE DESTROY NATURE'S GIFTS IN THE NAME OF DEVELOPMENT ?

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ABSTRACT

Electrical energy is a gift of modern civilisation. The major sources are hydro thermal, nuclear and renewable. The paper deals with the negative effect of power generation on the environment. Solution to this problem has also been suggested. An account of the development of power in Meghalaya and the relative advantage of hydro power over thermal power have also been added.

INTRODUCTION

Millions of years ago man was a part of nature. When he arrived on the scene, the earth was already inhabited by plants and animals. He lived in complete harmony with them. But there was a difference. He was superior in intelligence. As he developed further he started challenging Mother Nature, of which he was an off spring and completely dominated over other living things. Thus slowly he assumed the role of a dominant master. Once in control, he ruthlessly began to exploit the natural resources for his comfort.

His demand for food, shelter, clothing and for many other comforts increased steadily. As man understood more of science and mastered it and he grew in number in leaps and bounds, he started destroying vast acres of forest land for habitation and agriculture. To meet the growing demands, he plundered raw materials indiscriminately. Today his needs have increased manifold and his greed appears to have no end. While science has contributed immensely to human progress, it has played no small role in destruction of nature. It has provided man with faster means, mightier machines and more powerful weapons to speed up this process.

As a result the harmony existing between him and nature has been disturbed. Today many plants and animals have completely disappeared from the face of the earth. Before long, many more plants and animals are likely to vanish including man himself, unless we stop this plundering. It is therefore absolutely necessary to restore the delicate balance among man, science and environment.

During the last century, tremendous progress in science and technology has been achieved. The achievement in the field of medicine has helped mankind to greatly reduce the incident of epidemics such as small pox, measles, plague, cholera and increase the life span of human beings. In the field of agriculture, great strides have been made through the help of science. The field of many crops, particularly wheat and paddy has increased many fold. All of us know about green revolution. It was due to this revolution that we, who were a starving nation before independence, have now become self sufficient in food. We used to suffer from famines, now we are able to survive successive draughts. In a few years, we may succeed in our 'White Revolution' also, that is, in increasing our dairy products such as milk, cheese, butter etc.

Today we are able to travel from one part of India to another fast and easily. Thanks to technology. We are able to enjoy the comfort of a pleasant Shillong day in 50° C Delhi heat and the comfort of warm sunshine in sub-zero Himalayan temperatures. We can argue out problems with our associate a thousand kilometres away as if he were at our side using the latest communication technology. The list is unending.

But these revolutions that were made possible through the progress in science and technology have also created problems.

Various kinds of insects attack growing crops. Farmers use insecticides to kill these insects and protect their crops from them. However, insecticide pose a serious threat to other useful insects, animals and even human beings. Scientists have confirmed that overuse and misuse of chemical fertilizers pose serious threats to crops as well as human health.

The big industrial institutions that produce all kinds of goods for our comfort, luxury and health ranging from fast foods to electrical gadgets (like Steel plants, Chemical plants, garment factories, thermal and nuclear power stations), dump heavy chemical waste on land, rivers, lakes and other water bodies. They also pollute the air with smoke and other poisonous gases. The latest technology also help man to exploit the natural resources at a faster rate, there by depleting the resources at dangerous levels.

Plants, animals and human being depend upon air, water and soil (as well as on each other) for survival. These are the most precious resources. They are exhaustible. So are the other natural resources such as coal, natural oil, gas, minerals etc. Utmost caution and care need to be taken to preserve and utilize them so that the next generations can live in a clean and safe environment, with plenty of resources left for their benefit.

ENVIRONMENTAL POLLUTION

Environment pollution may be discussed in terms of the adverse effects on land, air and water due to man made activities, as these are the major constituents of our environment.

LAND POLLUTION

It is difficult to measure and control land pollution. Land is laid waste by destructive means of plantation and polluted by the disposal of domestic and industrial waste. Jhum cultivation, new habitations and settlements, big reservoirs made for various end use- irrigation, water supply and or power, all play a role in destroying and adversely changing the land surface. Unscientific mining and extraction of raw materials from the ground all have lasting damage on land. Sludge from the sewage plants is deposited on the land surface. Although it contains useful nutrients such as nitrogen and phosphorus, it is full of toxic metals and poisonous chemicals which affect the fertility of the soil. They are harmful to human beings and the plant kingdom alike.

WATER POLLUTION

The problem of water pollution is rampant in all thickly populated areas, especially urban conglomerates. Water does possess a self-cleaning property, but there is a limit to it. The problem intensifies with the addition of pollutants in our water-ways from many sources - wastes from reactors, laboratories, hospitals and fallout from nuclear explosions, domestic waste from the cities and towns, chemical wastes from factories and industrial units, etc. On account of such discharge of untreated sewage from the cities and towns situated on its banks the holy water of Ganga is today unfit for human consumption. A study on water pollution has shown that 90% of this pollution is due to human waste, which gives rise to such diseases as intestinal infection, hookworms cholera, typhoid, infectious hepatitis, etc. To an ever-increasing degree, chemicals, viz. DDT, Parathion, lindane and Hepta Chlorothane (used for insect and pest control), contribute a great deal to water pollution.

AIR POLLUTION

The air we breathe becomes polluted in various ways. The rural folk use cow dung, wood and farm waste for cooking their food, giving rise to such pollutants as carbon monoxide, sulphur dioxide, etc. Urban areas, particularly large cities like Delhi, Bombay, Calcutta and Madras, account for the worst level of pollution. Motor vehicles, power plants and refineries also emit carbon dioxide, carbon monoxide, sulphur dioxide, nitrogen oxide, etc., as well as dust particles. These dust particles get into our lungs. Fine dust often contains poisonous and heavy metal oxides, which lead to cancer of the digestive tract and many pulmonary diseases.

The presence of sulphur dioxide and nitrogenous oxides in the atmosphere causes acid rain that affects flora and fauna and soil fertility. Acid rain is harmful to aquatic plants and animals also. It affects our monuments and statues made of marble. It is apprehended that the fabled Taj Mahal would be irretrievably affected by the winds carrying sulphur dioxide from the Mathura oil refineries. Again, air pollutants like oxides of nitrogen, carbon monoxide and the accumulation of man made chemicals like chlorofluoro carbons in the atmosphere cause depletion of the ozone layer. Ozone layer absorbs the harmful ultra-violet radiation coming from the Sun. Any disturbance in the ozone layer will be harmful to the very existence of this planet of ours. It leads to increase in the incidence of skin cancer, eye ailments, damage to the immune system, etc. As the population records a spiralling growth, man is busy cutting down trees and clearing forests for locating new towns and industries, consequently, the proportion of carbon dioxide in the atmosphere increases. This has already resulted in the warming of earth and loss of rains.

DISCUSSION

If environmental degradation continues at the present rate, mankind is bound to perish one day or another, it is, therefore, imperative to take measures for protecting and minimising if not totally eliminating, pollution of the environment. Planners, Engineers Doctors, Scientists, Managers, Etc all have to be environmentalists one way or the other and to ensure that our future generation live and live in a good, healthy and clean environment.

LAND POLLUTION PREVENTION

The growth in population has cascaded land acquisition by man. land full of vegetation and forest were cut down to make way for his agriculture, habitation and business. Today the land surface is under strenuous strain with its forest cover depleting and land covered with poisonous wastes.

The existing effort for afforestation must be given utmost priority by different government agencies, NGO's and institution to increase forest cover. All schemes will have to adhere strictly to the environmental guidelines set and existing industrial houses should set aside sufficient funds to treat waste products from their factories.

WATER POLLUTION PREVENTION

To prevent water pollution, the discharge of effluents from industries as well as the use of DDT should be banned forthwith. All domestic waste should be properly treated before discharging it into the water bodies. Acid rain can be prevented by reducing the emission of oxides of sulphur and nitrogen from power plants, fertiliser plants, etc. This can be achieved in two ways; first, by filtering the emission through lime in order to remove traces of sulphur dioxide and nitrogen dioxide, secondly, by using lime along with coal in coal fired thermal power stations, where the sulphur in coal reacts with calcium in lime to form calcium sulphate, which is solid.

AIR POLLUTION PREVENTION

In order to control air pollution to some extent, people in the rural areas should be encouraged to use smokeless chullahs in their homes for cooking. Factories using coal as fuel should be asked to erect tall chimneys so that smoke and gas mix with the air and get carried away to far-off places. As a result, the surrounding areas at least remain free from air pollution. Electrostatic precipitators must be used by industries to remove particulate matter such as dust particles from the smoke. Certain harmful gases can be removed from smoke by passing them through a wet scrubber. The exhaust pipes of automobiles must be fitted with anti-pollution devices for eliminating water pollutant. The move by the Government of India, making all automobiles comply to the EURO-2001 is a step in the right direction.

Tree plantation drives must be undertaken on a massive scale and further deforestation should be checked. large-scale afforestation would minimise air pollution by reducing the carbon dioxide content in the atmosphere.

Trees also reduce noise transmission. Several studies prove that trees like neem, banyan and tamarind actually absorb noise. So at least a 50 metres wide green belt between the residential and the industrial areas, would help to solve the problem of noise pollution.

Researches are underway for devising new methods to control environmental pollution and protect the environment. In India, the Department of Environment and Prevention and Control of Pollution Boards, working at national as well as state levels, have enacted several laws to protect the environment and stop its further degradation. But mere laws to contain this global menace will not suffice. Unless the people realise the hazards of pollution and join in the governmental efforts in protecting their environment, all legislation would be futile and meaningless. In this context, the Chipko Movement started in 1973 in the Himalayan foothills of Uttar Pradesh has received worldwide acclaim as an exemplary instance of environmental action by the people themselves. The need of the time is to organise a mass movement to protect the environment, else we shall all perish.

ELECTRICAL ENERGY, A GIFT TO MODERN CIVILIZATION

The inquisitive human mind has been always engaged in inventing one thing or the other, which in turn has brought about changes in human society, in various degrees from time immemorial. However, three inventions appear to have permanent bearings on the ever changing face of human civilization - wheel, fire and electricity.

Electrical energy is a gift to modern civilisation. Whenever any new power house is completed, it means homage to Michael Faraday, who in the 19th century showed that when a coil of conductor is rotated in a magnetic field, then electricity flows in the coil. The prime mover utilised for the rotation of a coil designate the type of power station - hydro, thermal, nuclear, tidal etc. Almost every single phenomenon of our day to day lives having the distinctive mark of modern civilization is attributed to electrical energy, up to the extent that the per capita consumption of electricity is being considered today as one yardstick to measure the degree of development in a society or a country.

The major sources of this important energy, are classified as below

(i) Hydro (ii) thermal (iii) Nuclear (iv) Renewable

Hydro Power

The first hydro power station was a very small one of 10 KW, which was commissioned to illuminate the caves of Bavaria, USA in 1876. On September 12, 1882, a 12 KW hydro station was commissioned, utilising the water from Fox river, USA and this was the first hydro station constructed for generating power for public utility. In the same year, Sir Thomas Alva Edison commissioned sea power station to supply electricity to New York city,

Though irrigation in India was practiced from time immemorial, water power generation was started late comparatively with the commissioning of a project in Darjeeling, West Bengal in 1897 with an installed capacity of 130 KW. This is why, the year 1997 was celebrated as the 100th year of hydro power generation in India. The status of being the first major power station in India is however designated to Sivasamudram Power Station, on the river Kavery, commissioned in 1905 (5 MW).

According to the latest assessment of the Central Electricity Authority (1988), the hydro electric potential of the entire country is estimated at 84,044 MW at 60 % load factor. The annual energy contribution of this potential would be about 600 billion units which include the seasonal or secondary energy. The installed capacity in the country as on March, 1998 was 21,729 MW which is only 25.9 % of the potential.

Development of hydro power in Meghalaya started with the establishment of a small hydro electric project at Sonapani, Shillong in 1922 by a private company. This was primarily to meet the electricity requirements of the British administrators, inhabitants of the Cantonment and some local elite. After independence, the major development of hydro power started with the commissioning of Umtru HEP in 1957. Since then, four major hydro projects have been commissioned at the Umiam-Umtru basin of the state. As on today, the installed generating capacity of the State is 185.2 MW

Thermal Power

The steam era began in 1899 in India with an installation of 1000 kw thermal plant at Calcutta. Since then small stations were built in urban areas to meet the local power demand. At the time of independence the installed capacity of thermal power was 854 MW. This sector has travelled a long journey from a 30 MW unit to massive 500 MW unit, in the super thermal stations, in the country. The Present installed capacity of thermal power was 63,033 MW, as of March 1998.

Nuclear Power Development

The nuclear power technology entered the world energy scene in mid 50s when the first commercial scale nuclear power plant was commissioned at Calder Hall in UK in 1956. At present, 25 countries generate nuclear power totalling 32,600 MW. Prominent amongst them are UK, US, Canada, Russia, Sweden, Finland, France, Germany, Italy, Spain and Japan. India joined this elite club with the commissioning of the first unit of 220 MW at Tarapur in 1969. The nuclear power generation capacity of India is at present at 2225 MW as of March 1998. It is planned to increase the nuclear installed capacity to 10,000 MW by the turn of the century.

Renewable Power Development

The renewable sources of power which include solar, wind, tidal, geothermal, etc. are the most environmentally benign. The estimated potential of some are as follows :

Sl. No.	ENERGY SOURCE	ESTIMATED POTENTIAL
1	Solar Energy	20 MW/Sq. Km
2	Wind Energy	20, 000 MW
3	Small Hydro	1 0, 000 MW
4	Ocean Thermal Power	50,000 MW
5	Sea Wave Power	20,000 MW
6	Tidal Power	10, 000 MW
7	Bio-energy	17,000 MW
8	Draught Animal Power	30,000 MW
9	Energy from MSW	1,000 MW
10	Biogas plants	12 million plants
11	Improved wood Burning Stoves	120 million Stores

However, it will take sometime before these sources are commercially viable.

Negative Effect of Power Generating on the Environment

As any other technology, power generation also has it's part to play in destroying the environment. In this, we confine our discussions only to the two sources of electrical power - (a) Hydro power (b) Thermal power.

Negative Effect of Hydro System of Power Generation

Development of hydro-power is normally associated with apperent loss of forest cover, submergence of flora and fauna, displacement of people, cultural damage, noise pollution etc. Further there are apprehensions like reservoir induced seismicity leading to earthquakes, decomposition of organic material in the lake bottom resulting in production of methane and hydrogen sulphide, temperature variations leading to change in climate etc. Hydro-electric projects are blamed for opening up of previously inaccessible regions, leading to destruction of virgin forests and wild life. The removal of forest cover leads to soil erosion. The water spread created are expected to be breeding habitat of mosquitoes which increase diseases like malaria and other water-borne diseases. Sometimes there are cases of submergence of historical monuments.

Negative Effect of Thermal System of Power Generation

Each kilowatt of thermal power produced consumes oxygen required for breathing by 130 human beings. For each tonne of coal burnt in a thermal power station, 1000 kg of CO₂ and 10 kg of SO₂ are produced. It is estimated that some 19 billion tonnes of carbon-dioxide is pumped into the atmosphere from thermal power stations every year, contributing to greenhouse effect. Oxides of sulphur and Nitrogen dissolve in atmospheric moisture and precipitate as acid rain (pH 5.6) affecting crops, water bodies, fishes etc. Heat lost from thermal power systems is 3 to 4 times the energy produced in the form of electricity.

In India, ash content of coal being 35 to 50%, thermal power plants presently generate 27 million tonnes of fly ash every year, of which hardly 2% is utilise for making bricks etc. Rest of it causes environmental hazards.

CONCLUSION

But generation of electricity will and has to continue and the generation capacity has to be enhanced to meet the growing demand. Thus, it has become increasingly important to decide which form of power

to be generated to ensure that we have development without the side effects of the environmental hazards associated.

Generation of electrical energy With least impact on environment is one of the key issue of 'sustainable development', being attempted today. Hydro electricity comes from non- consumptive use of natural and renewal energy source with least impact on the environment and has been ranked as an attractive energy source by the world commission environment and development published in the report 'Our Common Future', which recommends its development to the maximum extent possible to help create a sustainable society. The international conference on global warning and climate change . Prospective from developing countries; held at New Delhi during February 1989 favoured higher priority for non-fossil renewable energy sources and nuclear power. At the world energy conference (September 1989) in Montreal, it clearly emerged during the session on 'Energy and Technology' that the renewable energy sources, including hydro power have an unquestionable edge over nuclear power in their high quality and safety value to a sustainable energy development. As a matter of fact, it was stressed that the value of environmental advantages should be accounted for in the cost / benefit / analysis of hydro project.

RELATIVE ADVANTAGES OF HYDRO POWER OVER THERMAL POWER

- 1 Hydro plants utilise inexhaustible, natural resource which is constantly being recycled and is available throughout the year in abundance. This is a remarkable trait as against fossil fuels (use in thermal plants) which are fast depleting with the present rate of consumption in India, fossil fuel is expected to exhaust within 150 years.
- 2 Water is immune to inflation, whereas equivalent input in the thermal plant, which is fossil fuel, will continue to cost more in time and with the depleting fuel reserves, particularly in the earth's upper layers.
- 3 Hydro provides clean power Without polluting the environment, whereas thermal contributes to ashes and smoke. Thermal plants, operating at not less than 3000 r.p.m create much more noise as compared to hydro plants which run at a few hundred r.p.m.
- 4 Water resources all over the world are more uniformly distributed compared to coal reserves. This goes in favour of hydro since it helps in keeping the regional balance in power development, besides avoiding huge losses in evacuation of power.
- 5 Water transportation in case of hydro project is under gravity and hence cost nothing, whereas, coal transportation from mines to thermal plants cost substantially, besides causing heavy burden to the Indian Railways.
- 6 Operation of hydro power station is simpler requiring small operating crew making them free from labour problems, unlike their thermal counterparts.
- 7 Hydro plants has longer lives compared to thermal, in India, there are power plants built 80 to 90 years back which are still in operation.
- 8 Hydro plants are robust and highly reliable, requiring minimum of maintenance.
- 9 Operating cost of hydro plants is very low. Hydro energy is the cheapest of all the alternatives available for electricity generation.
- 10 Foreign exchange components of investment in case of hydro is much less as compared to thermal.

FINE TUNNING

While hydro power is relatively more environmental friendly than thermal power, there is need to find ways to further reduce the obvious negative impact of hydro power on the ecology. The apparent destruction of forest cover by large reservoirs is one obvious negative impact of hydro power on environment. Hitherto, the size of hydro power projects have normally be decided on financial consideration. The approach needs to be completely changed and the environmental factor needs to be one of the key element in the decision.

Environmental considerations need to be inbuilt while preparing the viability and cost / benefit / analysis of a hydro project.

The problems faced in implementation of big projects like the Narmada Sagar and the Tehri with large scale submergence have forced hydro-project planners in India to optimise the size of schemes in relation to the environmental and ecological angle.

Here comes the relevance of the development of small and Mini Hydro Project.

DEVELOPMENT OF SMALL HYDRO

The power demand of far flung areas can be met by harnessing the local streamscanal falls, through construction of mini / micro hydel stations, rather than extending transmission lines to these areas. There are several advantages of developing of mini/micro hydel schemes. As per the latest technological advancements, all the generating units of small capacity can be assembled in the shop and transported to site and the scheme made operative in a much shorter period. At present, 117 small hydro plants with 300 generating units totalling 207 MW, are under operation in various parts of India. Unfortunately, as of now, the economic viability of mini / micro (not small) hydel schemes are unattractive compared to the mid-sized ones. It is also practically difficult, due to the poor grid performance in India, to connect the mini / micro hydro power stations to the grid. One hopes that in not a distant future, this short coming would be overcome.

However, small sized and run of the river hydel schemes are the most attractive and have competitive economic viability.

From environmental point of view, small hydro is favourable due to the following :

- (a) Negligible submergence
- (b) Lesser requirement of land and community displacement
- (c) Least impact on flora and fauna
- (d) least forest land requirement
- (e) lesser time to construct

DEVELOPMENT OF POWER IN MEGHALAYA

The development of power in Meghalaya is concentrated on small and mid sized hydro schemes, and all the existing power stations are in the range of mid to small hydro. And therefore the concept of small hydro is very much relevant in the context of the state of Meghalaya. The state in fact has an enormous potential for development of small hydro with its favourable rainfall, hilly terrain and sound geology. A total no of 33 schemes have already been identified by Meghalaya State Electricity Board in the state with a potential of around 3000 MW of installed capacity.

Most of these schemes are ROR Wth installed capacity ranging between 10 MW to 300 MW which are ideal schemes in the context of environmental considerations as discussed above.

ENVIROFILE

- India consumes around 86,311 tonne of technical grade insecticides annually to cover 182.5 million hectare of its cultivated land.
- As much as 1,95,000 cubic metres of sewage, 95 per cent of it untreated is directly pumped into the sea near Mahim, Worli and Gorai in Mumbai.
- Delhi is Yamuna's principal polluter. Every day, 630 million litre of untreated and large amount of partially treated sewage enters the river.

- 48.8 per cent of all vehicles in India run in the three metros namely Mumbai, Delhi and Calcutta. Carbon monoxide released in Mumbai (470 tpd), Delhi (810 tpd) and Calcutta (188.24 tpd). Delhi leads in the release of hydrocarbons and suspended particulate matter 310 tpd and 13 tpd respectively.
- The India auto industry spends less than one percent of its revenue on R&D. A car emits 90 times more carbon monoxide than a bus to carry the same number of people over the same distance.
- A study by Carter Brandon and Kirsten Hommann of the World Bank calculates that over 40,000 people are dying early because of air pollution in India.
- ICMR's "withdrawn" research titled Surveillance of food Contaminants (1993) in India has suggested exposure to pesticide residues as a strong cause of cancer. Of 2205 samples of cow and buffalo milk it was found Maharashtra had 74 per cent samples with DDT residues above the tolerance limit, Gujarat 70 per cent, Andhra Pradesh 57 per cent, Himachal Pradesh 56 per cent and Punjab 51 per cent.
- Tamil Nadu tops the lists of grossly polluting discharging into water course followed by Haryana.
- Garbage generated :

Mumbai	5800 MT per day
Delhi	3880 MT per day
Madras	3500 MT per day
Calcutta	3500 MT per day
- Most of the waste is of low calorific value of 800-1400, easy for bioconversion but difficult for power generation.
- Some Indian companies- Tata Chemicals produce cement using waste effluent and fly ash.

POWERGRID APPROACH TOWARDS MEETING POWER TRANSMISSION'S ENVIRONMENTAL & SOCIAL ISSUES

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ABSTRACT

Power being an important catalyst in development has witnessed considerable expansion in the last five decades. However, as we all know, the development during the last five decades could not satisfy the ever increasing demand of energy. The 21st century is going to witness a spurt in every sector activation unprecedented in the history of human civilisation. But such a growth has accompanied serious impact on environment. Virtually everyday concerned citizens and NGOs complain that power projects have indiscriminately degraded the natural resources or have been insensitive to socio-cultural issues. Although electricity is a clean form of energy at the point of consumption, the process of its generation through fossil fuel such as coal is by no means non-polluting. There are several energy sources through which electricity is produced but irrespective of the source, the transmission component is the same for transmitting the energy produced. The energy is transmitted from generation site to utilisation site by means of a network of high voltage transmission lines. This paper discusses the potential impacts of construction and operation maintenance of transmission system on environment and their mitigation with special reference to ESPP.

INTRODUCTION

POWER is an important catalyst in development . The power sector in this country has witnessed considerable expansion in the last five decades. The installed capacity of merely 1,400 MW at the time of our independence has now increased to about 90,000 M.W. Similarly, the transmission network has increased from 2,700 circuit kms. of 132 KV lines to about 2,25,000 circuit kms lines of various voltage levels ranging from 132 KV to 500 KV AC and DC. Further higher voltage level transmission lines of 800 KV are also under construction. That means, the power sector has experienced appreciable growth in terms of quantum as well as technology during last 50 years. However, as we all know, the development during the last five decades could not satisfy the ever-increasing demand of energy. But such a growth has accompanied serious impact on environment. Virtually everyday concerned citizens and NGOs complain that power projects have indiscriminately degraded the natural resources or have been insensitive to sociocultural issues.

In the changing scenario of economic liberalisation, the quality and reliability of power are the prime areas of concern. In fact, for the desired development in the agricultural, industrial and other sectors, power is one of the major inputs and for accelerating the National Development as a whole, uninterrupted power supply has to be ensured but can we achieve this without damaging the fragile environment ? With the massive expansion foreseen in the Power Sector, it is necessary to ensure to use the latest reliable technologies, and go for new inventions to optimise the use of our existing resources, economise on transmission of additional power and lay equal emphasis on environmental impact of transmission lines. Transmission lines need corridors for electrical clearances necessitating felling of trees during construction and pruning of branches during operation and maintenance phase. At the initial stage of development of transmission system, the voltage level was lower enough to keep the corridor width to a minimum but as the voltage for transmission increased the requirement of larger width became a point of concern to the environmentalist. Moreover, the concern for maintaining the ecological balance by keeping intact the natural habitat of the wild animals went on increasing and the countries became conscious of management of environmental issues to keep with the pace of development. Though felling of trees had a negative impact on the environment, the contribution of the transmission system towards maintaining a cleaner environment can not be denied. The following advantages weigh heavily towards the need for going for bulk transmission of power at higher and higher voltage to maintain the pace of development

- 1 Enables power plants to be located away from load centres
- 2 Reduces pollution levels in inhabited areas

- 3 Reduces transportation of coal
- 4 Facilitates hydro power generation at remote locations

Hence, laying of transmission lines needed efficient management of environmental issues. The ROW is the single most important issue which was left to the field managers only, needed a closer look at the policy making level.

India is a vast country. As you know, the generation resources are not uniformly distributed. The load growth also does not take place always where there is convenience for generation. Further, the peak demand and energy requirement of various regions are seasonal and do not take place at the same time. Under these circumstances, in certain periods one region becomes surplus in power whereas another experiences deficit. For example the large quantum of hydro potential identified in the North East invites attention. While potential for about 30,000 MW exists in the region, load growth of the same order is not expected there itself. Hence, the possibility of transferring this power to other deficit regions is being examined. In order to effectively exploit this potential and to do inter-regional power transfer through the narrow corridor, technological innovations like high power capacity AC, HVDC, Hybrid, Multicircuit lines of high reliability etc. may have to be adopted.

And why only for transfer of NER power, similar technologies may be adopted for intra-regional as well as inter-regional connections across the country as a whole. Proper planning and research & development in this direction are to be commanded well in advance.

Apart from this, the utility and industry may find solutions in enhancing the transmission capability of the lines using technologies like FACTS where requirement of laying additional transmission lines may be reduced to some extent. Further, to overcome the right of way constraints, thoughts should be directed towards identifying existing lower voltage lines and upgrading the same for higher voltage operation to enhance the power transmission capacity within the same corridor. POWERGRID have established feasibility of doing such upgradations for 66 KV and 220 KV lines. These aspects may be considered during planning process itself so that appropriate technologies on case to case basis can be developed in advance.

One of the important areas of concern as explained earlier is the right of way for transmission lines. Various factors such as high population density, other on-going infra-structural developments as well as our duty for environmental preservation, limit the freedom of power utility in selecting a suitable route for the transmission lines. Therefore, POWERGRID has integrated environmental and social management procedures into its corporate operations. POWERGRID has laid down guidelines for its approach towards these issues in its Corporate Environmental and Social Policy and Procedures (ESPP).

POWERGRID's ENVIRONMENTAL AND SOCIAL POLICY STATEMENT

POWERGRID believes that its guiding principles of Reliability, Security and Economy now have to match with the rising expectations of a cleaner, safer, healthier environment of people, both affected and benefited by its activities. The key principles of POWERGRID's Environmental and Social Policy statement are:

- Avoidance of environmentally and socially sensitive areas while planning project activities.
- Minimisation of impacts when project activities occur in environmentally and socially sensitive areas.
- Mitigation of any unavoidable negative impacts arising out of its projects.

In that order, apart from this Public consultation is carried out at every stage of construction/O&M to bring the transparency in POWERGRID operations.

ENVIRONMENT AND SOCIAL ISSUES IN POWERGRID OPERATIONS

As already mentioned, environmental impact of POWERGRID's operations are quite negligible. Therefore, Government of India has not by and large covered transmission projects under the scope of Environmental Impact Assessment under the Environmental (Protection) Act 1986 except in two district of Aravali range i.e.

Gurgaon in Haryana and Alwar in Rajasthan. International funding agencies which are very particular about the environmental aspect of individual projects are also of the same opinion. The World Bank has classified transmission projects as Category 'B' which requires only an Environmental Impact Analysis and Review instead of detailed Environmental Impact Assessment.

Social issues associated with transmission projects are chiefly related to land acquisition carried out for substation sites. Again, POWERGRID exercises flexibility in siting substations. POWERGRID has demonstrated its trustworthiness and capacity to build safe towers at railway, highway and other crossings. As far as possible, POWERGRID plans and conducts its construction activity after the harvests to avoid damage to crops. In case damage to standing crop is unavoidable, POWERGRID provides compensation at market rate for the same. POWERGRID ensures that hazards due to fires are non-existent by adopting high standards of safety.

POWERGRID APPROACH TOWARDS ENVIRONMENTAL & SOCIAL ISSUES

Environment

POWERGRID try to avoid orchards, plantations and forests in the course of line routing through studies of alternative routes. If inevitable, care is taken to route the line through a path of minimum disturbance. Most of the towers are located, by default, in agricultural land in an attempt to avoid environmentally pristine areas and human habitation.

POWERGRID takes into consideration the following points while routing its transmission lines:

- the route does not involve any human rehabilitation
- the route does not affect any monument of cultural or historical importance
- the proposed route does not threaten the survival of any community, especially tribal communities
- the proposed route does not affect any public utility services like play grounds,
- school and other establishments, etc.
- the line route does not pass through any sanctuaries, National Park, etc.

The transmission line is a linear facility and has the impact primarily within or in the immediate vicinity of the right of way (ROW). ROW is an issue specific to transmission lines. ROW width depends on the line voltage. Maximum width of ROW for transmission lines on forest land are given below:

Transmission Voltage in KV	ROW (in mts.)
132	27
220	35
400	52
800	85

POWERGRID uses manual stringing in thick forests and on slopes whenever possible to minimise damage to the environment. However some lopping of canopy and clearing of ground vegetation is inevitable while stringing. POWERGRID mitigates damage by allowing regeneration along the ROW, except in one strip of 3 meter width, which is kept clear for maintenance.

POWERGRID has incorporated the best technology practices in an attempt to deal with environmental issues. In landslide prone areas, POWERGRID designs tower bases and revetments that prevent soil erosion near the tower. POWERGRID has also designed special towers for wetlands, coasts and riverbeds. Unavoidable environmental issues that could occur in a power transmission project, and to minimise, POWERGRID takes mitigative measures which are shown in Table - I.

Social

POWERGRID tries to avoid Resettlement and Rehabilitation (R&R) in all its projects by siting substations on government land as far as possible. In case rehabilitation is totally inevitable, POWERGRID addresses R&R issues arising due to land acquisition through its R&R Policy. POWERGRID ensures proper valuation of land, assets, compensation for each category of PAPs and minimisation of lengthy cumbersome procedures. POWERGRID's experience from its past 55 (fifty five) substations indicates that a typical substation requires an area of 80 to 120 acres of land. Of this about 50% is usually private land and 50% government land. The land use of this area would usually be 70% agriculture and 30% wastelands. Hence, project affected persons (PAP) could lose agricultural land and their livelihoods. Till date, POWERGRID has acquired only one homestead for its past fifty **five** substations. POWERGRID enhances opportunities for marginalised groups through the RAP and IPDP.

Powergrid's Social Entitlement Framework

POWERGRID'S entitlement framework is based on progressive trends in Indian policies, with respect to the inclusion of project affected people(PAPs), and the nature and extent of compensation. In order to provide a framework for the R&R process and to supplement existing procedures, an illustration of entitlements is shown in Table-2 Basic categories of issues/ impacts under this entitlement framework are:

- Loss of land
- Loss of structure
- Loss of source of livelihood
- Loss of access to common resources and facilities
- Loss of standing crops and trees
- Losses during transition of displaced persons/ establishments and
- Losses to host communities

NATIONAL CONSULTATION

For the first time in India or probably in Asia that a public sector undertaking organised a National Consultation to obtain feedback on its operations with specific emphasis on environmental and social concerns to finalise the Environmental & Social policy and Procedures (ESPP) in June 97. More than 300 participants from Academia, NGO'S, Project Affected Persons (PAPs), media and concerned citizens participated in the National consultation on POWERGRID's ESPP. POWERGRID was commanded for the initiative taken to organise such a consultation which will not only bring much needed transparency in environment and social issues but also act as stepping stone for others. This will go a long way in the history of redresses of E&S related issues of the projects.

The policy document was evolved in close interaction with environmental and social experts of World Bank and other funding agencies. However, the ground realities were always kept in mind. This has been approved by POWERGRID Board and accepted by the Board of World Bank. This is now put on internet. The compliance of ESPP is mandatory for all ongoing as well as future projects in POWERGRID.

This is a need for similar philosophy to be adopted by the SEBS, and other power transmission utilities. Let it not be the end of innovations, and similar efforts should continue to optimise the use of transmission systems, and minimise environmental impact of transmission lines. Innovations and improvements in construction technology, project management etc. also would be a demanding aspect requiring attention when an ambitious development within limited time frame is in the offing.

TABLE - I

POWERGRID's ENVIRONMENTAL AND SOCIAL MITIGATION MEASURES

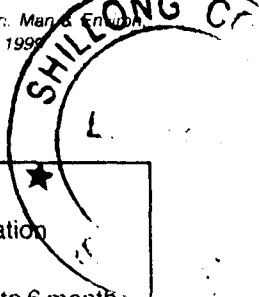
Potential Impacts	Mitigatory Measures
A. 1. Opening up of canopy in Natural Forests 2. Lopping of Trees 3. Habitat Loss 4. Vegetation Damage 5. Habitat Fragmentation 6. Edge Effect propagating generalist species 7. Increased access to Wild Lands 8. Paths/Access Roads 9. Run off and sedimentation from grading of access roads. B. 1. Chemical contamination from chemical maintenance techniques. 2. PCBs in electrical equipment C. 1. Change in landuse and population relocation due to towers 2. Change in landuse and population relocation for substations 3. Induced secondary development during construction	● POWERGRID avoids environmentally sensitive areas such as wild lands as far as practicable while selecting its ROW. ● To minimise damage to vegetation and habitat fragmentation, POWERGRID utilises hand clearing and transportation of tower material by headloads into forests. ● POWERGRID maintains only a 3m wide strip for O&M and allows for regeneration of vegetation in the other tow strips and also beneath the transmission lines to avoid habitat fragmentation and edge effect. ● POWERGRID does not create any access roads or paths during construction activity but utilises existing paths and field bunds for movement of material. ● POWERGRID does not use chemicals for forest clearance/ROW maintenance. ● POWERGRID does not use PCB's in its electrical equipment. As a cautionary measure, POWERGRID has arranged for studies with National Grid Company, U.K. for sampling of existing equipment and creation of a PCB management plan if necessary. ● POWERGRID does not acquire land for its transmission towers, POWERGRID pays compensation for any crop loss and damage caused during its activities. POWERGRID allows regeneration and cultivation beneath the towers and lines. ● POWERGRID avoids populated Urban/Rural areas, trees/plantations for its substation as far as possible. If unavoidable – ● POWERGRID pays compensation on the principle of replacement. Issues of R&R are addressed through its SAMP ● POWERGRID operations are shortlived and do not induce secondary developments during construction.

D. 1. Avian hazards from transmission lines and towers 2. Air craft hazards from transimission lines and towers 3. Impaired cultural and aesthetic resources 4. Health and safety 5. Fire Hazards 6. Pollution	● POWERGRID avoids nesting sites and crucial bird habitats by careful route selection. The suspension towers are provided with bird gaurds to prevent any avian hazards ● POWERGRID provides aviation markers, night light for easy identification of towers ● POWERGRID selects best possible designs and support structures for transmission towers. ● POWERGRID lines do not cause any hazards to health and safety. ● POWERGRID uses the best international standards in technology. ● POWERGRID uses equipment of latest technology in its transmission lines to prevent fire hazards ● Not Applicable

TABLE - II

POWERGRID'S SOCIAL ENTITLEMENT FRAMEWORK

Type of Issue / Impact	Beneficiary	Entitlement Options
Loss of land		
a. Homestead	i) Family	(i) Equivalent area of land subject to availability (State Govt./Voluntary sellers at existing rate within a radius of 25 km. or cash compensation + rehabilitation assistance **
(i) with valid title, or customary or usufruct rights		
b. Agricultural land	i) Titleholders	(i) alternative land of equivalent production potential subject to - agriculture based PAPs (rendered landless by project or left with landholdings that are not economically viable) - availability (State Govt./Voluntary seller at existing rate) within a radius of 25km - maximum limit is land ceiling limit or cash payment + rehabilitation assistance **
(i) with valid title, or customary or usufruct rights	ii) Individual	(ii) Local standard for min. economic land holding (if not claimed by owner) or cash payment an reimbursement for unexpired lease rehabilitation assistance
(ii) tenants, sharecroppers, lease holder, Squatters		(i) cash compensation + rehabilitation assistance ** (ii) Reimbursement for unexpired lease, transition allowance equivalent to 1 year average income as finalised by land purchase committee
C. Shop/Institutions	i) Titleholders	
(i) with valid title, or customary or usufruct rights	ii) Unit	
(ii) tenants, leaseholder		



Loss of structure a. House (i) With valid title, or customary or usufruct rights (ii) Tenant, leaseholder (iii) Squatters	(i) Family (ii) Family (iii) Family	(i) cash compensation + rehabilitation assistance** (ii) Lumpsum payment equivalent to 6 month rent to re-establish residence as finalised by land purchase committee (iii) cash compensation for structure + lumpsum payment equivalent to 6 (-) month income finalised by land purchase committee to re-establish residence + rehabilitation assistance and transition allowance as per category - 6.
b. Shop/Institutions (i) with valid title, or customary or usufruct rights (ii) tenants, leaseholder (iii) squatters	(i) Unit (ii) Unit (iii) Unit	(i) Cash compensation + rehabilitation assistance** (ii) Transition allowance equivalent to 1 year income as finalised by land purchase committee (iii) Cash compensation for structure+ lumpsum payment equivalent to 1 year income as finalised by land purchase committee to re-establish structure + rehabilitation assistance and transition allowance as per category-6
Loss of livelihood/trade/ occupation a. Wage/Self employment (i) Agriculture/Commercial	i) Individual	(i) Package for starting a income generating enterprise and transition allowance equivalent to 1 year income as finalised by LPC
Loss of access to common resources and facilities a. Rural common property resources. b. Urban Civic amenities	i) Household/ Community ii) Household/ Community	(i) Replacement CPRs/amenities or provisions of functional equivalence (ii) Access to equivalent amenities/services
Loss of standing crops/trees a. With valid title b. Tenant/lessee	i) Family ii) Family	For either category, only the cultivator will get compensation at market rate for crops and 8 years income for fruit bearing trees.
Losses during transition of displaced persons/establishments a. Shifting/Transport b. Maintenance c. Construction	i) Family/unit ii) Family/unit iii) Family/unit	(i) Provision of transport or equivalent cash (ii) Cash payment to be finalised by the LPC (iii) Cash for transport of materials
Losses to Host Communities a. Amenities/Services	i) Community	(i) Augmentation of resources of host community to sustain pressure of PAPs

* The proposed entitlement framework will be applicable only in the case of land acquisition for substation

** POWERGRID will provide adequate compensation as required under Indian law and will compensate at replacement cost. POWERGRID, if required will complement (i.e. top up) this with rehabilitation assistance and other measures to ensure that PLPs are not made worse off by their operations.

ENVIRONMENTAL POLLUTION AND ITS IMPLICATIONS ON MAN AND THE ENVIRONMENT

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ABSTRACT

The depletives of the environment had started since the beginning of the Industrial Revolution and has accelerated significantly in the last 50-60 years.

In this paper an attempt has been made to highlight the various problems of environmental pollution. Some measures have been suggested to tackle the problem of effluents from industries. A note of caution has also been sounded to prevent ecological imbalance.

INTRODUCTION

There has been no greater abuse of the environment by man than for the last 50 years or so. Industrial development has made great strides in the Nineteenth and Twentieth centuries. The depletion of the environment had started since the beginning of the Industrial Revolution. It has only accelerated significantly in the last 50 - 60 years.

In dealing with environmental problems, we have to bear in mind a basic premise of ecology which may be stated as follows :

- 1 Everything is connected to everything else
- 2 Everything has to go somewhere.
- 3 Nature knows best how to deal with the complicated economical and biological mechanisms that operate within it.

The problem of environmental pollution is being experienced all over the world. It varies between the developed and underdeveloped countries simply in the nature of the pollution. In the developed countries, pollution is mainly due to discharge of industrial waste. In the under-developed countries, it concerns with the organic pollution and improper sanitary and health condition, as well as ecological degradation resulting from deforestation.

In the context of the increasing growth of Industrialization through the development process - mainly Five Years Plans several problems of pollution are manifested to the area, water discharge, Municipal and Industrial waste both into the streams and rivers and also into the atmosphere. As a result, legislation was even enacted in Parliament by way of the Prevention of Water Pollution Act. Another legislation known as the Prevention of Area Pollution Act is also on the anvil. Some more forward State have already taken the lead in enacting similar legislation and enforcing them.

DISCUSSION

A simple reason why we should take more interest, in environmental pollution is that we have to live in the environment. It must be realised that pollution has certain inherent dangers from which no one can escape. Once we are aware of this there will be a consciousness of the need to maintain a healthy environment and also to find ways to tackle the problem.

There are many aspects to the problem of environmental pollution. Some of them are given below.

- 1 Industrial wastes
- 2 Sludge handling and disposal
- 3 Problem of waste and effluent disposal into water courses
- 4 Pollution control.

- 5 Planned operation.
- 6 Present pollution research plants.
- 7 Regional programmes under polluted discharge and treatment schemes
- 8 Standard guidelines for effluent discharge and their economical effects
- 9 Combine overflow of sewage and industrial wastes on land
- 10 Low cost waste disposal.
- 11 Process of equipment and development.
- 12 Pollution control facilities in industries.
- 13 Problems of combine treatment of municipal and industrial wastes
- 14 National planning for water pollution controls
- 15 Legal provisions.

Both domestic and industrial wastes often are discharged into water systems, the soil or the atmosphere. Comparative convenience and economic disposal are the main reasons for discharging such wastes especially into the stream and rivers without regard to civic or environmental factors. Care has to be taken to ensure that the pollution is within the limits of tolerance of the systems or else environmental degradation will be the consequence.

Pollution means the introduction of anything which adversely and unreasonably impairs final use of water. This may or may not involve health hazards. Pollution is caused by the presence of organic, inorganic and radio-active substances in industrial wastes in minute suspended or colloidal or of micro organism. The composition of the substances by micro organisms often produce foul odour and are harmful to life apart from the unpleasant appearance. Organic compounds may produce odour, colour and taste. Inorganic compounds may produce turbidity, foaming, odour, etc. Bacteria of animal and plant life thrive in such wastes.

If the organic pollution load is small and the depleted oxygen of the stream is high bacteria breakdown of organic waste into smaller compounds which are relatively harmless and odourless takes place. Oxygen is obtained from the atmosphere as well as by photosynthesis in plants. If the depleted oxygen is unable to cope with the load, the bacteria decompose organic load into compounds of organic sulphates, hydrogen sulphide which produce a foul odour. The introduction of these pollutants into the rivers and streams produce obnoxious mixture which have to be removed for utilization of the water. The oxygen demand load of the effluent wastes into rivers should be controlled as this will be more economical than treating polluted water at a later stage. Therefore industrial wastes should be given proper treatment before they are discharged into the water systems.

The disposal of industrial effluents on land for irrigation purposes is more common. There have been often successful results especially for affluent of food processing pharmaceutical and paper and pulp industries. It is necessary to limit the constituents in the effluent, especially toxic ones, so that the quality of irrigation water can be maintained. Industrial effluents disposed of on land should not contain constituents which may pollute the ground water and make it unfit for human or animal consumption.

The discharge of industrial effluents into municipal sewers create economic additional sewage treatment problems. It may also lead to deterioration of the sewage system and consequential increase in pollution and maintenance costs. If the discharge of industrial waste into municipal sewers implies high financial costs for treatment, etc., the industries causing such pollution should bear a proportionate cost of the maintenance.

Large amounts of sulphate in effluents corrode sewers through the formation of sulphuric acid. Presence of elements such as chromium, acidity or alkalinity and high temperature adversely affect biological activity in the treatment plant. Inflammable and toxic chemicals may cause explosions in treatment plants with consequential damage. Oils, grease and tar may stick to the walls of sewers and reduce hydraulic capacity. It is therefore necessary to limit the concentration of all these constituents.

Domestic sewage is treated by the local Municipality. In respect of Industrial wastes, Municipalities must insist on adequate treatment of wastes before it is finally disposed. Industrial wastes consist of mainly the following :

- 1 The process of effluents from industries (agricultural, synthetic organic and inorganic chemicals).
- 2 Floor/plant washing.
- 3 Sanitary and faecal wastes.

As industrial wastes are peculiar in their characteristics depending on the type of industries, a study should be undertaken to choose an appropriate treatment method for their disposal. It may not always be necessary to treat the entire waste. Some measures may be possible to deal with the problem, such as (1) Process of change eg. use of soft detergents (alkyl, benzene sodium, alkyl sulphuric) rather than hard detergents or polyphosphate which eliminate foaming. (2) Material recovery (such as recovery of silver from silver nitrate in photographic processing) (3) water recycling where from boilers are circulated to disperse the heat thereby reduce thermal pollution (4) Mixing waste water from different industries (mixing acidic, and alkaline wastes which neutralize each other to bring about normal pH value).

The burning of coal produces carbon dioxide, carbon monoxide, sulphur and nitrogen, water vapour suspended particulate material (SPM), and high levels of ash content. These are major causes for global warming, depletion of the ozone layer and acid rain. This kind of pollution causes diseases like asthma, mental tension, hardness of hearing and various deficiencies in the system which lowers resistance to combat diseases. They also affect plant and animal life.

Large amounts of ash that is often released in coal burning plants produce pollution problems. The fly ash content produces toxic elements like solonium, arsenic, magnesium, titanium etc. When their concentration exceeds permissible limits it has an adverse impact on plant and animal life.

Fly ash causes health hazards through increased air pollution, especially in the summer months. Fly ash particles thrown into the atmosphere add to the SPM level and often causes respiratory ailment.

NATURE AND ECOLOGICAL BALANCE

Nature has an amazing ability to maintain the environmental balance. It gives us many gifts for our need. They are not to be abused through misuse. Environmental elements are interdependent. Plants, trees and living beings help one another in maintaining the ecological balance. Trees and living beings are complementary to each other. Trees assimilate carbon dioxide and release oxygen. Living being inhale oxygen and exhale carbon dioxide. In addition trees & plants absorb other gases like oxides of sulphur and nitrogen, water vapour and minerals and convert them into useful substances for human and animal life. They also reduce temperature, noise level and SPM level.

Man has disturbed this balance by trying to develop and acquire wealth without taking into consideration the limits in the capability of the environment and plant life to maintain the equilibrium. By selfishly exploiting nature's gift and reducing this capacity for stabilising animal and plant life requirements, we have increased environmental pollution and are posing a threat to the ecological balance. It is necessary that we realise our limitations and confine our activities within these parameters for our own benefit as much as it is important to preserve plant life and thereby not endanger our future generations.

PLANT GENETIC RESOURCES CONSERVATION STRATEGIES – A SECURITY FOR MAN AND HIS ENVIRONMENT

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ABSTRACT

To feed the ever increasing human population, the maintenance of plant genetic diversity is indispensable. For this, the natural ecosystem preservation is prime important which can allow the evolutionary process and prevent the genetic erosion. The conservation of plant diversity is of critical importance, because of the direct benefits to human that can arise from its exploitations in new agricultural and horticultural crops, the development of medicinal drugs and the pivotal role played by plants in the functioning of all natural ecosystems. The economic, political and social consequences that would result from a steady loss of plant diversity combined with rapid population growth is likely to be devastating, if unchecked. The paper is discussed on various complementary conservation strategies of rich Botanical diversity of Northeastern region of the country.

INTRODUCTION

The conservation of plant genetic resources can contribute the potential benefits to humankind through the adoption of appropriate strategies and its scientific exploitation. The United Nations, Conference on the Environment and Development (UNCED) held in Rio in 1992, recognised its importance in terms of economic, political and social point of view. There are more than half a million plant species in the world (both phanerogams and cryptogams) and each species has got its own way to survive and contribute to the humankind directly or indirectly.

Plant genetic resources conservation is urgently required as they are disappearing at very fast rate. Raven (1988) estimated that 200 plant species were being lost every year in the tropics and subtropics, based on the loss of half the species in the area likely to be deforested by 2015. Based on the trend of destructions, Myers (1988) calculated that 7% of the plant species of the world could be lost in the next decade. Humankind are dependent on plants for their survival which provide the basic need i.e food, fibres, shelter and medicines. The potentiality of hardly 10% of plants have ever been evaluated for the agricultural and medicinal purpose. Therefore, certainly many more new crops and drugs are yet to be discovered. Unless this living species are available the chances will go forever.

METHODOLOGY

Conservation is the process that actively retains the diversity of the gene pool with a view to actual or potential utilisation; utilisation is the human exploitation of that genetic diversity. The raw materials of genetic conservation are genes within gene pools, the total diversity of genetic material of the particular taxon being conserved. This may be represented as follows -

Gene ————— Conservation ————— Utilisation.

APPROACH

If the conservation measure is to be taken to a limited scale, it is better to conserve either on **in situ** or **ex situ** condition, because the financial, temporal and technical resources are mostly remain inadequate. Based on the comparative value of a taxa, their importance and priority, the selection of target taxa should be chosen for the necessary conservation. When the selection of target taxa is identified the commissioning of the conservation activities actually start. Objectives, of selection of target taxa should be specified. Target area, utilisation of material, where the materials are to be conserved, where it can be duplicated etc. which can not only remain within the National boundary but may involve the International organisations. Plant species does not know any political boundary but it spread over its acclimatized area.

The next phase is Ecogeographic survey which contribute the information on geographical, ecological and taxonomic data. The synthesis of these informations help and assist towards the formulation of collection

and conservation programme. During field exploration, population structure, crop and wild species, range of diversity, sampling method, genetic variation within and between population are the essential aspects to be recorded.

CONSERVATION STRATEGIES

There are two categories of conservation strategies. The convention on biological diversity (UNCED, 1992) defines it as follows:

Ex-situ Conservation : the conservation of components of biological diversity outside their natural habitats.

In-situ Conservation : the conservation of ecosystems and natural habitats and the maintenance and recovery of viable population of species in their natural surroundings.

Thus **ex-situ** conservation involves the sampling, transfer and storage of germplasms or target taxa while **in-situ** involves the designation, management and monitoring of target taxa where they are encountered. The division of these two basic conservation strategies are further divided into several specific techniques.

Ex situ	In situ
i) Seed storage	i) Genetic reserve
ii) in-vitro storage	ii) On-farm
iii) DNA storage	iii) Home gardens
iv) Pollen storage	
v) Field gene bank	
vi) Botanical garden	

There are advantages and disadvantages in both the systems. These cannot be think in isolation rather they are complementary to each other.

CONSERVATION PRODUCTS AND ITS DISSEMINATION

Conserved germplasm, live and dried plants, tissues culture and the generated data are the end products of the conservation activities. The products are either maintained in their original environment or deposited in a range of **ex situ** storage facilities. Provision should be kept so that a duplicate set of germplasm may be maintained safely at duplication site.

UTILIZATION OF PLANT GENETIC RESOURCES

Conservation and utilization are complimentary to each other. The genetic material can be used directly and immediately for various breeding programme or the conserved material can be used at a future date. However, in between, characterisation/evaluation data will help to determine the approach for useful utilization. The products of utilization are numerous which may be a single resistant gene, a particular chemical products or a new crop variety.

RELEVANCE OF PLANT GENETIC RESOURCES CONSERVATION IN CONTEXT OF NORTH EAST INDIA

The average forest area in Northeastern states of India is about 42%, against its total geographical area. However, the legally notified forest area is 22.9%, while the photo-imagery survey indicates only 19.5%. Within such forested area, 43% of total floristic elements of the country are available in this region. Therefore, in comparison with area, the population pressure and the rate of deforestation, the situation is definitely vulnerable and hence the conservation measures are indispensable.

From the PGR conservation point of view, the region has undertaken some effort by way of conserving the natural areas (**in situ**) as Biosphere reserve, National Parks, wild life sanctuaries, Reserve forests, Gene reserve. The respective number and area for each state of the region have been stated in Table - I. However, more efforts are needed to bring more virgin area within any of these categories. The survey made by the

NBPGR Regional Station, Shillong in this regain also unfolds some interesting facts which necessitates to protect more areas as genetic reserve (**in situ**) in order to maintain the particular plant genetic diversities (Table - II). On farm conservation initiative is in infant stage which warrants adequate attention. For **ex-situ** conservation in the region, a regional crop gene bank is going to be commissioned very soon which will help the researchers for crop germplasm (seed) storage.

Food security and healthy environment are the basic need for human sustenance. Conservation of Plant Genetic diversities is the only answer for sustainable development of present and future human race.

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TABLE - I

NUMBER OF DIFFERENT NATURE RESERVES IN NORTHEASTERN STATES

State (s)	Biophere Reserves	National Park	Wild life sanctuaries Reserved Forests	Game Reserve	Total area (Sq.kms)
Assam	1 (Manas)	1 (kaziranga)	8	2	4384
Arunachal Pradesh	1 (Namdapha)	1 (Mouling)	12	-	19325
Meghalaya	1 (Nokrek)	1 (Balphakram)	3	-	302
Mizoram	-	-	1	4	941
Manipur (**)	-	1 (Keibul)	1 (yangoupokpi)		225
Nagaland	-	-	2	2	222
Tripura	-	-	4	-	*
Total :	3	4	31	8	

* Not available. **More reserved area have been declared recently.

TABLE - II

IDENTIFIED AND PROPOSED GENETIC RESERVES (In situ)

State	Species	Locality
1 Arunachal Pradesh	Citrus jambhiri	Around Shimmong, Pugging, Ramshing and Gossang villages of Yingkiong, along the course of Siang river.
2 Assam	14 species of Bamboos	In between Lumding and Halflong, NC Hills district.
3 Meghalaya	<i>Phyllanthus emblica</i>	Nongkhyllum, Khonjoy, Nongjri and Rajaju of West Khasi Hills district.
4 Manipur	i) <i>Lilium mackliniae</i> ii) <i>Zizania latifolia</i>	Siroy hills, Ukhul district Loktak Lake area
5 Tripura	i) <i>Psidium guianensis</i> ii) <i>Zizyphus spp.</i>	West Tripura district - Do -

LAND DEGRADATION AND ITS EFFECT ON THE ENVIRONMENT

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ABSTRACT

The unending rapid rate of land degradation hampering crop productivity and causing a host of socio-economic as well as environmental problem has become a matter of serious global concerns. The paper makes a survey of factors leading to land degradation. A statics of land degradation in India is given for ready reference. The consequence of land degradation and sustainable land management are also mentioned.

INTRODUCTION

The National Land Use Policy - Outline Adopted at the first meeting of the National land Use and Wastelands Development Council, envisages:

"Among the major resources available in the country, the most important is land comprising soil, water and associated plant and animals involving the total Eco-system. The community's demand for food, energy, and many other needs has to depend on the preservation and improvement of the productivity of this natural resource".

"Land must be treated as a single entity and the sectional interests and pressure groups must not be allowed to defeat the prime objective of increased productivity and elimination of poverty".

With the increasing population and enlarging aspiration of the communities in free India the extraction of biomass has been very extensive over large areas and at the cost of land's natural capability of regeneration, replenishment and re-enrichment. Over-exploitation and unwise use with the primary objective of immediate gains without due regard to long-term sustainability leads to various kinds of its degradation, at times resulting in an irreversible condition. The un-ending rapid rate of land degradation hampering crop productivity and causing a host of socio-economic as well as environmental problem has become a matter of serious global concerns.

In a general way, land degradation can be defined as a loss of land productivity, quantitatively or qualitatively, through various processes such as erosion, by water or wind, salinization, waterlogging, depletion of nutrients, deterioration of soil structure, and pollution. The loss of productivity may be partial or total. Historians often relates the vanishing of civilizations to losses of productivity of the lands that once supported them. In present times the increasing world population and the resulting pressure on the land are additional threat to the retention of production potential.

Out of the total land area of 13.5 billion hectares in the world approximately 3.03 billion hectares (22 percent) is potentially cultivate of which hardly one half (1.4 billion) is cultivated and that too at different levels of productivity due to various constrains. The total degraded land in the would is estimated at 2 billion hectares while the annual current loss of arable land is reported to the tune of 5-7 million hectares with a projected figure of 10 million hectares by 2000 A.D. The relative adverse influence of soil degradation is estimated at 39% in Asia, 25% in Africa, 12% in South America, 11% in Europe, 8% in North America and 5% in Oceania (Down to Earth, April 15 1996, p. 60) indicating that Asia is the most seriously affected continent. Regarding the relative share of the main types of soil degradation the spread of water erosion is 56%, wind erosion is 56% chemical degradation 12% and physical degradation 4% thereby suggesting that water erosion is the most widespread malady in the world. The loss due to waterlogging and salinization comes to 0.2 - 1.5 million hectares, while the depletion of essential plant nutrients has affected 1.2 billion hectares in the world and 450 million hectares in Asia alone. In the developing world, 1 billion

hectares of arable land is moderately to severely degraded and another 9 million hectares beyond redemption. The magnitude of soil loss through degradation will be much larger than the additional area brought under cultivation, more so in the developing countries plagued with a higher rate of population growth and poverty.

LAND DEGRADATION

Factors leading to land degradation can be grouped into the following categories:

- Geology and Soils : Weak geological formation, seismic/volcanic eruption, steeply sloping land, coarsed textured soil, impermeable soil, highly erodible soil etc.
- Climate : High intensity - short duration rainfall, evaporation exceeding precipitation, drought, high velocity winds, cyclones and storms, climatic change etc.
- Agrarian : Wrong land use, faulty cultivation methods, cultivation on marginal and fragile lands without conservation measures, improper cropping system, excessive use of agro-chemicals, imbalanced fertilizer use, un-sustainable production, exploitive agriculture, mismanagement of irrigation water, overdrawal of ground water etc.
- Silvi-pastoral : Indiscriminate and excessive deforestation, shifting cultivation, forest fires, heavy, over-grazing etc.
- Socio-economic : Heavy population pressure, poverty, shrinking landman ratio, small fragmented holdings, lack of realisation of adverse effect, conservative social customs, slow adoption of improved technologies, lack of group participation, rights of animal grazing and wood collection, effect of untreated sewages, industrial wastes, town refuse, tourism, war etc.
- Organisational, administrative and developmental : Land tenure system, ineffective land policies, non implementation of soil and water conservation measures, lack of organised drainage system, unplanned industrial development, mining, brick kiln construction of roads, airports, railroads and other communication system, inadequate extension infrastructure, limited technical support deficient credit and input supply facilities etc.

LAND DEGRADATION IN INDIA

India ranks very high among the developing countries in respect of both the extent and severity of land degradation. Out of the total, land area of 329 M.ha, 174.95M. ha (53.2%) are affected by different kinds of degradation (Government of India 1994, India Agriculture in brief 25th edition) of which the breakup is as follows :

Area affected by water and wind erosion	141.25 M. ha. (80.7% of the total degraded land)
Area affected by salinization and Solidification	9.08 M. ha.
Area affected by water logging	8.51 M. ha.
Acid soils	4.5 M. ha.
Ravines and gullies	3.97 M. ha.
Area affected by shifting cultivation	4.91 M. ha.
Area affected by riverine and torrents	2.73 M. ha.

Approximately 93 M. ha of the agricultural land and 35 M. ha. the forest land are damaged to varying degrees. The average area affected annually by flood is estimated at 8 M.ha. And the total drought prone area at 260 M. ha.

CONSEQUENCES OF LAND DEGRADATION

Land degradation exerts many on-site and off-site negative effects, some of which are direct while others are indirect. The indicators of the consequences are distinguished by certain workers into : (1) directly visible, and (2) directly not visible. Under very extreme intensity of land degradation the affected areas are even abandoned from cultivation and the civilizations destroyed. Broadly, land degradation has the following economic, social and environmental consequences:

ECONOMIC

- Decrease in soil fertility and land value.
- Decline in crop intensity, yield and quality
- Un- sustainability of the farming system.
- Siltation of reservoirs, canals, channels, drains etc.
- Loss of water resources and their quality.
- Abandonment of land from cultivation.

SOCIAL

- Increased un-employment, poverty and income inequity.
- Unhygienic conditions, diseases and poor health.
- Loss of life, property and infrastructure.
- Obstruction of traffic movement.
- Increased criminal activity.
- Set-back to developmental programmes.

ENVIRONMENTAL

- Climatic changes, desertification.
- Increased droughts and floods.
- Enhanced weed growth.
- Loss of biodiversity.

It is estimated (Down to Earth, Oct. 15, 1996) that land degradation in India causes between 4.0 and 6.3% productivity loss in total agricultural output every year which is equivalent to US \$ 1.5 - 2.4 billion (i.e. Rs. 5,250 - 8,400 crores). The annual production loss due to rangeland degradation varies from US \$ 238 to 417 million, assuming a 20 to 35 per cent reduction in the carrying capacity of the natural rangelands over time. These estimates represent losses as a result of soil degradation that has occurred over many years.

SUSTAINABLE LAND MANAGEMENT

- 1 Improving soil fertility.
- 2 Introducing soil conservation measures.
- 3 Introducing watershed management concepts;
- 4 Enhancing groundwater recharging through water-harvesting structures;
- 5 Encouraging participatory development of agricultural technology;
- 6 Involving different factors in the research and development process.

CONCLUSION

Widely spread land degradation is not only detrimental to current agricultural production but is a threat to the survival of mankind. It is imperative that an awareness of this situation be created at all levels, with decision makers at the national level down to the farmer in his own field, with land-use planners and those responsible for technical and financial assistance, with scientists and research workers. A sound technical basis for conservation programmes needs to be established, starting with an assessment of a country's land resources, then production potential and degradation hazards. Parameters for estimating the intensity of various degradation processes need to be collected and interpretations made thereof. Precise information needs to be compiled and collected on the effects of different forms of land degradation on production in terms of specific types of land use and for specific soils and climates. This information is essential to evaluate land for alternative uses and for adjusting present land use in order to ensure sustained production. Governments will need to play an increasingly important role in ensuring the maintenance and improvement of their country's land resource base, at the risk of increasing dependence on food produces elsewhere. Their major role will be to create a socio-economic environment which encourages the farmer's community to devote effort and resources to the conservation of the country's soil capital. Agricultural development should be guided towards those land-use patterns which most effectively combine conservation of land and water resources with the objectives of intensification and increasing productivity. Failing such a policy, ongoing land degradation may one day outpace the positive expansion of arable land. Estimates of productive potential would be very deceiving if the effects of degradation were to be ignored. Land use planning at various levels should include a careful evaluation of conservation needs so that the most appropriate utilization could be determined to the long term benefit of the entire community.

POLLUTION - CUM - DEPLETION OF TRIBALS' ETHNOBOTANICAL KNOWLEDGE SYSTEMS

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ABSTRACT

There has been a rapid spurt of interest in recent years in Tribals' ethnobotanical knowledge system studies, mainly because of the search for potentially new medicines and economic plants, etc. and the need for conservation and utilisation of plant resources found in tribal areas for socio-economic development. The International Decade for the World's Indigenous People's, which started from 1 January 1995 is taking stalk of the contemporary relevance of indigenous knowledge systems and of the contribution of tribals to the conservation and genetic enhancement of biological diversity. Tribal communities have generally preserved their traditions, art, culture, etc., since time immemorial, but the present status of environment mainly due to pollution has caused alarming depletion to the continuity of their lifestyles and sources of livelihood. The forest which the tribal guarded so scrupulously for centuries have now become the scene of ruthless onslaught for extracting its wealth to feed the ever increasing demand of the present materialistic technology based civilization. The situation has become so serious that it polluted and it affected profound change in the tribal life.

INTRODUCTION

Since ages the tribals totally submitted themselves to forest settings and lived in perfect harmony with nature. Forests have been their dear home with deeply rooted sentiments and represented a whole way of life. But the forests which the Tribals guarded so scrupulously for centuries have now become the scene of ruthless onslaught for extracting its wealth by the so called civilized society to feed the ever increasing demand of its materialistic technology based civilization. The helpless tribals became mute victims of this onslaught on their habitats. The utilization of forest resources have assumed the form of exploitation which depleted the resources and degraded the forests and this undermined the economic base of the tribals. The situation has become so serious that it affected profound change in the tribal life. For survival they had no option but to change their traditional constructive dependence to a destructive dependence on forests. To get food and other basic necessities of life, they began to fell trees and shrubs and sell it to the outsiders. Some of them even drifted into the fringes of industrial working sites of nearby cities/towns to become casual or bonded labourers for survivals.

The tribals have a sensitive understanding of ecological interdependence and seasonal variations and know-how to exploit the forest resources without destroying it. The conservation of many plants/animals of the forests were a part of their faith and traditions and a set of fables, folklores, totems, taboos, religious beliefs, etc. perpetuated this culture. The 'International Decade for the World's Indigenous People's, which started from 1 January 1995 is taking stock of contemporary relevance of indigenous knowledge systems and of the contributions of tribals to the conservation and genetic enhancement of biological diversity.' But of late, there has been a change in the outlook of these tribals/aboriginals as a result of their contact and interactions with the modern world that polluted their age-old relationship with the nature leading to a transaction of from what may be termed as constructive dependence to destructive dependence. The reason of this unfortunate and undesirable trend in them can be traced to the onslaught by the civilized society on the forest and forest resources who unscrupulously began to exploit the resource base which the tribals have guarded so safely for centuries. This situation left the tribals confused and bewildered and finally for survival many of them had to forgo their lifestyle, sources of livelihood and traditions.

At the time of independence Government of free India realised the sad plight and desperate situation of the tribals and endorsed a policy for a planned development of tribals, forests and environment. However, most of the developmental efforts made by the Government for the welfare of tribals did not yield fully the desired results. The reason for this is mostly attributed to the lack of proper understanding on the complex fabric of tribal life, their peculiar needs, problems and aspirations. The realization of this led the Government to launch various action oriented research projects that could provide a scientific basis and guidance to help the planners/policy makers and administrators engaged in tribal welfare and development programmes. AICRPE or All India Coordinated Research Project on Ethnobiology under the MAB India Programme is one of such research

programmes launched in 1982 by the Ministry of Environment & Forests, Government of India. This action oriented socio-ecological project adopts a system approach to understand and evaluate the tribal situation. It makes an indepth study and analysis on their peculiar needs and problems, and identify the critical constraints and suggests suitable measures to deal with it.

NORTH EAST INDIA TRIBES

The Indian subcontinent is inhabited by over 40 million tribal people of different ethnic groups distributed states, and many of these tribal people are inhabiting in North eastern region of India. Tribals inhabiting the region are as follows :

Arunachal Pradesh : Adi (including Ashing, Bokar, Bori, Gallong, Minyong, Padam, Pangi, Ramo, Slimong and Tangam), Aka (Hrusso), Apatani, Bagung, Digaru-Mishmi, Hill-Miri, Idu-Mishmi, Kangbo, Khampti, Meyer, Miju (Kaman), Mishing (Miri), Mishmi, Monpa, Na, Nishi (Dafla), Nocte, sherdukpen, Sinpho, Sulung, Tagin, tangsa (Hawa, Khomsing, Longphi, Lungchang, Mosang, Ponthai, Rongram, Tikkhak, Yogli), Wanchu and Yabin (Lisu) etc.

Assam : Bodo or Boro-Kachari, Deori, Dimasa-Kachari, Hojong, Hmar, Hojai, Kachari including Sonawai, Kuki (Biate, Changsan, Choggloi, Doungel, Gamaihou, Gangte, Guite, Hanneng, Haokip or Houpit, Haolai, Hengna, Hongsungh, Hrangkhawl or Rangkhoh, Jongbe, Khawehung, Khawathlang, Kelma, Kholhou, Kipgen, Mangjel, Misao, Sairhem, Selnam, Singson, Sithou, Sukte, Thado, Thangngen, Vibub, and Vaiphei), Lakher, Lalung, Man, Mech, Mikir (Karbi), Mishing (Miri), Pawi, Rabha, Tiwa, etc.

Manipur : Aimol, Anal, Chiru, Chothe, Gangte, Hmar, Kabui, Koirao, Koireng, Kom, Lamgang, Mao, Maram, Maring, Monsang, Moyong, Paite, Purum, Ralte, Sahte, Simte, Tangkhul, Thodou, Vaiphei, Zou, etc.

Meghalaya : Garo, Khasi, Pnar, (Banai, baro, Bhoi, Biate, Dalu, Koch, Lyngam, Man, and War-Jaintia), etc.

Mizoram : Mizo includes several tribes- (Hmar, Lushai, Paite, Ralte, Chawngthu, Chawhto, Nagente, Klawhting, Khaingte, Pautu, Rawite, Renthlet, Tlau, Vongchhia, Zawn-gte, etc.).

Nagaland : Angami, Ao, Chakhesang, Chang, Chir, Knyak, Khamniungan, Lotha, Makware, Phom, Rengma, Sangtam, Sumi, Yimchunger, Zeliang, Pochury, etc.

Tripura : Chakma, Halam, Jamatia, Mag, Naotia, Riang, Tipra, etc.

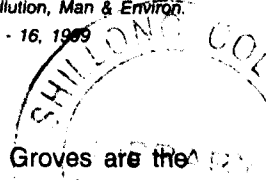
TRIBES' IDENTITY

Each tribal community has a separate entity, maintaining its social distance from the other tribes on ground of traditional decree of social prestige; and apart from their original religions, customs and traditions, each tribe also maintained its identity through different coloured-cum-designed traditional dresses.

The Tribals depended on nature and have an indigenous knowledge system since time immemorial in utilizing wild fibre and dye-yielding plants for making their traditional dresses. With the passage of time, wild fibre and dye-yielding plants such as *Albizia odoratissima*, *Antidesma Diandrum*, *Chloranthus officinalis*, *Sterculia villosa*, *Urena lobata*, etc. once common but over-exploitation has brought about their alarming depletion in the wild. The use of imported synthetic fibres and synthetic dyes as substitutes have made the tribals disregard for these natural living resources. This has effected and polluted their deep reverence and age-old relationship with nature.

RELIGIOUS BELIEF AND SACRED GROVES

The religious belief of the tribals is very strong and they observe the religious and sacred forests with great reverence, and with great concern for its natural resources, particularly the living resources and conservation with great respect of all living things, whether plants or animals, as part of their culture. Saving the living species from any damage or injury is reflected in their Folk-Songs, Tales and Proverbs.



In N.E. India, the tribal people maintain Sacred Groves in many places. The sacred Groves are the patches of forest which are left undisturbed on religious grounds. It is a Sang or Taboo for anyone to cut any plant or kill animals inside these Sacred Groves. In the State of Meghalaya alone there are about 79 Sacred Groves. The tribals of the state had a wonderful indigenous knowledge system for nature's conservation and more divinely inspired to know that 'No tree can be without land nor Life can remain without Trees', and so they began with laying down the system of their land tenure and Sacred or Religious Forests were constituted to be sources for supply of good, clean, pure drinking water and pure Air for people. These were our wonderful heritage, the height and depth of its meaning we seem presently to have ignored. Till fifty years or so ago, it could very well be said that people in general had profound regard for old values, and deep reverence for customs and traditions. Unfortunately, with changing times, the spread of foreign religions in particular, Pollution-cum-Disbelief started getting ground, and this made them lose faith in their old belief in the beauty, truth and spiritual strength of their own original religion, culture and traditions; and started breeding into them growing disrespect for the sanctity of sacred or religious forests, etc. as mere superstitions of the benighted and unlettered people.

FOLKLORE – MEDICINES

India has a rich tradition of folk-lore medicines. Its rich biodiversity provides a wide choice of species. Although drugs from animals and mineral resources were also explored and used by the tribals, the use of plant drugs far exceeded in various disorders. Ethnobotanical work has brought several thousand of folk claims about medicinal properties of plants into the scientific literature. The development of a folk medicine into a drug of therapeutic importance is exemplified by *Rauvolfia serpentina*. The root of this plant has been used for centuries in Indian medicines as a cure for insanity, epilepsy and high blood pressure. Similarly, several other medicinal plants are related with medico-botanical histories in aboriginal societies, but many are becoming rare and by the turn of the centuries many such species would be wiped out from their native habitats. *Rauvolfia serpentina*, *Copits teeta*, *Dioscorea* spp., *Panax pseudo-ginseng*, *Digitalis* spp., *Podophyllum* spp., *Solanum* spp., *Taxus baccata*, etc. serve as glaring examples. This made the tribals to start turning towards synthetic medicines as substitutes for their folk-medicines, to disregard the natural living resources and this has finally resulted to pollution of their age-old social relationship with nature.

CONCLUSION

Tribals' ethnobotanical indigenous knowledge systems are similar to general scientific information in that they are part of public knowledge. The tribals used to be the traditional collectors of forest produce which provide a substantial part of their subsistence economy. The depletion of nature's material resources has polluted and caused a great set back to their religious belief and traditional life style. The information generated by the AICRPE may be reckoned as valuable criteria in involving realistic tools to aid the development and welfare programmes for better future of the tribal communities.

SCIENCE & TECHNOLOGY AND ENVIRONMENT

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ABSTRACT

Very lately it has been realised by the entire globe that both Science & Technology and Environment should go hand in hand to ensure environmental-friendly development in all fronts. It has also been realised that almost every scientific and technological development has a negative impact on the environment to a certain extent. It is for this reason, that the present generation of scientific community is trying to ensure that each and every scientific development is a balanced development in the context of the environment. Hence, in the present days we hear a lot of eco-friendly technologies, technologies which do not tend to bring about damaging effect on the environment, but instead, maintain a sound environment.

INTRODUCTION

"Environment" in a simple word means 'human-surroundings'. Thus, Environment includes the components of land, water and air. It also includes all the living and non-living things which exist in these components.

When we talk about the relation between Science & Technology and Environment we cannot ignore the fact that almost each and every scientific and technological development creates a pressure on the environment and brings about adverse effects on it. Development in Science & Technology leads to economic development, social upliftment, industrialisation, modernisation, urbanisation, etc. Such developments in turn leads to depletion of forests and minerals resources, distortion of land-form, soil erosion, destruction of natural scenic beauty and natural wealth, pollution of air and water and unfavourable changes in climatic conditions. Such changes in the environment had been experienced much greatly during the last 50 to 60 years. However, the harm that such developments can do to the environment and human life was much realised only very lately.

One of the committees of the United nation which met at Stockholm on the 5th June, 1972 realised the extent of the damages that Science and Technology progress can cause to the environment, if the associated developments are not properly checked. It was also realised that if such developments are not controlled, a situation would arise in the immediate future where people would no longer get a fresh and clean air to breath in, a pure water to drink and a fertile soil to produce food fit for consumption. It was also noted with great concern the fact that man does need development through Science & Technology intervention and at the same time the environment does need to be protected and preserved. Hence, it was decided that both Science & Technology development and environmental concern should go hand in hand and that every development should be a balanced development in the context of the environment. Thenceforth, effort has been made by the scientific community on generating eco-friendly technologies which do not tend to disturb and destroy the environment, but instead, attempt at maintaining a sound environment.

It was also noted in the meeting of 5th June, 1972 at Stockholm that a general awareness on protection, preservation, conservation and regeneration of the environment should be created at all levels, right from the international level up to the local level. It was from that day (which was designated as "World Environment Day") onwards that massive environmental awareness programme had been launched in all nooks and corners of the globe. In our country as well, environmental awareness campaigns are being launched throughout the length and breath of the Country by various authorities including the Ministry of Environment & Forest, Govt. of India.

DISCUSSION

In the State of Meghalaya, we have been witnessing a wide range of environmental awareness activities launched and supported by various departments and agencies like Forest & Environment Department, Soil

Conservation Department, Pollution Control Board, etc. including the State Council of Science Technology & Environment (SCSTE), Meghalaya.

The SCSTE, Meghalaya is having a programme termed as Science and Environmental Fair which is being implemented regularly at the block and district-levels. The objective of this particular programme is to inculcate a scientific temper and environmental consciousness amongst young school children with a view to generate scientific minded citizens in the near future who would also become environmentally conscious. Apart from this programme, the SCSTE, Meghalaya is also implementing the "Environmental Awareness Programme" under which voluntary organisations are encouraged to take up activities aimed at generating environmental awareness amongst the general public. Such organisations are provided with financial assistance and technical support by the SCSTE, Meghalaya.

The SCSTE, Meghalaya also has a programme termed as "Specific Projects Programme" under which environment-based scientific projects could be taken up. There also exists an opportunity for young science students to take up projects relating to environment under the "Students Projects Programme".

It is encouraging to note that within a short span of time, since 1972, a large scale of environmental awareness programmes had been generated in the country. Also, the scientific community had been able to evolve a wide range of environmental control techniques as well as environment-friendly technologies which tends to save our mother Earth from the danger of environmental degradation, pollution, etc.

It is also very inspiring to see that a large number of voluntary groups and organisations have come up in the country lately who are capable not only to create environmental awareness among the masses but also to study and tackle the various factors that could harm the environment. In the State of Meghalaya as well, a good number of NGO's have emerged who are committed to the cause of environmental conservation. Few organisations are also in existence who could scientifically observe and analyse the changes in our environment from time to time. It is also very fortunate that lately few centres as well as voluntary agencies have come up who could scientifically observe and analyse the changes in our environment from time to time and study the various aspects of the environment status in our State.

Meghalaya is rich in natural resources like forests, mineral resources, water and land resources, wildlife, wild plants including medicinal plants, herbs, wild edible plants, orchids, etc. Meghalaya had also been famous world-wide for its scenic beauty, green hills, fresh air and crystal clear spring water and pleasant climate. These resources are constantly exposed to environmental risks due to commercial exploitation by the people. If a concern towards this problem is not felt seriously by each and every citizen of the state, the nature-pride of our state will one day vanish. Therefore, it is the duty and responsibility of each and every citizen to put in all effort at his/her capacity to maintain this fame of our state, particularly, the fame of being the part of one of the biodiversity hot spots in the globe.

Meghalaya is also rich in eco-friendly traditions and practices. Such traditions and practices include sacred groves, community social action, nursing care, herbal cure, blacksmithy, locksmithy, cane and bamboo works, etc.

CONCLUSION

It is a matter of necessity that immediate effort should be made by all concerned at various capacities to protect, restore, preserve and regenerate the above resources, traditions and practices. Effort should also be made to identify appropriate Science & technology inputs which could help in achieving this goal. It is also necessary at this juncture to evolve relevant technologies, processes and techniques which could attempt at deriving maximum benefits from these resources, traditions and practices in a very judicious and environmentally conscious manner without disturbing the sentiments of the citizens.

In the process of evolving useful eco-friendly technologies to tap the resources of the State, the scientific community and the voluntary organisations in the State have a major role to play. The State Council of Science Technology & Environment is always there to provide a catalytic support in this process.

It has also been observed that inspite of the potentials for development offered by the environment prevailing in our State as already described above, there are also certain areas in the society, particularly in rural sector, where environment-friendly situations do not exist. For example, people at large are still cooking their food using fuel wood in an inefficient manner, they are still engaged in unhygienic sanitation habits, they still drink unfiltered and unboiled water, they construct their houses in an expensive manner, the use of organic manure is not yet prevalent amongst them, etc.. In this context the SCSTE, Meghalaya is currently putting great effort in promoting eco-friendly technologies to combat such situations. Such technologies includes the improved chulha, low-cost toilet, low-cost water filter, stabilished mud block, organic compost, etc. However, the Secretariat of the SCSTE, Meghalaya is not free from constraints like manpower and fund constraints, etc.. Hence, the cooperation and support of various concerned agencies including volunteers and voluntary agencies is very much needed at this stage.

It is confident that with the support of the scientific community and the voluntary sectors, the SCSTE, Meghalaya will be able to achieve the goal in its effort to introduce eco-friendly technologies for the all-round development of the society in particular and the State in general as a whole

DECADAL VARIATION IN CHEMICAL QUALITY OF GROUND WATER IN MEGHALAYA

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ABSTRACT

Meghalaya state with a total population of 1774778 (1991 census) and with seven districts underlain mostly by Quartzitic and Phyllitic rocks of Shillong series of Precambrian age and followed by Granitic gneiss of Archaean age. At places, this is intruded by metabasic rocks which has concordant relation with the parent rock.

For determination of chemical quality and variation of quality with time, water samples were collected every year in the month of April. Moreover, water samples were collected in connection with various investigations and exploratory drilling of Central Ground Water Board. The samples have been analysed in the Regional Chemical Laboratory at Guwahati and the results obtained have been interpreted. The decadal variations in various cations and anions are found to be not of much significance.

INTRODUCTION

Ground water is a vital natural resource for lives. All facets of life have imprint on water availability. It is also necessary to study the chemical composition of ground water and its changes with respect to time and place. Detail study of chemical constituents of ground water provide a better picture of the possible changes in quality as development progresses. Though our country is having enormous ground water resources, there is an acute shortage of safe water in some places due to factors prevailing upon the shortage of ground water and rapid urbanisation. The storage and movement of ground water depends upon the geographical, topographical, climatic and hydrogeological factors. In this paper an attempt has been made to show the variation of chemical quality of ground water in respect to time and place in the state of Meghalaya.

TOPOGRAPHY AND HYDROGEOLOGY

The state of Meghalaya with a total geographical area of 22489 sq. km. and population of 1774778 (1991 census) is situated in the north eastern part of India between north latitude 25°05'00" & 26°10'00" and east longitude 89°47'00" & 92°47'00". Meghalaya was converted into a full fledged state on 21st January, 1972.

The state is a remnant of ancient plateau of Precambrian Indian Peninsular shield with average altitude from 150m. to 1961m. above mean sea level. The plateau is marked by highly dissected and irregular topography in the northern and western part and steep and regular slopes in the southern part.

There are seven districts namely – Jaintia Hills in the east, East and West Khasi Hills in the middle, East, West and South Garo Hills in the western part of the state.

Hydrogeologically the state can be divided into three major units ie. consolidated, semiconsolidated and unconsolidated formations. These units play an important role for storage, movement, and control of ground water's chemical quality and its variation.

The whole northern part of the state comprising major portions of Khasi and Garo Hills are covered by hard and consolidated formations of Archaean age and Shillong group of rocks. The Archaean rocks comprise of quartzites, phyllites, conglomerate, intruded by acid and basic intrusives. All the rocks are weathered to different degrees, depth of weathering is more in topographic depressions, but usually down to about 10 to 15m. below ground level. The zone of weathering is the main repository of ground water. Apart from it, the open plans of weakness in the underlying hard and massive rocks such as joints, faults, fractures etc. held considerable quantity of ground water and also acts as channels for its movement.

The entire south western and south eastern parts of the state in Garo and Jaintia Hills district is covered by semiconsolidated sandstones, siltstones, shales and conglomerates of Upper Paleozoic to Tertiary

age. Intergranular porosity in the soft and porous semiconsolidated formations, mainly in the sandstones facilitates the storage and circulation of ground water within them.

The unconsolidated formations occur in the state bordering the plains of Assam in the north and Bangladesh in the south. It consists of sand, clay, silt, gravel and pebble of Upper Tertiary and Quarternary age. These unconsolidated formations form moderately thick discontinuous aquifer which may be of unconfined or confined in nature depending on the boundary conditions. These formations held very good potential for ground water development.

Ground water occurs in shallow depth under water table condition in unconsolidated formations and in weathered residuum of consolidated formations. In consolidated formations – fissures, fractures and joints act as secondary porosity for movement and storage of ground water, particularly in the deeper aquifers. In semiconsolidated formations intergranular pores of sandstones act as good repository of ground water.

Depth to ground level in the state, observed from the Central Ground Water Board National Hydrographic Stations located in the different districts are found to vary from 1.92m. to 5.80m below ground level in premonsoon and 0.50m below ground level to 4.50m below ground level in postmonsoon period.

CHEMICAL QUALITY OF GROUND WATER

To determine the chemical quality of ground water and to monitor its quality variation with time Central Ground Water Board has established a vast network of observation wells throughout the state of Meghalaya. At present Central Ground Water Board is continuously monitoring about 30 number of wells and every year during the month of April water samples have been collected and analysed for the determination of its inorganic constituents. For the present study eight wells have been selected randomly to project a representative picture of the ground water quality and nature of its evolutionary trend for the decade 1986-87 to 1996-97.

The values of major cations and anions (Table – I & II) were first plotted in the Piper Trilinear Diagram (Figure - 3 & 4). From the diagram, it was observed that alkaline earth (Calcium & Magnesium) exceeds alkali metals (Sodium & Potassium) and weak acidic anions (Carbonate & Bicarbonate) exceeds strong acidic anions (Chloride & Sulphate). This indicates recharging water of limestone, sandstone and igneous and metamorphic rocks and can be categorised as Calcium Bicarbonate type water. A comparison between the plots of Piper Diagram for the year 1986-87 and 1996-97 shows that during the decade not much variation has taken place in the chemical quality of ground water except in the Rongjeng Well, which may be attributed to some localised factor.

Similarly the plot of Wilcox Diagram (Figure - 1 & 2) indicate that during the decade ground water has become slightly saline in few wells but as a whole the quality has remained unchanged and fall in the water type (C_1S_1) i.e. Low Sodium – Low Saline. Increase in salinity in few wells can be attributed to localised factors like damage of the ring wells and deposition of mud and clay in the well.

TABLE - I

CHEMICAL ANALYSIS DATA (1986-87), MEGHALAYA

LOCATION	pH	E.C.	TDS	HCO ₃ ⁻	Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Fe ³⁺	SiO ₂ ²⁻	TH
DAUKI	8.2	76	40	76	21	2	8	5	3		0.4	5	50
GAROBANDHA	7.8	150	160	31	25	0.1	16	7	20		0.5	12	70
JOWAI	7.7	120	420	24	21	0.1	12	2	8		0.3	9	175
MAIRANG	7.5	113	180	31	25	0.1	16	2	5		0.75	9	
MENDAL	7.5	158	80	73	11	0.1	20	4	3		0.4	13	65
MENDIPATHAR	8	240	90	104	18	0.1	12	6	12		0.6	15	55
PHULBARI	8.1	140	90	79	14	0.1	16	5	7.5		0.6	27	60
RONGJENG	6.9	89	60	55	14	0.1	10	2	5		0.1		35

Concentration in mg/L, E.C. – Electrical Conductivity, TDS – Total Dissolved Solid, TH – Total Hardness

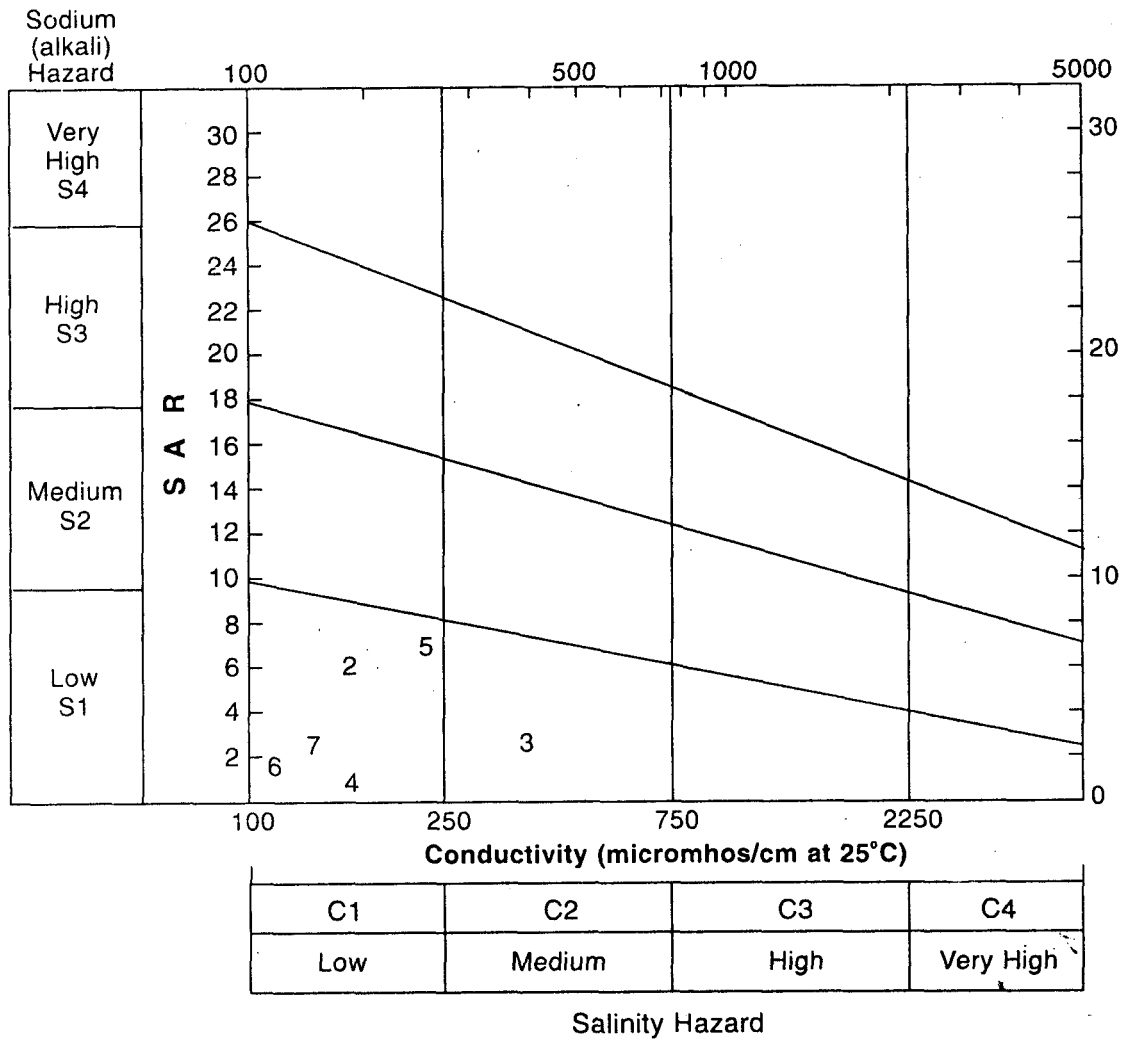
TABLE - II

CHEMICAL ANALYSIS DATA (1996-97), MEGHALAYA

LOCATION	pH	E.C.	TDS	HCO ₃ ⁻	Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Fe ³⁺	SiO ₂ ²⁻	TH
DAUKI	7.2	75	50	31	14	0.1	10	5	2	1	0.7		45
GAROBANDHA	7.5	220	140	49	24	0.1	26	4	5	2	2.4		80
JOWAI	7.6	360	240	122	21	0.1	40	7	8	10	0.7	9	130
MAIRANG	7.7	510	310	153	7	0.1	65	45		3	0.2	16	105
MENDAL	6.6	116	80	31	18	0.1	18	4	5	2	2		45
MENDIPATHAR	7.2	123	80	55	14	0.1	20	2	3	1	1.2	16	60
PHULBARI	7.5	141	90	55	18	0.1	18	11	3	1	0.1		90
RONGJENG	8.2	1350	970	226	24	0.1	12	6.1	121	10	0.4	12	285

Concentration in mg/L, E.C. – Electrical Conductivity, TDS – Total Dissolved Solid, TH – Total Hardness

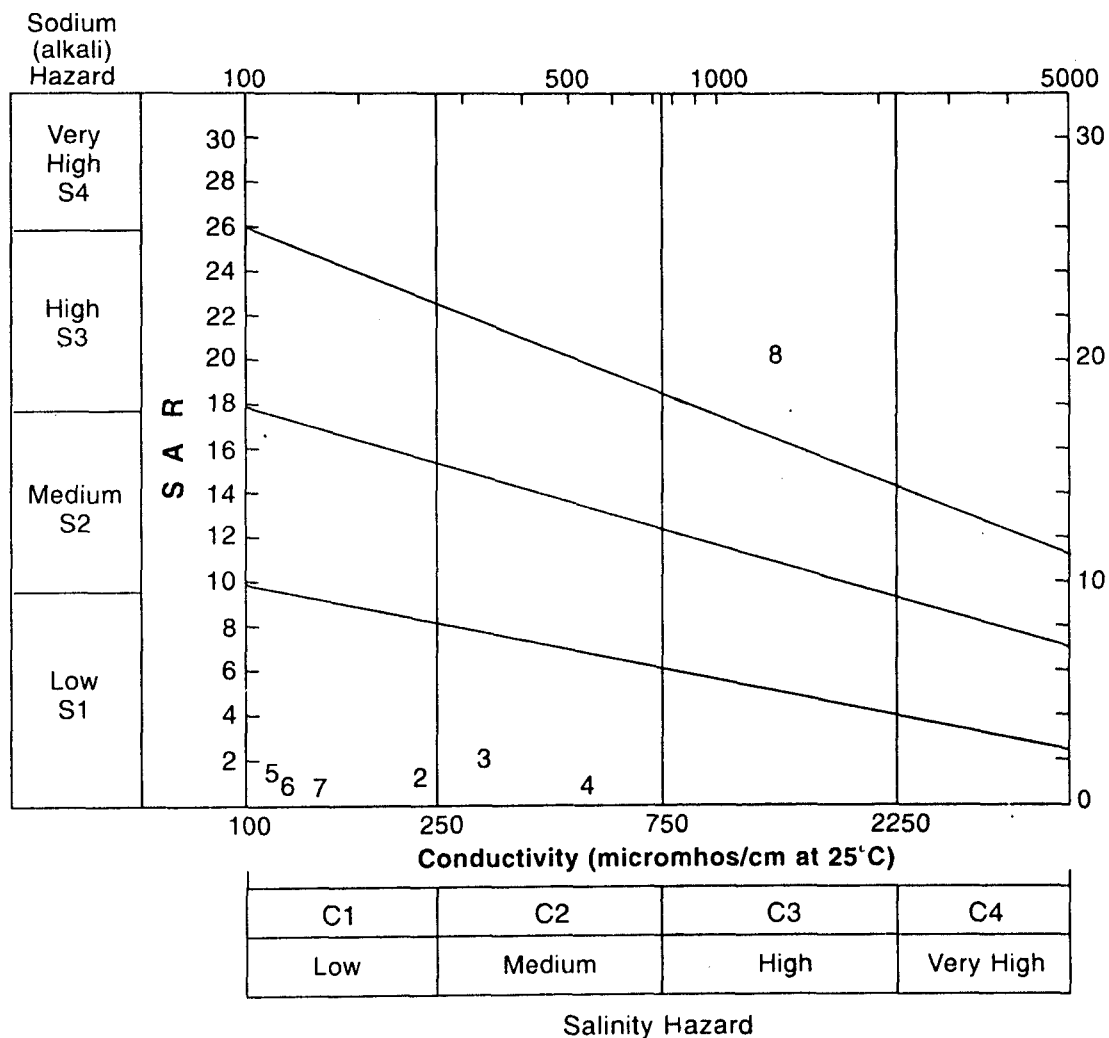
WILCOX DIAGRAM - MEGHALAYA (1986 - 87)



1 DAUKI	3 JOWAI	5 MENDIPATHAR	7 PHULBARI
2 GAROBANDHA	4 MENDAL	6 MAIRANG	8 RONGJENG

Figure - 1

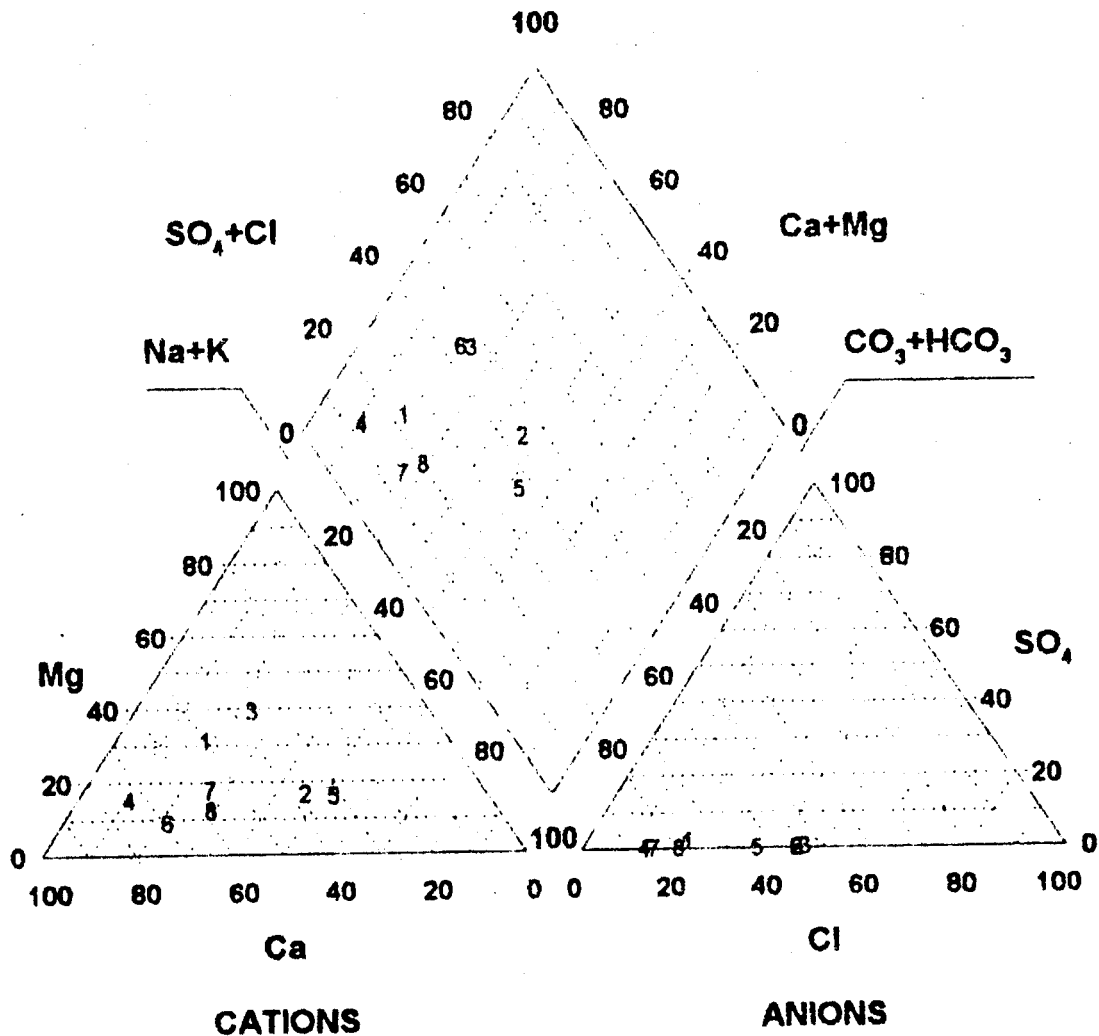
WILCOX DIAGRAM - MEGHALAYA (1996 - 97)



1 DAUKI	3 JOWAI	5 MENDIPATHAR	7 PHULBARI
2 GAROBANDHA	4 MENDAL	6 MAIRANG	8 RONGJENG

Figure - 2

PIPER DIAGRAM - MEGHALAYA (1986 - 87)



1 DAUKI	3 JOWAI	5 MENDIPATHAR	7 PHULBARI
2 GAROBANDHA	4 MENDAL	6 MAIRANG	8 RONGJENG

Figure - 3

PIPER DIAGRAM – MEGHALAYA (1996 – 97)

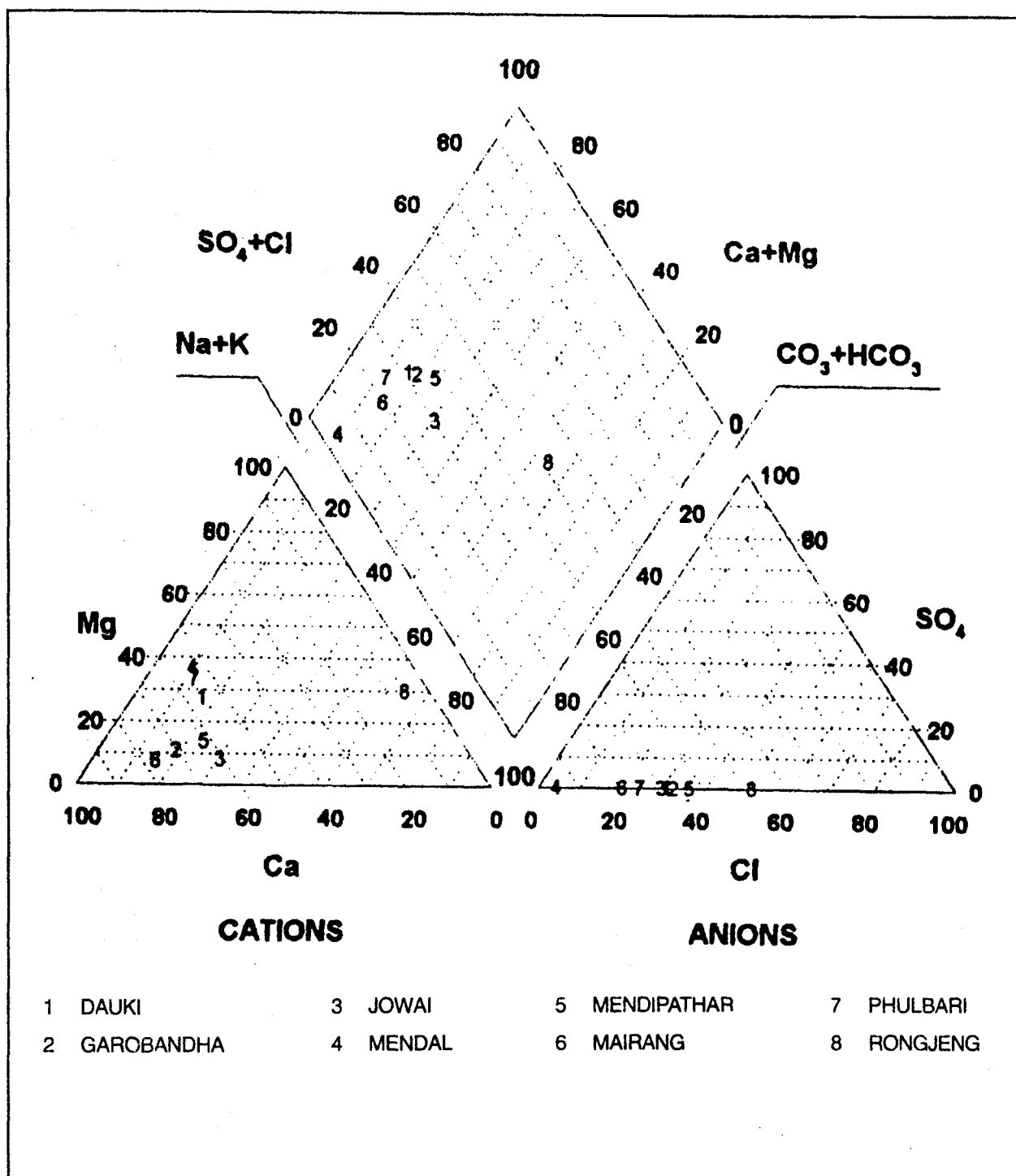


Figure – 4

AN IDEA OF ENVIRONMENTAL LEGISLATIONS AND ADMINISTRATION IN INDIA : IMPLICATIONS FOR INDIA'S NORTH-EAST

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ABSTRACT

The humanity today stands at a defining moment in the earth's history. More than ever, we are confronted with increasing problems, disparities between the haves and have not, with a widespread visible worsening of poverty, hunger, ill health and illiteracy, and the continuing deterioration of the resource base on which we depend for our survival. However, integration of environmental concerns with development activities will lead us to the fulfilment of our basic needs, improved living standards and effectively manage ecosystems for sustainable development.

In India, one of the means of reconciling environment and development has been through the enactment of various legislations to protect and improve the environment. To this effect we have not only the constitutional provisions, but also legislations to address the air, water, land, wildlife, forest and the environment as a whole. Some of these landmark legislations are the Wildlife (Protection) Act, the Water (Prevention and Control of pollution) Act, the Air (Prevention and Control of Pollution) Act, the Air (Prevention and Control of Pollution) Act, the Forest (Conservation) Act, the Environment (Protection) Act, etc. Added to these, India is also a signatory to a number of international conventions on environment-related concerns.

The present essay is to give an idea of the existing major environmental legislations of the country and the regulatory mechanism of these legislations of the country and the regulatory mechanism of these legislations in the overall environmental administration in reconciling environmental concerns with developmental needs. The possible implications of these legislations in the development thirsts and aspirations of the region are also being raised as an issue that require a wider debate on the subject.

INTRODUCTION

From the ancient time, the protection of nature or the environment has been the cornerstone of Indian ethos, culture and tradition. This fundamental feature of our ancient philosophy resulted into elevation of a number of rivers, animals and trees as sacred. Even today, this culture is very much prevalent among the general masses of the Indian population. The indigenous communities of the north-east too did not lack in this respect. Therefore, we still have a number of 'sacred groves' or forests among the Khasis and Jaintias of Meghalaya. Sacred objects (of trees, rivers, mountains/hills, animals) are also very much prevalent among the traditional communities of the region, particularly those practicing 'animistic' religion.

Although a good environmental sense has been one of the fundamental features of our ancient philosophy, over the past decades there has been progressive pressure on the environment and natural resources. Increased population growth, urbanization, industrialization, modern development pressure, and many other factors have contributed to the creation of this progressive pressure on the environment. The alarming consequences of the pressure on the environment is becoming increasingly evident in appalling proportions. These consequences indeed detract from the gains of development and may worsen the standard of living of larger proportion of our population who are directly dependent on natural resources.

It is in this context that we need to look at our actions on the environment, and give a new thrust towards conservation and sustainable development through proper appreciation and understanding of the environment legislations of our country. In modern times too, the Indian Constitution constantly reminds us through Article 48A and Article 51A(g) that while the State shall endeavour to protect and improve the environment, it is the fundamental duty of every citizen of this country to protect and improve the natural environment including forests, lakes and rivers and wildlife, and to have compassion for the living creatures.

The objectives of the present essay is to give an idea of the various environmental legislations of the country and their methods of administration for giving effects to the assorted provisions of the acts. Emphasis is also given to the various acts and legislations enforced in the north-eastern states, and would be limited to three broad aspects of the environment, viz., the forests, wildlife and environment. It is expected that an understanding of these legislations would generate better appreciation of the need and methods of reconciling

development with the environment. It is also expected to generate debate on the implications of these acts on the overall development stratifies and progress of the north-eastern region.

CENTRAL ACTS / LAWS AND RULES

The acts relating to the environment, forests and wildlife are enacted either by the Central government or the State governments. In many cases, legislations enacted and rules framed by the Central government are normally adopted by the state governments. Although conservation, protection and preservation of the environment have been the cornerstone of the Indian ethos, culture and traditions, even right from the ancient time it was felt necessary to promulgate environmental regulations in India. Thus, we see the edicts of Emperor Ashoka being promulgated in the various pillars and stupas concerning wildlife protection and preservation in ancient India.

In modern India, besides the various independent rulers of India, it was the British administration in India that particularly felt the need for promulgation of various environmental legislations in the country. However, major landmark legislations were enacted after the country attained independence. As a result, today we have at least 50 major legislations pertaining to the environment, forests and wildlife (Table - I), and 33 legislations specific to various subject-matters of the environment (Table - II). List of Central Acts and Rules relating to the environment, forests and wildlife may be seen in the Table - IV and Table - V.

TABLE - I

NUMBER OF MAJOR LEGISLATIONS RELATING TO FORESTS, WILDLIFE AND ENVIRONMENT IN INDIA

Types	Number
Forest	3
Wildlife	14
Environment	33
Total	50

TABLE - II

NUMBER OF MAJOR LEGISLATIONS SPECIFIC TO DIFFERENT SUBJECTS OF THE ENVIRONMENT

Subject	Number
Poison and insecticides	2
Factory and industries	2
Food adulteration	2
Mines and minerals	1
Sea and coastal zones	2
Water	8
Air	2
Environment Protection Act & Rules	2
Hazardous wastes	3
Miscellaneous (EIA, PLI, Ecomarks, etc.)	9
Total	33

MAJOR LEGISLATIONS ENACTED BY THE CENTRAL GOVERNMENT

Smooth functioning of development efforts in the country is specifically facilitated by some of the major legislative measures of the Central government, which include (a) Wildlife (Protection) Act, 1972, (b) Forest

(Conservation) Act, 1980, (c) water (Prevention and Control of Pollution) Act, 1974, (d) Water (Prevention and Control of Pollution) Cess Act, 1977, (e) Air (Prevention and Control of Pollution) Act, 1981, (f) Environment (Protection) Act, 1986, (g) Public Liability Insurance Act, 1991. It is important that we have brief idea of these major central legislations that facilitate our developmental efforts. Treatment of these legislations are available in Diwan & Diwan (1992) and Singh et al. (1994).

THE WILDLIFE (PROTECTION) ACT, 1972

The Indian wild life laws have a long history and is the culminative result of an increasing awareness of the compelling need to restore the catastrophic ecological imbalances inflicted on nature by the human dimension of development. The earliest codified law in the matter of preservation of wildlife and environment is credited to the Emperor Ashoka, who reigned as the King of Magadha during the 3rd century B.C. Some of his edicts on pillars and stupas still bear testimony to this ancient wisdom and vision.

The first codified law in modern India which heralded the era of legislation for wildlife protection was enacted by the British under the name and style of the Wild Birds Protection Act, 1887. This Act enabled the then Government to frame rules prohibiting the possession or sale of any kind of specified wild birds, which have been killed or taken during the breeding season. By 1912, another act entitled the Wild Birds and Animals Protection Act, 1912 was enacted, which was amended in the year 1935 by the Wild Birds and Animals Protection (Amendment) Act, 1935 (Anonymous, 1999).

However, during the post-independent era, the first comprehensive legislations relating to protection of wildlife was passed only in 1972. Thus, the Wildlife (Protection) Act, 1972 is an act to provide for the protection of wild animals, birds and plants and all other matters connected therewith or ancillary or incidental thereto. The Act has since been amended through (a) the Constitution (Forty-second Amendment) Act, 1976 and (b) the Wild Life (Protection) (Amendment) Acts of 1982, 1986, 1991 & 1993.

The Act is operated through a number of rules that had been framed under the act. These rules are known as (a) the Wild Life (Transactions and Taxidermy) Rules, 1973, (b) the Wild Life (Stock Declaration) Central Rules, 1973 (c) the Wild Life (Protection) Licensing (Additional Matters for Consideration) Rules, 1983, (d) the Wild Life (Protection) Rules, 1995 and (e) the Wild Life (Specified Plants - Conditions for Possession by Licensee) Rules, 1995.

Through this act and various rules of the act, the central government determines the various authorities to administer the provisions of the act, prohibits or regulated hunting of wild animals or collection of plants, schedules specified species of plants and animals for protection both within and outside conservation areas, regulates or prohibits trade or commerce in wild animals and plants, or articles or trophies derived from plants and animals, takes cognizance of offences on wild plants and animals, and so on.

THE FOREST (CONSERVATION) ACT, 1980

The Forest (Conservation) Act, 1980, in short known as the FCA, checks or regulates indiscriminate diversion of forest land for non-forest purposes. Any central or state agency/department, requiring diversion of forest land for non-forest purpose, is required to submit the proposal(s) to the Central government through the State governments along with such details as flora, fauna, map of the area, compensatory afforestation, etc. While diversion of forest land for non-forest purpose is discouraged in principle, forest lands so diverted for non-forestry purposes strictly in accordance to the provisions of the act, usually carry stipulations for details of compensatory afforestation, etc. The Forest (Conservation) Act and Rules, amongst others, also had laid down important guidelines for diversion of forest lands for non-forest purposes.

THE WATER (PREVENTION AND CONTROL OF POLLUTION) ACT, 1974

Called as the Water Act in short, the main provisions of this Act aim at prevention and control of water pollution as well as restoration of water quality through the establishment of State Pollution Control Boards. Subject to the provisions of the Act, some salient features of the Act are:

- (a) No person shall knowingly cause or permit any poisonous, noxious or polluting matter determined in accordance with such standards as may be laid down by the State Pollution Control Board, to enter (whether directly or indirectly) into any stream or well or sewer or on land;
- (b) No person shall knowingly cause or permit to enter into any stream any other matter which may tend, either directly or in combination with similar matters, to impede the proper flow of the water of the stream in a manner leading or likely to lead to a substantial aggravation of pollution due to other causes or of its consequences;
- (c) No person shall, without the previous consent of the State Pollution Control Board:
 - (i) establish or take any steps to establish any industry, operation or process, or any treatment and disposal system or an extension or addition there to which is likely to discharge sewage or trade effluent into a stream or well or sewer or on land (such discharge being hereafter in this section referred to as discharge of sewage); or
 - (ii) bring into use any new or altered outlets for the discharge of sewage; or
 - (iii) begin to make any new discharge of sewage.

Any investor, intending to set up an industry, is required to apply in the prescribed form to the SPCB concerned, to obtain consent to establish as well as the consent to operate the industry after its establishment. While granting the consent, the SPCB also stipulates specific conditions relating to the temperature, volume, composition, rate and point of discharge of effluents, etc. The consent to operate an industry or consent to discharge trade effluents, with stipulations to be complied with, are granted for specific period. Performance of the industry in meeting the standards are reviewed or checked by the Board from time to time. Stringent penalties are prescribed in this Act for defaulting industry, or for those who operate their industry without valid consent or in violation of consent conditions.

THE WATER (PREVENTION AND CONTROL OF POLLUTION) CESS ACT, 1977

The purpose of this Act is to levy and collect cess on water, consumed or utilized by certain categories of industry, specified in the schedule appended to the Act. Local Authorities may also specify the categories of such industries. The money thus collected is utilized by the Central and State Pollution Control Boards to prevent and control water pollution. Some salient features of the Act are :

- (a) The assessing authority under the Act levies and collects cess based on the amount of water consumed by these industries, the rate of which is determined by the purpose for which the water is used;
- (b) The concerned industries are required to install standard water meters at such places as may be required by the concerned authority for measuring and recording the quantity of water consumed by the industry;
- (c) Based on the cess returns to be furnished by the industry every month, the amount of cess is assessed by the assessing authorities;
- (c) Aggrieved persons may appeal against the assessment to the Appellate Authority;
- (e) The Act also provides for a 25% rebate on the cess payable to those industries who consume water within the quantity prescribed for that category of industries and also comply with the effluents standards prescribed under the Water Act or the EPA.

THE AIR (PREVENTION AND CONTROL OF POLLUTION) ACT, 1981

Known as the Air Act, the objectives of the Act is to prevent, control and reduce air pollution, including noise pollution, and to establish SPCB to implement these provisions. Under this Act, no person shall establish or operate any industrial activity without prior consent of the SPCB. For obtaining consent to establish an industry under this Act, the investor is to apply to the SPCB in the prescribed form accompanied by the prescribed fees. Consent is granted with a number of stipulations to be complied with particularly relating to

prevention and control of emissions of air pollution. Most provisions of this Act are similar to those of the Water Act, 1974.

THE ENVIRONMENT (PROTECTION) ACT, 1986

Popularly designated as the EPA, this is an umbrella Act that provides a single focus in the country for the protection of environment and seeks to plug the loopholes or limitations of earlier legislations relating to environment. Under the provisions of this Act, the Central government has been bestowed with a wide range of powers to make rules or bring out regulations/notifications in order to protect the environment. Some of the important points of this Act are:

- (a) The Central Government may put restrictions on an area in which any industry, operation or process or class of industries or operations shall not be carried out. If they are to be carried out, they may be permitted with certain safeguards;
- (b) Emissions and standards in respect of 61 categories of industries have been evolved and notified so far;
- (c) The standards in respect of pollutants are to be achieved within specified time period (usually one year from the date of notification), specially by those industries identified as highly polluting;
- (d) The SPCBs have been empowered to either reduce the time limit for compliance of (c) above, and/or prescribe more stringent standards in respect of specified categories of industries within their jurisdiction. The SPCBs however cannot relax either the time limit or the standards;
- (e) Those industries who require consent under the Water Act, Air Act or both, or authorization under the Hazardous Waste (Management and Handling) Rules, 1989, are required to submit an environmental audit report to the concerned SPCB on or before 30th September of every year.

It may be mentioned here that under the EPA, several sets of Rules relating to the management of various aspects of the environment, including management of hazardous chemicals, wastes, micro-organisms, Environmental Impact Assessment of Development Projects, Coastal Regulation Zone, Public Hearing, Disposal of Bio-Medical wastes, etc. were notified. Each of these rules or notifications have far reaching consequences and regulatory measures as far as environmental protection is concerned.

MANAGEMENT AND HANDLING OF HAZARDOUS WASTES RULES, 1989

Under the Rules regarding Management and Handling of Hazardous Wastes, 1989, every occupier (or investor) generating hazardous wastes and intending to collect, treat, transport, store and dispose of such wastes, is required to make an application in the prescribed form to the SPCB, which issues the authorization along with stipulations for treatment and disposals of such wastes.

MANAGEMENT, STORAGE AND IMPORT OF HAZARDOUS CHEMICALS RULES, 1989

Under the Rules for the Management, Storage and Import of Hazardous Chemicals, 1989, the occupier shall not undertake any industrial activity involving any of the identified hazardous chemicals unless the occupier has prepared a Safety Report containing the requisite information specified in the Rules. New industries are required to prepare the safety report within 5 years of coming into operation. The occupier of industries handling hazardous chemicals is also required to prepare and maintain an up-to-date and off-site emergency plans for dealing with major accidents.

RULES FOR THE MANUFACTURE, USE, IMPORT, EXPORT AND STORAGE OF HAZARDOUS MICRO-ORGANISMS AND GENETICALLY ENGINEERED ORGANISMS OR CELLS, 1989

Under the Rules for the Manufacture, Use, Import, Export and Storage of Hazardous Micro-organisms and Genetically Engineered Organisms or Cells, the investor is required to submit an application in the prescribed proforma to the Ministry of Environment & Forests. The Genetic Engineering Approval Committee (GEAC)

constituted by the Ministry examines the application and makes recommendations. All industries involving hazardous micro-organisms or genetically engineered organisms, are required to constitute an Institutional Bio-Safety Committee (IBSC) to oversee the planning and execution of various operations in a safe manner and prepare an on site emergency plan to deal with any accident which may occur due to a hazardous micro-organism.

ENVIRONMENTAL IMPACT ASSESSMENT NOTIFICATION, 1994

The EIA Notification of 1994, issued under the EPA is another landmark regulatory mechanism in reconciling development with the environment protection. Under this notification, any person or agency, who desires to undertake any new project or the expansion or modernization of any existing industry or project listed in the Schedule I of the notification, shall submit an application in the prescribed proforma to the Central Government in the Ministry of Environment & Forests (MoEF). The application shall be accompanied by a project report which shall, inter alia, include an Environment Impact Assessment Report/Environment Management Plan prepared in accordance with the guidelines issued by the Central Government in the MoEF, and where investment is above Rs. 50 crores, or area involved is more than 5 ha in case of mining. Under the EIA, prior site clearance by the Central Government is also a mandatory requirement for site specific projects such as mining, hydro-power, major irrigation project, pit-head thermal power stations, ports and harbours.

Coastal Regulation Zone Notification, 1991

Under the Coastal Regulation Zone or CRZ Notification of 1991 and its amendments, the Government of India has declared the coastal stretches of seas, bays, estuaries, creeks, rivers and back waters which are influenced by tidal action in the landward side upto 500 meters from the High Tide Line (HTL) and the land between the Low Tide Line (LTL) and HTL as ecologically sensitive areas covered under the CRZ. Certain activities are prohibited in the CRZ, such as, (a) Setting up of new industries or expansion of existing industries except those directly related to water front or directly needing foreshore facilities; (b) Manufacturing, handling, storage or disposal of hazardous substances; (c) Setting up and expansion of units or mechanism for disposal of wastes and effluents, etc.

AN IDEA OF ENVIRONMENTAL ADMINISTRATION IN INDIA

The Ministry of Environment & Forests is the nodal agency in the administrative structure of the Central Government for the planning, promotion and coordination of environmental and forestry programmes in the country. Therefore, in relation to the central legislations or acts or rules mentioned heretofore, a fair amount of responsibility of translating the various provisions of these acts into concrete actions, lies with the Ministry of Environment & Forests.

The Ministry, with its mandates of (a) survey, conservation and utilization of natural resources of forests, wildlife, plants and animals, including biological diversity, (b) environmental impact assessment of developmental efforts, (c) prevention and control of pollution, (d) research, education, training and human resource development in the areas of environment, forests and wildlife, has been able to chart out its responsibility through its secretariat and/or its numerous sub-ordinate/autonomous organizations, including its regional offices.

The Wildlife (Protection) Act, 1972 is implemented both by the Central and State Governments. In a simplistic way, it can be said that while trade and commerce on wild plants and animals, including articles and trophies originating from wild animals or plants are directly administered by the Central Government through the Regional Offices of the Wildlife, conservation and management of wildlife under the Act is implemented by the concerned State Governments through the Forest Department.

The Forest (Conservation) Act, 1980 and the Environment (Protection) Act, 1986 are administered by the Central Government in the Ministry of Environment & Forests. The FCA is regulated to a large extent through the Regional Offices of the MoEF. Thus, as per the amended Rules in force now, the Regional Offices (RCCFs) have been delegated the powers to decide proposals involving forest land upto 5 ha. Proposals involving forest land between 5-20 ha is processed by the ROs (RCCFs) in consultation with a State Advisory Group consisting of representatives of the concerned State Government. Proposals involving more than 20 ha of forest land are required

to be placed before the Advisory Committee constituted by the MoEF. However, all proposals under the EPA are directly administered by the Central Government in the MoEF in New Delhi.

The State Pollution Control Boards (SPCB), established in every State of the country, and under the administrative control of respective State Governments, are responsible for implementing the Air Act and Water Act, as well as issuing the rules, regulations and notifications thereof, which prescribe the standards for emission and effluents of air and water pollutants and noise levels. In the case of Union Territories (UT), the Pollution Control Committee (PCC) is responsible for this. Therefore, all industries located or to be located in any State or UT, are required to interact with respective SPCB or PCC as the case may be. Rules and notifications brought out under the EPA, such as bio-medical wastes, public hearing of development projects, etc. are also being implemented by respective SPCB.

The Central Pollution Control Board (CPCB), an autonomous organization of the MoEF, coordinates the activities of the SPCBs and PCCs. It also advises the Central Government on any matter concerning the prevention and control of air, water and noise pollution.

While the Ministry of Environment & Forests is the nodal Ministry for environmental legislations in the country, several States and Union Territories have also enacted their own legislations, besides of course, adopting the major legislations enacted by the Central Government (MoEF). For instance, while the Wildlife (Protection) Act of 1972 is followed by almost all the States, the State of Jammu & Kashmir has enacted its own act for the protection of wildlife. Similarly, as would be seen subsequently, all the States in the North-Eastern Region had also enacted their own legislations in order to protect, improve and manage their forests and wildlife resources, besides of course, adopting the central legislations on forests and wildlife.

Toady, it may said with certainty that we now have a system of environmental checks and balances fully in place. The country has enough institutional, legislative and political strength to ensure development without destruction.

ACTS & RULES RELATED TO FOREST & WILDLIFE IN NORTH-EAST INDIA

Besides adopting the Central legislations on forests, wildlife and the environment, the various States of the North-Eastern Region also enacted their own legislations, particularly relating to the forests and wildlife. Thus, perusal of literature shows that there are as many as 40 legislations or acts, 59 rules and 7 autonomous district council acts relating to forests and wildlife in the region, which had either been enacted by one state and/or adopted by other states (Table III). List of the acts passed or adopted by the north-eastern States may be seen in Appendix II and those of the acts passed by the District Councils in Appendix III. Some treatment of the overall forest policies and legislations in the country with reference to the north-east may also be seen in Darlong (1999). However, it is not intended to discuss the details of these acts or rules in this paper. One must also verify the effective implementation of each of these acts or rules in each state with the respective state government. The existence of the acts and rules in each state has been recorded as such based on available records and information.

TABLE - III

NUMBER OF ACTS AND RULES RELATING TO FORESTS AND WILDLIFE PASSED BY THE STATES AND AUTONOMOUS DISTRICT COUNCILS IN NORTH-EASTERN REGION

States	Acts passed or adopted by States	Rules passed or adopted by States	Acts passed by District Councils
Arunachal Pradesh	4	2	-
Assam	12	26	2
Manipur	-	2	-
Meghalaya	17	13	2
Mizoram	1	-	3
Nagaland	3	13	-
Tripura	3	3	-
Total	40	59	7

IMPLICATIONS OF LEGISLATIONS FOR DEVELOPMENT IN NORTH-EAST INDIA.

Like elsewhere in the country, in the North-East India too, one of the major efforts of the governments both at the Centre and the States, is to appropriately reconcile environmental management with that of the development processes of the region. To give effect to this philosophy and goal, the central legislations have been adopted by the various State Governments of the region, and in many cases, additional legislations have been enacted or adopted.

The National Forest Policy 1988 envisaged that the hill areas, like the north-eastern states, should aim at maintaining 66% of its area under forest cover. While this goal may not be too difficult in achieving in terms of vegetative cover, however maintaining and transforming this into quality forests could be a challenging task. We are usually confronted with two situations in this case, viz., (a) large part of the forests in the region are under the traditional control of district councils or under the ownership control of individuals/private or the community; (b) there is still differences of opinion with regards to the applicability or inapplicability of the FCA in these areas, the ground reality is that it is difficult to make it operationalized at the individual level.

Large areas of forest lands under the traditional control and management of the district councils or under the ownership of the community, continue to be diverted for non-forest activities, in the hill areas of the north-east. And yet, none of these diversions come within the purview of the Forest (Conservation) Act, 1980. For example, there is not a single case of forest diversion in Nagaland and yet development works in forest areas or using forest lands continues to be taken up. In Meghalaya, large areas of lands continue to be diverted for coal mining, and yet these diversions attract neither the FCA nor the EPA.

What is felt is that it would be at the best interest and proper management of our own natural resources if we can take advantage of the various provisions of these acts. It is expected that applications of these acts would ensure sustainable utilization of our natural resources on a long term basis. In short, application of FCA would ensure compensation of the lost forests through compensatory afforestation; similarly, application of EPA would ensure proper environmental management, for example in coal mining areas it would mean eco-restoration or eco-rehabilitation mine abandoned sites, control of air and water pollution, etc.

The Wildlife (Protection) Act, 1972, also called as WPA too appears to be enforced only in the conservation areas of the north-east. Vast areas of forests under the control and management of the district councils or community ownerships, which are also home to various wild animals and plants, do not appear to be appropriately covered under the WPA. Large quantities of various species of endangered species of plants, particularly medicinal plants and orchids, continue to be collected from these stretches of forests which are otherwise prohibited under the WPA. While many of the individuals would not be aware of the existence of this act, the enforcing agencies must work along with local socio-traditional institutions and NGOs to bring about better awareness of the act, as well as to ensure the applications of its various provisions in a way that people can appreciate them to their own advantage. Recent initiatives of the Peoples Group (VO), an NGO in Nagaland in this respect is worth emulating and appreciating.

The institutional mechanism and infrastructure built-up of many of these law enforcing agencies in various states of the north-east are still weak. For example, the State Pollution Control Board, which oversees the enforcement of Air Act, Water Act, certain provisions of EPA, etc. are yet to be fully established in the States of Arunachal Pradesh, Nagaland and Mizoram. Not only that these Boards lack appropriately trained man power, but are also weak in their infrastructures to enable them to carry out their expected assignments. These lacunae must be rectified if the environmental legislations are to be gainfully administered and applied in the development processes of the region.

CONCLUDING REMARKS

The environmental legislations are in a way a blueprint for survival. Our numerous laws and regulations on environment, forests and wildlife are to ensure sustainable development through scientific management and conservation of our natural resources. These legislations not only facilitate the survival and maintenance of our natural heritage in the forms of wildlife, biodiversity, air, water and soil, but also guarantee the very survival of the mankind, both present and future generations.

It may also be appropriate to keep in mind that environmental impact has no political or geographical boundaries. Air pollution caused at one point may have far reaching consequences elsewhere; similarly, soil erosion caused in India may create floods in Bangladesh. Therefore, appreciating our country's or state's legislations on environment, forests and wildlife would also mean appreciating India's international commitment to the environmental conservation and management.

India is a signatory or a party to a number of international conventions, declaration or agreements on forests, wildlife and environment. Some of the significant international agreements, in which India is a party, are the :

- (a) Stockholm Declaration on Human Environment.
- (b) Convention on International Trade in Wild Species of Endangered Fauna and Flora (CITES).
- (c) Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat.
- (d) World Heritage Convention.
- (e) Bonn Convention on Conservation of Migratory Species of Wild Animals.
- (f) Vienna Convention for Protection of Ozone layer.
- (g) Montreal Protocol for Reduction of Elimination of CFC.
- (h) Rio Declaration on Environment and Development.
- (i) Statement on Sustainable Management Principles for the World's Forests.
- (j) FAO Commission on Plant Genetic Resources.
- (k) UN Law of the Seas.
- (l) UN Convention on Conservation of Biological Diversity.

In India, a number of governmental and non-governmental organizations are working on issues concerning environment, forests and wildlife. Some of the prominent central government organizations or supported by it are the (1) G.B. Pant Institute of Himalayan Environment & Development, Almora (2) Centre for Environmental Education, Ahmedabad (3) C.P.R. Ayar Environmental Education Centre, Chennai (4) Salim Ali Centre for Ornithology & Natural History, Coimbatore (5) Centre for Ecology Research & Training, Bangalore (6) Indain Institute of Forest Management, Bhopal (7) Indain Council of forestry Research & Education, Dehra Dun (8) Animal Welfare Board, Chennai (9) Wildlife Institute of India, Dehra Dun, etc. Besides these, there are also a number of state government sponsored organizations in different states of the country working on issues pertaining to environment, forests and wildlife.

Similarly, several non-governmental organizations have been very active in working and promoting on issues concerning forests, wildlife and the environment. Some of these are the (1) WWF-India, New Delhi (2) Bombay Natural History Society, Mumbai (3) Tiger Link, New Delhi (4) Wildlife First, Bangalore (5) Wildlife Protection Society of India, New Delhi (6) Centre for Science and Environment, New Delhi, (7) M.S. Swaminathan Research Foundation, Chennai, etc. In the north-eastern too, there are several NGOs, like the Nature's Beckon, Aranyak nature Club, Rhino Foundation (all in Assam), Acharya Jagdish Chandra Bose Sangstha in Tripura, Manipur Association for Science and Society, Young Mizo Association in Mizoram, etc. which are trying to contribute towards environmental protection and nature conservation.

Although our country has a wide range of legislations to deal with issues concerning the environment, forests and wildlife, it must be kept in mind that in a vast country like ours with multi-dimensional interest groups on environment, the Ministry of Environment & Forests or the State Pollution Control Boards or the State Environment & Forest Departments alone cannot ensure the total environmental safeguards of the country. As already enshrined in our constitution, the protection of environment is the fundamental duty of every citizen of this country. Indeed, everyone who cares about our planet has a role to play. Often this role will be adversarial, when the establishment may have to be opposed. Much more often, however, cooperation, coordination and constructive participation would be more effective. That, after all is how nature's blueprint for survival itself works (Sanctuary Asia, 1999).

TABLE - IV

CENTRAL LAWS & RULES

FORESTRY

- 1 Indian Forest Act, 1927
- 2 Forest (Conservation) Act, 1980
- 3 Forest (Conservation) Rules, 1981

WILDLIFE

- 1 The Cattle Trespass Act, 1871
- 2 The Elephant Preservation Act, 1879
- 3 Indian Fisheries Act, 1898
- 4 Livestock Importation Act, 1898
- 5 Wild Birds and Animals Protection Act, 1912
- 6 Prevention of Cruelty to Animals Act, 1960
- 7 Prevention of Cruelty to Animals Rules, 1960
- 8 Prevention of Cruelty (Capture of Animals) Rules, 1972
- 9 The Wildlife (Protection) Act, 1972
- 10 The Wildlife (Transaction and Taxidermy) Rules, 1973
- 11 The Wildlife (Stock Declaration) Central Rules, 1973
- 12 The Wildlife (Protection), Licensing (additional matters for consideration) Rules, 1983
- 13 Transport of Animals Rules, 1978
- 14 The Prevention of Cruelty to Animals (Registration of Cattle Premises) Rules, 1978

ENVIRONMENT

Poison & Insecticides

- 1 The Poisons Act, 1919
- 2 The Insecticides Act, 1968

FOOD ADULTERATION

- 1 The Prevention of Food Adulteration Act, 1954
- 2 The Prevention of Food Adulteration Rules, 1955

FACTORY & INDUSTRY

- 1 The Factories Act, 1948
- 2 The Industries (Development & Regulation) Act, 1951

Mines & Minerals

- 1 The Mines and Minerals (Regulation and Development) Act, 1957

SEA & COASTAL ZONES

- 1 Merchant Shipping (Amendment) Act, 1970
- 2 Coastal Regulation Zone Notification, 1991

WATER

- 1 The Indian Boilers Act, 1923
- 2 The River Board Act, 1956
- 3 The Water (Prevention & Control of Pollution) Act, 1974

- 4 The Water (Prevention & Control of Pollution) Rules, 1975
- 5 The Water Pollution (Procedure for Transaction of Business) Rules, 1975
- 6 The Water (Prevention & Control of Pollution) Cess Act, 1977
- 7 The Water (Prevention & Control of Pollution) Cess Rules, 1978
- 8 The Water (Prevention & Control of Pollution) Amendment Act, 1978

AIR

- 1 The Air (Prevention & Control of Pollution) Act, 1981
- 2 The Air (Prevention & Control of Pollution) Rules, 1982

UMBRELLA, ACT & RULES AND ITS OFF-SHOOTS

- 1 The Environment (Protection) Act, 1986
- 2 The Environment (Protection) Rules, 1986
- 3 Hazardous Wastes Management & Handling Rules, 1989
- 4 Manufacture, Storage & Import of Hazardous Chemicals Rules, 1989
- 5 Manufacture, Use, Import, Export and Storage of Hazardous Micro-organisms/genetically Engineered Organisms or Cells Rules, 1989
- 6 Motor Vehicles Rules, 1989
- 7 Public Liability Insurance Act, 1991
- 8 Public Liability Insurance Rules, 1991
- 9 Labelling of Environmental Friendly Products --- Ecomark Notification, 1991
- 10 Notification on Environmental Impact Assessment of Development Project, 1994
- 11 National Environment Appellate Authority Act, 1997
- 12 National Environment Appellate Authority (Appeal) Rules, 1997
- 13 Notification on Procedures for Public Hearing, 1997

TABLE - V

FOREST & WILDLIFE RELATED ACTS PASSED OR ADOPTED BY THE STATES IN THE NORTH-EAST

ARUNACHAL PRADESH

- 1 Arunachal Pradesh Anchal Forest Reserve (Constitution and Maintenance) Act, 1975
- 2 Arunachal Pradesh Anchal Forest Reserve (Constitution and Maintenance) Amendment Act, 1984
- 3 Arunachal Pradesh (Removal of Timber) (Regulation) Act, 1983
- 4 The Assam Forest Regulation, 1891 (Act VII of 1891)

ASSAM

- 1 The Assam Forest Regulation , 1891 (Act VII of 1891)
- 2 The Assam Land and Revenue Regulation, 1886
- 3 The Assam Cattle Preservation Act, 1951
- 4 The Assam Acquisition of Land for Flood Control and Prevention of Soil Erosion Act, 1955 (Act 6 of 1955)
- 5 The Garo Hills Regulation, 1882 (Regulation 1 of 1882)

- 6 The Goalpara Tenancy Act, 1928
- 7 The Assam State Acquisition of Zamindary Act, 1951 (Act 18 of 1951)
- 8 The Assam Rhinoceros Preservation Act, 1954
- 9 The Elephant Preservation (Assam Amendment) Act, 1959
- 10 The Assam State Acquisition of Land belonging to Religious or Charitable Institutions of Public Nature Act, 1959
- 11 The Assam National Parks Act, 1968
- 12 The Forest Protection Force Act, 1986 (Act 22 of 1987)

MIZORAM

- 1 Mizoram Forest Act, 1990

MEGHALAYA

- 1 The Assam Land and Revenue Regulation, 1886
- 2 The Assam Cattle Preservation Act, 1951
- 3 The Assam Acquisition of Land for Flood Control & Prevention of Soil Erosion Act, 1955
- 4 The Garo Hills Regulation, 1882
- 5 The Goalpara Tenancy Act, 1928
- 6 The Assam State Acquisition of Zamindary Act, 1951
- 7 The Assam Rhinoceros Preservation Act, 1954
- 8 The Assam State Acquisition of Land belonging to Religious or Charitable Institutions of Public Nature Act, 1959.
- 9 The Assam National Parks Act, 1968
- 10 The Meghalaya Forest Regulation (Application and Amendment) Act, 1973
- 11 The Meghalaya Tree Preservation Act, 1976
- 12 The Meghalaya Forest (Removal of Timber) Regulation Act, 1981
- 13 The Meghalaya Protection of Catchment Areas Act, 1988
- 14 AWIL Fees Act, 1960
- 15 The Bengal Alluvion and Dilluvion Regulation Act, 1925
- 16 The Bengal Cruelty to Animal Act, 1869
- 17 The Meghalaya Wild Animal and Birds Protection Act, 1971

NAGALAND

- 1 Nagaland Forest Act, 1968
- 2 Nagaland Jhum land Act, 1970
- 3 Nagaland Village Areas and Regional Council Act, 1970

TRIPURA

- 1 Indian Forest Act (Tripura Amendment), 1984
- 2 Indian Forest Act (Tripura Second Amendment), 1986
- 3 Tripura Forest (Regulation of Removal of Timber) Act, 1991
- 4 The Tripura Land Revenue and Land Reforms Act, 1960

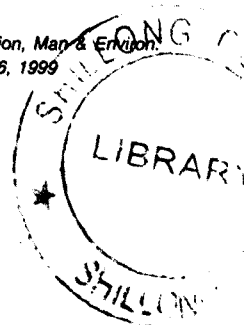


TABLE - VI

ACTS PASSED BY AUTONOMOUS DISTRICT COUNCILS IN THE NORTH-EAST

AUTONOMOUS COUNCIL AREAS OF KARBI ANGLONG & N.C. HILLS OF ASSAM

- 1 Mikir Hills District (Forest) Act, 1957
- 2 Mikir Hills (Jhum) Regulation Act, 1954

GARO, KHASI & JAINTIA HILLS AUTONOMOUS DISTRICT COUNCILS OF MEGHALAYA

- 1 Garo Hills District (Forest) Act, 1958
- 2 *The United Khasi & Jaintia Hills Autonomous District (Management and Control of Forest) Act, 1958*

DISTRICT COUNCIL AREAS OF MIZORAM

- 1 MIZORAM (Forest) Act, 1955
- 2 The Pawi Autonomous District (Forest) Act, 1976
- 3 The Lakher District Council Forest Act, 1981

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ENVIRONMENTAL IMPACT ASSESSMENT OF LIMESTONE MINING PROJECT

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ABSTRACT

An Environmental Impact Assessment study was undertaken for the proposed limestone mining project of Lum Mawshun Minerals Private Limited, Meghalaya at Nongtra village of Meghalaya. The study examined thoroughly various technical aspects of the mining project for a realistic assessment of its likely impact on the environment and people of the project area. Baseline data of the project area such as, climate, topography, geology, soil, hydrology, landuse, vegetation, flora, fauna, socio-economic condition of the people and the problems faced by them, meteorology, air quality, and water quality of the streams and rivers flowing in the project area were collected. Positive and negative impacts of the mining operation were critically examined. Expected level of pollution and changes in air quality, hydrology, hydrogeology, water quality, noise and vibration levels due to mining were predicted. Impacts of storing and various hazardous materials as well as deposition of mining wastes were also assessed. Social and economic impacts of the project were critically analysed. Extensive interaction with the affected populations and traditional institutions such as village durbars was undertaken in order to address adequately the local problems likely to arise out of the mining project.

Although the impact of the project on the environment was considered minimum and no serious consequences was visualised, an environmental management plan was prescribed to compensate the impact. Besides, mitigation measures for each of the above aspects were suggested to reduce the impact of mining operation on the surrounding environment. Associated occupational health and safety measures required to be taken were also outlined. The environmental management plan induced various activities like, reclamation of mined areas, establishment of a green belt, conservation of a biodiversity-rich pocket identified within the mining area and compensatory afforestation.

INTRODUCTION

Some of the environmental concerns pertaining to the mining of limestone are : i) surface and ground water pollution ii) solid waste management iii) land degradation iv) air pollution v) noise and vibration vi) subsidence and land slide vii) displacement of human settlements viii) impact of mining on the hydrology and water regime ix) leaching of toxic elements from waste dump. In view of the above environmental implications, the Ministry of Environment & Forests, Govt. of India has placed the mining of limestone under Schedule I of the Environmental Impact Assessment Notification, 1994. It is mandatory to undertake a EIA study to identify all the environmental concerns related to the project so that the required mitigation measures are incorporated during the planning and implementation phases of the mining operation (Anonymous 1981, 1994). The EIA intends to analyse and assess all the environmental implications of the project and suggest various remedial/mitigation measures to minimise/neutralise the impact of mining on the environment.

The present paper describes the methods and findings of an Environmental Impact Assessment study carried out for a limestone mining project in Meghalaya. Based on the findings, the study recommends various mitigation measures and a comprehensive environmental management plan to minimize the environmental impact of the mining operation.

STUDY SITE

The EIA was conducted in the proposed limestone mining site of Lum Mawshun Mineral Pvt. Ltd. (LMMPL), Meghalaya, located in Phlangkaruh area. The site is situated on the western side of Umiar river at an aerial distance of about 2 km from the river bank immediately to the north of Shella - Hat Mawden - Balat border road section which runs along Indo-Bangladesh border. The area is located between the latitudes 25° 11'18" and 25° 11' 55" N and longitudes 91° 37' 57" E (approximately). The mining site can be reached via Cherrapunjee, which is 55 km away from the site. The other alternative approach to the area by road from Shillong is via Mawsynram. The important settlements within the 10 km radius of the proposed mining site are, Shella bazar, Pyrkan, and Phlangkaruh village. An area of 100 ha has been acquired by the LMMPL on lease basis for mining. There is no archeological or historical site within 10 km radius of the mining site.

CLIMATE

The project site is situated at an altitude of 180 m asl. The maximum and minimum temperature vary between 25-30°C and 13-25°C, respectively. Winter (December to February) is moderate. During rest of the year the weather remains hot and humid. The relative humidity at 6 am varies between 83 and 98%. The area receives an average annual rainfall of 4456 mm, most of which occurs during the monsoon season (May-September). The wind direction during January to March is south-easterly, while from April to December the direction is north-easterly. The wind varies between 15-30 km/hour.

REASONS FOR SELECTING THE SITE FOR MINING

The site was selected for commercial mining due to the following reasons:

- i) The site had commercially viable limestone deposit and the decision to carry out mining was taken after thorough consultation with the concerned village durbar, the custodian of the land. The land was left unused covered with degraded forests and, therefore, the site was preferred by the durbar to lease out the same to LMMPL for mining.
- ii) Other factors responsible for selecting the proposed site are: availability of water source, away from the human habitation, closer to the Islam Cement Limited Plant site at Chhatak, easy accessibility by road, less vegetation clearing and minimum damage to the rich biodiversity as the area was at the outskirts of the forest.
- iii) As per the data obtained from the chemical analysis of bore hole logs, the average core quality of the limestone obtained from the project site is as follows: CaO - 51.9%, MgO - 1.08%, SiO₂ - 1.96%, Al₂O₃ - 1.05% and Fe₂O₃ - 0.60%. The overall quality of the lime stone is considered to be good.

DESIGN OF THE LIMESTONE MINING PROJECT FOR WHICH EIA WAS CONDUCTED

The process of limestone mining consists of the following steps : (i) Drilling to place of explosives; (ii) Exploding mines; (iii) Crushing and screening to get proper size; (iv) Transporting and loading into the tram cars of the rope-way. The open cast method of mining by deep hole blasting was to be adopted and limestones were planned to be excavated with the help of heavy earth moving machineries. The blast holes were of 11 m depth and 115 mm dia. The holes will be in two rows. In the first row, the burden will be 5 m and spacing 6 m. The second row will be 4 m from the first row and spacing of holes will be 6 m. Blasting will be done once in a week. The charge shall be made up of 40% slurry explosive at bottom charge and 60% ANFO (Ammonium Nitrate Fuel Oil) explosive as top charge. The powder factor as commonly adopted for limestone will be 0.35 kg/m³. Thus the charge per hole will be 80 -90 kg and explosive required per week 2940 kg of which 1176 kg will be slurry explosive and 1764 kg will be ANFO. In a typical blast, the charge in each hole will be initiated by detonating fuse connected to a trunk line with one trunk line for each row. Each trunk line will be connected to separate millisecond delay detonators of connected to an exploder. To minimize vibration, delay detonators will be used whilst throw of material will be controlled by using inclined blast holes 60° to 70° from horizontal. As very few detonators and no nitro-compound explosive shall be used, there will be less noise.

The projected average production of the mine is 2450-3000 tonnes per day. On this scale of production, the quantity of waste to be handled will be about 540 tonnes per day. The mine would be designed to have a capacity to handle about 3500 tonnes of Limestone and waste per day. Year-wise limestone production is given in Table – I.

TABLE - I.

YEAR-WISE LIMESTONE PRODUCTION FOR THE FIRST FIVE YEARS

Year	Limestone (tonnes)	production (volume m ³)	Waste (tonnes)
I	160,000	400,000	32400
II	320,000	800,000	64800
III	320,000	800,000	64800
IV	320,000	800,000	64800
V	320,000	800,000	64800

METHODS

The EIA study was conducted through extensive field visits, Interaction with the villagers, and collection and analysis of soil, air, water and vegetation samples. The baseline data for the study was collected from the area encompassing Phlangkaruh and Nongtraï villages and their surroundings extending over 10 km radius of the project site. The entire study area was about 315 sq. km and about 60 hamlets and villages were scattered over this area.

Soil Analysis

In order to get an over all picture of soil characteristics, samples were collected from crevices, hill slopes and foot-hills of the project area. These were analysed for a few important physico-chemical properties following standard analytical methods (Allen et al. 1974).

Faunal Inventory

List of avifauna was prepared by observing the birds by a binocular during the morning (7-9 am) and in the evening (4-6 pm) from a view point located 200 m uphill from the mining site and also on the basis of published literature.

Measurement of Air, Temperature, Relative Humidity and Wind Speed

A wet and dry bulb thermometer was used for recording of ambient temperature and humidity at hourly interval collected for 24 hours during March and April, 1997. Wind speed and direction were monitored using automatic cup-counter anemometer with wind vane facility. The equipment was placed at a height of 3 meters from the ground level and the data were recorded for 24 hours at 1 hour interval. A precision Barometer was used to observe the changes in the atmospheric pressure during ambient air sampling.

Ambient Air Sampling and Analytical Procedure

The Shella Bazar was chosen as a buffer zone for ambient air quality monitoring as this is the nearest populated and the biggest commercial centre situated in the South-East direction of the proposed mining site at a distance of about 2 km. The other station was at the proposed mining site in Phlangkarush village for determining concentrations of SPM, SO₂ and NO_x. The ambient air quality samples were collected in the months of March and April, 1997 as per the norms fixed by the Central Pollution Control Board, New Delhi. The sampling was performed for 24 hours in a manner that 3 sets of 8 hourly samples covering day and night periods could be collected for SPM. Six sets of 4 hourly samples were collected simultaneously for SO₂ and NO_x.

At both the stations, 24 hours sampling period was covered with 3 consecutive 8 hourly sets described as (12 am - 08 pm, 08 pm - 04 am, and 04 am - 12 am Shifts) for SPM and 6 consecutive 4 hourly samples

(12 am - 04 pm, 04 pm - 08 pm, 08 pm - 12 pm, 12 pm - 04 am, 04 am - 08 am, 08 am - 12 am) for SO_2 and NO_x .

Suspended Particulate Matter (SPM)

The ambient air sampling was done using High Volume Sampler (HVS, Envirotech APM 410). The sampler draws ambient air through pre-weighted glass fibre filters of 20x24 cm size at a flow rate ranging from 1.1 to 1.6 Cum per minute. The samplers are provided with specific angled housing which ensures pre-separation of suspended particles larger than 100 microns diameter before ambient air samples comes in contact with the filter surface. EPM 2000 glass fibre of Whatman make were used for sampling. The HVS were operated continuously for 24 hours and 3 sets of 8 hour samples were collected for SPM by changing the filter papers in each shift of 8 hours. The flow rates were measured at the beginning and in the end of each set of sample. The volume of air sampled was calculated from average flow rates during the sampling period. The SPM concentrations were calculated from the mass of the dust collected and the volume of air sampled. The results are presented in $\mu\text{g}/\text{Nm}^3$.

Sulphur Dioxide (SO_2)

The improved West and Gaeke Method as recommended by the Central Pollution Control Board, New Delhi was adopted for sampling and analysis of SO_2 concentration in the ambient air. The ambient air was drawn at a controlled rate of 1 litre per minute (LPM) through 0.1 M sodium tetrachloromercurate solution in impingers. The sample was collected for a period of 4 hours. SO_2 in the ambient air sample was absorbed in the absorbing solution. The procedure results in formation of dichlorosulfitomercuro complex. After sampling, the sample solution was first treated with sulphuric acid solution to destroy the nitrite anion formed due to absorption of the oxides of nitrogen present in the atmosphere, then it is treated with formaldehyde and specially purified pararosaniline hydrochloride. Pararosaniline, formaldehyde and bisulfite anion react to form an intensely coloured pararosaniline methyl sulfonic acid. The absorbance of this solution was measured at 575 nm wavelength with the help of UV-Visible Spectrophotometer (HITACHI U2000) and the results are presented in $\mu\text{g}/\text{Nm}^3$.

Oxides of Nitrogen (NO_x)

Jacob & Hochheiser modified (Sodium Arsenite) Method was employed for the sampling and analysis of the ambient NO_x concentration. The ambient air was sampled at a controlled rate of 1 LPM through Sodium hydroxide Sodium Arsenite solution in an impinger. The air was sampled continuously for 24 hours and 6 sets of 4 hourly samples were collected. During the sampling ambient NO_x was converted into Sodium nitrite. After Sampling, the absorbing solution is treated with solutions of hydrogen peroxide, sulphanilamide, and NEDA (N-1 Naphthylethylene diamine dihydrochloride). The absorbance of nitrite ion in the solution thus formed was measured with the help of UV-Visible Spectrophotometer (HITACHI U2000) and the results are presented in $\mu\text{g}/\text{Nm}^3$.

Water Sampling and analytical methods

Water sampling of the two rivers was done in the months of March and April, 1997. Water temperature, pH, conductivity were recorded on the spot using a Water Analysis Kit. Dissolved oxygen was fixed on the spot. The samples were preserved as per the requirement of testing of the specific parameters. The analysis of the collected water samples was performed according to the Standard Methods for Examination of Water and Wastewater (APHA, 1985).

RESULTS

BASELINE DATA

Soil

The entire hill slope is practically devoid of soil having typical karst topography. The soil in the crevices is sandy clay loam in texture, whereas on the hill-slopes and foot-hills, it is sandy loam. The soil reaction is

near neutral to alkaline with pH ranging from 6.93 to 7.86. The soil accumulated in rock crevices is rich in organic carbon, organic matter, total nitrogen and available phosphorus. Cation exchange capacity of soil is fairly high (Table II).

TABLE - II

PHYSICO-CHEMICAL PROPERTIES OF SOIL AT THE PROJECT SITE

Parameters	Crevices	Hill Slope	Foothill	Mean
Texture				
Clay(%)	17.46 ± 0.83	11.20 ± 0.70	7.6 ± 0.69	12.09 ± 2.87
Slit(%)	14.82 ± 0.58	8.84 ± 0.70	17.81 ± 0.00	13.82 ± 2.63
Sand(%)	67.72 ± 0.65	79.95 ± 1.22	73.86 ± 0.00	73.84 ± 3.53
Textural Class	SCL	SL	SI	SL
Moisture content (%)	30.72 ± 0.20	28.80 ± 0.02	27.34 ± 1.99	27.72 ± 1.99
pH	6.93 ± 0.03	7.086 ± 0.01	7.67 ± 0.02	7.48 ± 0.28
TKN (%)	3.48 ± 0.02	3.28 ± 0.03	1.96 ± 0.02	2.91 ± 0.47
Organic Carbon (%)	2.69 ± 0.02	2.58 ± 0.02	1.54 ± 0.02	2.27 ± 0.36
Available Phosphorus (%)	0.04 ± 0.0003	0.04 ± 0.001	0.04 ± 0.0003	0.42 ± 0.002
CEC (m.eqv. %)	14.56 ± 0.03	14.63 ± 0.02	14.82 ± 0.01	14.73 ± 0.010

+ = S.E.; CEC = Cation Exchange Capacity; SCL = Sandy clay loam; SL = Sandy loam; TKN = Total kjeldahl nitrogen.

Land Use

Landuse in and around Nongtrai village can be divided into two major categories: (i) land used for agricultural purposes, and (ii) land under forest cover. The details of landuse in the study area is presented in Table III.

TABLE - III

LANDUSE IN THE EIA STUDY AREA (BASED ON IRS - 1B DATA-DECEMBER, 1994).

Landuse	Area (sq. km)	Per cent of total area
Settlements	5.42	1.72
Agriculture	82.63	26.30
Grass/Shrub	14.61	4.65
Forest	188.33	59.95
Sandy river bed	1.82	0.58
Limestone	21.35	6.80
Total Area	314.16	100.0

Forest, covering about 60% of the total area within 10 km radius is the dominant land use of the area. Agriculture is the next important landuse in the area. Most agricultural lands are situated in the plain areas located towards southern side of the project site near the Bangladesh border. Rice is the principal crop. On

hills the agricultural land is negligible. The principal land based economic activity of the people is plantation of betel nut, oranges and betel leaf. These plantations are interspersed with natural forests and provide a dense vegetal cover to the land. The open forest, covering the limestone area constitute about 7% area within 10 km radius of the proposed mining site.

ECOLOGICAL ASPECTS

The vegetation of the area is a tropical semi-evergreen forest composed of deciduous and evergreen tree elements. The plant species in the forest are distributed in three distinct layers, the top layer is composed of sparsely distributed tall trees, the middle layer composed of young trees forms a dense canopy at many places. This layer is characterised by the presence of large number of lianas, the third and lower layer is represented by shrubs and herbs. The shrubs are scattered and the herbaceous species are limited in number. The low number of herbs and their poor growth are mainly due to the lack of soil. Majority of the valuable timber trees have already been extracted from the mining site.

Plants are restricted to the crevices and on the gentle hill slopes where there is some soil. The distribution and occurrence of plants appear to be mainly dependent on the soil depth and its fertility. The site provides a wide variety of habitats ranging from deep gullies having thick deposit of moist and nutrient rich soil to dry and exposed rock surfaces without any soil cover. As a result, diverse kinds of plants, ranging from massive trees (d.b.h. of up to 235 cm) and lianas to xerophytic euphorbias were growing on the site. Woody plants growing on rocky substrata have developed interesting root and stems forms. High humidity during most part of the year are responsible for luxuriant growth of epiphytic orchids and ferns in the forest. Wild bananas were also present at many places, particularly where there was some deposition of soil. Small amount of humus rich soil accumulated in the fissures and depressions provided favourable sites for germination and establishment of a variety of plant species. The plants have adapted themselves in such a way that they are able to grow luxuriantly in very limited soil volume. Plant litter accumulated in the pockets provide necessary nutrients to plants by a faster rate of decay due to high temperature and rainfall. It appears that a closed nutrient cycling prevailing in the depressions favours the growths of trees. Presence of a good number of serophytic species in the vegetation indicates limited availability of soil water.

Frequency distribution of d.b.h classes reveals abundance of young trees in the project site. The average tree density in forest is 4 trees/m² and average basal cover is 185 sq. cm/m². The average d.b.h. of cut stumps is 83 cm (Table – IV).

TABLE - IV

AVERAGE DENSITY, BASAL COVER AND D.B.H. (DIAMETER AT BREAST HEIGHT) OF THE TREES PRESENT AT THE MINING SITE

Average tree density (No. of trees/m ²)	366.00
Average basal area (cm ² /m ²)	185.37
Average diameter of tree stumps (cm)	83.10

Flora

An inventory of flora of the project area prepared on the basis of field survey. The site is mostly covered with pole size trees, shrubs and herbs. However, some small patches of dense forests exists at a few places particularly near the cavern in the extreme southwest of the site where a large number of old trees and a wide variety of shrubs, herbs, epiphytes, pepper, canes, palms, medicinal plants and lianas are present. Such forest patches are dominated by trees like *Trema* sp., *Duabanga grandiflora*, *Firmiana* sp., *Ficus* spp. and different species of palms. Many economically important species such as *Albizia* spp., *Kydia calycina*, *Hibiscus macrophyllus*, *Anthocephalus chinensis*, *Duabanga grandiflora*, *Gmelina arborea*, *Terameles nudiflora* were found at the project site.

Other important tree elements in the forests are *Castanopsis* spp, *Elaeocarpus* spp. *Ficus* spp *Heritiera* sp, *Sterculia* sp, *Toona ciliata* and tree members of Rubiaceae. Luxuriant epiphytic growth of ferns and orchids

was seen at the site. The wood rotting fungus, particularly the members of Polyporaceae were common in the dense forest patches. The floristic data furnished in Table V clearly indicates that the forests at the study site is rich from the point of view of plant biodiversity.

TABLE - V
FLORISTIC COMPOSITION OF VEGETATION AT THE MINING SITE

Vegetation component	Number of species
Tree	38
Evergreen	22
Deciduous	16
Shrubs	19
Herbs and under shrubs	10
Climbers and Lianas	24
Epiphytes	15
Rare and wild relatives of crop plants	14
Total	120

Fauna

Terrestrial insects, arthropods, mammals, reptiles and amphibians were observed during weekly field trips undertaken for this purpose. Fishes and other aquatic fauna were recorded during the day time in the Phlangkaruh river.

Folklores related to animals were used as a key to identify the fauna of the area. The older folks and other knowledgeable persons of Nongtraï and Shella villages were also consulted for this purpose. For soil fauna, samples were collected from 5 km away from the mining area, and from four different depths, i.e. 0-5, 5-10 and 15-20 cm at the mining site. From these soil samples insects the arthropods were extracted using the common light extraction method. For collecting nocturnal insects, light traps were used, employing a petromax near the mining area. The traps were of white porcelain trays half filled with water and surface covered by kerosene. Four traps were set from 6 p.m. to 4 a.m. Summary of the observations are furnished in Table VI.

TABLE VI
SUMMARY OF FAUNAL COMPOSITION OF THE EIA STUDY AREA

Class	Important Species
Mammals	Civet Cat Large black squirrel
Avifauna	44 species
Reptiles	Snakes Python (<i>Python molurus</i>) Lizards (<i>Lacertilla spp.</i>)
Snails and Fishes	Snail (<i>Limnea spp</i>) Fishes (<i>Garra gotyla</i> , <i>Neolissocheliuss</i> , <i>Hexagonolepis</i> , <i>Danio dangila</i> , <i>Channa spp.</i>)
Amphibians	<i>Limmonectus Limnocharis</i> Hyla spp <i>L. cyanaophlyctis</i> Rana spp.
Soil Insects	Insects 24 Species Spider mites Termites Ants

SOCIO-ECONOMIC CONDITIONS

Population Structure and Habitation

As the area of study falls under East Khasi Hills district, about 80 per cent population belong to Khasi tribe. The people settled on southern slope are called War Khasi. A segment of garo ethnic group and Bengali linguistic group migrated from Bangladesh form about 20 per cent of the total population. The immigrant people are engaged in mining and trades while indigenous War Khasis are engaged in agriculture. Besides agriculture, areca nut, betel leaf and orange gardening are parts of their economic activity. Khasi is the main language of the area.

The hamlets and villages are nucleated in pattern. There are about 63 villages within 10 km radius of the proposed mining site near Nongtraí area. The river Umiam divides study area into two halves. The eastern part falls under Shella-Bholaganj C.D. Block while the western part falls under Mawsynram C.D. Block. The average family member in a household varies widely in both C.D. Block. The population growth in the villages of Shella-Bholaganj C.D. Block during the last decade (1981 - 1991) was 1.77 per cent while the growth in Mawsynram C.D. Block was 6.05 per cent. This growth rate is far below the Meghalaya's average of 32.86 per cent. The total estimated population within 10 km radius of the mining site (only in Meghalaya side) is 16,487.

Social Setup of Nongtraí Village

Nongtraí is one of the mine villages of Shella confederacy. According to a census conducted during 1997 there were 106 households with a total population of 627 persons in Nongtraí. The average population distribution comes to about 6-7 persons per household. The range varies from 3-8 per household.

Nongtraí is neither a mono-clan village nor any single clan could be identified as numerically dominant. Our respondents belonged to Khasi tribe but they had different religious affiliation; e.g. 50% Presbyterian, 30% Church of God, 10% Catholic and 10% indigenous Khasi faith.

About 15% of the population was below 14 years of age, 20% were between 15 to 25 years, 20% were between 26-45 years, 20% were within 46-65 years of age and the rest were above 65 years of age. More than 3/4th of the village population was young in age.

The literacy rate in the village is 75%. Two lower primary schools, one managed by the District Council and the other by Roman Catholic Church, and a Middle English school managed by the village have contributed to the high literacy rate of the village. Majority of school going students discontinue their studies after completing lower primary and middle level education due to lack of motivation and financial constraint. Even, under such constraints the village has produced graduates in different fields.

Majority of population depend on agriculture/horticulture. The produce include, betel nut, betel leaf, oranges, wild pepper, broom and bay leaf. Some household having private forest have entered in timber trade. A small number of persons are engaged in local trades. Only few persons are in Government services.

Administrative Set Up

The political administration of the village is directly linked to the Shella confederacy. The confederacy is headed by a Chief known as Wahadar. Under Wahadar there are village chiefs or Headmen. The headman is elected by the village council. The village council has two committees: (i) Special Affairs Committee relating to boundary disputes, and (ii) Local Affairs Committee relating to Government Schemes and methods of implementation. The members of both the committees are selected by the village council. The village council selects two prominent members as its representative to the Wahadar Durbar.

Problems

The problems faced by the villagers are stated below :

- i) There is no water supply for the village. This poses tremendous difficulty for domestic hygiene and sanitation.
- ii) The production of plantation crops has shown a declining trend during the last six years due to various crop diseases.

- iii) The price of the crop products is controlled by the market forces. As a result, the planters do not get remunerative prices of their produce.
- iv) Although the village is connected by road, there is lack of public transport facility.
- v) Availability of limestone within the village is seen as a potential source of income generation but due to lack of cooperation of the Shella village in allowing transportation passage for limestone, the residents of Nongtraï are facing hardships.
- vi) Medical and health care facilities are available through a Public Health Care Sub-Centre but it is not able to handle even common diseases such as fever, malaria, dysentery, and other related stomach ailments.

Economic Condition

In a household, normally all the members are not engaged in economically remunerative activities. The ratio of non-earning members to the earning members is a good measure of the degree of dependency in the family. The ratio varied between 1-3 in about 50% of the family in the villages. Dependency ratio was higher in the large families.

Employment

Agriculture and plantation labour, mine labour, porters and small trade are the major employment opportunities available for the villagers. The normal wage rate for unskilled male labour is Rs. 60-70 per day and for female labour Rs. 35-40 per day. The skilled labourers may get up to Rs. 90-100 for a day's work. The employment is available only for 8 to 9 months in a year.

Socio-economic Infrastructure

Health, education and sanitation are the major components of social infrastructure, whereas road, power and other civic facilities are the part of economic infrastructure. Most of these infrastructural facilities are not available to the villagers living near the project site. For example, Primary Health Centre is 4 km away from Shella Bazaar, and the nearest hospital is 55 km away from the Shella bazaar at Cherrapunjee. For drinking water most of the villages are solely dependent on natural sources. During dry season, people face acute shortage of water. Though most of the villages are electrified, the supply of power is very irregular. Shella Bazaar has a branch of State bank of India, a police thana, custom office, a veterinary centre and a post office.

Meteorological Data

The international border of Bangladesh is 2-5 km away in the southern direction from the mining site. The Chhatak District of Bangladesh being close to the proposed mining place, the weather conditions at Chhatak would be more similar to the weather of mining site. Therefore, meteorological data consisting of Ambient Temperatures, Relative Humidity, Average monthly Rainfall, Wind Speed and Wind Direction recorded by Envirocare (Pvt) Limited, Dhaka for preparation of Environmental Impact Assessment Report for Islam cement Limited have been considered.

The average monthly ambient temperature ranges from a minimum of 13.4°C in the month of January to a maximum of 32.8°C in the month of April. The average monthly relative humidity recorded at 6 P.M. ranged from 51% in March to 85% in September. The average relative humidity at 6 A.M. ranged from 83% in March to 97% in July. The average annual rainfall was 4456 mm. Though there is some rainfall in every month, most of it occurs between May and September. The average wind speed is relatively high and it ranges from a minimum of 9.4 km/hour in the month of August to a maximum of 27.2 km/hour in the month of March. Wind blows in South-East direction during monsoon and in the North-East direction during winters. Some meteorological data recorded on hourly basis during the ambient air quality samplings in the months of March and April, 1997. The ambient air temperature in March, 1997 varied from a minimum of 13.0°C at 3.00 A.M. in the morning to a maximum of 34.0°C at 3.00 P.M. in the evening. The ambient air temperature recorded in April, 1997 varied from a minimum of 17.8°C at 3.00 A.M. in the morning to a maximum of 32.6°C at 1.00 P.M. in the afternoon.

The relative humidity in March, 1997 varied from 50% at 1.00 P.M. to 99% at 2.00 A.M. In April, 1997 the minimum relative humidity was 62% at 1.00 P.M. and maximum (96%) was at 3.00 A.M. The wind speed in March, 1997 varied from a minimum of 2.0 km/hour at 5.00 P.M. in the evening to a maximum of 28.9 km/hour at 2.00 A.M. The minimum wind speed recorded in April, 1997 was 2.88 km/hour at 9.00 A.M. and maximum 11.9 km/hour at 11.00 P.M. at night.

Air Quality

Data collected during dry months (March - April, 1997) for SPM, SO_2 and NO_2 were found to be well within the prescribed Ambient Air Quality Standards. These months represents the dry period of the year and the concentrations of SPM and the other gaseous pollutants were expected to be maximum during this period.

This place is located in the remotest part of Meghalaya and except a few small traditional lime kilns and scattered limestone quarries there is no industrial activity in this area. Therefore, it is highly unlikely to get any of air pollutants in the wet period of the year lasting for about 6-8 months in a year.

At mining site maximum SPM concentration of $50.3 \mu\text{g}/\text{Nm}^3$ for Shella bazaar was recorded during April, 1997 at 12 AM-08 PM shift and a minimum SPM of $32.3 \mu\text{g}/\text{Nm}^3$ here was recorded in 08 PM-04 AM shift in March, 1997. At the mining site maximum SPM concentrations for the proposed mining site was recorded in 12 AM-08 AM shift in March, 1997 and a minimum of $22.8 \mu\text{g}/\text{Nm}^3$ in 08 PM-04 AM shift in April, 1997.

The maximum SO_2 concentration of ($4.8 \mu\text{g}/\text{Nm}^3$) in Shella Bazaar was recorded in 12 AM-04 PM in April, 1997 and a minimum of BDL (Beyond Detectable Limits) was recorded mostly during the night shifts in March and April, 1997. The maximum SO_2 concentration at mining site was ($4.6 \mu\text{g}/\text{Nm}^3$) in March, 1997 in 08 AM-12 AM shift and a minimum of BDL in March, 1997 in 04 AM-08 AM shift of the same months.

At mining site maximum NO_2 concentration ($20.2 \mu\text{g}/\text{Nm}^3$) for Shella bazaar was recorded in March, 1997 in 04 PM-08 PM shift and a minimum of ($8.6 \mu\text{g}/\text{Nm}^3$) in the same month in 04 AM-08 AM shift. At mining site maximum NO_2 concentration ($28.2 \mu\text{g}/\text{Nm}^3$) was recorded in March in 04 AM-08 AM shift.

A few limestone quarries and traditional lime kilns operating in and around Shella Bazaar area are the main sources of air pollution in this area.

Water Quality

The main river close to the proposed mining site is the river Umiam which originates from Cherrapunjee plateau and after passing near Shella Bazaar area flows in the Bangladesh and joins there with the Surma river. The next important surface water body is the Phlangkaruh river, which originates from the foothills of the proposed mining site and joins river Umiam further downstream from Shella. The river Umiam is the main source of domestic water supply for the inhabitants of Shella Bazaar. The Phlangkaruh village having about 200 inhabitants is located in south on the bank of this river. These two water bodies were chosen for the study as they are likely to have maximum impact of the proposed mining activities. The water quality at both the stations did not change frequently.

Temperature

The temperature of river Umiam ranged from 21°C in March to 23°C in April, 1997. In Phlangkaruh it varied from 20°C in March to 22°C .

Turbidity

The turbidity of river Umiam ranged from 1.8 to 10.0 while that of Phlangkaruh ranged from 1.6 to 2.8 during March and April, 1997. The change in turbidity was mainly due to the rainfall.

Conductivity

The conductivity of river Umiam ranged from 43 to $49 \mu\text{mho cm}^{-2}$ and in river Phlangkaruh it varied from 147 to $172 \mu\text{mho cm}^{-2}$ during March and April, 1997.

pH

The pH of river Umiar ranged between 7.3 - 7.5. Water of Phlangkaruh river was more alkaline (pH 7.6 - 8.0) than the Umiar river.

Alkalinity

Alkalinity values of river Umiar ranged from 12.0 to 14.0 mg/l. In Phlangkaruh river it ranged from 40.0 to 64.0 mg/l.

Total Hardness (TH)

Total hardness value ranged from 38.0 to 46.0 mg/l in river Umiar and in Phlangkaruh river from 110.0 to 112.0 mg/l. Substantial difference in the TH values of Umiar and Phlangkaruh river may be because the later originates from the bed of the limestone deposits.

Chloride

The Chloride contents in both rivers varied between 5.0 to 6.0 mg/l.

Iron

The Iron concentration in river Umiar was 0.1 mg/l and in river Phlangkaruh it was 0.04 mg/l. It did not change during March and April, 1997.

Nitrite - Nitrogen

The Nitrite - Nitrogen could not be detected in these rivers.

Calcium

The calcium concentration ranged from 8.0 to 9.8 mg/l in river Umiar and 35.0 to 35.2 mg/l in of Phlangkaruh river.

Dissolved Oxygen (D.O.)

The D.O. concentration in both the rivers was quite high (9.0 mg/l).

Biochemical Oxygen Demand

The BOD concentrations in river Umiar ranged between 0.8 to 1.0 mg per litre. In case of phlangkaruh river it ranged between 0.7 to 0.8 mg per litre. The low values of BOD in these rivers is mainly because they do not receive any domestic waste water and solid waste.

Chemical Oxygen Demand

The COD values ranged from 2.0 to 2.4 mg per litre and from 1.8 to 2.1 mg per liter in case of Umiar and Phlangkaruh rivers respectively.

Total Coliform

Total Coliform bacteria in river Umiar ranged from 4 to 6 MPN/100 ml and in Phlangkaruh River the value was still lower. The quality of water is within the standards prescribed for the drinking purpose.

Faecal Coliform

Faecal coliform bacteria were not found in both the rivers. This indicates that these water bodies are not contaminated by sewage.

Noise Level

The site is located far from any human habitation or any activity centre and the prevailing noise level is extremely low. Therefore, it was not necessary to quantify the level of noise in the calm and quite environment of the proposed project area.

EXPECTED LEVEL OF POLLUTION DUE TO MINING

It is difficult to simulate the level of pollution caused by any project which is not yet established. One way of getting some idea about the expected level of pollution is to collect data from similar projects established in nearby areas. However, often the reliability of such data may be limited due to the difference in technology, quality of raw material, pollution abatement methods used and microclimate which may cause variance in the simulation exercise. Still in order to have a board idea about expected level of pollution, data were collected from the Komra Limestone Mine, Ichhamati which is about 20 km away from the proposed site and is in operation for more than fifty years.

The data collected from the Komra Limestone Mine reveals that the levels of Suspended particulate matter (SPM) Sulphur dioxide (SO_2) and Notrogen Oxides (NO_x) are well below the national standards for industrial and mixed areas, as laid down by Central Pollution. Control Board, New Delhi under section 16(2)h of the Air (Prevention and Control of Pollution) Act 1981. The air quality standards as notified for the stone crushing units by the Government of India under the Environment (Protection) Amendment Rules 1993 states that "the SPM contribution value at a distance of 40 metres from a controlled, isolated as well as from a unit located in a cluster should be less than $600 \mu\text{m}/\text{Nm}^3$. Thus the level of SPM expected to be generated shall be below the prescribed limit.

The data on quality of water collected at three differennt points viz., adjacent to quarry, near pump house and near the junction and near the junction reveals that the water quality has not been adversely affected due to the mining of limestone at Komra. The levels of various parameters analysed are well within the national standards laid down by Central Pollutioun Control Board, New Delhi.

At present, the level of air pollutants was found to be well within the Ambient Air Quality Standards notified by the Central Pollution Control Board, New delhi. The mitigation measures recommended would minimise the impact of these emissions on the environment.

The limestone mining and its associated activities shall have the pollution impact on the hydro-environment and may lead to the changes in physical and hydro-chemical characteristics of the water. The Phlangkaruh river originates near the proposed mining site. The mining operations may substantially reduce the quantity of discharge water to this river and may possibly lead to the extinction of this water body. This will affect adversely the interests of about 200 people living in Phlangkaruh village. However, this needs a detailed investigation. The other important variations in the following chemical and bacteriological characteristics of these rivers may be caused due to the mining and its associated activities! i) Suspended Solids, ii) Total Dissolved Solids, iii) pH, iv) metals, v) DO, vi) COD, vii) BOD, viii) Total Coliform, ix) Feecal Coliform.

An expected noise level of 80 - 100 dBA during day time and 50 - 60 dBA during night time would be generated due to mining operations. Besides, high vibration may occur within 500 m diameter of the mine exploding point.

Although the mining waste will not have any toxic effect on the environment, its dumping area measuring about 200 m x 250 m i.e., 50,000 m^2 may affect the landscape structure of the area. Spread uniformly, the height of the loose dump may rise to about 2 m annually.

SOCIAL IMPACT

The impact of the project on socio-economic conditions of the people of surrounding villages was assessed through interaction with the villagers and interviewing village council members, village elders, youth and members of youth club, and the women. The members of the village council on one hand, were apprehensive of the adverse impacts of this project which it may produce on their social and political life and on the other hand, they also felt that the project will provide avenues for alternative income and employment generation.

ECONOMIC IMPACT

Monetary Benefits

The expected monetary benefit to different agencies from the export of limestone is given below :

Head	Rs./tonne limestone	Income Rs. lakh/annum
Cess to govt. of Meghalaya	5	38.75
Royalty to District Council	35	271.25
Central Sales Tax to Govt. of India	4	31.00
Royalty to Village Durbar	5	38.75
Metals and Minerals Corporation Ltd., Shillong	25	173.75

Employment Generation

The Project will generate direct employment for skilled and unskilled persons. The skilled manpower will include Managers, Engineers, Machine Operators etc.

Direct employment: 77 persons

Working days in year : 310

Employment generated : $77 \times 310 = 23870$ man days/year

The total number of many-days employment that the project would generate indirectly would be more than the direct employment.

Foreign Exchange Earning

Since the project is an export oriented one, the Government of India will earn foreign exchange. The amount would depend on the quantity of limestone exported to Bangladesh.

Direct, Indirect and Induced Effects on the Economy

- (i) Social infrastructure development : It is expected that the project will help improve health and educational facilities, social and cultural upliftment of people living in areas surrounding the mining site.
- (ii) Economic infrastructural development : Construction of road, bridges, public buildings, residential accommodation, marketing facilities etc. may increase after commencement of the project.
- (iii) Gainful employment to local people.
- (iv) Development of agriculture, horticulture and services sector for the local economy.
- (v) Development of ancillary industries to cater various requirements, like power sector, engineering activities etc.

Development of one economic sector induces investment in other linked sectors directly and indirectly and enhances the process of economic growth in the region. Development/expansion of an economic sector generates employment, increases the income of the people, and improves their standard of living. This increases the demand for consumption goods. These in turn increases the output, employment, investment in the consumption good sector and lead the economy to a higher level of economic, but would also influence economy of neighbouring regions like Meghalaya and Bangladesh.

The project would likely to have direct economic impact on those sectors from which it is likely to draw its inputs. Power being a main input, Meghalaya State Electricity Board would have to increase its activity in the area, to develop necessary infrastructure and to ensure uninterrupted power supply at the project site. There is a proposal for establishing a market area near the project site. The project would enhance various productive economic activities in other sectors which directly supply inputs to this project.

Since cement is one of the key sectors which play a vital role in developing any economy, therefore, Bangladesh would get its output-led-forward spill over effect.

Besides both backward and forward direct linkage effects, the project will have indirect impacts on the economy of Meghalaya and Bangladesh.

The project would help in reducing the unemployment problem by generating employment opportunities for local people. The project is likely to generate secondary and tertiary employment along with the primary employment within the project. Most of labourer respondents of the area, complained that they do not get full-time employment through out the year. The proposed project would be in a position to provide full-time employment to the labourers throughout year. In the local labour market, wage rate is not fixed. When an organized sector like LMMPL would offer employment to its labourers at a reasonable wage rate, it is likely that wages would increase and stabilize in other areas for the benefit of poor people of the area.

The gainful employment of the people may induce investment in other economic sectors and thereby increase the demand for goods of mass consumption. Due to increase in cash-flow, opportunities for self employment would increase in the area. This will further increase the trade and commerce activities and help in raising the overall living standard of the people of the region.

DISCUSSION

Impacts of the Project

The project is expected to contribute positively to the socio-economic development of the project area. Besides creation of basic infrastructure and employment opportunities, the project will have the following positive impacts on the locality: (i) Economic benefit to the village community, District Council, State and central Governments in the form of royalty, cess and other taxes; (ii) Improvement of trade relations with the neighbouring country; (iii) Community development works such as establishment of educational and health care facilities to be taken up by the company; (iv) Success of the project may encourage more investment/international collaborations in the region; (v) Increased economic activity due to forward and backward linkages of the project.

The following negative impacts are anticipated due to the mining project: (i) Construction and operation of rope way: Land acquisition (84 sq. m) for pillars and hazards of falling of limestone from the rope way baskets during transportation; Dust emission during transport; (ii) On-site storage of the uncrushed/crushed limestone causing undesirable change in the landscape; (iii) Emission of dust during mining, crushing and loading; (iv) Wastewater from mining and sewage discharge from housing colony; (v) Solid wastes up to 500 t per day; (vi) Removal of vegetation; (vii) Noise produced from blasting and operation of machines; (viii) Slurry due to spraying of water; (ix) contamination of river water and possible effect on human and aquatic life; (x) Influx of outsiders.

Mitigation Measures

The limestone deposits at the mining site are devoid of overburden and therefore, dust generation would be considerably less. Even then, the following mitigation and pollution control measures should be adopted so that air pollution levels may not alter baseline environmental characteristics in case of ambient air :

- (i) Black topping of all life haul and service roads.
- (ii) Water spraying before and after drilling and blasting operations and use of right system such as blasting by effective stemming using millisecond detonators.
- (iii) Proper deployment of heavy equipments and machineries to reduce gaseous emissions.
- (iv) Water spraying in haul roads, service roads, overburden (if any), coil dumps and the transfer points of limestone handling.
- (v) Provision of dust collectors at drills and at transfer points in limestone handling.
- (vi) Provision of green barriers.

Water shall be used for suppression of dust generated during blasting and other mining operations. Wastewater treatment facilities for settlement of suspended solids and separation of oil and grease from the effluents shall be provided at the mining site. Septic tanks and soak pits should be provided with each house of the residential quarters so that no additional provision shall be required for domestic effluent treatment.

Noise due to blasting should be reduced by using Delay Detonators. Secondary blasting to be reduced to the minimum by use of hydraulic rock-breakers. CT-series Cummins Engines are to be preferred for earth moving equipment. Efficient maintenance of silencers at all times is another measure to be adopted for keeping the level of noise to a minimum.

To minimize vibration, delay detonators should be used and throw of material should be controlled by using inclined blast holes. Inflammable materials like High Speed Diesel and Lubricants should be stored properly. During storage and use of explosive, the provisions of the Indian Explosive Act and Rules and also the provisions of the Mines Act and rigorously trained in handling of explosives and to follow the rules strictly. The storage place for fuel and lubricants should be provided with fire fighting equipments, materials and warning notices.

The waste material should be spread over the dump uniformly through leveling and consolidation so that the dump rises only about 1.5 m per annum. For safety and to check the flow of the material to the surroundings, the dump should be benched so that each bench is not more than 6 m height.

Occupational Health and Safety Measures

The surface limestone mining and its associated activities can result in air pollution which may have the following effects: (i) Dust particles below 10 micron size may cause pulmonary diseases like pneumoconiosis, silicosis etc. ; (ii) Suspended particulate matter along with the dust particles may reduce the visibility range;

In order to reduce the impact of noise from the quarrying equipments and blasts, the following mitigating measures should be undertaken: (i) Regulating spacing between noise sources and between operators; (ii) Providing ear defenders for the workers involved in blasting and working near pneumatic machines.

To prevent health hazards, dust suppression by wet spraying should be adopted. respirators, goggles and earplugs should be used by the concerned workers. First aid stations and ambulance to be maintained and first aid training programmes are to be organised.

Environmental Management Plan

Based on the findings, a comprehensive Environmental Management Plan was recommended which included the followings :

- (i) reclamation of mined areas through plantation of fast growing indigenous tree species such as, *Duabanga grandiflora*, *Erythrina stricta*, *E. indica*, *Holarrhena antidysenterica*, *Sterculia villosa*, *Dillenia indica*, *mmelina arborea*, *Toona ciliolata*, *zanthoxylum sp.*, *Albizia procera*, *Acacia mangium*, *Bauuhina purpurea*, *castanopsis* spp. etc.
- (ii) establishment of a green belt: An area of 100m width surrounding the whole 100 ha mining plot will be demarcated for undertaking aided natural regeneration of the existing species duly mixed with the dust tolerant fast growing tree species so tha a permanent green belt can be created. Currently, the proposed land has very sparse tree growth intercepted with blank areas. The proposed green belt will help reduce air and noise pollution arising from the mining operation.
- (iii) Conservation of a biodiversity-rich forest patch: The south-west corner of the proposed mining plot has a deep cavern where the depth of limestone deposit is very thin, but has a deep cavern where the depth of limestone deposit is very thin, but has high plant diversity. This would be helpful in conserving plant biodiversity on one hand and reduce pollution level on the other.
- (iv) Compensatory afforestation : Two barren plots of 200 ha area in Nongtrai and mawdet villages were recommended for afforestation using multipurpose tree species as a compensatory measure.
- (v) Environmental management and waste minimization cell: A high-level environment management cell and a waste minimization cell were recommended to look into all the environmental aspects of various mining activities and waste minimization process, respectively.
- (vi) Risk analysis and emergency preparedness plan and an environmental monitoring plan.

The anticipated environmental impact of the project was considered to be within the prescribed limits. With the adoption of various mitigation measures and environmental management plan, as discussed above,

the adverse environmental impact of the project can be kept at minimum. Therefore, the study recommended the implementation of the mining project after incorporating the suggested measures.

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ENVIRONMENTAL POLLUTION MANAGEMENT IMPLEMENTATION IN DHANSIRI VALLEY PROJECT (DVP), ONGC LTD, JORHAT (ERBC), ASSAM

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ABSTRACT

Oil industry integrates its operations with environment for a coherent relationship between industry and ecosystem. The immediate tools available are : (i) proactive environment management programme, (ii) environment impact and performance parameter monitoring (iii) environmental auditing of operational facilities, and (iv) recycling/waste minimisation. DVP, Jorhat implements environmental monitoring in and around its oil fields and production installations rigorously to meet statutory obligations. The amount of gaseous effluent like carbon-monoxide less than 1 ppm, suspended organic matter between $41-127 \mu\text{gM}^{-3}$, sulphur dioxide between $1.0-6.0 \mu\text{gM}^{-3}$ nitrogen oxides between $32-84 \mu\text{gM}^{-3}$ and hydrogen Sulphide below detection limits in air sample collected at Borholla GGS and Rig-E-T60-X confirm to National Ambient Air Quality Standards by Central Pollution Control Board. The periodic analysis of liquid drilling fluid effluent, conducted by Regional Laboratory, Sibsagar indicated dissolved solids, suspended solids, and C.O.D. values, confirming to Minimum National Standard, MINAS/IS-2490 specifications. DVP, Jorhat has adopted a "self-control" approach for environmental monitoring for pre-and post-project oil operations.

INTRODUCTION

The hydrocarbon exploration has culminated in development of several major and marginal oil fields in Oil & Natural gas Corporation LTD (ONGC). Dhansiri Valley Project (DVP), Jorhat which was setup to intensify exploration activities of the southern part of Assam Shelf in Dhansiri Valley and its adjoining area in Schuppenbelt, (Sharmah D.N. 1995), has two marginal oil fields i.e. Borholla-Champang and Khoraghat under its operational control. Borholla-Champang field in DVP has the distinction of first oil field in India to produce from fractured granite basement. The hydrocarbon resource exploration activities do interact with environment and there by result in its deterioration and degradation. Environment pollution in oil exploration and production can not be eliminated totally, but can be minimised considerably. In line with ONGC's commitment to maintain ecological balance and protection of environment around its work centers, DVP has made concerted efforts to implement various environmental protection measures to take remedial action during project formulation and implementation stages itself to deal with pollution control authorities and on occasions avoid unnecessary confrontations with environmentalists and general public residing nearby operational areas. Present paper describes the strategies for monitoring environment pollution in and around its Borholla oil field.

ENVIRONMENT POLLUTION MITIGATION APPROACHES AND OPTIONS

Oil industry has revised its approach to environment management from compliance-driven gaseous and liquid effluent treatment to that of a pro-active waste reduction and waste management strategies. Produced-consumed-disposed approach which prevailed for a long time in oil industry, is experiencing a shift towards preventive environment pollution control. 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). This has created a drastic change from "pollutor pays" to "pollution prevention pays" concept. With the national Safety and Environmental legislations becoming more stringent, especially after the enactment of Environment Protection Act and several other regulations attached to it, the need for "self-regulatory controls" has gained importance. The mechanism of "Self regulatory control" is two fold. One, the project proponents are required to monitor effluents' disposal to environment and any contravention in environmental pollution norms. Second, - it is also required to periodically forward this data to state and central regulatory authorities. This dual mechanism places greater responsibility on project's safety & Environment Management (SEM) cell.

Dhansiri Valley Project (DVP) has adopted "self regulatory control" approach, in line with ONGC Ltd's commitment to environment. Today common man also demands protection from environmental pollution caused by oil industry. Appreciation for self-regulatory need of Environment and safety has shot-up not only for the sake of satisfying stipulations laid down by regulatory agencies, but as a socio-economic compensation paid

due to contraventions of statutory laws. Hence, recommended code of practices (RCP) and oil mines regulations (OMR), serving as references, some of the environmental pollution checks are observed in-built, with development activities itself at DVP, Jorhat.

POLLUTION PROBLEM IDENTIFICATION

Pollution controls are aimed at two areas, (a) pollution that are emitted to surrounding environment, which may endanger public health or property, and (b) those, which are generated and emitted within project's working area, and pose hazard to the employees. A clear-cut definition of pollution problem is necessary, before considering specific controls (Sharma, J.S. 1994), as it is the responsibility of polluter/organisation to meet all governmental regulation as well to avoid the threats of shut-downs and fines. The relationship between public and Oil industry (the Public Liability Insurance Act 1991) should be on sound basis. Giving highest priority to environment pollution abatement, DVP, Jorhat undertook a careful identification of the problem with the help of IPSEM (Institute of Petroleum Safety and Environment Management), Goa through actual tests performed at the site of existing facilities in Borholla field for Ambient Air Quality monitoring and concept implementation. To maintain the culture of carrying out exploration and production activities in eco-friendly environment, similar studies are being undertaken in Khoraghat field of DVP also, along with noise pollution survey this year. This lays strong emphasis on balance between resource consumption and waste discharge that can be sustained in DVP's operational areas without progressively impairing bio-productivity and ecological integrity.

SELECTION OF PERFORMANCE PARAMETERS

In the context of environmental pollution, monitoring has a general meaning i.e. repeated measurement of existing or fixed norms against references, so that changes over a time frame are followed (Preston, 1975) and information is gained about the present deviants in levels of potentially harmful pollutants in effluents and discharges to environment. Though, there is no single and universally accepted monitoring programme, to start with, project details, objectives of monitoring and available resources are helpful parameters to adopt one. In ideal situations, the need to integrate operational functions with ecosystem will depend upon coherence between environmental studies before project formulations and environmental studies during operations. Post production stage studies are generally adopted to off-set initial damage to ecosystem.

A detailed feasibility study from environment angle was set up by ONGC Ltd. to assess the adverse impact of organisation's activities in Assam and to suggest the remedial measures (majumdar N. et al., 1996). The Committee in its operational and technical findings recommended that each field must have properly designed ETP/ETPs to treat liquid waste from work centres under its command. The effluent from the pit be regularly treated and then recycled or disposed off. The gaseous emissions be monitored for ambient air quality standards. In tune with the study's recommendations DVP, Jorhat has installed a fixed design conventional technology ETP of 80 M³ capacity for drill-site liquid waste/effluent treatment and disposal at Borholla field where most of the rigs are operational.

A study conducted by Sharma and Choudhury (1985) on upper Assam oil fields of ONGC in Sibsagar district have reported sulphation and nitration values below permissible levels as per national Ambient Air quality Standards (NAAQS) in most of the operation areas in eastern region. But these levels are reported high in mixed use type of areas where industrial as well as anthropogenic activities are going on. In line with aforementioned study DVP, Jorhat entrusted IPSEM to conduct an Ambient Air Quality Monitoring around Borholla field. The objective of this study was to form a database for submission to statutory bodies such as PCB and Ministry of Forest and Environment, as and when required. It may also serve as status level report on air quality around installations in Borholla field for future reference (Jayaraman P.S. et al., 1996).

METHODOLOGY

The details of methodology, selection of sampling stations, duration of study and meteorological parameters were selected by IPSEM. High Volume Air samplers (NPM-HVS-M/S Netel chromatographs) were used for sampling of suspended particulate matter (SPM) and common air pollutants viz. NO_x, SO₂, H₂S. Glass fibre fillers (GFA-whatman) were used for collection of SPM. Standard methods of analysis were employed for determination of NO_x, SO₂ and H₂S spectrophotometrically (WHO 1976, IS-5182). A UV-Vis-spectrophotometer

(Shimadzu) was used for determination of NO_x , SO_2 and H_2S . Carbon Monoxide was monitored using a carbon monoxide detector (Co-2000, Endee Engineering Pvt. Ltd.) with a lower detection limit of 1 ppm. Samples were collected for three consecutive days on 24 hourly basis in each installation and were analysed for NO_x , SO_2 and SPM (Jayaraman P.S. et al. 1996). The treated effluent from Borholla ETP is tested for its acceptability for disposal and reuse as per IS-2490 (Pal et al., 1995).

OBSERVATIONS AND DISCUSSION

Major gaseous pollutants emitted in air are CO, CO_2 , sulphur-oxides, nitrogen oxide, 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.

The data on Ambient Air Quality around Borholla field presented in Table - I clearly indicates that the suspended particulate matter (SPM) values range between 41-81 μgM^{-3} for Rig E 760 - X and 20-127 for G.G.S (A range of values is depicted in Table-I, as these observations were made on four different dates from same sample area). These values are within the permissible limit of National Ambient Air Quality Standards (NAAQS) of CPCB. The ranges of NO_x values are from 27 - 84 μgM^{-3} , SO_2 concentration ranges from 1.0-6.0 μgM^{-3} . As the sampling was done within the drill site area itself, the air quality can be compared with the standard set for industrial area. From the data from Table-I, it is clear that these values are well within the prescribed permissible level of NAAQS for industrial and residential areas. Concentration of hydrogen sulphide was found to be not in detectable range in the study area during the entire period of study. This implies absence of any source of H_2S in and around drill site installations. Concentration of CO in the air were also found to be below detectable limit i.e. less than 1ppm. From the data IPSEM has concluded that there is no appreciable impact on environment due to drilling activity in Borholla area of DVP. (Similar study with the help of IPSEM. Goa is also envisaged in other operational area of Khoraghat in Dhansiri Valley Project).

Pollution by liquid drilling effluents are managed by designing effluent pits of APCB desired capacity and capability i.e. made impervious by brick lining and high density polyethylene lining. Prolonged and heavy rains which are natural characteristic of North-East India, aggravates the pit overflow. The concept of oil-traps has been introduced to separate oil-slick/oil-patches on drillsites to imagine oil spills to nearby fields, hence saving costly compensations. The concept of recycling has been introduced by installing an effluent treatment plant (ETP) in Borholla-field. Central Pollution Control Board (CPCB) has formulated Minimum National Standards (MINAS) for eco-friendly effluent discharge. At DVP, treated effluent is regularly tested for MINAS levels, by ONGC's regional chemical laboratory at Sibsagar. The results (Table - II) 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.

CONCLUSION

The treated liquid effluent parameters from ETO, Borholla Confirm to MINAS/IS-2490 specifications. The concentration of air pollutants around Borholla field are well within the tolerance limits prescribed by NAAQS-1994 by CPCB. Pre and post-project environmental statutory obligations can be effectively met with a self regulatory "pollution-prevention pays" approach.

TABLE - I

AIR QUALITY DATA OF BORHOLLA AND NAAQS LIMITS

Location / Category	Concentration in micrograms per meter cube			
	SPM	SO ₂	CO	NO _x
<u>BORHOLLA FIELD</u>				
1. E-760-X rig	41-81	1.0-6.0	BDL	27-84
2. GGS	20-127	BDL-5.7	BDL	32-62
<u>AS PER NAAQS</u>				
1. Industrial & mixed use areas	500	120	5000	120
2. Residential & rural areas	200	80	2000	80
3. Sensitive areas	100	30	1000	30

* Specified by Central Pollution Control Board, New Delhi.

- Concentration of H₂S is below detection limit (BDL), therefore not reported.

TABLE - II

CHEMICAL CHARACTERISTICS OF TREATED WASTE WATER OF ETP, BORHOLLA & STANDARD TOLERANCE LIMITS

Chemical Characteristics	Tolerance Limits as per IS - 2490, 1981			
	Value	Into onland Surface	Into Public sewers	Onland for irrigation
pH	7.0	5.5-9.0	5.5-9.0	5.5-9.0
Dissolved solids (mg/L)	729	2100	2100	2100
Suspended solids (mg/L)	15	100	600	600
Chloride (mg/L)	160	1000	1000	1000
Sulphate (mg/L)	111	1000	1000	1000
C.O.D. (mg/L)	128	250	-	-
Oil/grease (mg/L)	Nil	10	20	10

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