

North-East **Biodiversity and** **Sustainable Economic Development** **Issues and Challenges**

Editors

Atul Kumar Gupta
Dhiman Daschaudhuri
Biswendu Bhattacharjee
M. Datta



Northeast India is one of the richest in biological values as geographical 'gateway' for much of India's flora and fauna being located at the confluence of Indian, Indo-Malayan and Indo-Chinese biogeographic regions meeting place of the Himalayan Mountains and peninsular India. The immense variety of the climatic, edaphic and altitudinal variations in Northeast have resulted in great range of ecological habitats, lowland-highland transition zones supporting the highest diversity of biomass or ecological communities, supporting extremely high species diversity.

While this immense diversity has fascinated mankind towards its exploration, it has also thrown tough challenges in effectively highlighting by means of studies, surveys, research etc. This edited volume is an attempt to humbly capture the vastness and greatness of this land of wonders through chapters depicting varied aspects and to enrich the horizon of knowledge and unravel a roadmap to utilise the available diversity for the sustainable development.

Dr. Atul Kumar Gupta, IFS (1982 batch) is MBA, Postgraduate in Zoology, Sociology, Forestry, Wildlife Management, and PhD from Cambridge University, U. K. Dr. Gupta is currently serving as PCCF & Chief Wildlife Warden, Forest Department, Government of Tripura, and also working as CEO & PD, Indo-German Project; MS, Tripura Biodiversity Board and VC, State Medicinal Plants Board.

Er Dhiman Daschaudhuri an Agricultural Engineer from Marathawada Agricultural University, Parbhani, Maharashtra is now working as Technical Officer in Agrometeorological Advisory Services of ICAR Research Complex for NEH Region, Tripura Centre. He has 15 years of working experience in Agrometeorological Research.

Biswendu Bhattacharjee is post graduate in Journalism and Mass Communication. He has authored several books on environment science for secondary students of Tripura besides practicing professional journalism over past one and half decades in nationally and internationally renowned media organisations.

Dr Mrinmoy Datta had Ph.D. in Soil Science & Agricultural Chemistry from the University of Calcutta and is currently Joint Director in Tripura Centre of ICAR Research Complex for NEH Region. Dr. Datta has 34 years of research experience in the domain of Soil Chemistry and Soil Fertility, Agroforestry, Farming System Research and Agrometeorology.

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Atul Kumar Gupta
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*This Edited Volume is dedicated
to
Late Professor Amitabh Sinha*

Foreword

Tripura, a hilly State in North-East India with nearly 60 per cent forest cover can be a great location for biodiversity conservation. The factors that operate against biodiversity conservation in this State are its high population density (350/sq. km) and their dependency on the natural resources for survival. Agriculture and allied activities are the mainstay of the economy and provide employment to about 64 per cent of the population. Food crop production dominates the agricultural sector (62%) followed by cash crops such as tea and rubber. In the context of understanding the biodiversity values crucial for the well-being of the people of Tripura and North-East India, and the threats these values face, the workshop convened on the Environment Day on 5th June, 2010 by ARPAN, Tripura has become extremely relevant. It is notable that 61 per cent of the authors of the 18 abstracts that were submitted for the workshop were from Tripura.

The topics presented were varied but important. Some covered broader topics like biodiversity and its values, biodiversity conservation in North-East India with reference to Tripura, and fresh water biodiversity in North-East India with reference to Tripura. Their findings seem to suggest that high income countries are not technically more efficient in maintaining biodiversity and the diverse climatic regime of Tripura could be the basis for its rich biodiversity. Since Tripura is largely an agricultural State, knowledge on experiments on bacterial wilt disease affecting tomato and information on seed protein variability in diverse indigenous rice varieties become exceedingly important. Methods for conservation agriculture in North-Eastern Hill regions have been suggested and it appears that indigenous conservation

practices in Nagaland have increased economic returns from the field by three-fold.

The people of North-East India, live close to nature and have great faith in the curative properties of medicinal plants, and this is evident in some of the abstracts presented. More than 270 species of medicinal plants have been identified in Tripura which give the State a unique position in traditional systems of medicine. Another Chapter discusses 28 edible fruit plants in Cachar district in Assam which have medicinal properties against dysentery, jaundice, diabetes, stomach disorders, cough, and fever. Some of these plant products also have anti-septic properties, can cure skin diseases and purify blood. Over the past few decades, an increasing prevalence of antibiotic resistant strains of bacteria has underscored the need for alternatives. It has been reported that several members of the Rubiaceae family, 48 genera out of 611, have anti-bacterial properties which would be vital for strengthening the health of mankind. When the world faces increasing incidents of cancer affecting people of all age classes it is comforting to know that anthocyanins isolated from the corms of taro (*Colocasia* sp.) are reported to have anti-inflammatory and anti-oxidant properties which could protect the intestine from carcinogens.

During the workshop, suggestions emerged from a number of other topics which were discussed. Fish conservation in North-East India's rivers, and for that matter in any river system in India, may need modern tools like GIS and remote sensing but for the fish populations to thrive there should be controlled over unregulated fishing particularly in the spawning grounds. Besides, habitats should be protected from over-exploitation, especially excessive sand collection, garbage disposal and pollution. Exotic harmful weeds such as *Ipomoea carnea* and *Eichornia crassipes* should be eradicated from aquatic systems. If there are species like mahseer, cat fishes and murrel, the concerned agencies could think about promoting sport fishing which can bring in benefits to the local population and paving the way for the protection of fishes and their habitats. The problem of E-waste, which is hazardous to the environment, was highlighted and needs to be addressed. It has also been suggested during the workshop that the media which reports on environmental issues could be much more effective if it were united in fighting for the cause of biodiversity conservation.

I admire and wish best wishes to the organizers of the Workshop for taking pains to organize this workshop which has led to this volume containing valuable information for strengthening conservation in North-East India. I congratulate the entire Editorial team led by Dr. A. K. Gupta, a forester, wildlife biologist and conservationist for bringing together this volume of valuable and informative Chapters that will not only be useful to the scientists but also would make an interesting and informative reading to the general public for raising awareness towards conservation of biodiversity.

Dr. A.J.T. Johnsingh
Naturalist
Ex Dean, Wildlife Institute of India, Dehradun
Nature Conservation Foundation
Mysore and WWF (India)

Preface

North-East India (2,62,040 km²) comprising of the States of Arunachal Pradesh, Assam, Meghalaya, Manipur, Tripura, Mizoram, Nagaland and Sikkim can be physiographically categorized into the Eastern Himalayas, North-east hills, the Brahmaputra and Barak valley plains. The region has a wide diversity of zonation, viz., agro-climatic zones, Alpine Zone, Temperate Zone, Sub-tropical Hill Zone, Sub-Tropical Plain Zone, Mild Tropical Humid Hill Zone and Mild Tropical Humid Plain Zone. The region is also the abode of approximately 225 out of total 450 recorded tribes in the country. The cultural and customary variations and differentiations have an important role in understanding biodiversity conservation and management issues. The region is rich in medicinal plants and many other rare and endangered taxa. Its high endemism in higher plants, vertebrates and avian diversity has qualified it to be a biodiversity hotspot. A total of 51 Forest types have been identified in the region that are broadly classified into six major forest types, viz., tropical moist, deciduous forests, tropical semi-evergreen forests, tropical wet evergreen forests, subtropical forests, temperate forests and alpine forests. Out of the 9 important vegetation types of India, 6 are found in the North-Eastern region. These forests harbour 40 out of 54 species of gymnosperms, 500 out of 1,012 species of Pteridophytes, 825 out of 1,145 species of orchids, 80 out of 90 species of rhododendrons, 60 out of 110 species of bamboo, 25 out of 56 species of canes. In terms of floral species richness, the highest diversity is reported from the States of Arunachal Pradesh (5,000) and Sikkim (4,000) amongst the North Eastern States belonging to about 200 families out of 315 recorded from North-East India. Some of the families such as *Nepanthaceae*, *Illiciaceae* and *Clethraceae* are

unique in the world. These families are reported from the South-East Asian countries and are represented by a limited number of species like *Clethra* sp. and *Nepenthus khasiana* in North-East India. It is pertinent to mention that 10 per cent of the total flowering plants in the country are endangered. Of the 1500 endangered floral species, 800 alone are reported from North-East India. The faunal diversity is also varied in nature. However, the recent discovery of new faunal species across the North-Eastern regions [such as the *Tawang Macaque* (*Macaca* spp.), extended range the Chinese goral (*Nemorhaedatus caudatus*), and leaf deer (*Mentiacus putaoensis*)] calls for immediate actions for more extensive research and systematic documentation of biodiversity of the North-East.

The main stay of economy in the entire North-East India is agrarian in nature and, therefore, agriculture has been one main source of livelihood amongst the hills and the plain tribes. About 63.3 per cent of the total geographical area in the North-East is under forest cover, 5.38 per cent of the area is being used for non-agricultural purposes, 9.06 per cent is reportedly barren land, 6.64 per cent is the uncultivated land excluding fallow and only 15.31 per cent is the net sown area in the region. The settled agriculture is supplemented, rather overshadowed at places by the shifting cultivation, locally called *jhuming*, which is practiced by many tribal groups. *Jhuming*, wherein as many as 35 varieties of crop is raised on single plot, may be ranked as one of the most ancient systems of farming believed to have originated around 7000 BC in the Neolithic period. That the *jhuming* has survived so long is an indication of its intimate and intricate linkages with the ethos of the social and cultural values of the tribal communities.

This edited volume *North-East Biodiversity and Sustainable Economic Development* is a collection of papers from across the region presented and discussed in a National Symposium organized to observe the Environment Day. The chapters describe and explore wide range of topics in the domain of biodiversity highlighting issues and challenges, threats to biodiversity, role of media in conservation of biodiversity, biodiversity and human interference and finally socio-economic issues and biodiversity. The sustainable development of the region mainly depends upon agriculture and allied activities, of which rich biodiversity of the region provides much needed food security to the people who are away from mainstream development. Agriculture sector in North-

Eastern region (NER) provides livelihood to almost 84 per cent population but it accounts for only 30 per cent of Net State Domestic Product (NSDP). Contribution of this region to national foodgrain production is hardly 1.5 per cent, which is insufficient to sustain 3.8 per cent of country's population. Though agriculture in NER grew at a much higher rate (3.8%) than the average for the country but still the region has to import foodgrains for its consumption. As the region hosts species-rich tropical rainforests and supports diverse flora and fauna and several crop species, the present volume is an attempt to present the readers a treasure in this direction, would definitely help the readers to enrich the horizon of knowledge and unravel a roadmap to utilise the available diversity for the sustainable development in the region to address the issue of poverty alleviation thus helping fulfilling one of the major goals of Millennium Development Goals in the region and overall across the South-East Asia.

Editors

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It gives us the immense pleasure to express our deep gratitude to Sri Jitendra Chaudhury, Hon'ble Minister for Forest, Government of Tripura, Shri Pabitra Kar, Hon'ble Member, Tripura Legislative Assembly, Tripura & Chairman, Tripura Industries Development Corporation, and Sri R.P. Tangwan, IFS, the then Principal Chief Conservator of Forest, Government of Tripura for kindly consenting to be the Patrons of the Organizing Committee for National Seminar on Biodiversity held at Agartala, Tripura during June 5-7, 2010. The seminar was organized to address the issues of implications of forestry in economy with rising societal demands on a sustainable basis. The deliberations were also made on topics addressing how to minimize the gaps between the demand and supply for the forest based products linked very intimately with the livelihoods of the forest dependent communities, with special focus on Tripura.

We express our deep sense of gratitude to the members of the Advisory Board, namely, Dr A K Gupta, IFS, PCCF & CWLW; Dr M Datta, Joint Director, ICAR, Tripura Centre; Dr S N Sen, Director, Department of Agriculture; Dr C Bandopadhyay, Director, Department of Horticulture; Shri P Biswas, IFS, Conservator of Forest; Dr J R Dhanze, Dean, College of Fisheries; Dr K Sasikumar, IFS, CEO, Medicinal Plant Board; Sri Pranab Sarkar, Secretary, Agartala Press Club for their valuable suggestions and guidance for successful organization of the event.

Our heartfelt thanks are also due to ONGC, Tripura Asset; Tripura State Pollution Control Board; NEEPCO; TIDC Ltd.; and Tripura Biodiversity Board for their financial contributions and technical and administrative support for organizing the event.

We are equally indebted to every member of Organizing

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Editorial Team

Contents

<i>Foreword by Dr. A.J.T. Johnsingh</i>	vii
<i>Preface</i>	xi
<i>Acknowledgements</i>	xv
<i>List of Contributors</i>	xxi
<i>A 20 Point Recommendations for Sustainable Biodiversity in Tripura</i>	xxv

Part 1

BIODIVERSITY: ISSUES AND CHALLENGES

1. Biodiversity for Prosperity: Unique Assemblage of Biodiversity and Conservation Challenges in Northeast India, with Special Reference to Tripura <i>A.K. Gupta</i>	3
2. Biodiversity Conservation : North-East India with Focus on Tripura <i>A.K. Ghosh</i>	37
3. Freshwater Biodiversity of North-East India with Special Reference to Tripura Issues, Challenges and Conservation Strategies <i>Ratan K. Saha</i>	43
4. Climatic Resources for Sustainable Biodiversity in Tripura <i>D. Daschauthuri and M. Datta</i>	61
5. Diversity of Fishes of Barak Drainage using GIS and Remote Sensing as a Tool for their Conservation <i>Anjam Hussain Barbhuiya</i>	74

6. Biodiversity Conservation Intended to Socio-Economic Development in Nagaland 94
Swati Biswas, G.C. Munda, Anupam Misra, S.V. Ngachan, P. Chowdhury, and R.K. Singh
7. Antibacterial Activity of Some Plants belonging to the Family Rubiaceae : A Review 124
Katyayani Dutta Choudhury and M. Dutta Choudhury
8. Resource Conservation in Agriculture and its Practices in NEH Region 139
Mandira Chakraborti, A.K. Singh and M. Datta

Part 2

THREAT TO BIODIVERSITY

9. Varietal Screening against Bacterial Wilt Disease of Under Subtropical Humid Climate of Tripura 151
Pranab Dutta, Britan Rahman and A.K. Singha
10. e-Waste : Downside of e-Revolution 155
Sajal Debnath

Part 3

ROLE OF MEDIA IN CONSERVATION OF BIODIVERSITY

11. Biodiversity and Media Advocacy 169
K.V. Nagraj
12. Media Advocacy for Biodiversity Conservation Study on North-East 176
Biswendu Bhattacharjee and Deepak Upadhyaya
13. The Role of SHGs in Propagation of Information to Rural India with Special Reference to Tripura 185
Bijit Debbarma
14. Biodiversity and Media Advocacy Concerns: A Few Reflections 192
Deepak Upadhyaya

Part 4
BIODIVERSITY AND HUMAN INTERFACE

- | | |
|--|-----|
| 15. An Account of Local Rice Germplasm for Abiotic Stress Tolerance in Tripura
<i>M. Datta, S.P. Das and S.V. Ngachan</i> | 207 |
| 16. Genetic Variability and Contribution of Seed Protein Content in Diversity of Some Indigenous Rice Germplasm from North-Eastern Region of India
<i>Krishnendu Chattopadhyay, Avijit Das and S.P. Das</i> | 222 |
| 17. Edible Fruit Plants of Cachar District, Assam and their Ethno-Medicinal Uses
<i>M.K. Baruah, G. Chakraborty, P.D. Choudhury, K.D. Choudhury, and M. Dutta Choudhury</i> | 228 |
| 18. Biodiversity of Mushroom in Eastern Region of India
<i>Jai Prakash Sharma</i> | 236 |
| 19. Bioactivity of Colocasia species
<i>Saswati Roy, Rumki Nath and M. Dutta Choudhury</i> | 270 |
| 20. Performance of Certain Upgraded Poultry Variety in Agro-Climatic Condition of West Tripura
<i>N. Islam, P. Dutta, S. Malik and A.K. Singha</i> | 283 |
| 21. Diversity of Flowers in North-East India
<i>L.C. De and R.P. Medhi</i> | 290 |
| 22. One Decade Study Report on Diversity Status of Turtle Fauna and their Conservation Initiative in Northeast India
<i>Kulendra C. Das</i> | 309 |

Part 5
SOCIO-ECONOMIC ISSUES AND BIODIVERSITY

- | | |
|--|-----|
| 23. Impact of Economic Crisis on Tribal Society, Degeneration of Traditional Institutions, Pattern of Social Change in Tribal Society
<i>Jitendra Chaudhury</i> | 337 |
|--|-----|

xx	<i>North-East Biodiversity and Sustainable Economic Development</i>	
24.	Biodiversity, Demography and Economy : An Exploration of Linkages <i>Amitabha Sinha</i>	348
25.	Biodiversity of Medicinal Plants in Tripura and their Problems and Need for Conservation <i>Sukhen Chandra Das and A.K. Deb</i>	357
26.	Biodiversity : The Indian Scenario and its Value to Our Society <i>P. Biswas</i>	384
27.	Organisations and Environment <i>Bijit Debbarma</i>	398
	<i>Index</i>	409

List of Contributors

- Barbhuiya, Anjam Hussain**, Research Scholar, Department of Life Science, Assam University Silchar-11
E-mail: anjam.barbhuiya@gmail.com
- Baruah, M.K.**, Department of Botany, Cachar College, Silchar-788001, Assam, India
E-mail: mkb_taxonomy@rediffmail.com
- Bhattacharjee, Biswendu**, Correspondent, United News of India, Agartala Bureau, Tripura, Regular Contributor, Times of India
E-mail: biswendu.tripura@gmail.com
- Biswas, P.**
- Biswas, Swati**, Research Associate, NAIP Comp-III, Division of Agronomy, ICAR Research Complex for NEH Region, Umroi Road, Umiam-793103, Meghalaya
E-mail: swati0biswas@gmail.com.
- Chakraborty, G.**, Department of Botany, Cachar College, Silchar-788001, Assam, India.
- Chattopadhyay, Krishnendu**, Crop Improvement Division, Central Rice Research Institute, Cuttack, Orissa-753006
E-mail: krishnendu_c@sify.com
- Chaudhury, Jitendra**, Ministry for Forest, Rural Development, Industries & Commerce, Government of Tripura
E-mail: chaudhuryj@hotmail.com
- Choudhury, K.D.**, Department of Life Sciences, Assam University, Silchar-788011.
- Choudhury, Katyayani Dutta**, Ethnobotany and Medicinal Plant Research Laboratory, Department of Life Science and

Bioinformatics, Assam University. Silchar-788011
E-mail: katyayanidc@gmail.com

Choudhury, M. Dutta, Ethnobotany and Medicinal Plant Research Laboratory, Department of Life Science and Bioinformatics, Assam University, Silchar-788011.

Choudhury, P.D., Department of Botany, Cachar College, Silchar-788001, Assam, India.

Chowdhury, P., Technical Officer, Division of Agricultural Engineering, ICAR Research Complex for NEH Region, Umroi Road, Umiam-793103, Meghalaya.

Das, Avijit, ICAR Research Complex for NEH Region, Tripura Centre, Lembucherra.

Das, S.P., Sr. Scientist, ICAR Research Complex for NEH Region, Lembucherra, Tripura-799210.

Das, Sukhen Chandra, Assistant Professor, College of Agriculture, Lembucherra, Tripura-799210, Tripura, India
E-mail: sukhenchandra@rediffmail.com

Daschadhuri, D., Technical Officer (Agromet), ICAR Research Complex for NEH Region, Tripura Centre, Lembucherra-799210, Tripura
E-mail: dhiman.neh@gmail.com.

Datta, M., Joint Director, ICAR Research Complex for NEH Region, Lembucherra, Tripura-799210
E-mail : mdatta2@rediffmail.com.

De, L.C., NRC for Orchids, Pakyong-737106, Sikkim.

Deb, A.K., Medicinal plants Board of Tripura, Forest Research Division, Gandhigram, Agartala-12, Tripura, India.

Debbarma, Bijit, Lecturer, Department of Management, Tripura University, Suryamanninagar-799130 E-mail: bijitdb@yahoo.com.

Debnath, Sajal, Faculty of Information Technology, Department of Management, Tripura University.

Dutta, P., Programme Coordinator, Divyodaya KVK-West Tripura, Chebri-799207.

Dutta, Pranab, Programme Coordinator,

Ghosh, A.K., Centre for Environment and Development, 329,
Jodhpur Park, Kolkata 700068
E-mail: cedkolkata@yahoo.com.

Gupta, Atul Kumar, PCCF, Forest Department of Govt. of Tripura,
Agartala.

Islam, N., SMS-Animal Science
E-mail: nurul1977@gmail.com

Malik, S., Senior Scientist-Poultry Division, ICAR RC for NEH
Region, Tripura Centre.

Medhi, R.P., NRC for Orchids, Pakyong-737106, Sikkim.

Misra, Anupam, Principal Scientist and Head, Division of
Agriculture Extension, ICAR Research Complex for NEH
Region, Umroi Road, Umiam-793103, Meghalaya.

Munda, G.C., Principal Scientist and PI, NAIP Comp-III, Division
of Agronomy, ICAR Research Complex for NEH Region, Umroi
Road, Umiam-793103, Meghalaya.

Nagaraj, K.V., Head, Department of Mass Communication, Assam
University, Silchar.

Nath, Rumki, Ethnobotany and Medicinal Plants Research
Laboratory, Department of Life Science, Assam University,
Silchar-788011
E-mail: rumki_nath2000@yahoo.com

Ngachan, S.V., Director, ICAR Research Complex for NEH Region,
Lembucherra, Tripura-799210.

Ngachan, S.V., Director, ICAR Research Complex for NEH Region,
Umiam, Meghalaya, Umroi Road, Umiam-793103, Meghalaya.

Rahman, Britan, SMS, Krishi Vigyan Kendra, Chebri-799207, West
Tripura.

Roy, Saswati, Ethnobotany and Medicinal Plants Research
Laboratory, Department of Life Science, Assam University,
Silchar-788011
E-mail: roysaswati97@gmail.com.

Saha, Ratan K., Department of Fish Health and Environment,
College of Fisheries, Central Agricultural University,
Lembucherra, Post Box No. 60, Agartala.
E-mail: ratankumarsaha123@rediffmail.com

Sharma, Jai Prakash, ICAR Research Complex for Eastern Region,
Research Centre, Plandu, Ranchi, Jharkhand-834010.
E-mail: jaibina_05@yahoo.co.in,
dr.jai.prakash.sharma@gmail.com

Singh, R.K., Senior Scientist (SWCE) and Head I/c, Division of
Agricultural Engineering, ICAR Research Complex for NEH
Region, Umroi Road, Umiam-793103, Meghalaya.

Singha, A.K., Senior Scientist, Zonal Project Directorate, Zone-
III, ICAR RC for NEH Region, Umium (Barapani), Meghalaya-
793103.

Singha, A.K., Sr. Scientist, ZPD, Zone-III, ICAR, Umium
(Barapani), Meghalaya-793103.

Sinha, Amitabha, Reader, Department of Analytical Applied
Economics, Tripura University, Agartala
E-mail: omitabha@gmail.com

Upadhyaya, Deepak, Assistant Professor, Department of
Journalism and Mass Communication, Tripura University,
Agartala-799130
E-mail: deepakupadhyaya81@gmail.com

A 20 Point Recommendations for Sustainable Biodiversity in Tripura

1. Detail documentation of aquatic biodiversity resources and issue based intervention.
2. Measures to contain the habitat loss of aquatic resources and conservation of natural wetlands.
3. Strict implementation of laws related to conservation of biodiversity.
4. Set Up Biodiversity Management Committee (BMC) at Block level on priority basis.
5. Beneficiary-wise, location-wise Register has to be made mandatory biodiversity resources.
6. Apposite steps to be taken for soil conservation especially to soil eco-system, soil health, checking soil and mapping of soil microbial diversity.
7. Steps to be taken for conservation of Rudrasagar and other wetlands with a comprehensive approach to strengthen Wetland Board.
8. Wetland conservation has to be incorporated in all development plans.
9. Agartala City urgently need of a Master Plan.
10. Agartala needs a practical approach for mobility plan.
11. Integrated plan for conservation of urban biodiversity.
12. A comprehensive training programme has to be framed on biodiversity and environmental issues for the working journalists.
13. Use micro media in awareness campaign.
14. Emphasis to be given on media sensitization.
15. *In situ* and *ex situ* preservation of Germplasm with special reference to rice.
16. Steps need to be taken for preservation of local *jhum* varieties of rice and vegetables.

17. Enhancement of sustainable medicinal plant research and ensure the codification under the provisions of Intellectual Property Right Act.
18. Promotion of Clean Development Mechanism (CDM) in Tripura for environmental sustainability.
19. Kerala model has to be replicated for promotion of eco-tourism in Tripura.
20. Develop and practice the mechanism of real value assessment of natural resources for the benefit of the local people.

Part 1
Biodiversity: Issues and Challenges

1

Biodiversity for Prosperity: Unique Assemblage of Biodiversity and Conservation Challenges in Northeast India, with Special Reference to Tripura

A.K. Gupta

Introduction

Northeast India (lying between 22-30 degree N latitude and 89-97 degree E longitude) is one of the richest in biological values and is considered as the geographical 'gateway' for much of India's flora and fauna, owing, mainly to its location at the confluence of Indian, Indo-Malayan and Indo-Chinese biogeographic regions and has been a meeting place of the Himalayan Mountains and peninsular India. The immense variety of the climatic, edaphic and altitudinal variations in Northeast India have resulted in a great range of ecological habitats, lowland-highland transition zone supporting the highest diversity of biomass or ecological communities where species diversities within these communities are also extremely high. Northeast India is considered a part of the [northward migrating] 'Deccan Peninsula' that first touched the Asian landmass after the breakup of Gondwanaland in the early Tertiary Period.

Northeast India is blessed with a wide range of physiography and eco-climatic conditions. The State of Assam has extensive flood plains, while Khangchendzonga in Sikkim stands 8586 m tall. Cherrapunjee in the State of Meghalaya holds the record for the highest rainfall in a single month (9300 mm) as well as the most in

a year (26461 mm) in India, while the nearby Mawsynram has the world's highest average rainfall (11873 mm). The forests in the region are extremely diverse in structure and composition and combine tropical and temperate forest types, alpine meadows and cold deserts. There are regions, for example, in the State of Sikkim, where the faunal assemblages also change rapidly from tropical to subtropical, temperate, alpine and finally to cold desert forms.

After the Andaman and Nicobar Islands and the Western Ghats, Northeast India forms the main region of tropical forests in India, especially the species-rich tropical rain forests. The tropical semi-evergreen and moist deciduous forests in the lowlands of this region extend south and west into the subcontinent, and east into Southern China and Southeast Asia. The subtropical forests extend from northern Pakistan and adjacent Afghanistan through Northeast India to Southwest China. Each of the eight States of the region namely Arunachal Pradesh, Assam, Meghalaya, Manipur, Mizoram, Nagaland, Sikkim and Tripura, boast of several endemics in flora as well as fauna. This region represents an important part of the Indo-Myanmar biodiversity hotspot, one of the 25 global biodiversity hotspots recognized currently (Ramakantha, Gupta & Ajith, 2003).

The Floral Diversity in Northeast India and Tripura

This region accounts for nearly 50 per cent of the total number of plant species in India as a whole, and about one third of total northeastern flora is endemic. However, this region also exhibits close affinity and resemblance with Indo-Malayan and other neighbouring and far off countries. In over 1.7 lakh sq. km of forest area in the northeast, more than 200 families (about 7500 species) out of a total of 315 families of angiosperms are represented in this region, and Sikkim support about 5000 species of flowering plants. It is considered that the northeastern region has been the originator of gene pools of citrus, banana, mango and rice. The pitcher plant (*Nepenthes Khasiana*) is endemic to Meghalaya and Siroy Lily (*Lilium mackiniae*) is endemic in the eastern border area of Manipur.

Presence of many primitive flowering plants (*Magnolia pealiana*, *M. gustavii*, *Manglietia sp.*, *Myrica esculenta*, *Corylopsis himalayana*, etc. and families, such as, Coriariaceae, Nepenthaceae, Tumeraceae, Illiciaceae, Rupiaceae, Siphonodontaceae and Tetracentraceae and

monogeneric are unique features of flowering plants in the northeast India. Among the species representing the tropical forests (located at Indo-Myanmar border), such as, *Dipterocarpus tuberculatus*, *D. turbinatus* and *Melanorrhoea usitata*, are few unique species *vis-à-vis* found in India elsewhere. Some of the northeastern states (Sikkim) exhibit floristic elements of Sino-Japanese near and far-off lands. Certain areas in the northeast region have also been responsible for Isolation of certain species. Northeast India has presence of about 700 species of orchids (34 of these are listed among the threatened plants of India) out of a total of 1300 in India (158 genera). Arunachal Pradesh alone has about 530 species of orchids, of which many are of medicinal importance, being used as aphrodisiac, analgesic and for longevity. The regions also abounds in species for human consumption, be it medicinal plants, species yielding Non-Timber Forest Products (NTFP), and bamboo. Tripura has about 65 such species yielding NTFPs and 266 species producing medicinal value. Sikkim contribute for human consumption from about 180 species; 430 medicinal plants from Manipur.

Out of 82 species of rhododendrons recorded from Himalaya, 70 species are confined to eastern Himalaya, including 45 new species alone from Sikkim. Most of these are now highly rare and endangered facing extinction pressure.

Northeast is heaven for bamboo species, which found their uses among the people of the northeast from proverbial 'cradle to coffin'. Of the total about 140 reported species on bamboo in India, 64 species (from 22 genera) are found in northeast, of which about 26 species are considered rare and endangered. There is a definite distribution pattern among the species based on the altitude; *Bambusa*, *Dendrocalamus*, *Dinochloa*, *Cephalostachyum* and *Neohouzeoua* are mostly confined to the lower altitude upto 800 m and *Arundinaria*, *Chimonobambusa*, *Semiarundinaria*, *Sinobambusa*, *Thamnocalamus* and *Phyllostachys* beyond that altitude. The largest contribution to the growing stock is from *Dendrocalamus strictus* (45%), followed by *Melocanna baccifera* (20%), *Bambusa bambos* (13%), *D. hamiltonii* (7%) and *B. tulda* (5%), with the rest sharing 6 per cent. In Northeast India, conifers are represented by 28 species. *Pinus Kesia* and *Gnetum gnemon* from Khasi, Jaintia and the Naga hills, *Cycas pectinata* in Kamrup, *Podocarpus nerifolia*, a broad-leaved gymnosperm is reported from the Khasi hills, but also occurs in

the tropical forests of Barak Valley in Manipur State and in Assam. Northeast India is also known for a variety of saprophytic and high diversity of non-flowering plants. Of about 1000 species of ferns found in India, nearly half are represented in Northeastern India. *Dipteris wallichii*, *Asplenium nidus*, *Osmunda cinnamomea*, *O. claytoniana*, *O. regalis*, *Helminthostachys zeylanica*, *Botrychium lanuginosum*, *Angiopteris evecta*, *Cyathea gigantea*, *C. spinulosa*, *Psilotum nudum*, *Phagopteres auriculata* etc., are some of the rare non-flowering vascular plants. Of these, *Platyserium wallichii* (Staghorn Fern) from Manipur appears to be the first report of its occurrence within India. This epiphytic fern grows in the moist deciduous forests in the Indo-Myanmar border areas in great profusion. Fern-allies such as *Lycopodium* and *Selaginella* are also diverse in this region. The region is exceedingly rich in lichens, mosses and liverworts. These seemingly unimportant plants need to be investigated, studied, appreciated and above all, protected, as they serve vital ecological roles as soil protectors; contribute to the recycling of nutrients and water, offer food and shelter to an assemblage of invertebrates and take a part in purification and carbon sequestration (Ramakantha, Gupta & Ajith, 2003).

Floral Biodiversity of Tripura

The research on status of flora identifying 379 species of trees, 320 shrubs, 581 herbs, 165 climbers, 16 climbing shrubs, 35 ferns, 45 epiphytes and 4 parasites (Total 1,545 taxa) reveal that there are 50 plants species restricted to Tripura and its neighbouring States. Out of them 7 are endemic and 18 are rare plants. *Angiopteris evecta*, a fern and *Gnetum montanum*, a giant climber belonging to Gymnosperm are two rare species but occur in profusely in Trishna Sanctuary. Tree ferns (*Cyathia* spp.), which are also primitive and endangered, are found in South Tripura. There are 24 species of orchids of which and *Dendrobium* has the highest species diversity (14 species). Endangered orchids like Blue vanda (*Vanda caerulea*) and Red vanda (*Renunthera imschootiana*) are found in the state. There are 266 species of medicinal plants in the State (68 trees, 39 shrubs, 71 herbs and 88 climbers). Maximum value of *Plant-Diversity Index* (Shannon-Weiner) reported is 5.23, which generally ranges from 3-4, indicating presence of a variety of species uniformly.

The floral diversity of Trishna WLS is unique all over its area. A total of about 230 tree species, 400 species of herbs, 110 species of shrubs and about 150 species of climbers have been recorded in the sanctuary. Besides, large numbers of orchid species have also been noted in the sanctuary. Of the total vegetation diversity, many plant species are rich in medicinal values. Some of the major tree species are (local name): *Dipterocarpus turbinatus* (garjan), *Schima wallichii* (kanak), *Terminalia belerica* (bahera), *Artocarpus chaplasha* (chamal), *Terminalia chebula* (harr), *Syzygium cumini* (jamun), *Ficus* species (butt), *Dillenia pentagyna* (hargaza), *Careya arborea* (kumira), *Sterculia villosa* (udal), *Shorea robusta* (sal), *Albizia procera* (koroi), etc. The tree density is about 111 trees/ha. The tree volume varies between 21 to 28 m³. The non-clump forming bamboos have 1252 culms/ha. The heterogeneous mixture of ground flora is indicated in the agglomeration of various monocots and dicots, herbs, shrubs, climbers, lichens, ferns, fern allies, underground rhizomes and regeneration of species.

Medicinal Plants Resource

Tripura has one of the oldest, richest and most diverse cultural traditions associated with use of medical plants. There are large number of village based herbal medicines practitioners who have traditional knowledge of herbal home remedies of ailments & nutrition. Besides the above, registered medical practitioners of modified system of Indian Medicine (such as Ayurveda) use medical plants. The herbal medicines used by rural people including tribal have not yet been documented. Compiling an exhaustive inventory of medicinal plants in the State is the need of the hour. So far about 266 species of medicinal plants (68 trees, 39 shrubs, 71 herbs and 88 climbers) have been identified and documented.

Bamboo and Cane Resource

Bamboo plays a very vital role in the economy of the State as it serves the artisan and non-artisan users of the state. The bamboo forests of Tripura may be fitted into the following types and sub-types as per Champion and Seth classification.

- (i) Moist mixed Deciduous Forest – 1/3/3C/C3
- (ii) Secondary moist Bamboo Brakers – 1/2/2B/2Si

Species of bamboo found in Tripura

A total of 19 species of bamboo are reported in the State; Barak (*Bambusa balcooa*), Bari (*Bambusa polymorpha*), Mritinga (*Bambusa tulda*), Muli (*Melocanna baccifera*), Kai (*Bambusa nutans*), Paora (*Bambusa teres*), Rupai (*Dendrocalamus longispathus*), Dolu (*Neohuzeaua dullooa*), Makal (*Bambusa pallida*), Pecha (*Dendrocalamus hamiltonii*), Kailyai (*Oxytenanthera nigrociliata*), Kanak kaich (*Bambusa offinis*), Lanthi bans (*Dendrocalamus strictus*), Tetua (*Bambusa spp.*), Ish (*Bambusa spp.*), Jai (*Bambusa spp.*), Bombash (*Bambusa spp.*), Sairil/Wadu bamboo (*Melocalamus compactiflorus*), Bosai (*bambusa spp.*).

The Faunal Diversity in Northeast India and Tripura

There is a paucity of exploration and research concerning the fauna of Northeast India. Mammals are often considered the best-known groups, especially the ungulates. However, a new species of barking deer, 'Leaf Deer' (*Muntiacus putaoensis*), which was recently discovered in Myanmar, is reported from the forests of Arunachal Pradesh in the year 2003 as a new record for India, and this amply justifies the above observation that much is yet to be identified, named and studied in Northeast India. The remoteness of the region, difficult terrain as well as the severe hunting pressures exerted by the people around their immediate surroundings in many parts of the region make it extremely difficult to document the fauna of the region (Ramakantha, Gupta & Ajith, 2003).

Primates

Of the total sixteen species of primates in India, 11 are reported from the Northeast India as per the revised taxonomy description. However, excepting three species, all are facing severe threat of extinction due to various anthropogenic reasons. Hoolock gibbon (*Bunopithecus hoolock*) is the only ape in India, has been reported from 6 of the 8 northeastern states, with uncertain distribution in Nagaland and no reporting from Sikkim. The eastern limit for this

lesser ape is Salween River in Myanmar and its range extends to Southern China. In spite of extensive distribution range, this species faces severe extinction pressure due to its own specific habitat requirements and specialized behavioural traits and ecological needs, such as frugivory, brachiation for movement, monogamy, small family size, etc. Moreover, hunting is another major cause of its disappearance, mainly linked with superstition that its body possesses medicinal properties. Among langur, there are three species, namely, Phayre's (*Trachypithecus phayeri*), capped (*Trachypithecus pileatus*) and golden (*Trachypithecus geel*). While the Phayre's langur is restricted in its distribution in Tripura mainly, with splinter populations reported from Cachar of Assam and some part of Mizoram, the golden is confined between Manas and Sankosh Rivers in the Himalayan foothills along the Assam – Bhutan border areas. This narrow endemic was discovered in Chakrashilla Hills Reserve in the Dhubri District of Assam. The capped langur, though widely distributed across the region, yet population is very thinly distributed. Another langur species, namely, *Semnopethicus schistaceus* (*Nepal Langur*) is endemic to the higher elevations in Sikkim and Nepal.

The Rhesus, macaque (*Macaca mulatta*), pig-tailed macaque (*Macaca nemestrina*), Assamese macaque (*M. assamensis*), Stump-tailed macaque (*Macaca arctoides*), Northern pigtailed macaque (*M. leonine*), and recently reported Arunachal macaque (*Macaca munzala*) are found in different sympatric combination, and except rhesus macaque, all other species are in severe extinction crisis. The Slow Loris (*Nycticebus bengalensis*), is another highly endangered primate species has its distribution in northeast south of the Brahmaputra River.

Of the six large cat species in India, 4 species, namely, tiger (*Panthera tigris*), leopard (*Panthera pardus*), snow leopard (*Uncia uncia*) and the clouded leopard (*Neofelis nebulosa*) are reported from northeast India. Of these, the clouded leopard is restricted to northeastern regions. Arunachal Pradesh has a unique distinction of supporting all four large cats, while other state have combination of 2 to 3 species of large cats. While, many know extinction pressure on tigers, one main concern is now felt for the survival of clouded leopard, whose habitat is shrinking fast.

Northeast region is perhaps the richest region for small carnivores having their diverse assemblages of small cats, martens,

badgers, viverrids, otter etc. The marbled cat (*Pardofelis marmorata*), golden cat (*Catopuma temmincki*), leopard cat (*Prionailurus bengalensis*), fishing cat (*Prionailurus viverrinus*), jungle cat (*Felis chaus*), yellow-throated marten (*Martes flavigula*), ferret badger (*melogale sp.*), hog badger (*Arctonyx collaris*), Eurasian otter (*Lutra lutra*), smooth-coated otter (*Lutrogale perspicillata*), small Indian civet (*Viverricula indica*), large Indian civet (*Viverra zibetha*), common palm civet (*Paradoxurus hermaphrodites*), Himalayan palm civet (*Paguma larvata*), binturong (*Arctictis binturong*) and spotted linsang (*Prionodon paradicolor*), etc. are the main species inhabiting many states of northeastern region.

The red Panda (*Aliurus fulgens*) is yet another flagship species of this region, restricted to the higher altitudes. The rich assemblage of small carnivores and other biota in the northeastern states could be attributed to the wide ranging altitudinal variations that one comes across in the region and also to the heavy rainfall and humidity that support luxurious plant growth especially in the lower elevations. It needs to be emphasized that all these rare animals occupy narrow bands of forests in the hills and valleys of the region, and, living in small populations, they are extremely susceptible to habitat degradation and hunting pressures. Many of the species in lowland forests are already on the brink of extinction as these forests were the first to be occupied, altered and degraded by man (Ramakantha, Gupta & Ajith, 2003, Gupta 2000). All the bear species that occur in India are recorded from the northeastern region. Besides, Northeast India forms the western end of the range for Malayan Sun Bear (*Helarctos malayanus*). Bears of the lower elevations are under especially serious threats owing to habitat degradation as well as persecution by man, as the bile of the animal is considered highly medicinal. Wild dog or dhole, is yet another rarity in the wilderness of Northeast India. Wild dog found in Sikkim (*Cuon alpinus primaevus*) is considered as same subspecies of *Cuon alpinus adjustus* found in eastern Arunachal Pradesh. Although lacking in systematic inventory on bats and rodents, yet, sparse documentation indicate that bats dominate the mammalian fauna of Northeast India. The Wroughton's free-tailed bat (*Otomops wroughtonii*), Namdapha flying squirrel (*Biswamayopterus biswas*), hairy-footed flying squirrel (*Belomys pearsoni*) and parti-coloured flying squirrel (*Hylopetes alboniger*), Orange-bellied Himalayan squirrel (*Dremomys lokriah*), Malayan

giant squirrel (*Ratufa bicolor*), Hoary-bellied squirrel (*Callosciurus pygerythrus*) and Himalayan striped squirrel (*Callosciurus maccllellandi*), hispid hare (*Caprolagus hispidus*), etc. are few habitat specialists present in northeastern region and facing the threat of elimination from the region. In northeastern region, the elephants make up for about 32 per cent of the total population in India of about 27500. Assam alone accounts for more elephants than Myanmar, Thailand, Indonesia or any other country in Asia. However, elephant population is dwindling sharply, especially in central Assam whereas those in the southern parts have virtually vanished. Only a few left in Manipur and Mizoram and probably none in Nagaland, almost constant in Tripura. Heavy loss of prime elephant habitat is an issue of great concern as loss of elephant habitats heralds doom for smaller creatures as well. Great Indian Rhinoceros (*Rhinoceros unicornis*) is restricted to Kaziranga, Pabitora and Orang in Assam. Historical records suggest that both the one – horned javan rhinoceros (*Rhinoceros sondaicus*) and the two-horned Sumatran rhinoceros (*Didermocerus sumatrensis*) were once found in parts of Northeast India. Both the species are now extinct from the region. The water buffalo (*Bubalus bubalis*) found in Northeastern India has a rather alarming genetic problem due to breeding with the domestic buffalo. The banteng (*Bos javanicus*), was earlier reported from the hills of Manipur till as late as 1990s is now reported extinct from the State. The brow- antlered deer (*Cervus eldi eldi*) is endemic to the State of Manipur. The Swamp Deer (*Cervus duvauceli*) found in Assam is yet another cervid of great conservation significance. The serow (*Capricornis sumatraensis*), goral (*Naemorhedus foral*) and red goral (*Naemorhedus baileyi*) are three other species that are of great conservation significance in this region. The pygmy hog (*Sus salavanius*) is the smallest and the rarest wild suid in the world, and only a few isolated wild population survive in Northeast India. Among other mammals in the northeast India, yak (*Bos grunniens*), Tibetan wild ass (*Equus hemionus kiang*), markhor (*Capra falconeri*), Ibex (*Capra ibex*), great Tibetan sheep (*Ovis ammon hodgsoni*), blue sheep (*Pseudois nayaur*), Chinese Pangolin (*Manis pentadactyla*), Indian Pangolin (*Manis crassicaudata*), Ganges river dolphin (*Platanista gangetica*) are few unique fauna recorded in the northeastern region.

Northeast India supports some of the rare most, least known and most sought after birds of the Oriental region. This region

perhaps supports the highest diversity of bird species in the Orient. More than 400 species of birds are recorded from Kaziranga National Park alone in Assam and although not thoroughly explored, the State of Arunachal Pradesh has a record of 665 species of birds and Tripura more than 350 species. Through avifauna is one of the most studied group, there is acute paucity of information concerning the avian fauna of the region and at the same time new species are continuously being added to the regions list. The Assam Plains and the Eastern Himalaya have been identified as endemic Bird Areas by Bird Life International. The Eastern Himalayan part of Northeast India supports 22 restricted range bird species and with the exception of Manipur bush quail (*Perdicula manipurensis*), which is considered to be extinct, other remaining 21 bird species holds one of the largest concentrations of globally zones in the region. White-winged wood duck (*Cairina scutulata*) is perhaps the rare most duck in the world today and this bird occupied the pride of place among the avifauna of the region. However, extensive destruction of its natural habitat ranging from Assam and Arunachal Pradesh to Java has pushed this species into isolated groups of small populations. The Sclater's Monal (*Lophophorus sclateri*) and Vlyth's Tragopan (*Tragopan blythii*) are among the rare and beautiful pheasants that live in a limited range of the eastern Himalaya. All the pheasant species that occur in this region are to be considered endangered. Ward's Trogon (*Harpactes ward*) is yet another beautiful resident bird reported from Arunachal Pradesh and Sikkim. The bird is sighted in the State of Manipur also. Buff-throated Partridge (*Tetraophasis szechenyii*) is a rare resident of rocky ravines and Rhododendron thickets in the subalpine zone of central Arunachal Pradesh. Though there is less information about the migration routes of birds in Northeast India, the Brahmaputra River and her tributaries are thought to form a flyway for birds from Northeast Asia.

The reptilian fauna of northeast India has the greatest affinity to the Oriental, Indo-Malayan and Indo-Chinese regions. According to existing records, there are 137 species of reptiles in Northeast India, but in reality there could be many more species that are yet to be identified. With better sampling and studies on the herpetofauna, the number of species is expected to change considerably for each of the states and for the region as a whole. Among the component of reptilian fauna, the gharial (*Gabialis*

gangeticus) found in Brahmaputra River is of great conservation significance. Northeast India has the highest diversity of turtles. Of the 26 species of non-marine chelonians reported from India, 19 are found in this region. However, the information on this group of reptiles is also quite inadequate as most of the available records concerning the known species available are from the Brahmaputra Plain and adjoining areas in lower Eastern Himalaya. The hill states, especially south of Brahmaputra basin, viz., Nagaland, Manipur, Tripura, Meghalaya and Mizoram, remain poorly studied. As recently as 2000, a chelonian species- *Amyda cartilaginaea*, was reported from Mizoram as first record for India, the previous range for this species being from southern Myanmar to central Vietnam, Laos, Cambodia, and Thailand. This species was not found to be particularly rare in the study area but was not reported. *Kachuga sythetensis* is endemic to the region. The elongated tortoise (*Indotestudo elongate*), Asian brown tortoise (*Manouria emys*), narrow-headed soft-shell turtle (*Chitra indica*) and Indian flap-shell turtle (*Lissemys punctata*) are very rare among the recorded species.

The Lizard fauna of Northeast India is profoundly influenced by the Indo- Chinese connection. Published records indicate 20 lizard species from the State of Assam, and 18 species from the tiny state of Manipur. The tokay gecko (*Gekko gekko*) is the largest gecko alive today and is found in northeast India. The Burmese glass snake (*Ophisaurus gracilis*) is yet another interesting reptile of Northeast India. Fifty eight species of snakes have been recorded in Assam and 34 from Manipur. *Python reticulates*, the largest snake in India, is found in northeast India and *Python molurus bivittatus* is known from a single specimen from the Arunachal Pradesh, which was a first record for India. One can expect to sight both the snakes in 'Mouling National Park' in the Upper Siang District of Arunachal Pradesh. King Cobra (*Ophiophagus Hannah*) is the most awe –inspiring reptile of the region. *Typhlops jerdoni*, *T. tenuicollis*, *Stoliczka khasiensis*, *Elaphe mandarina*, *Oligiopan melazonotus*, *Xenochrophis punctulatus*, *Bungarus bungaroides*, *Trimeresurus jerdoni* are just a few examples of very elusive and rare snakes of Northeast India.

Due to inadequate systematic studies, presence of only 64 species of amphibians could be too less representation than the actual number. A survey of amphibians conducted in the State of Nagaland

from 1998 to 2002 has resulted in 19 species as new records for the State and 5 species (*Megophrys wuliangshanensis*, *M. glandulosa*, *Amolops viridimaculatus*, *Rana humeralis* and *Rhacophorus gongshanensis*) as new records for India. Only four species of caecilians, *Ichthyophis garensis*, *Ichthyophis hussaini*, *Ichthyophis sikkimensis* and *Gegeneophis fuller* are known from Northeast India. The Himalayan newt (*Tylototriton verrucosus*) deserves a special mention, as it is the only species of Salamander known from India, occurring in Manipur, Khasi Hills and Sikkim in Northeast India. Hitherto, they were little affected by man, but use of the pesticides in paddy cultivation is posing a threat to the species.

Fishes are the most ancient and numerous of vertebrates. Northeast India is exceptionally rich in freshwater fishes, and it is heartening to note that the region has been extensively surveyed, and accounts for 236 species from the State of Manipur alone, 167 species of freshwater species belonging to 11 orders, 31 families and 84 genera are recorded. The fish fauna of Loktak Lake in Manipur comprises 64 species. Sona Lake (1.5 km long and 3.0 km. wide), is one of the biggest tectonic lakes in Assam. It sustains 75 species of fishes under 24 families and 49 genera and of which, 20 species are widely distributed while 8 species are native to Northeast India. Despite a very high diversity of fresh-water fishes, Northeast India does not have many endemic species (the fish fauna of India contains 2 endemic families, both of which are absent from the region).

Invertebrates

The biodiversity strategy and Action Plan for Northeast Eco-region suggests that 3624 species of insects and 50 mollusks are recorded from the region. Butterflies and moths are by far the best studied invertebrates in Northeast India, and the region contributes the maximum number of species for the group in the country. A decade ago, 689 species of butterflies were recorded from the State of Sikkim. Honey-bees, render very valuable ecological services like pollinating wild and cultivated plant species apart from producing honey, and their advanced social behaviour has always been a source of fascination for man. Four indigenous species of honey-bees are recognized from India: *Apis cerana*, *A. dorsata*, *A. florea* and *A. andreniformes*. Of these, *Apis andreniformis* is only known from a few

specimens collected from Northeast India where the species is exceedingly uncommon. It is an unfortunate practice that people in certain parts of Northeast India not only consume the honey and larvae of this insect, but also fry and eat the honey bees themselves.

THE FAUNAL DIVERSITY: TRIPURA

Introduction

Tripura is a small (10,490km²) State located in the Northeastern part of India. It is located between 2256'-2432'N and 9010' – 9221'E. It has a common international border with Bangladesh for about 839 kms towards its West, South and North. It also shares boundary with Assam and Mizoram in the East. The geographical continuity with the Indian mainland is maintained only in the NE with Karimganj sub-division in Cachar district of Assam. In British political parlance Tripura was known as Hill Tipperah and true to its name about 70 per cent of the total geographical area in Tripura is hilly. The small geographical area, however, does not deprive Tripura is being one of the richest areas with regards to the biodiversity and biological resources. Tripura owes this rich biodiversity and copious wealth of biological resources to her unique bio-geographical [Tripura falls under "North East Hills Province (9B)" of the "North East (9) Biogeographic Zone (Rodgers, *et al.*, 2002)] and zoogeographical (Indian sub-region of Oriental Zoogeographical Regions) location and position. Although by virtue of her location in Assam Hills, Tripura is a part of Indian sub-region of Oriental Zoogeographical Region, yet, the flora and fauna in Tripura bear a very close affinity and resemblances with the floral and faunal components of Indo-Malayan and Indo-Chinese sub-regions of Oriental Region. In addition to this, the flora and fauna in Tripura also has a close affinity with Ethiopian and Palaearctic Zoogeographical Regions.

Physiography and Climate

Physiography

The physiography of the entire state can be divided into three distinct physiographic zones, namely, Hill Ranges, Highland &

Plateau, and Alluvial Valleys. The Hill Ranges Zone includes five major hill ranges with North-South orientation, each separated by narrow valleys (20 kms). The Highland and Plateau zone forms the western limit of the hilly region. The plateau gradually rises from West to East with an elevation ranging from 3m to 37 meters and finally merges with the eastern hilly tract. This zone is dissected by valleys, streams and gullies and is severely eroded. The Alluvial Valleys are below 7 meters in height above mean sea level. Low lands interspersed by hillocks and swamps are locally called 'loongas'.

Climate

The State has typical warm and humid tropical climate with four distinct seasons, i.e. winter (December to February), summers (March to May), South West monsoon (June to September) and post monsoon (October to November). The average rainfall is 2100 mm. (82.7"). Mean maximum temperature is 10.4°C. Humidity is generally high throughout the year ranging from 70 per cent to 80 per cent.

Ecosystem

Tripura has diverse ecosystems ranging from forests and grasslands to freshwater wetlands. There are six types of 408 wetlands, of which, water logged (seasonal) are most numerous followed by oxbow lakes and lakes/ponds.

Watershed/Catchments Areas: The State has 10 major rivers running over a total length of 903 km across the State. All these rivers have watershed/catchments areas of over 9400 ha covering 6 major hill range.

Ecological Hot Spots

A total of 30 (thirty) Conservation Hot Spots (CHS) were identified and assessed based on their performance against four major Values, namely, Biodiversity Values, Taxa-based Values, Socio-economic Values, and Conservation Feasibility Values (Gupta 2000). All CHS were further assessed for their ranking based on their score-types for each of the Sub-values under above mentioned 4 major Values, Of these 30 CHS, 11 are from South District, 5 from West District,

6 from Dhalai District, and remaining 8 from North District. The area of hot spots ranged between 2 to 15 km², majority of these CHS (22) were above 10 km² in size.

Biodiversity

Faunal Biodiversity

Unfortunately, there is no authentic or scientific record of wildlife resources in Tripura. Whatever little information of wildlife wealth in the state is available, it is based either on personal casual observations by different scientists or available in the literary works by contemporary writers.

Sterndale (1884) provides the first scientific report about the wildlife species in Tripura, and in his book entitled 'Mammalia of India', has described the presence of Javan rhinoceros, capped langurs, brush tailed porcupines, Tipperah langurs, etc. Stray records are, however, available on mammalian fauna in Tipperah (the old name of Tripura) from the reports of Blyth (1844,1847), Sclatter (1891), Khajuria (1954-55) and others, based on the collections made by F. Skipwith, A. Grobe and J. Barbe during the middle of 19th century. Rajamala, the famous literary work by Sh. Kailash Chandra Singha (1897), mentions the abundance of different species of wild mammals all over the State such as rhinoceros, tigers, wild dogs, wild goats, slow loris, etc. These descriptions are mostly on large mammalian species, e.g., large population of Rhinoceros (*Rhinoceros unicornis*) a place in Dhalai District in Tripura is called 'Gandachhara', because large population of Rhinos (locally called as 'Ganda') existed there in the past. The mixture of facts and myths and above all the absence of any corroborative accounts and evidence in want of any detailed studies, has made it difficult to project the true picture of wildlife resources in Tripura. However, on the basis of the trophies still left with the local inhabitants, there are sufficient indications to prove that three Schedule-I wildlife species, wild buffalo, rhinoceros and tiger had once existed in plenty. About 35 tigers were killed in and around Fatikroy in the North district of Tripura in one single year (Datta Roy, 1986)

Pocock (1939) reported the presence of the leaf monkey [(*Prebyits (Trachypithecus) phayrei*, Blyth (1847)], capped langur [P

(*Trachypithecus*) *pileatus*] and slow loris (*Nycticebus coucang*), from Tipperah region. In 1970, a report on wildlife of Tripura by the Forest Department recorded presence of 6 Tigers in the State. The census report on Manu Forest Division in 1972 confirms the presence of many wildlife species including Elephant, Sloth Bear, Indian Bison, Leopard, Hoolock Gibbon, Sambar, Hog Deer, Barking Deer, Wild Dog, etc (Table No.1). In 1974, the Tiger census report of Tripura confirmed presence of 7 Tigers in Longtharai RF (North Tripura). Menon (1975) has noted in the Tripura District Gazetteers that "Fauna of Tripura bear a close resemblance to that of Chittagong Hill Tracts of Bangladesh and Hills of Southern Assam in India, thus, exhibiting a mixture of fauna peculiar to these two regions". Many species have been listed in the Gazetteers which were once abundant in Tripura.

Agarwal and Bhattacharjee (1977) described 31 species and sub-species of mammalian fauna based on the survey in Tripura conducted during 1969-73. This includes one species of bat (*Rousettus amplexi candatus*) and one sub-species of mongoose (*Herpestes auropunctatus birmanicus*) new to the Indian region. They have noted that several species, e.g. the short nosed fruit bat (*Cynopterus sphinx*), the rhesus macaque (*Macaca mulatta*) and the Irrawaddi squirrel (*Callosciurus pygerythrus*), etc. are widely distributed throughout the state, whereas, some other species e.g. the slow loris (*Nycticebus coucang*), the leopard cat (*Felis begalensis*), the golden cat (*Felis temmincki*), elephants (*Elephas maximus*) etc. which were quite common in this area in the last century, have now become scarce and are now confined/localized in the south-eastern portion (foothills of Longtharai, Salkhan and Atharamura-Kalajhari belt) of the State (Gupta (1998). Kali Prasanna Sen in his Rajmala has also dealt at length with elephants and elephant resources of Tripura. The large populations of Elephants have reportedly shifted to the adjoining Bangladesh area.

In 1984, Bhattacharjee and Chakraborty further updated this list of mammalian fauna to 56 Mammalian species belonging to 9 Orders and 20 Families. In 1989-90, based on a thorough survey all over the State, this list was further updated and 90 land-mammal species from 65 Genera and 10 Orders were identified by Gupta and Mukherjee (1994), which make up for about 19 per cent, 48 per cent and 100 per cent of total land-mammal species, genera, and orders, respectively, in India. Main extant land-mammal

species include Elephant (*Elephas maximus*), Bear (*Melursus ursinus*), Binturong (*Arctitis binturong*), Wild Dog (*Cuon alpinus*), Porcupine (*Artherurus assamensis*), Barking Deer (*Muntiacus muntajak*), Sambar (*Cervus unicolor*), Wild Boar (*Sus scrofa*), Gaur (*Bos gaurus*), Leopard (*Panthera pardus*), Clouded Leopard (*Neofelis nebulosa*), and many species of small Cats and Primates.

Gupta (1999) has described presence of rich diversity of mustelids, viverids and herpestids. Based on the published information and surveys conducted in the state, a total of 6 species of mutelids (Eurasian otterm *Lutra lutra*; small clawed otter *Aonyx cinerea*; Yellow throated martin *Martis flavigula*; Burmese ferret badger *Melogale personata*; Hog badger *Arctonyx collaris*; Yellow bellied weasel *Mustela kathiah*), 5 species of viverids (large civet *Viverra zibetha*; small civet *Viverricula indica*; palm civet *Paradoxurus hermaphroditus*; spotted linsang *Prionodon pardicolor*; and binturong *Arctitis binturong*) and 3 species of herpestids (common mongoose *Herpestes edwardsii*; crab-eating mongoose *H. urva*, and small Indian mongoose *H. javanicus*). Recently, in the year 2003, a tigress with two cubs was sighted in Trishna Wildlife Sanctuary.

Primates: Tripura has amazingly high density of primates all over the State, including some highly endangered species. Different survey teams from Zoological Survey of India, Eastern Region, Calcutta had conducted primate surveys in the State in the past. Their reports have confirmed that out of a total of 15 free-ranging primate species in India, 7 (46.7%) species are found in Tripura, which is highest recording in any one Indian State. In 1988, one more primate species was added to the list of 7 free ranging primates in the State, when two groups of golden langur (*Trachypithecus geei*) were released in the wild at Sepahijala and Trishna Wildlife Sanctuary (one group in each area). Of these two groups, the one in Sepahijala has survived well and with suitable increase in its population size has further split into two sub-groups (Gupta and Mukherjee, 1994). In 1989, based on the primate survey conducted by the author all over the State, a total of 287 groups of all 7-primate species were located in Tripura (Gupta, 1994). In 1994, primate survey in Sepahijala Wildlife Sanctuary revealed presence of 5 species in very high density (17 groups of Phayre's langur, 18 groups of Capped langur, 11 of Pig-tailed macaque, 30-35 groups of Rhesus macaque and 3-4 individuals of slow loris) (Gupta, 1996).

Avifauna: Ornithofauna comprises 342 reported species in the State, of which about 58 are migratory species one near threatened species – the darter. There is high diversity of birds of prey, frugivorous birds, marsh birds and flower peckers. In the aquatic ecosystem 14 (fourteen) species of fish have been recorded, of which 2 are endangered (*Anguilla bengalensis* and *Psuedeatroptus alterinoides*) and 12 vulnerable. Due to silting of river-beds and filling up of wetlands, different species of marsh birds and fishes are on decline.

Tripura is also very rich in its avifauna. According to various estimates and also as per the mid-winter waterfowl census results (Gupta, 1989, 1990) about 400 different species of both land and water birds are identified in Tripura. These also include many migratory species (e.g., Large and Small Whistling Teals) that occupy many water bodies across the State in large numbers all over the State for wintering. A preliminary list of avifauna was documented from the Sepahijala Wildlife Sanctuary (Gupta and Gupta, 1994).

Reptiles, Amphibians and Fish fauna: Definite information on various reptilian and amphibian species and their population status is also not known in Tripura. Based on the available habitat conditions, however, it can safely be concluded that Tripura must be rich in those. This is very well reflected in presence of 21 species of aquatic terrapines and soft-shelled turtles [including 7 endangered species according to Wildlife (Protection) Act, 1972], and other endangered poisonous (pit viper, viper, krait, cobra, etc.) and non-poisonous (python) snakes. Among the amphibian fauna noticeable are the skipping frog, Indian Bull frog, tree frog, toad, etc. *Heteropneustes fossilis* (singhis), *Cirrhina mrigala* (Mrigal), *Pautius sophole* (Ptui), *Labeo rohita* (rohu), *Catla catla* (Katal), Kal, Maka, carps, Durkina, etc. are the major fish fauna in the State.

Endangered Status of Wild Fauna of Tripura

In current habitat conditions, most of the wildlife species are facing extinction pressure in the State. Of the total 65 genera and 90 species of mammalian fauna in the State, about 14 genera and 18 species are included in Schedule I of Wildlife (Protection) Amendment Act, 2002 as highly 'endangered' species. Similarly, 10 genera and 14 species are included in the Appendix I of CITES (Convention in International Trade in Endangered Species of Flora and Fauna).

Three land mammal species, namely, tiger (*Panthera tigris*), rhinoceros (*Rhinoceros unicornis*), and wild buffalo (*Bubalus bubalis*) have already become extinct from Tripura. Some highly endangered wildlife species are as follows:

- (a) In Part I of Schedule I of WL(P) Act : Phayre's Langur (*Trachypithecus phayrei*), Capped Langur (*T.pileatus*), Gibbon (*Bunopithecus hoolock*), Slow Loris (*Nycticebus coucang*), Leopard (*Panthera pardus*), Clouded Leopard (*Neofelis nebulosa*), Gaur (*Bos gaurus*), Serow (*Capricornis sumtraensis*), Giant Squirrel (*Petaurista petaurista*), Chinese Pangolin (*Manis pentadactyla*), Mouse Deer (*Tragulus meminna*), Common Otter (*Lutra lutra*), Elephant (*Elephas maximum*), Binturong (*Arctitis binturong*), Caracal (*Felis caracal*), Fishing Cat (*Felis viverrina*), Golden Cat (*Felis temmincki*), Leopard cat (*Felis bengalensis*), Sloth Bear (*Melursus ursinus*).
- (b) In Part II of Schedule I of WL (P) Act : Python and 7 species of turtles and Tortoises (*Lissamus punctata*, *Kechuga tecta tecta*, *Trionyx gangeticus*, *Trinyx hurum*, *Kechuga kechuga*, *Geoclemys hamiltoni*, *Betagus baska*).
- (c) Part III of Schedule I of WL(P) Act : Bamboo Partridge, Black Necked Crane, Great Indian Hornbill, Indian Pied Hornbill, Hawks, Large Whistling Teals, etc.
- (d) In Part I of Schedule II of WL(P) Act: Pig tailed Macaque (*Macaca nemestrina*), Stumptailed Macaque (*M. arctoides*), Rhesus Macaque (*M. mulatta*), Wild Dog (*Cuon alpinus*), etc.
- (e) In Part II of the Schedule II of WL (P) Act: Black Himalayan Bear (*Selenarctos thibetanus*), civets (*Viverridae*), Jackel (*Canis aureus*), jungle cat (*Felis chaus*), yellow throated marten (*Martes flovigule*), Eurasian otters (*Lutra lutra*), giant squirrel (*Ratufa indica*).
- (f) In Appendix I of CITES: species included in Appendix I of CITES are already covered under different Schedules of WL(P) Act as noted above.

History of Wildlife/Biodiversity Management in Tripura

The history of wildlife management in Tripura is not very old. In 1939 A.D. in which year for the first time rules were framed for

the first time to organize the Forest Department followed by the constitution of some Reserved Forests that could actually be demarcated only during the years 1954-55 A.D. The first ever attention towards wildlife matters related with the assessment of the provisions of the Indian Forest Act 1927 and the Wildlife Elephant Preservation Act, 1879, which were found inadequate for the purpose of management and protection of wildlife in the State. The first ever wildlife sanctuary covering the central catchment area in the North District was notified in 1979. However, it could not remain operational for long and had to be de-notified. Later, after a gap of about seven years in 1986 Trishna Wildlife Sanctuary was declared covering an area of 173 km² to provide protection to the only surviving population of Indian bison (*Bos gaurus*) Tripura. In the year 1989, three more wildlife sanctuaries were notified, namely, Gumti, Roa, and Sepahijala Wildlife Sanctuary:

<i>Name of the sanctuary</i>	<i>Area in Km²</i>	<i>Important flora and fauna found</i>
1. Sepahijala Wildlife Sanctuary (West district)	18.540	Birds and primates, migratory birds in the winter
2. Gumti Wildlife Sanctuary (South district)	389.540	Elephant, sambar, barking deer, wild goats, serow etc.
3. Trishna Wildlife Sanctuary (South district)	194.710	Bison, leopard, barking deer, wild dog, capped langur, king cobra, spectacled monkey, slow lorries, etc.
4. Bison National Park	31.63	Bison, Hoolock, barking deer, wild dog
5. Clouded National Park	5.08	Clouded leopard, barking deer, Phayre's langur
4. Roa Wildlife Sanctuary (North district)	0.860	Many species of birds and primates
TOTAL (4 WL Sanctuaries)	603.650	

In addition to *in-situ* conservation efforts, *ex-situ* conservation measures are being fulfilled in the State through Sepahijala zoo. The zoo houses 532 animals belonging to 56 different species. Conservation breeding programme on clouded leopard, binturong, pig-tailed macaque and Phayre's langur is strongly contributing to *ex-situ* conservation, education and awareness promotion efforts.

Problems in Management and Protection of Biodiversity

While the forests of northeastern states have been under systematic management for past century or so, this fragile resource base has been shrinking due to various anthropogenic disturbances resulting in degradation which is directly affecting the ecological stability, biological diversity, economic viability & environmental security of the states. The impact has been so severe that even species like wild buffalo, rhinoceros and tiger are now extinct in Tripura state and few other faunal and floral species are struggling hard under extremities for their viable survival in many other northeastern states. The factors responsible for the deterioration in the environment quality leading to the neglect and decimation of the biodiversity could broadly be ranked either as direct and indirect factors. These are briefly discussed in the following paragraphs.

Direct Factors***Forest Degradation***

Almost entire area of forests of the northeastern states has been subjected to severe degradation. During survey of forest resources in the state by FSI in 1989, it is shown that majority of forest areas (up to 72.73%) are heavily to moderately degrade. During the past few years there has been a reversal trend in degradation. Although, the area of dense cover has increased, yet the area under open forests has also increased reflecting degradation. The primary vegetation in extensive areas of the Northeast India has been disturbed and modified and in some places destroyed by seismic activities, frequent landslides and resultant soil erosion. While these natural causes have contributed only marginally to the change in vegetation type, it is the activity of man has led to the irreversible transformation in the landscapes and has resulted in colossal loss of biodiversity in the entire region. Human influences have pushed many species to the brink of extinction and have caused havoc to natural fragile ecosystems. Such devastations to natural ecosystems are witnessed almost everywhere in the region and is a cause of great concern.

Northeast India has 64 per cent of the total geographical area

under forest cover and it is often quoted that it continues to be a forest surplus region. However, the forest cover is rapidly disappearing from the entire region. There has been a decrease of about 1800 sq km forest cover between 1991 and 1999 including the quality resulting into conversion of the dense forests (canopy closure of 40% or more) into open forests or scrubs. Though there is a succession of several edaphic formations, a vast area of land has already been transformed into barren and unproductive wastelands. For example though the forest cover in Manipur extends to 75 per cent of the total geographic area, only 22 per cent of forest area is under dense forest cover and has been converted to open forests.

Though Northeast India is predominantly mountainous, the region is very rich in aquatic ecosystem diversity. A large number of bheels, ponds and marshlands in the low-lying and floodplain areas of Assam, Arunachal Pradesh and Tripura represent the diversity in lentic ecosystems. However, deforestation and the resultant loss of soil, especially in the hill areas, are leading to increased siltation of rivers and streams. The deep pools that are the favoured habitats of many species, are rapidly becoming shallow and choked with silt, leading to a decline in habitat. At the same time, swamps, marshes, and other wetlands are increasingly being reclaimed for urban and agricultural expansion. The forests of Assam once acted as sponge, absorbing the tremendous impact of the monsoons. The natural drainage of the vast northeastern Himalaya is channelled through Assam. However, with the loss of thick forest cover, Brahmaputra, one of the largest and fastest flowing rivers of the subcontinent is the main cause of floods with devastating effects. A decline in primary forests in the northeastern regions, specially in Assam and Meghalaya, has been very fast and irrecoverable (Balakrishnan, 1981). Referring to the colossal losses to the biodiversity with reference to the Arunachal Pradesh, Agarwal (1986) has remarked that more than 700 species of plants from the Northeast India are facing the threat of survival in the wild.

Influx of People from Across the Border

There has been large influx of people in Tripura from the neighbouring country, the erstwhile East Pakistan (now

Bangladesh). The fast growth in population (density 304 per square km., 2001 Census) in the State, coupled with poor infrastructure and lack of alternative livelihood options resulted in mounting pressure on forest and forestland. This has also led to a reduction in per capita forest area from 0.97 ha to a present level of 0.18 ha. and encroachments and over exploitation of forest resources. Smuggling of forest produce through 856 km long porous border with Bangladesh has posed most serious conservation problem in the State. The enormity and extent of such illegal fellings can be judged from the annual revenue earned from intercepted illicitly extracted forest produce (1.85 crores) which is only a small portion (around 10%) of produce stolen/ and smuggled across the border. This is a big challenge and need be tackled head on through creation of infrastructure and other assets including capacity-building and networking with active cooperation of the local people.

Shifting Cultivation

This form of primitive agricultural practice is well rooted in cultural ethos of the tribal and is major cause of deforestation, land degradation and soil impoverishment. From the survey conducted by Tribal Welfare Department (1990), it is estimated that this form of cultivation is presently practiced by around 55,049 tribal households over 35,000-40,000 ha annually, equivalent to 6 per cent of the forestland in the State. Systematic efforts are being made through different schemes for in-situ rehabilitation of these tribal along with rehabilitation of degraded forests, but the problem still persists. Many forest bird species, especially those with ranges restricted to Northeast India declined in abundance or disappeared in successional fallows of less than 10 years of regeneration in secondary successional and mature tropical rain forests in shifting cultivation mosaic habitat in Dampa Tiger Reserve, Mizoram (Raman, 2001). Gupta and Kumar (1994) revealed that the Phayrer's langur (*T.phayrei*) could survive in secondary forests, provided that regeneration is allowed to continue for at least 15 years and degradation of forests poses a threat even for such adaptive animals. Similarly, studies conducted by Raman, (1997) reveal that arboreal mammal species such as Malayan Giant Squirrel (*Ratufa bicolor*), Pallas's Squirrel (*Callosciurus erythraeus*) and gibbon are

dependent on tall, undisturbed primary forests or at least, late successional vegetation (25 years old, or more). However, it is a stark reality that in most parts of Northeast India, fallow periods have declined to 5-10 years and in some places may be as short as 3-5 years. With sharp decline in their population, the role of birds, bats, ungulates and primates as seed dispersers is decreasing, leading to further impoverishment of the primary as well as the secondary forests. Choudhury, (2003) described that though there are good populations of Hoolock (*Bunopithecus hoolock*) in the forests of West Khasi Hills, but those are on private and community lands and their long-term survival may be a great cause of concern.

Forest Encroachments

Encroachment of forestland is a serious threat to forests and its conservation. As per record maintained by the Forest Department, the position is alarming and needs special attention to tackle this problem. The category-wise position of encroachment of forest land in Tripura is as given below:

<i>Period</i>	<i>R.F. (ha)</i>	<i>P.R.F. (ha)</i>	<i>P.F. (ha)</i>	<i>Total (ha)</i>
Before 1980	3209.50	752.61	1343.19	5305.30
After 1980	4981.34	1374.93	2264.14	8620.41
Total	8190.84	2127.54	3607.33	13,925.71

The position of encroachment has further aggravated. The latest survey conducted by Revenue Department of Tripura to assess the actual encroachment in forestland, has shown encroachment to the extent of 593.11 km². This has not only caused loss of forest area but has also created perpetual site of degradation of forest. This is true in almost all the northeastern states resulting into habitat loss for the key indicator species, losses of which create a cascading effect resulting into decimation of other subsidiary species as well.

Forest Fire

Forest fires are common and frequent in the plains (around 20% of the total forest area of the State) as the villagers, at the end of

winter, set fire to get flush of new grass for their cattle. Forest Survey of India has estimated that forest fire has led to heavy to moderate degradation of around 6.16 per cent of the forests. The forests atop all the hills get burnt due to *Jhum* fire, which spreads to nearby forest areas. This causes immense harm by completely wiping out regeneration (natural as well as artificial). It also adversely affect already threatened many a wildlife species. The main constraints in control of forest fires are lack of communication facility for early detection of forest fire and also the lack of effective fire fighting equipment.

Grazing

In Tripura alone, the estimate indicate presence of more than 22 lakhs of domestic animals (cattle, sheep and goat) in the State with 2.9 per cent annual rate of increase, against the human population of about 35 lakhs. It is estimated that 60 per cent of this animal population graze in the forest area and cause soil compaction and heavy damage to the forest plantations and natural regeneration areas. The intensity of such disturbances, especially near the habitation, is far beyond the carrying capacity of the forests. There are no grazing grounds. The community lands for grazing purpose in villages have either been encroached upon or diverted to other land uses. Thus grazing constitutes a threat to conservation of biodiversity in all the northeastern states. Enforcement of strict control or imposition of restrictions on such disturbance under present socio-economic condition is practically impossible. A well designed interface with the department of Animal Resource for a rational livestock planning and augmenting fodder availability is urgently required.

Overburdening Rights and Concessions

Forests of the State are presently overburdened with rights and concessions. The adverse effect on forests of unregulated removal of forest produce on this account is steadily increasing with increase in population, without corresponding increase in biodiversity rich areas. Taking a case in point from Tripura, it is seen that there is immense pressure on forests from fringe dwellers for basic requirements, as well as from miscreants

involved in illegal felling and smuggling of forest resources across the border. This has led to severe degradation of existing forest resources in the State. Simultaneously, the forests are viewed as a source of livelihood by the millions living below poverty line, leading to unsustainable utilization of biodiversity resource well beyond the recuperating capabilities. This is common in practically all other northeastern states who share almost same geo graphical, demographical and ecological parameters.

Forestry as a Source of Livelihood

Forestry is one of the most important sectors to support the tribal and rural poor for subsistence, employment and household income. Enhanced outlay for development works have resulted in creation of more man-days during last decade or so. The people get gainful employment in collection of bamboo and minor forest produce and selling them in the market and other ancillary activities such as value additions. Many people are earning their livelihood through forest-based industries (saw mills, wood based industries, etc.). This dependency has most often taken a heavy toll on the biodiversity resources whenever their exploitation crosses the sustainable limits. More man-days shall be generated from the forest-based industries. The Department has already issued licenses to 57 saw mills and about 600 furniture shops and other wood-based establishments/units. The forest based industries using bamboos and timber products shall be encouraged as a permanent source of income and employment.

Indirect Factors

Population Explosion

It is one of the most striking among the indirect factors. The unprecedented increase in population by 143.5 per cent from the period 1952-1971 clearly shows that Tripura was severely affected by the political upheavals, which took place in the Indian sub-continent just after Independence. The spurt in population in Tripura is mainly due to the influx of migrants from Bangladesh that started in 1942 and was most alarming during the years 1950,

1952 and 1955-56. The high percentage of increase in population by 78-79 per cent from 1951-61 is clearly indicative of this phenomenon. It had a direct and severe impact on the forest cover, which got chiseled out from the administrative control of the Forest Department. The per capita forest cover in Tripura comes to 0.12 hac only as against 1.40 hac that was available in 1951. The shrinkage in forest cover thus had been to the extent of about 90 per cent in about six decades.

Encroachment Over Forest Lands

In Tripura, there are hardly any protected forest, proposed reserved forest and reserved forests land, which are totally free from any kind of encroachment. The influx of thousand of destitute families after partition started making inroads into forests as a result of which the legality of the reserves constituted by Maharajas were questioned in the later part of the 1950s. In compliance with the verdict of Supreme Court in 1961 a new process of reservation had to be started under section 4 of the Indian Forest Act, 1927. The finalization of this took many years and the encroachments increased. It was more so for land having rich forest cover due to the sale value of standing trees therein.

Amendment of Land Rules

In the year 1984, the amendment in the Land Rules (TLR and LR Rules, 1961) in Tripura gave full property rights over trees standing on Government land to the applicants as soon as the land in question has been allotted to them. It has led to the rapid depletion of the forest cover, first of valuable timber species and then of non-timber value species. The beneficiaries who are mostly the tribal sell those trees to the forest contractors for petty sum of money. The contractors in turn reap a rich harvest by further selling them in the open market. The depletion of the forest cover from such private lands has adversely affected the biodiversity status therein.

Unawareness and Apathy Towards Biodiversity

Even though, the entire northeastern regions is rich in biodiversity, the apathy and unawareness of its role and importance in the

conservation and preservation of ecology prevails amongst the people. It was only during the yearly celebration of Van Mahotsava and Wildlife Week that the importance of biodiversity is highlighted as a routine matter without seriousness. This attitude has caused irreparable damage to the rich habitat of wild flora and fauna, which in turn has led to the depletion of the biodiversity. With the enactment of the Biodiversity Act 2002 and constitution of the State Biodiversity Boards in practically all the northeastern states, there has been much better awareness on the conservation of biodiversity in its different formats. The BD Act has also provided scope for biodiversity conservation linked with economic gains through Access and Benefit Sharing provisions at the ground level with the provision of Biodiversity Management Committees at the village level.

Hunting

Tripura is primarily a tribal state. The tribal population in Tripura stands about 30 per cent of the total population. There are 19 different tribes. Though hunting is basically resorted to for meeting food requirements, it is also resorted to in a small scale for protecting crop fields from animal damage. There are instances to suggest that the guns provided to the tribal for crop protection had also been used for shooting the wildlife thronging their paddy fields. There were no rules and regulations to control hunting till 1952, when the rules to regulate hunting/shooting, etc. were enacted and enforced in the state. As a consequence of this, these interior areas, which incidentally also form rich wildlife refuge, were left unprotected and poachers had a free hunting ground. It is primarily due to the severe hunting pressure that some of the wildlife species have now become endangered, such as slow loris, hoolock gibbon, few poisonous snakes, etc. and some species such as rhinoceros, tiger and wild buffalo, have become extinct from Tripura. Moreover, similar to jhooming, hunting is also an inherent cultural trend in the life style of most of the tribal communities, which they find quite difficult to shun.

Similarly, a vast majority of the indigenous inhabitants of northeastern region are meat-eating in their food habits and almost all communities have expert hunters, trappers and fishermen. One can find bones, skulls and hides of large and small mammals in tribal huts. It should be noted that though the traditional practices

of trapping, snaring etc. of animals are carried out in very remote areas, in most parts of Northeast India shooting wild animals with guns is prevalent. Besides, certain meat is valued as medicinal and such animals are persecuted as great efforts are made by a few individuals to seek such animals and bring home their body parts. In the past, the hunting/trapping was done with considerable prudence with many taboos and restrictions. For example, the Anaal Naga in Manipur did not consume turtle or tortoise meat. The Maram Naga did not eat pork and the Thangkhul Naga did not eat any member of the cat family. Unfortunately, such taboos no more hold any sway among the people now. It is great tragedy that in many parts of Northeast India some people poison the rivers, streams and other water bodies to get good catches of fish. Apart from using plant poisons, lime, DDT, copper sulphate (CuSO_4) and other synthetic chemicals are being used for fishing. Some are even using dynamite and gelatin sticks for the same purpose. This has serious ill effects on the entire aquatic ecosystem. Fish stocks are being entirely wiped out; several species of amphibians, birds and other fish predators are also being affected in the process; and nothing is known as to what happens to human beings on consuming such poisoned fishes. Northeastern India is often called India's forgotten corner and it was perceived that the remoteness of the place has helped preserve its biodiversity. However, the penetration of roads into interior areas has already exposed the local populace to market economy, unscrupulous urban traders and middlemen in most parts of the region. A series of proposed dams across Northeastern region may lead to submergence of vast tracts of rainforests. Comprehensive environmental impact assessments, which are mandatory as per the law of the land, reveal the possible danger that these projects pose to the biodiversity of the region (Ramakantha, Gupta & Ajith, 2003).

Disappearance of Wetlands

Practically no records are available regarding draining of 'jala' areas (wetlands) for cultivation and with that, few prime habitats for different life forms (plants and animals) have been lost forever. Tripura is still rich in its bird population which includes about 300 species; but loss of habitat is the prime cause for decimation of avi-fauna, amphibians and reptiles.

Low Financing of Forestry Sector

Current investment in Forestry Sector is very low. The allocation to the sector under State Plan has actually declined steadily as a proportion of total plan outlay of the States, which stand at roughly 1 per cent of the total State outlays. It is also seen that total budgetary allocation to the sector (Plan+Non-Plan+CSS) is inadequate in comparison to minimum requirement of the sector as per working plan prescriptions for sustainable management of the forests. The gap between the budgetary requirement and the flow to the sector is a cause of concern. In view of low and declining investment in the sector under State Plan, there has been hardly any scope for investment in essential infrastructure, while even modest facilities created earlier have withered due to inadequate financial allocation.

Conclusion: The Way Ahead

Realizing that the long term economic security of the people is contingent upon the ecological security of the natural resources, it is considered essential to jealously augment forestry and biodiversity resources for generating sustained tangible and intangible benefits. Taking advantage of the unique juxtaposition of the geographic and demographic features in the region consisting of large tracts of watershed/catchments, it is proposed by the forest department to undertake an integrated approach for the enhancement of forestry resources on one hand (ecological stability and biodiversity conservation) and sustained flow of tangible and intangible benefits (socio-economic security) to the human society at large, on the other hand. The aim is to link all biodiversity conservation and management related activities with the poverty reduction mechanisms. This could be achieved broadly in two ways: (1) through indirect and intangible sustained benefits flowing as a result of ecological restoration of forestry and biodiversity resources, and (2) direct economic benefits emanating through various existing and proposed beneficiary oriented forestry and non-forestry schemes. The traditional ethno-botanical knowledge among the people of Northeast India is praiseworthy and need be linked with the technological advanced techniques for enhanced economic benefits on the one hand and ecologically

sustainable use of the natural resources without adversely affecting the biodiversity, on the other.

However, colossal deforestation and the loss of species on the region is a matter of serious concern. It is recommended that the mandatory provision of having at least 10 per cent of the total geographical area under the protected area cover should be ceremoniously followed by the states through the applicability of Wildlife (Protection) Act, 1972. With the provision of constitution of Conservation and Community Protected Areas under the Act, enough scope exists to address the economic and social issues of the local population sharing the wildlife habitat, thus bringing in the participatory approach into play to avoid conflict between the conservation and people's needs. Surveys all across the region has also revealed in no uncertain terms presence of more biodiversity outside the protected areas. This mandates putting into practice the provisions of forestry management for biodiversity conservation as well in areas of unusually rich in biodiversity. The provisions as in existence in the new Working Plan Code necessitating vetting of the Working Plan by the Chief Wildlife Warden ensuring the Wildlife Circles are constituted wherever necessary for wildlife and biodiversity rich habitats.

The Biodiversity Act, 2002, is a very progressive legislation, which not only talks of conservation of biodiversity, but also facilitates economic gains to communities who have been engaged in the protection and conservation of the biodiversity. This Act further provides scope for economic benefits to the local communities out of the commercial benefits accruing following commercial use of biodiversity components from a given area. The provisions of patenting of traditional knowledge being possessed by the local communities can also be used for augmenting conservation values.

The provision of Forest Rights Act, 2005 that provides right to cultivate over forest lands that had been occupied by the local people for past many years for their sustenance, can be very judiciously used for settling the shifting cultivators, which in turn shall help in restoration of degraded forests, thus adding to the biodiversity richness. The sustainable use of lands under forest rights to the forest dwellers shall in long run help in providing alternative livelihood options to the forest dwellers thus reducing their dependency on the forestry and wildlife resources.

The scope of carbon trading under the REDD and REDD Plus provisions may also be used for ensuring economic benefits to the forest dwellers and reducing their dependency on the forestry resources, which will help in building up of the lost biodiversity.

The northeastern regions have immense potential for eco-tourism development as the entire region is endowed with vast natural resources. The eco-tourism in all the states has the potential to provide income opportunities to the local people in the service sector coupled with the recreation and education awareness. To realize this potential, enabling policies have to be framed for integrated development of (eco)tourism sector in the state as livelihood provider to the local people.

The main issue addressing the biodiversity conservation may revolve around the need for improved and sustained flow of goods and services to the entire population with maximum livelihood opportunities consistent with conservation and enhancement of ecology and environment of the State. The Economics of Ecosystem and Biodiversity approach need be taken to actually work out the price tags on various components of the biodiversity that do not form the part of the gross domestic products due to their intangible nature as benefit provider.

The Afforestation policy of the Forest Departments must favour active and meaningful participation and support of local communities and their grass-root representatives for protection and development of forests. Joint Forest Management has been taken in all the States in large scale benefiting the people and the forests on equal footing and adding to the biodiversity status of the given area of operation.

All above efforts are bound to lift the status of biodiversity in the region and also enhance the economic and social status of all. The policies and practices being followed in this direction would also help raise the economic standard of the dependent people by way of providing them alternative sustainable livelihood options.

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