XI Conference of Parties
CONVENTION ON BIOLOGICAL DIVERSITY
HYDERABAD INDIA 2012
OCTOBER 1-19

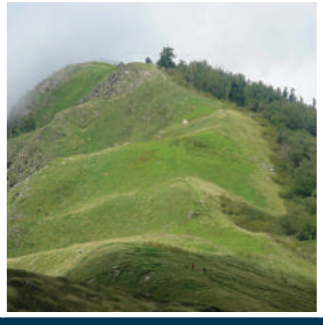
सत्यमेव जयते

United Nations
Educational, Scientific and
Cultural Organization

Compendium on

Indian Biosphere Reserves

Progression During two Decades of Conservation



G.B.Pant Institute of Himalayan
Environment & Development

जहाँ है हरियाली ।
वहाँ है खुशहाली ।।

Ministry of Environment and Forests,
Government of India

Compendium on Indian Biosphere Reserves is an outcome of a collaborative effort of the Ministry of Environment & Forests (MoEF), Govt. of India, and the G.B. Pant Institute of Himalayan Environment & Development (GBPIHED). The designated Lead Coordinating Centres and the Biosphere Reserve Managers contributed chapters jointly or independently on respective Biosphere Reserves (BRs) in the country. The document intends to provide glimpses of representativeness, uniqueness and values of Indian BRs to inculcate excitement about these reserves amongst diverse stakeholders in India and as well as abroad. The document is presented in a popular reading style; therefore, scientific citations have been largely excluded.

The facts contained in individual chapters and opinions expressed therein are not necessarily those of editors, and do not commit their respective organizations (i.e, MoEF & GBPIHED).

This first reprint of compendium has been produced for wide distribution amongst participants of CoP 11 (2012)

Compendium on

Indian Biosphere Reserves

Progression During two Decades of Conservation

Compendium on Indian Biosphere Reserves Progression During two Decades of Conservation

Year 2012

Editors

Lok Man Singh Palni
Ranbeer S Rawal

G.B. Pant Institute of HImalayan Environment & Development

Rama K Rai
S Venkata Reddy

Ministry of Environment & Forests Government of India

[**PHOTO CREDITS** – **Cover**: *Lepcha tribes in Khangchendjonga - HK Badola; Mangrove in Gulf of Mannar - AG Pandurangan; Wild- Ass in Kachchh- S Panchal; Timber-line in Nanda Devi- Balwant Rawat; Agriculture in Cold Desert - SS Samant; Strobilanthus (Kuranji) in Nilgiri - AG Pandurangan.* **Cover inside**: *River Palpada in Simlipal- HS Upadhyay;* **Back Cover**: *Mukesh Bhandari* **Title Inside**: *Biosphere Components -S Nainwal;* **Contents**: *Maldhari in Kachchh- S Panchal;* **Foreword**: *Valley of Flowers: S Nainwal;* **Preface**:*Evergreen Forest in Simlipal- HS Upadhyay;* **Acknowledgements & following page**: *Bet and mudflats in Kachchh- S Panchal;* **Chapters**: *Authors or otherwise indicated*].

Contents

सत्यमेव जयते

मु. फ़ै. फारूक़ी
अपर सचिव
M.F. Farooqui
Additional Secretary
& Chairman, Indian National
MAB Committee

पर्यावरण एवं वन मंत्रालय
Ministry of Environment & Forests
भारत सरकार
Government of India
नई दिल्ली–**110003**
New Delhi- 110003

Foreword

Human activities are progressively reducing the earth's life support capacity largely due to increasing demands on its resources. Unless development is guided by environmental, social, economic, cultural and ethical considerations, it will continue to have undesirable side effects. In this background the MAB programme was launched in 1970 by UNESCO basically as a research Programme to understand the interrelationship between Man & the Environment and predict the consequence of today's action on tomorrow's world and thereby to increase man's ability to manage effectively the natural resources of the biosphere. The idea of 'Biosphere Reserve' was introduced to show the relationship of Man with the Biosphere. The broad objectives were to reconcile the use and the conservation of natural resources and to achieve this, it called for reinforcing the conservation of biological and cultural diversity through a world network of protected areas. It also stressed upon the need to ensure harmonious coexistence of rural populations with ecosystems from which they derive their subsistence and income.

2. The MAB Research Programme, however, developed fairly well without paying too much attention to the "Biosphere Reserve" component. As a result, between 1976 and 1981, new biosphere reserves were added on the list but only a limited number of them actually fulfilled their '**development** and **co-operation**' function.

3. At the Seville Conference organized by UNESCO in 1995 at Seville, the definition and specificity of biosphere reserves and strategy for further action were adopted. This was named as the 'Seville Strategy' which formulated a **Statutory Framework for the World Network of Biosphere Reserves**. This Statutory framework was formally adopted by the UNESCO, providing the network and its individual sites with an international legitimacy, visibility and credibility.

4. The proposal for establishment of Biosphere Reserves in India was considered by the Committee of Secretaries in 1983 and the Committee recommended creation of a scheme on establishment and management of Biosphere Reserves. These Reserves were intended to conserve representative eco system types of the country and are eco system oriented, self contained units of land/water/flora/fauna/micro organisms and were introduced to strengthen the scientific basis for sustainable use and conservation of natural resources. The Nilgiri BR was established in India as first BR in 1986. Till now, 18 BRs have been designated covering different bio-geographic regions of the country. These reserves are intended to conserve diversity within natural eco systems and provide areas for multi-faceted research and monitoring.

5. I am glad to mention here that the programme has progressed well and the impact of various interventions is distinctly visible as evident from the detailed evaluation report submitted by the Wildlife Institute of India, Dehradun. This booklet is intended to bring brief understanding of the existing 18 BRs and it is hoped that this information will go a long way in understanding these unique and complex eco systems and carryout improvement in their management.

6. I sincerely thank my colleagues in the Ministry Mr. R Mehta, Advisor, Dr. R K Rai, Director, Dr. S V Reddy, Director as well as Dr. L M S Palni and Dr. R S Rawal from G.B. Pant Institute for their sincere efforts to bring out this publication. I am also thankful to UNSECO for financial assistance in bringing out this booklet.

M.F.Farooqui
November, 2011

Preface

India with a strong commitment for UNESCO's Man and the Biosphere (MAB) Programme, particularly in the last two decades or so, has shown a steady progression in designating Biosphere Reserves (BRs) in representative biogeographic zones of the country. These Reserves, as we know, by way of integrating biological, socio-economic and cultural dimensions of conservation and development, significantly contribute towards building a harmonious relationship between the human activities on one side and the overall health of ecosystem on the other.

The MAB programme of UNESCO, which celebrated 40th anniversary of its existence in 2011, is a science driven and multiple stakeholders & constituencies based programme. It targets diverse range of stakeholders through integration of research, education, and demonstrations. The programme seeks cooperation at local to global levels. On a wider canvas, the MAB programme considers BRs as : (i) sites of excellence where new and optimal practices to manage nature and human activities are tested and demonstrated; (ii) tools to help countries implement the results of the World Summit on Sustainable Development and, in particular, the Convention on Biological Diversity and its Ecosystem Approach; (iii) learning sites for the UN Decade on Education for Sustainable Development. Over the years, we have witnessed remarkable response from the programme to effectively accommodate the emerging local needs as well as address the global challenges. For instance, the most pressing global issues, under focus now, include: (i) accelerated climate change with consequences for societies and ecosystems; (ii) accelerated loss of biological and cultural diversity with unexpected consequences that impact the ability of ecosystems to continue to provide services critical for human wellbeing; and (iii) rapid urbanization as a driver of environmental change.

The Madrid Action Plan (MAP), agreed at the 20th Session of MAB-ICC and the 3rd World Conservation Congress (February 2008), aims to raise BRs to be the principal internationally-designated areas dedicated to Sustainable Development in the 21st century. Among others, Science and Capacity Enhancement has been identified as one of the main action areas to orient MAB and World Network of Biosphere Reserves (WNBR) so as to effectively capture emerging challenges under global change scenario. This action calls upon BRs to play crucial role in generating knowledge on how natural systems work and how to maintain a resilient ecosystem with sustained flow of benefits to humankind by way of goods and services. In order to achieve this, there is an imminent need for significant strengthening of both science and capacity in the existing BRs.

As a part of India's global commitment for conservation and sustainable development, the national planning process emphasizes on: (i) integrating environmental considerations into policy making in all sectors of economy, and (ii) promotion of people's participatory institutions and social mobilization for ensuring the environmental sustainability of the development process. In this context, the Ministry of Environment & Forests, GoI, among others, has taken definite strides in strengthening the Biosphere Reserve programme. For instance, realizing the need for developing a coordinated programme to strengthen researches on critical issues and to formulate a 'Perspective Plan' for intensive management of BRs in the country, a country wide project on Inventorization of Biosphere Reserves through effective use of RS and GIS technology has been launched.

Further, realizing the strong need for building an information base on existing Biosphere Reserves in the country, the Ministry of Environment & Forests along with the G.B. Pant Institute of Himalayan Environment & Development, and with funding support from UNESCO, has come-up with this compendium which provides brief profile on progression, over the last two decades, in respect of each designated BR in the country (upto Dec. 2011). Also, the first chapter attempts to briefly summarize the overall progress and present status of the programme in India. The compendium attempts to provide a glimpse of existing BRs in a manner that interest the diverse stakeholders. Further, it intends to identify major gaps/issues in the overall BR programme as well as in respect of individual BRs.

The Ministry of Environment and Forests, GoI and G.B. Pant Institute of Himalayan Environment & Development would welcome inputs, critical comments and suggestions for its improvement in the future.

L.M.S. Palni
Director, GBPIHED
Kosi-Katarmal, Almora
December, 2011

Message

UNESCO's Man and the Biosphere (MAB) programme which celebrated 40 years of its existence in 2011 is an Intergovernmental programme that provides scientific basis needed to solve environmental and natural resource problems specially with regard to biodiversity and ecosystem services. The World Network of Biosphere Reserves (WNBR) is the flagship product of the MAB Programme with 598 biosphere reserves in 117 countries as of today. Biosphere reserves, over the years have become the focus of activity of the MAB Programmes through a variety of initiatives combining science, policy and community led practices for sustainable development. In fact biosphere reserves provide answers to address complex issues of development versus conservation by initiating conservation linked sustainable development. These sites along with the world natural heritage sites, which in many cases are common, are the only internationally designated sites providing a vast network for global cooperation in research on environment, biodiversity, climate change and sustainability.

The MAB programme started with the ecological research agenda initially but was transformed into a conservation linked sustainable development instrument over the years. While the Seville Strategy (2005) provided it a statutory framework, the Madrid Action Plan adopted at the 3rd World Congress on Biosphere Reserves at Madrid in 2008 defined its action agenda. The 40th anniversary of MAB was another milestone marked by organization of an International Conference on *For life, for the future. Biosphere reserves and climate change* held in Dresden (Germany) in 2011. The Dresden Declaration sets the future agenda for biosphere reserves to address critical issues such as climate change, green economy and biodiversity conservation linked sustainable development.

India has been on the forefront of the MAB and biosphere reserves programme and has provided leadership in the Asia Pacific region. It took the lead to form the SACAM (South and Central Asia MAB) Network with memberships from 9 Asian countries - Afghanistan, Bangladesh, Bhutan, India, Iran, Maldives, Nepal, Pakistan and Sri Lanka, for greater synergy and collaboration in south and central Asian regional MAB programmes. India's MAB programme is unique in the sense that it provides active linkage of research institutions by designating a set of associated scientific and research organizations with each biosphere reserve. There are currently 19 biosphere reserves in India of which 8 are designated by UNESCO under the World Network. Indian National MAB Committee works closely with UNESCO in promoting the MAB programme and Biosphere Reserves as learning laboratories for sustainable development and biodiversity conservation through capacity building of BR managers for effective management of these sites and sustainable use and conservation of biological diversity.

The "Compendium of Indian Biosphere Reserves: Progression during Two decades of Conservation" is an outcome of collaborative efforts of UNESCO, G B Pant Institute of Himalayan Environment and Development and Ministry of Environment and Forests, Govt of India. The publication provides glimpses of representativeness, uniqueness and values of Indian Biosphere Reserves to create awareness and excitement about these sites amongst diverse stakeholders in India as well as globally. India being a mega biodiverse country also has linked cultural and ethnic diversity spread over 550 tribal communities of 227 ethnic groups in over 5,000 forest villages. Biosphere reserves represent wider base for conservation of entire range of living resources and their ecological – representative ecosystems under conservation and sustainable use on a long term basis. The programme has a strong participation of local communities particularly cultural diversity which provides basis for effective management through sustainable use of bioresources for improving livelihood of the local inhabitants. The publication of this Compendium is timely during the International Decade of Biodiversity when India hosts the COP11 of the Biological Diversity. I hope that this will showcase the rich biodiversity of the country to the delegates of the COP11.

It gives me a great pleasure to thank the team of experts from G.B. Pant Institute of Himalayan Environment and Development and officials of the Ministry of Environment & Forests, Govt of India for their sincere effort to bring out such an interesting publication. I would also like to thank my colleagues in UNESCO New Delhi for overall planning, coordination and technical support to this important initiative.

Shigeru AOYAGI
Director and UNESCO Representative

Acknowledgements

The United Nations Educational, Scientific and Cultural Organization (UNESCO), office in New Delhi, India provided financial support for (i) the compilation of information, (ii) organization of a special session of experts on Biosphere Reserves during International Workshop on 'Mountain Biodiversity and Impacts of Climate Change with Special Reference to Himalayan Biodiversity Hotspot' held at G.B. Pant Institute of Himalayan Environment & Development (GBPIHED) during December 6-8, 2010, and (iii) subsequently for the publication of this compendium. The financial assistance received from UNESCO is gratefully acknowledged.

The Chairman, Indian National MAB Committee, Shri M.F. Farooqui (Additional Secretary, GOI), remained a constant source of inspiration and kindly agreed to write a foreword to this compendium. We sincerely thank him for his keen interest and encouragement. Among others, Shri Hem Pande, Joint Secretary, Shri B.M.S. Rathore, Joint Secretary, Dr. R. Mehta, Advisor, Dr. G.V. Subrahmanyam, Advisor and Shri Vivek Saxena, Director, also from the Ministry of Environment & Forests, New Delhi, took special interest and provided valuable facilitation at different stages of this task.

This compendium is an outcome of a collaborative effort of the BR Lead Institutions and the Managers of respective reserves. Authorities of these organizations deserve deep appreciation for ensuring effective and timely inputs. In particular, the support received from contributors of chapters on individual BR was excellent. Dr. Ram Boojh, Programme Specialist, UNESCO New Delhi office facilitated work contracts and constantly provided inputs for improvement of the contents. We acknowledge and appreciate all his support.

Various experts, namely Professor S. P. Singh, former Vice Chancellor, HNB Garhwal University, Dr. E. Sharma, ICIMOD, Kathmandu, Dr. G.S. Rawat, Wildlife Institute of India, Dr. S. Patnaik, UNESCO New Delhi, Dr. R.C. Sundriyal, Director Herbal Research & Development Institute, Gopeshwar, Shri B.K. Gangte, Director NDBR, Shri Manoj Chandran, Deputy Conservator of Forests, and Dr(s) P.P. Dhyani, K. Kumar, S.K. Nandi, R. K. Maikhuri, S.S. Samant, P.K. Samal, H.K. Badola, K.K. Singh, G.C.S. Negi and S. Sharma (all from GBPIHED) provided valuable inputs for improving the contents of the draft compendium during special session of above mentioned International Workshop at GBPIHED. Dr. Yashpal Singh, Consultant, Ministry of Environment & Forests, and Drs. I.D. Bhatt and K.C. Sekar, Scientist, GBPIHED, were Instrumental in establishing an effective information flow mechanism amongst diverse players. Furthermore, a number of research scholors at GBPIHED facilitated information collection and authentication, we sincerely thank them.

Last but not the least, on behalf of entire editorial team, we wish to thank all those who could not be listed above but their direct or indirect involvement helped us in completing this task.


“The soil is the great connector of our lives,
the source and destination of all.”
-Wendell Berry

1
Introduction and Progression of the Biosphere Reserve Programme in India

1.1. Background

The Biosphere Reserves (BRs) are internationally designated landscape/seascape units under UNESCO's flagship programme: "Man and the Biosphere (MAB)". Over 40 years of its existence the programme has contributed significantly towards building a harmonious balance between the human activities and ecosystem conservation. The Biosphere Reserves represent characteristic ecosystems in different biogeographic regions and consider human communities as their integral component. Broadly, the BR objectives include: i) ensuring *in-situ* conservation (at all levels of biodiversity ranging from genes to ecosystems) in totality as part of wider ecosystem; ii) widening the understanding (through research and monitoring) of components of ecosystems; iii) achieving integrated development (improved quality of life for indigenous communities living in and around) of the area. The BRs are, therefore, sites for experimenting with and learning about Sustainable Development[1].

Considering the importance of such areas, a total of 580 units in 114 countries have been designated in the World Network of Biosphere Reserves (WNBR)[1]. The World Network of Biosphere Reserves consists of a dynamic and interactive network of sites of excellence and has emerged as one of the international tools to develop and implement sustainable development approaches in a wide array of context[2]. Over the years, with experience from different regions of the world, the BR concept has been refined considerably. The 'Seville Strategy'[3] considers BRs as one of the important testing grounds for linking conservation with sustainable livelihood needs of local communities on a short term time frame and sustainable development of the region as part of a long term strategy[4]. The Madrid Action Plan (MAP), agreed at the 3rd World Conservation Congress (February 2008), builds on Seville Strategy and aims to raise BRs to be the principal internationally-designated areas dedicated to Sustainable Development in the 21st century[1].

> **Biosphere reserves represent characteristic ecosystems in different biogeographic regions and consider human communities as their integral component.**

> **The 'Seville Strategy' considers BRs as one of the important testing grounds for linking conservation with sustainable livelihood needs of local communities. The 'Madrid Action Plan' aims to raise BRs to be the principal internationally-designated areas dedicated to Sustainable Development in the 21st century.**

Towards achieving this, the MAP goals attempt to:

- Anchor the research, training, capacity building and demonstration agenda of MAB
- Enable the active use of places included in WNBR as learning sites for Sustainable Development
- Collect, collate, synthesize and disseminate lessons learned
- Contribute to the emergence of a new generation of professionals and practitioners

Science and Capacity Enhancement has been identified as one of the 4 main action areas defined in MAP, particularly to orient MAB and WNBR activities during 2008-2013 in the face of new challenges in an ever-changing world. This action area considers BRs to play crucial role in generating

[1] http://www.unesco.org/new/en/natural-sciences (accessed on Dec 20, 2011)

[2] UNESCO, 2008. Madrid Action Plan for Biosphere Reserves (2008-2013), UNESCO Paris.

[3] UNESCO, 2006. Biosphere Reserves: the Seville Strategy and Statutory Framework of the world network, UNESCO, Paris.

[4] Ramakrishnan, P.S. 2002. Executive Summary. In Traditional Ecological Knowledge for Managing Biosphere Reserves in South and Central Asia, P.S. Ramakrishnan *et al* (eds). Oxford & IBH Publ Co Pvt. Ltd., New Delhi.

> The Madrid Action Plan (MAP) calls upon the relevant national, regional and global authorities to use BR management issues and problems as research questions for multi-disciplinary institutes of higher learning.

knowledge on how natural systems work and how to maintain a resilient ecosystem with maintaining a sustained flow of benefits to humankind in the form of goods and services. In order to achieve this, there is a need for adequate strengthening of both science and capacity in the Biosphere Reserve network. In this context, the MAP calls upon the relevant national, regional and global authorities to use BR management issues and problems as research questions for multi-disciplinary institutes of higher learning[1].

1.2. Indian Scenario

1.2.1. Diversity Representation

India, with an area of 329 million hectares, is the seventh largest country in the world. The diverse topography marked by mountainous regions covering an area close to 100 million hectares, arid and semi-arid zones spreading over 30 million hectares and long coast line of over 7500 kms, coupled with varied precipitation provides a rich landscape diversity. All these features and many more, have resulted in diversity of habitats which harbor and sustain immense biological diversity at all levels. With only 2.4% of world's land area, India accounts for 7-8% of recorded species of the world. The geographical location of India between 8°4' N and 37°6'N provides a wide latitudinal spread and permits a vast range of variations in climatic conditions. Broadly, India consists of: (i) Two 'Realms'- the Himalayan region represented by Palaearctic Realm and the rest of the sub-continent by Malayan Realm; (ii) Five Biomes- (a) Tropical Humid Forests; (b) Tropical Dry or Deciduous Forests; (c) Warm Deserts and Semi-Deserts; (d) Coniferous Forests, and (e) Alpine meadows; and (iii) Ten Biogeographic Zones (1- Trans Himalaya, 5.6%; 2-Himalaya, 6.4%; 3-Desert, 6.6%; 4- Semi-arid, 16.6%; 5-Western Ghats, 4.0%; 6- Deccan Peninsula, 42%; 7-Gangetic Plain, 10.8%; 8-Coasts, 2.5%; 9- North East, 5.2%; 10- Islands, 0.3%) and Twenty eight Biogeographic provinces[5] .

1.2.2. BR Programme - Progression

Considering the diversity of ecosystems and also recognizing the importance of Biosphere Reserves in ensuring long term conservation and sustainable use of India's representative and diverse biological diversity, the Indian Man and Biosphere Committee identified potential sites for designation as Biosphere Reserves in 1979. Subsequently, in 1983 the Committee of Secretaries approved establishment of Biosphere Reserves in India for conservation of critical eco-systems.

As a result, the Indian National Biosphere Reserve Programme was initiated in 1986. Broadly following the UNESCO guidelines, the programme is primarily aimed at[6]:

- To serve as a wider base for conservation of entire range of living resources and their ecological foundations, in addition to already established Protected Area (PA) network system.
- To bring out representative ecosystems under conservation and sustainable use on a long term basis.
- To ensure participation of local inhabitants for effective management and advise on means of improving livelihood of the local inhabitants through sustainable use.
- To integrate scientific research with traditional knowledge of conservation, education and training as a part of the overall management of BR.

In order to cover a wide representation of characteristic ecosystems from diverse biogeographic zones/provinces in the country, the Ministry of Environment & Forests (MoEF), GOI, has, as on December 2011, established 18 BRs (Table1.1) and many other sites have been proposed as potential BRs.

The thorough analysis of BR designation in the country reveals

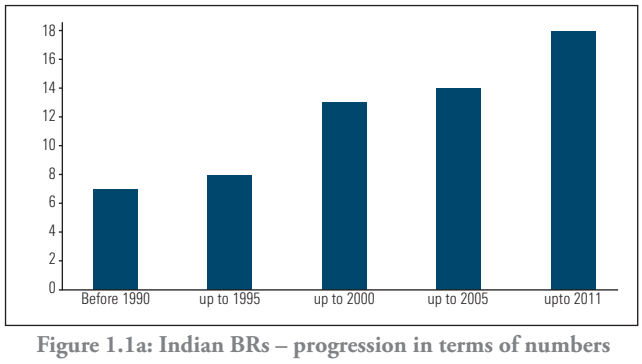


Figure 1.1a: Indian BRs – progression in terms of numbers

[5]Ministry of Environment & Forests, GoI, 2009. India's Fourth National Report to the Convention on Biological Diversity, New Delhi.

[6]Ministry of Environment & Forests, GoI, 2007. Biosphere Reserves in India-guidelines and proformae. www.envfor.nic.in.

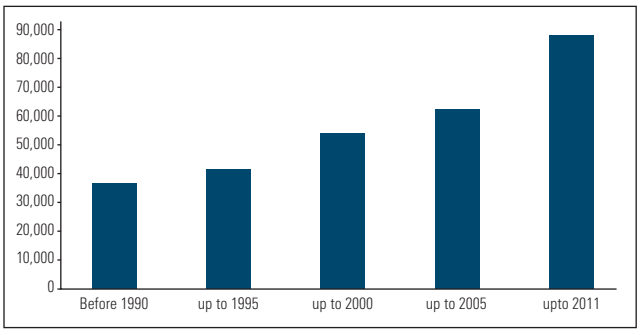


Figure 1.1b: Indian BRs – progression in terms of area coverage (km^2)

that over the years India has responded positively towards increasing BR network (numbers and area of coverage) in the country (Figure 1.1 a,b). As of now, the designated 18 BRs in the country cover approximately 90,000 km^2 area. In recent years (beyond 2005) the increase in both numbers and area coverage has been more prominent indicative of a more proactive role played by the Government. Distribution of BRs in different biogeographic provinces of India is presented below (Figure 1.2).

As of now, 7 BRs of India, i.e., Nilgiri, Sunderban, Gulf of Mannar, Nanda Devi, Nokrek, Simlipal, and Pachmarhi have been included in WNBR. A few more are in the process of nomination.

1.2.3. Indian BRs - Global Recognition

Recognizing the representativeness and unique universal value, seven BRs in India have been included in the UNESCO's World Network of Biosphere Reserves. The sequence of inclusion of BRs in WNBR is in the order: Nilgiri

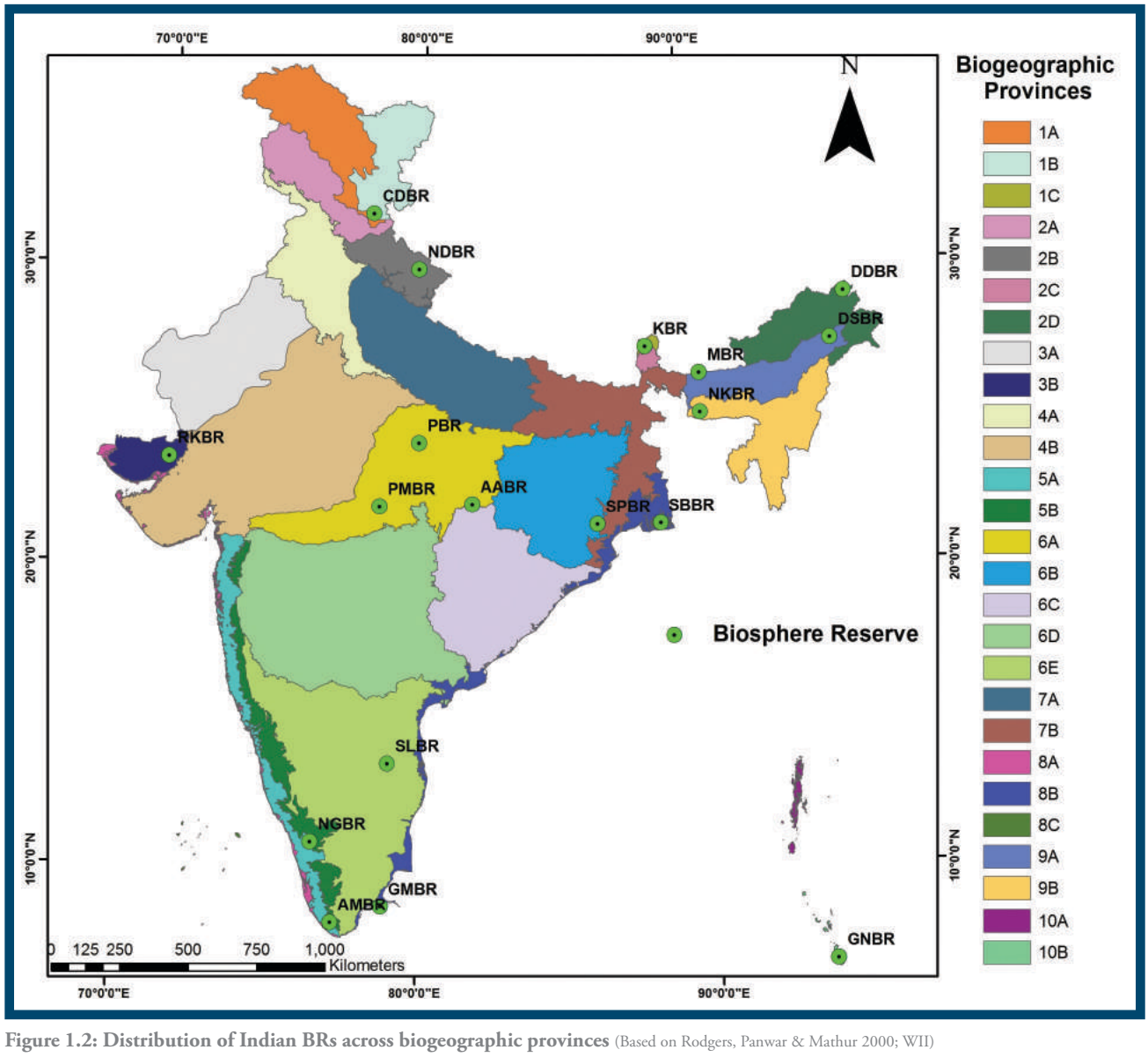


Figure 1.2: Distribution of Indian BRs across biogeographic provinces (Based on Rodgers, Panwar & Mathur 2000; WII)

Table 1.1: The progression of Biosphere Reserves designation in India (upto December 2011)				
S.No.	Name of BR (Date of Notification)	Area Covered (km^2)	Biogeographic Zones (Provinces)	State of the Indian Republic
1.	Niilgiri - NGBR (1.08.1986)	5520	5B: Western Ghats (Mountains)	Tamil Nadu, Kerala & Karnataka
2.	Nanda Devi - NDBR(18.01.1988)	6407.03	2B: Himalaya (West Himalaya)	Uttarakhand
3.	Nokrek - NKBR (1.09.1988)	820	9B: North East (Hills)	Meghalaya
4.	Great Nicobar - GNBR (6.01.1989)	885	10B: Nicobar Islands	Andaman & Nicobar Islands
5.	Gulf of Mannar - GMBR (18.02.1989)	10500	8 B: Coast (East Coast)	Tamil Nadu
6.	Manas - MBR (14.03.1989)	2837	9A: North East (Brahmaputra Valley)	Assam
7.	Sunderban - SBBR(29.03.1989)	9630	8B: Coasts (East Coasts)	West Bengal
8.	Simlipal - SPBR (21.06.1994)	5569	6B: Deccan Peninsula (Chotta Nagpur)	Orissa
9.	Dibru-Saikhowa - DSBR (28.07.1997)	765	9A: North East (Brahmaputra Valley)	Assam
10.	Dehang –Dibang - DDBR (02.09.1998)	5111.05	2D: Himalaya (East Himalaya)	Arunachal Pradesh
11.	Pachmarhi - PMBR(3.03.1999)	4981.72	6A: Deccan Peninsula (Central Highlands)	Madhya Pradesh
12.	Khangchendzonga - KBR (7.02.2000)	2931.12	2C: Himalaya (Central Himalaya)	Sikkim
13.	Agasthyamala - AMBR(12.11.2001)	3500.36	5B: Western Ghats (Mountains)	Tamil Nadu & Kerala
14.	Achanakmar Amarkantak - AABR (30.03.2005)	3835.51	6A: Deccan Peninsula (Central Highlands)	Madhya Pradesh & Chattisgarh
15.	Kachchh - RKBR (29.01.2008)	12454	3B:Desert (Kachchh)	Gujarat
16.	Cold Desert - CDBR (28.08.2009)	7770	1B: Trans Himalaya (Tibetan Plateau)	Himachal Pradesh
17.	Seshachalam - SLBR (20.09.2010)	4755.99	6E: Deccan Peninsula (Deccan South)	Andhra Pradesh
18.	Panna - PBR(25.08.2011)	2998.98	6A: Deccan Peninsula (Central Highlands)	Madhya Pradesh

(2000), Gulf of Mannar (2001), Sunderban (2001), Nanda Devi (2004), Simlipal (2009), Pachmarhi (2009), and Nokrek (2009). A few more BRs, such as Khangchendzonga and Manas, etc., are in the process of nomination.

Further, at least two of these BRs, with their core areas inscribed in world heritage list (i.e., Nanda Devi BR – Nandadevi & Valley of flowers National Parks; and Sunderban- Sunderban National Park), represent properties of outstanding universal value.

1.3. New Initiatives

While the BR programme in India, under the guidance of Indian Man and Biosphere Committee, has taken definite strides, particularly in the last decade or so, more recently the Government of India has realized an urgent need for developing a coordinated programme to strengthen research on critical issues, and to formulate a 'Perspective Plan' for intensive management of BRs in the country. As a result, the Ministry of Environment and Forests, under its National Natural Resource Management System (NNRMS) programme, has come up with a country wide project to: i) create Natural Resources and Social database using latest Remote Sensing (RS) images of existing BRs with a focus on

land use land cover maps, (ii) study temporal changes in the land use dynamics (at 5 year interval starting from 1990 or from the date of designation) as a result of BR management, (iii) make recommendations for effective management of BRs for redefining the zones/boundaries, (iv) develop and test RS/GIS based approaches for assessment and valuation of ecosystem services in a selected BR in the Himalayan region. The successful completion of this project is expected to: (a) help in the formulation of a Comprehensive Management Plan with respect to each BR, (b) develop Decision Support System through GIS based resource mapping, (c) facilitate ecological simulation of natural resources for prediction and scenario development, and (d) establish monitoring indicators for assessing effectiveness/impacts of various schemes/programmes[7]. Therefore, this country wide project on BRs of India specifically meets the global expectations of UNESCO-MAB programme, which promotes the idea of biodiversity related research through *in-situ* and remote observations using space technologies for the monitoring of BRs[8].

1.4. Gaps and the Way Forward

> **The country wide project on BRs of India specifically meets the global expectations of UNESCO-MAB programme, which promotes the idea of biodiversity research through *in-situ* and remote observations using space technologies for the monitoring of BRs.**

1.4.1. Biogeographic representation

As reflected from the analysis, in spite of the proactive steps taken by the Government of India, many of the representative biogeographic units are yet to be included in the Biosphere Reserves Network of India. So far, eight out of the ten biogeographic zones are represented by one or more BRs. Therefore, establishment of at least one representative Biosphere Reserve in the remaining two Biogeographic zones (i.e., 4: Semi- Arid, and 7: Gangetic Plains) would appeare to be an urgent priority. As both these zones cover considerably large geographical area (16.6 and 10.8%, respectively) of the country, the need assumes manifold significance.

Further, for a more specific coverage of existing variations of biogeographic conditions across the country, ideally all the identified biogeographic provinces need to be represented by at least one BR. In this context, Trans Himalaya - Ladakh Mountains (1A) and Sikkim Trans Himalaya (1C), Himalaya - North West Himalaya (2A), Desert - Thar desert (3A), Semi Arid – Punjab Plains (4A) and Gujrat Rajputana (4B),Western Ghats- Malabar Plains (5A), Deccan Peninsula -Eastern Highlands (6C), Gangetic Plains- Upper and Lower (7A/B), Coasts- West (8A), Lakshadweep (8C) and Andman Island (10 A) deserve immediate consideration.

In addition to initiatives for bringing all representative biogeographic units under BR network, there is an imminent need to put in vigorous efforts for increasing the number of globally accepted BRs. With respect to WNBR, as of now, India lags far behind China (29 BRs), Australia (14 BRs) and Iran (10 BRs) in the Asia & Pacific region.

1.4.2. Infusing dynamism

Further, towards ensuring desired functions of the designated Biosphere Reserves, country needs to infuse further dynamism in the entire programme. Among others, this can be achieved through:

- Linking Biosphere Reserves with concerted promotion of local level economic development, that is sustainable both in terms of ecology and socio-cultural milieu. This would imply proactive encouragement of participatory mechanisms for strengthening livelihood options along with conservation.
- Establishing mechanisms for un-interrupted long-term researches to capture the changing dimensions of bio-physical values of the reserve so as to develop scenarios and action plans to address issues associated with such changes.
- Developing infrastructure to ensure research, monitoring, education and information exchange on local, regional and global issues.
- Building skills and capacity of Biosphere Reserve Managers and field staff so as to appropriately address issues of local to global dimensions in relation to conservation, development and communication.

Further, for injection of greater dynamism in the programme, it is essential to bring our understanding of and functioning of BRs at par with the contemporary global thinking. For instance, the MAB programme of UNESCO through WNBR currently promotes application of an integrated approach

[7]GBPIHED, 2012. Fact- File 'Inventorization and monitoring of biosphere Reserves in India using Remote Sensing & GIS Technology'.

[8]http://www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/biodivers.

for addressing biodiversity and climate change issues. Both MAB programme and WNBR are committed to realize the main objectives of the UNESCO Strategy for Action on Climate Change to: (i) build and maintain the climate change knowledge base, (ii) promote mitigation and adaptation to climate change[1]. Thus it brings added value to the fight against the negative impacts by way of application of an integrated, multidisciplinary approach. Therefore, there exists an imminent need to evaluate our programme on BRs to see if it has adequately incorporated this approach. Accordingly appropriate reorientation of the programme is required. Similarly, effective integration of many other major international scientific programmes of MAB, such as, GLOCHAMORE- GLobal CHange in MOuntain REgions and SUMAMAD-Sustainable Management of Marginal Dry-lands, may be considered for action on priority.

Given that the BRs are increasingly being considered as suitable candidates for long-term monitoring of biodiversity, including its ecological, economic and socio-cultural dimensions, it would be appropriate to identify representative BRs across diverse biogeographic conditions in the country for establishing long-term environmental monitoring sites. However, while thinking of such sites and monitoring, it would be desirable and important to follow the standard globally accepted protocols. For example, GLORIA (Global Observation Research Initiative in Alpine Environment) has been developed as worldwide observation network to monitor the effect of changing climate on vegetation of alpine peaks[9].

More importantly, the conservation and development paradigm of Biosphere Reserves in the country has to essentially synchronize with the broad philosophy of national plans, that is guided by the principle of 'Faster, Sustainable and More Inclusive Growth' as projected in the approach paper for the 12th Five Year Plan of the Planning Commission, GoI[10]. Furthermore, it is high time when BR programme in the country may appropriately attempt to build a synergy with the National Action Plan on Climate Change (NAPCC-2008) which addresses the urgent and critical concerns of the country through a directional shift in the development pathway, including through the enhancement of the current and planned programmes. It identifies measures that promote our development objectives while yielding co-benefits for addressing climate change issues effectively. The Eight National Missions, (i.e., National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, National Mission for a Green India, National Mission for Sustainable Agriculture, and National Mission on Strategic Knowledge of Climate Change) form the core of NAPCC and represent multi-pronged, long-term and integrated strategies for achieving key goals in the context of climate change[11]. In this respect, the need for effectively aligning BR programme with these National Missions is evident.

It is high time when BR programme in the country may appropriately attempt to build a synergy with the NAPCC which addresses the urgent and critical concerns of the country through a directional shift in the development pathway, including through enhancement of current and planned programmes.

The role of BRs in addressing issues of Climate Change vulnerability in sectors like water, agriculture, forests, tourism, and animal husbandry, and many others, needs to be brought up front to help indigenous communities in finding better livelihood options. Among others, this calls upon the BR management to find ways and means for effective co-ordination with ongoing state and central sector schemes and programmes. For instance, the Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA), a national flagship programme, aims at enhancing the livelihood security of people in rural areas by ensuring 100 days of employment per year to all rural households through unskilled labour. The funds under MNREGA are, therefore, available to the inhabitants of the target areas. The types of work that can be supported under MNREGA broadly fall in the category of soil conservation, watershed management, road connectivity, etc. With appropriate planning and co-ordination this opportunity can be harnessed effectively for ensuring benefits both to the inhabitants and the reserve. In addition to various efforts from the government sector, several non-government organizations are supporting various livelihoods improvement and conservation initiatives in the region to promote the welfare of local communities, and to

[9]Swerhun, K., Jamieson, G., Smith, D.J and Turner, N.J. 2009. Northwest Science 83(2): 101-116.

[10]GoI, 2011. An approach to the 12th Five Year Plan: Faster, Sustainable and More Inclusive Growth. Planning Commission, New Delhi.

[11]GoI, 2008. National Action Plan on Climate Change. PM Council on Climate Change, GoI, New Delhi.

maintain natural heritage. The BRs can pro-actively consider integrating such efforts within their research and management plans in the best interest of the target communities and the ecosystems. However, while linking BRs with issues of Climate Change and Sustainable Development, it would be important to review the appropriateness of boundaries and functions of existing zones. The reserves wherein these zones have not been properly defined should get attention of the respective state governments for taking up the issue on priority.

Finally, it would not be out of place to mention that over the last two decades or so, India has shown a strong commitment for strengthening its Biosphere Reserve network. However, there are enough possibilities and reasons to give this programme a further impetus by way of reorienting it to address challenges of local to national and global dimensions.

Lok Man S Palni, Ph. D.
Director
(psdir@gbpihed.nic.in)

Ranbeer S Rawal, Ph. D
Nodal Person Lead-BR Centre
(ranbeerrawal4@gmail.com)
G.B. Pant Institute of Himalayan Environment & Development
Kosi-Katarmal, Almora 263 643, Uttarakhand (INDIA)

Rama K Rai, Ph.D.
Director
(ramakrai@yahoo.com)

S Venkata Reddy, Ph.D.
Director
(sv_reddy@nic.in)
Ministry of Environment & Forests,
Paryavaran Bhawan, CGO Complex
Lodhi Road,
New Delhi 110 003 (INDIA).

Photo Credits: HS Upadhyay, IFS (Deokund, Simlipal)

WNBR
INDIAN BIOSPHERE RESERVES

Nilgiri Biosphere Reserve

UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION

MaB

Man and the Biosphere Programme

By decision of the International Co-ordinating Council of the Programme on Man and the Biosphere,

Nilgiri Biosphere Reserve · India ·

has been designated for inclusion in the World Network of Biosphere Reserves.

The world's major ecosystem types and landscapes are represented in this Network, which is devoted to conserving biological diversity, promoting research and monitoring as well as seeking to provide models of sustainable development in the service of humankind.

Participation in the World Network facilitates co-operation and exchanges at the regional and international levels.

Date
10 November 2000

Director-General of UNESCO

2

Nilgiri Biosphere Reserve – Western Ghats, India

2.1. Introduction

Nilgiri Biosphere Reserve (NGBR), the first Biosphere Reserve designated by the Government of India, exemplifies the tropical forest biome that falls within the Western Ghats system of mountains. Biogeographically, Western Ghat represents one of the most important regions of the world and recognized amongst the global biodiversity 'hot spots'. The Biosphere Reserve, seated within the 'hot spot' is represented by unique and threatened ecosystems including a host of forest types, ranging from seasonal rain forests in the low hills, tropical montane forests and grasslands in the higher reaches and moist deciduous to scrub through dry-deciduous forests towards the plains in the eastern end. The region is known for its species richness, which houses about 3500 species of flowering plants, with nearly 1500 as endemic to the Western Ghats. The fauna consists of over 100 species of mammals, 550 species of birds, 30 species of reptiles and amphibians, 300 species of butterflies, and a large number of invertebrates and many more species that await discovery by scientists.

Designation Date	: 01 September 1986
Total Area	: 5,520 km^2
Core Area	: 1,240 km^2
Buffer Area	: 3,574 km^2
Transition Area	: 706 km^2
Extent	: 11° 36' and 12° 0' N 76°0' and 77°15' E

The Biosphere Reserve, seated within the global biodiversity 'hot spot' is represented by unique and threatened ecosystems including a host of forest types, ranging from seasonal rain forests in the low hills, tropical montane forests and grasslands in the higher reaches and moist deciduous to scrub through dry-deciduous forests towards the plains in the eastern end.

2.2. Area Description

The Nilgiri Biosphere Reserve is situated in the tri-junction of the three southern States of India, Karanataka, Kerala and Tamil Nadu (Figure 2.1). It consists of mountain ranges with some pockets of plain forests varying in elevation from 300 to 2655 m. Dodabetta is the highest peak in the reserve. The very name Nilgiris' with literary meaning 'blue mountains' has originated from the spectacular appearance of blue flower clad mountains of the Nilgiris plateau within the State of Tamil Nadu. The blue flowers are borne by an endemic species of *Strobilanthus kunthianus*, locally known as Kurinji which flowers gregariously once in 12 years and gives the wonderful blue cover to the mountains periodically.

Tropical climate prevails in the Biosphere Reserve; while rainfall varies widely between 500 mm to 7000 mm, temperature ranges from 4°C to 41°C. The total area of the reserve is 5520 km^2 and it is divided into a core zone (1240 km^2) and a buffer zone (3574 km^2). The buffer zone is further divided into manipulation-forestry zone (3239 km^2) and manipulation-tourism zone (335 km^2). The transition/ restoration zone with 706 km^2 area (with human habitation) is meant for multiple usage including compatible agriculture and development of eco-friendly industries.

2.2.1. Zonation details

Of the total 1240 km^2 area of the core zone is distributed between the States of Karnataka (701.8 km^2), Kerala (264.5 km^2) and Tamil Nadu (274.0 km^2). The core zone represents the least disturbed region existing more or less in its natural state. It houses a significantly diverse flora and fauna, including centres of endemism and genetic richness. In particular, Reserve Forest areas of Kakkakote, Amgudi, Berambadi, Nilambur Kovilakam, Mukkuruthi, Sispara, Silent valley, etc. are included in the core zone.

The buffer zone with 3574 km^2 area is intended for research, education, demonstration and development of proper

techniques for eco-restoration, and other manipulative methods for utilization of the resources in a viable manner and has access for harmonious interaction with people. Out of the total area of buffer zone, over 90% area is designated as forestry zone which include areas of Nagarhole, Begur, Sigur, Talamalai, New Amarambalam, Upper Bhavani and reserve forests of Coimbatore Division. The remaining about 10% area forms Tourism zone comprising of forest areas of Bandipur and North-east of Nagarhole. The transition/ restoration zone (706 $km^{2)}$ is drawn from the Reserve forests of Moyar, Attappadi, Amgudi and Berambadi. Majority of the buffer zone is formed by moist deciduous forests. The major habitat restoration works like waterholes, fodder development, fire-protection, etc. are taken up on scientific basis. Plantation activities in these areas are carried out only under direct supervision of the respective State Forest Departments. In addition, the transition zone is interspersed based on management requirements of the area such as providing sustainable livelihood to the indigenous people. This includes providing safe drinking water to local people, compensation for damages to life and crops, setting up of biogas plants, etc. to ensure the involvement of local people in conservation efforts. Eco-tourism activities are also in practice in other fringe areas, and eco-development works like compatible agriculture, industry, recreation and other relevant sectors are in progress with the participation of local people (Figure 2.2).

2.2.2. Biogeographic characteristics

The reserve falls under the Malabar Rainforest Realm No-4, Province No. 1 and Biome No. 1 of Udvardy's classification of biogeographical provinces of the world. The vast stretch of forests with a fabric of different forest types and habitats, dense flora and fauna including many endemic and endangered species subjected to varying degrees of human intervention represents an ideal ecological system to be designated as Biosphere Reserve. The natural vegetation of the Upper Nilgiri plateau (a rectangular shaped plateau which has a North-South orientation) is represented by sholas and grasslands or stunted forests and

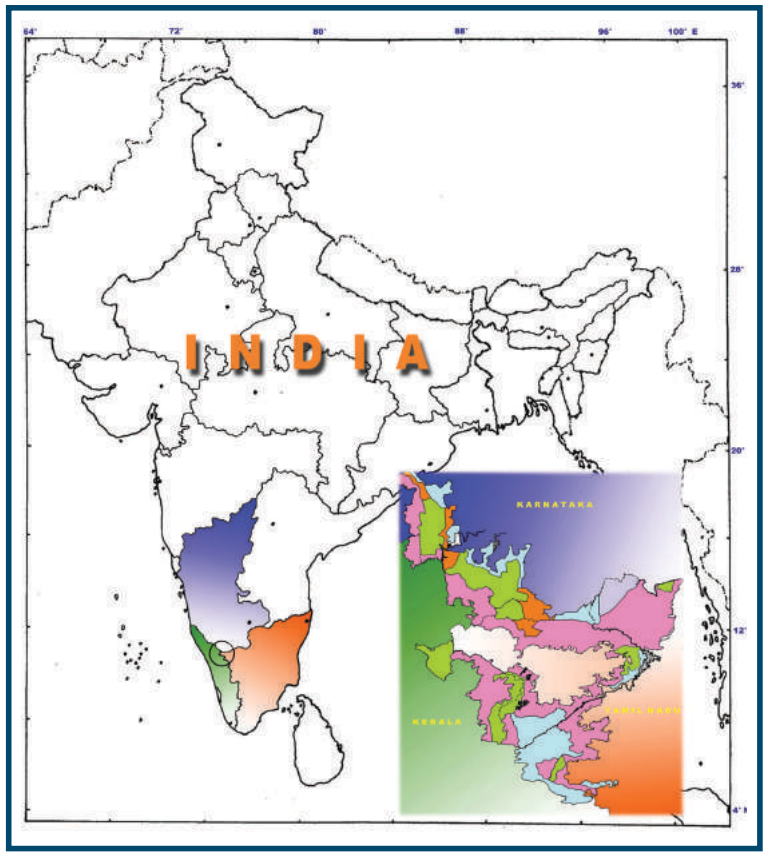


Figure 2.1: Nilgiri Biosphere Reserve: Location

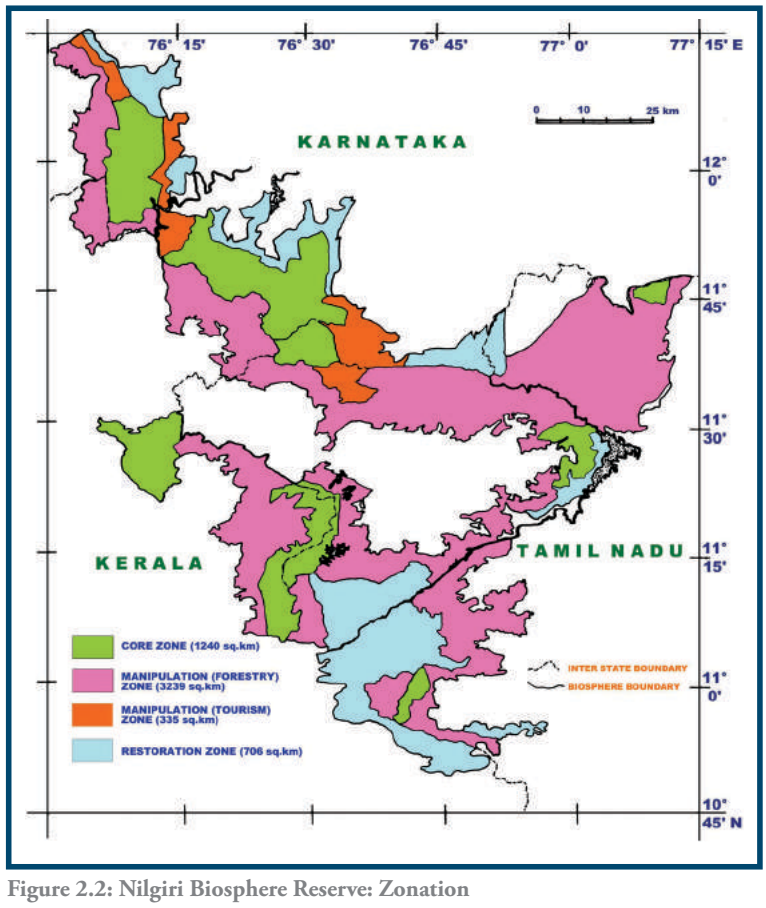


Figure 2.2: Nilgiri Biosphere Reserve: Zonation

montane savannah. This shola-grassland matrix is a fine example of two climatic climax vegetation types in dynamic equilibrium. Their characteristics biota have Himalayan affinities with notable representation of temperate elements. Descending from the upper Nilgiri plateau to the north, the vegetation turns through evergreen into deciduous forests of the Mudumalai Sanctuary (in the Gudallur plateau). Progressing eastward and southward the dry deciduous forest merge into the thorn forest at Annaikatty and the Sigur plateau. The Wyanad plateau, lying on the north-west side of the Nilgiri plateau, houses bamboo thickets, peat bogs and paddy fields, along with extensively planted coffee, tea, spices etc. The Nilambur region is rich in bamboos. The whole ecosystem complex with a mosaic of vegetational entities, natural habitats and land cover types harbour a rich and diversified fauna (Figure 2.3).

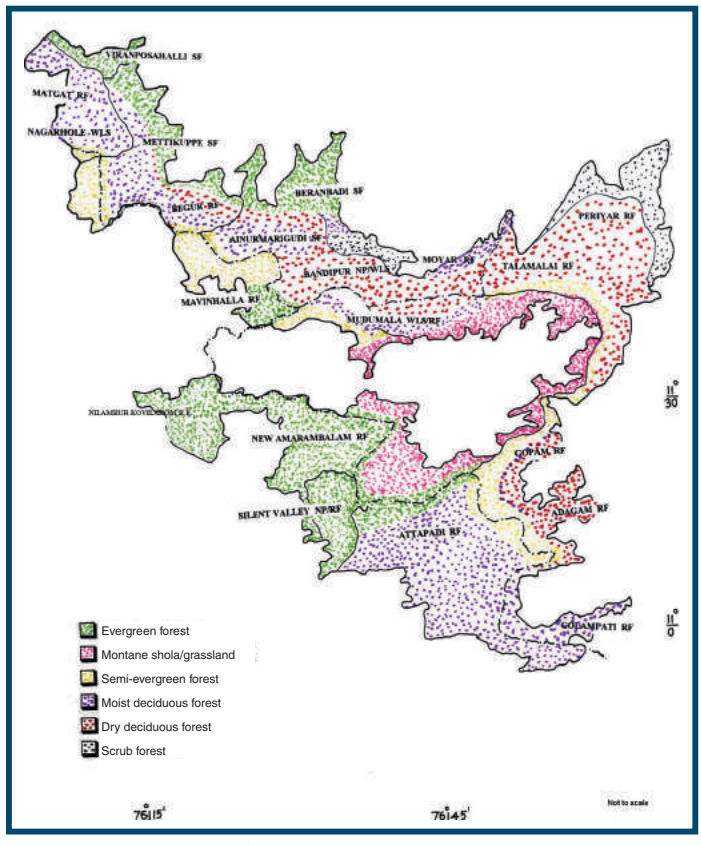


Figure 2.3: Nilgiri Biosphere Reserve: Vegetation

2.3. Background Information

Nilgiri Biosphere Reserve has highly varied physiography ranging from Montane Ghats to the upland plateau of lower elevations. The Western and Eastern Ghats meet at a point, the Dodabetta (2,655 m.) within the Biosphere Reserve that forms the second highest peak in southern India.

2.3.1. Landscape features and land use history

Physiographically the Biosphere Reserve ranges over an assortment of distinct zones, such as mountainous terrains of Western Ghats towards west and Nilgiri plateau in east. The Nilgiri plateau, with a near elevation of about 2,000-2,250 m, shows an abrupt rise from the Coimbatore plains and slopes down to the north-west gradually merging with the lower Wyanad plateau or Gudalur-Devala-Pandalur area, which slopes less gently towards east and southeast. The Attappady valley is an extensive secondary plateau merging imperceptibly with the Muthukulam Reserve Forest located near Palghat gap. The western end of Nilgiri plateau has the high Kunda range with a number of peaks over 2,500 m in elevation. From the western edge of the Nilambur plateau, extend a number of steep parallel edges running 10-12 km to the west and merging with the Nilambur plains having a mean elevation of less than 300 m. In between the parallel edges, the Nilgiris descend precipitously to the west forming abrupt ending valleys. The entire western phase of the Nilgiris is drained by Chaliyar

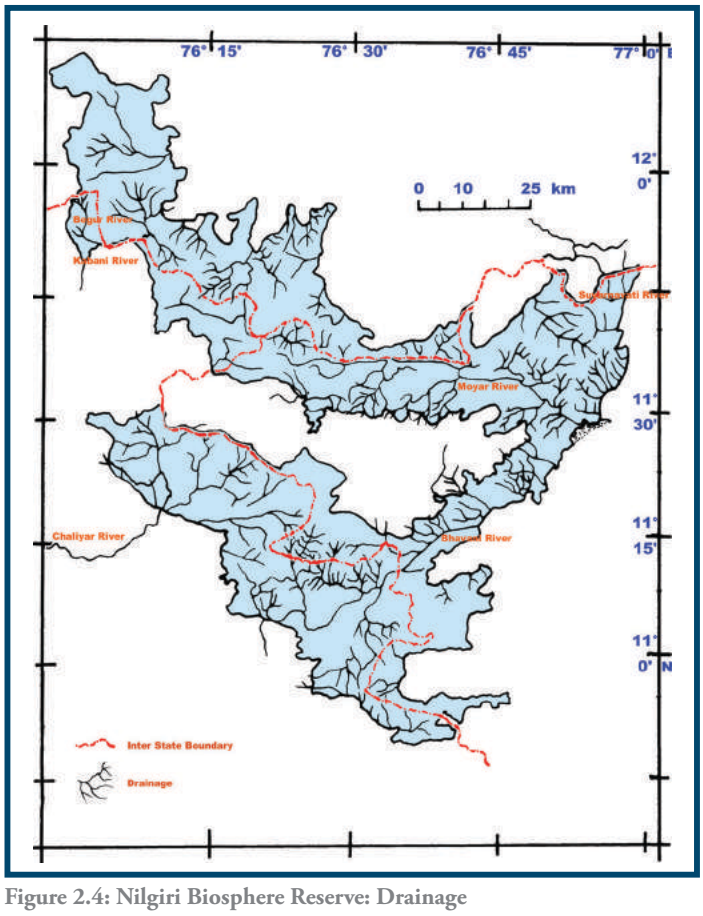


Figure 2.4: Nilgiri Biosphere Reserve: Drainage

river system while the eastern side constituting the highlands and plains having mean elevation of 800 m are drained by the greater Cauvery river system. Notable tributaries such as Bhavani, Kabbini, Moyar, Noyil, Nugu and Suvarnavati form the sub-basins of this system. In the southwest corner, the Nilgiris descend to a secondary plateau with mean elevation of 1,000 m towards the Silent Valley plateau. This plateau is drained by Kunthipuzha, a tributary of Bharathapuzha River. To the east of the Silent Valley plateau is the Attappadi Reserve Forest where from the Bhavani river flows through the plains of Tamil Nadu. The western side of the Western Ghats is drained by Kadalundi, Chaliyar and Bharathapuzha river systems (Figure 2. 4).

Historically, the Karnataka portion of the Nilgiri Biosphere Reserve was the hunting grounds of Maharajas of erstwhile Mysore and Kodagu States and later managed for timber extraction under selection system. The area has now been declared as National Park as per the Wildlife Protection Act, 1972. The Kerala portion, where Silent Valley falls consist of virgin evergreen forest ecosystems devoid of any altered land use practice. The adjoining region such as Mannarkad and Nilambur has vested forests and has been heavily exploited by erstwhile owners. Of late, portions of Nilambur and Wyanad were clear felled and converted into teak plantations to meet the local demand. During the pre-colonial era, the Nilgiris of Tamil Nadu region was a sparsely populated tract with a variety of human communities living on subsistence mode of resource use. The immigrants into the Nilgiris, the biosphere people and ecological refugees have played different roles in the process of land use changes and impacted the environment differently. The biosphere people during the colonial period were mainly European planters and agriculturists from the surrounding plains. The montane tropical environment of the Nilgiri plateau was ideal for cultivation of plantation crops like tea and coffee that had an international demand. By 1880s, tea and coffee were naturalized on the plateau and was known to be a profitable enterprise. With the support of the colonial state, large areas of shola forests and grasslands in the eastern portion of the plateau were cleared and tea and coffee plantations were put up. By the 1940's about 48% of all the cultivated lands of the Nilgiri district were under tea and coffee plantations controlled by the European companies and planters. During the post independence era emphasis on economic growth further aided the clearing of forests and expansion of cultivation.

2.3.2. Geology, geomorphology and soils

Three major types of rock formations of Nilgiri Biosphere Reserve include: (i) Archaean Charnockites, (ii) Unclassified granites and gneisses and (iii) closepet granites and gneisses. Out of these formations, classified under the Precambrian shield of peninsular India, the granites and granitic gneisses extend towards Western Ghats scrap and above the Ghats. Dharwar gneisses and minor regimes of schists are also found in the regions. Unclassified granites and gneisses cover the major portions of the highlands. Such rock formations are predominant over Bandipur, and Begur regions falling in the Karnataka State, Udhagamandalam and Mudumalai (Tamil Nadu) and north – east regions of the Biosphere Reserve. Towards the northern most part of NGBR, the geology changes to closepet granite and gneisses. However, in the southern portion, near Silent Valley and regions adjacent to Nilambur in Kerala State, intrusive pegmatites are also observed.

i) *Charnokites :* were earlier described as Nilgiri gneiss due to its wide occurrence in this region. Later in view of its distinct mineralogical and petrographic characher, Holland named it Charnokite in honour of Job Charnok. These rocks are generally deep seated and may behave as igneous rocks and also exhibit less weathering pattern.

ii) *Closepet granites:* are granites much younger than the peninsular gneiss. These rocks form N-S band (NNW –SSE in the north) right through Mysore, with a width of about 15 – 25 km. Only a small patch is seen in the northern part of Nilgiri Biosphere Reserve.

iii) *Unclassified granites and gneisses:* includes the peninsular gneisses, Khondalites and granites. A major part of reserve consists of rocks of this type. Regarding the pedological characteristics, there is a considerable variation in the soil types within the reserve. The mountainous tropical rain forests have a highly leached soil structure with higher amounts of organic matter deposits at the upper horizons due to large amounts of vegetal organic matter. The high infiltration rates have caused the removal of micronutrients from the soil profile by continuous leaching, that drastically brings down the fertility of the tropical soils. Vegetal cover removal further quickens this negative trend, which prevails in some of the westward regions of the Western Ghats. On the contrary, the higher plateau is deficient in soil moisture and, therefore, brings down the agricultural productivity (Figure 2.5).

2.3.3. Reserve inhabitants, demographic trends and dependence

The NGBR forms an abode for a number of tribes, the forest dwelling people, with striking countenances and unique

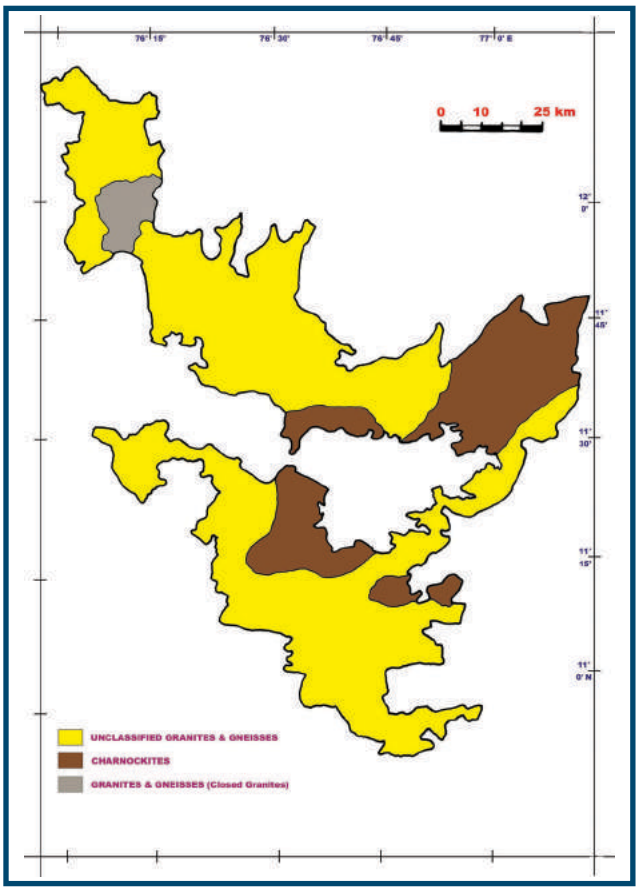


Figure 2.5: Nilgiri Biosphere Reserve: Geology

rituals – their traditions, particularly relating to healthcare and nature reverence are remarkable. The Karnataka portion of the reserve is mainly occupied by moist and dry deciduous forests and which forms an ideal habitat for a variety of animals such as tigers, elephants, sloth bear, sambar, deer, gaur, chitals, etc. Because of wildlife richness, the area was once marked as hunting grounds for the erstwhile state rulers. Seated within this region is the famous shrine of Shree Gopalaswamy Temple, which has a religious and cultural significance to the indigenous people and others in the vicinity. The Kerala part of the Biosphere Reserve has the largest tribal population; the Cholanaikans of the Nilambur forests are still live as hunter-gatherers with majority of them staying in caves. Kurichains of Wyanad forests had fought against the British rule with bows and arrows during the reign of King Pazhassiraja of Malabar. This was one of the notable events of the freedom struggle. The indigenous people of the region are Todas, Badagas, Kothas, Kurumbas, Irulas and Paniyas, with agriculture and pastural activities as mainstay of livelihoods. During the 15th century, Lingayaths moved from Mysore Plateau to Nilgiris to form the major pastoral group of the region. They have distinct religious and cultural identity maintained even today.

The inhabitants of the reserve, particularly the tribes are culturally, socially and emotionally attached to the area. They derive a wide variety of biological resources from their environment and are involved in the commercialization of natural resources and make intensive use of land, water and soil to produce a limited range of products for the market. However, there exists a demographic explosion in the Nilgiris. Hence, conservation oriented development programmes in the reserve are essenially needed which will not only check the erosion of the resource base but also improve the living conditions of the indigenous communities. In this context, ecodevelopment programmes are envisaged to take care of the basic needs of the people. Emphasis has been given to a visible clear-cut change in land use pattern associated with those schemes which generates additional income and security to the people. This includes popularisation of energy alternatives, forest and grassland management, habitat improvement, animal husbandry, apiculture and aquaculture, development of crafts, education, health and immunization, etc. Also a host of forest areas within the Biosphere Reserve, such as Silent Valley, Wyanad, Nagarhole, etc. offer ideal locations for development of ecotourism.

The reserve serves as an important catchment for the main rivers such as Bhavani, Kadalundi, Kabbini, Kunthipuzha, Moyar, etc. It also acts as an oxygen reserve and carbon sink apart from providing potable water in the lower valleys. The area helps in the conservation of soil, water, minerals, etc. and allows flow of nutrients, which in turn results in improved crop yields in and around these river valleys. The practice of agri-horticulture and enormous availability of NTFP's including medicinal plants serve the livelihood needs of people. The human population currently residing in different zones is detailed (Table 2.1).

2.3.4. State of knowledge

Different areas of the reserve have been fairly well explored for biotic, abiotic, socio-economic and cultural characteristics. It is well established that the reserve holds a remarkable genetic diversity of plants, animals and other lower life forms

Table 2.1: Human population residing in various zones of Nilgiri Biosphere Reserve

Zone	Permanently	Seasonally
Core area(s)	9,000	5,000
Buffer area(s)	3,76,200	50,000
Transition area(s)	7,75,000	5,00,000

Nilgiri marten, Nilgiri tahr, Bison, Gaur, Indian elephant, Tiger, Ruddy mangoose, Small Indian civet, Common palm civet, Stripe-necked mangoose, Leopard cat, Giant squirrel, Nilgiri langur, Lion tailed macaque, etc., are the important faunal elements in the reserve.

with an estimated 5.2 % of exclusive endemism (over the total number of species). The economically important species, including the traditionally used ones, include timber, edibles, fodder, plants and animals with medicinal value, apart from the wild progenitors of cultivated crops and domesticated animals. Important timber yielding plants of the region are *Tectona grandis, Dalbergia latifolia, Dipeterocarpus indicus, Mesua ferrea, Palaquium ellipticum, Artocarpus hirsutus, Hopea parviflora, H. wightiana, Kingiodendron pinnatum, Pterospermum reticulatum, Vitex altissima, Xylia xylocarpa, Lagerstromia speciosa, Terminalia tomentosa, Schleichera oleosa, Grewia tiliifolia, Pterocarpus marsupium,* etc., and also bamboos including *Bambusa bamboos* and *Dendrocalamus strictus*. Fruit trees, food plants, spices and contiments are represented by *Artocarpus*, *Syzygium*, *Cinnamomum*, *Myristica*, *Piper*, Vanilla, Curcuma, *Eletaria cardamomum* and plantains. Over 300 species of medicinal and aromatic plants have been reported from the region; important ones among them are *Cassia fistula, Phyllanthus emblica, Strychnos nuxvomica, Terminalia chebula, T. bellerica, Asperagus recemosus, Chlerodendrum serratum, Helectres isora, Hemidesmus indicus, Rauvolfia serpentiana, Canarium strictum, Cinnamomum* spp., etc. Important faunal elements of the region are Nilgiri marten, Nilgiri tahr, Bison, Gaur, Indian elephant, Tiger, Ruddy mangoose, Small Indian civet, Common palm civet, Stripe-necked mangoose, Leopard cat, Giant squirrel, Nilgiri langur, Lion tailed macaque, etc.

2.4. Global and National Significance

Nilgiri Biosphere Reserve encompasses a number of protected/reserve forests which house a spectrum of ecosystems and habitats. The reserve, therefore, contibutes significantly in maintaing the global biodiversity value of Western ghats Biodiversity 'hot spot'. The Western Ghats and the Eastern Ghats meet at a point within the Biosphere Reserves, representing the confluence of two distinct biogeographical provinces. All these physiographic and ecological characteristics make the region an ideal location

Apart from preserving biological and cultural diversity, the Nilgiri Biosphere Reserve also provides ecological sustainability to the entire region.

for practicing conservation, sustainable management of resources and education. Concentration of tribal groups is yet another remarkable feature of the region. Their sustenance is highly dependent on the biological resources derived from the forests. The tribes also get employment in fire protection and other forestry activities. The involvement of indigenous people thus ensures sustainable management of the Biosphere Reserve, at the same time contributes to their social and economic development. Also the reserve forms the catchments of major rivers, which play major role in the agricultural production of the states of Karnataka, Kerala and Tamil Nadu. Apart from preserving biological and cultural diversity, the Nilgiri Biosphere Reserve also provides ecological sustainability to the entire region. Research and monitoring of the management and conservation of the natural wealth of the Nilgiri Biosphere Reserve are being carried out by various government institutions and departments. A commitment to conserve this natural treasure house of resources is the need of the hour.

2.5. Biodiversity Values

With a wide spectrum of ecosystem types, such as tropical evergreen forests, montane sholas and grasslands, semi-evergreen forests, moist deciduous forests, dry deciduous forests and thorn forests, the reserve contributes to richness and uniqueness of Western Ghat biodiversity. Major part of the core areas spread over the States of Kerala and Tamil Nadu include evergreen, semi evergreen, moist deciduous montane sholas and grassland types of vegetation. Whereas the core areas spread over the State of Karnataka contain mostly dry deciduous forests and a few patches of moist deciduous, semi evergreen and scrub jungles. These range of ecosystems occur from hilly terrain to the meadows extending from 300 to 2655 m constitute an excellent habitat for the flora, fauna and other microbial forms. This is evident from the fact that the area harbours over 3500 species of flowering plants, which include 1500 (43%) as endemics and 1030 species of animals (100 mammals, 550 birds, 30 reptiles and amphibians and 300 butterflies). Researcher are of the opinion that many more species of flora and fauna from the region are yet to be identified and described. Among endemic plants, with great conservation value, includes *Rhododendron arboreum* var. *nilagirica,*

Actinodaphne malabarica, Garcinia morella, Glochidion neilgherrensis, Garcinia gummi-gutta, Litsea bourdillonii, Michelia nilgirica, Mahonia leschenaultiana, Cinnamomum sulphuratum, etc. Important faunal elements which need protection are *Panthera tigris* (Tiger), *Elephas maximus* (Elephant), *Boss gaurus* (Gaur), *Macaca silenus* (Lion tail macaque), *Axis axis* (Cheethal), *Cervus unicolor* (Sambar), *Sus scrofa* (Wild Boar), *Muntiacus muntjak* (Barking deer), etc. The Biophere Reserve is also a home for many rare and endangered species of flora and fauna and helps them rear in nature.

2.6. Progression of Conservation and Management

With designation as BR various conservation and management programmes have been implemented in a phased manner by the State Forest Departments of Karnataka, Kerala and Tamil Nadu since 1986. Management strategy for the core zone is not to interfere with any of the ecological processes in the area, except for fire protection and scientific research. In case of buffer zone, habitat improvement programmes are undertaken. These include activities aimed at improvement of forage value of degraded areas, removal of exotic weeds, soil conservation efforts, fire protection, and population restoration of ecologically significant species. In the forestry zone, the existing plantations are put under clear felling mode of operation while natural forests are preserved as such. No new plantations are developed, but gap planting in severely degraded areas without clearing is attempted. Development of nominal infrastructure, with no major construction activities, has been carried out in the tourism zone. The restoration zone is treated with scientific afforestation approaches. State level steering committees have been constituted for coordination between various government departments and organizations that are involved in the management of the Biosphere Reserve. District coordination committees have also been set up for local level synchronization of efforts. Facilities are also created for undertaking research programmes focused on conservation, eco-restoration and related areas funded by national and international agencies.

The reserve has been enduring human interference for a very long time pertaining to development projects (such as hydropower projects), agriculture, horticulture, etc., which have brought about substantial changes in the ecology.

Nature education camps, seminars, guided trekking, etc. are organized periodically for students, voluntary organizations and local inhabitants. Educational and research institutions of repute are entrusted to conduct such research and monitoring programmes and their findings are incorporated periodically in the management plan.

2.7. Issues and Concerns

There are issues which often arise due to conflict of interests amongst various stakeholders. The reserve has been enduring human interference for a very long time pertaining to development projects (such as hydropower projects), agriculture, horticulture, etc., which have brought about substantial changes in the ecology. Of the different environmental problems noticed in different parts of the Reserve, mention may be made of the following.

(i) **Intensive felling:** The increase in influx of population from the surrounding areas has led to deforestation and consequent habitat destruction. During the period from 1990 to 1996 there has been a decrease in the dense forest area. An area of 28.96 km^2 of dense forests has become open forest and 22.67 km^2 of dense forests is changed into non-forest areas. Intensive felling has led to degradation and depletion of the natural systems and their resources, apart from destroying and altering the habitats of the several species of animals and birds. Some of them like the Nilgiri wood pigeon, Nilgiri pipet and Nilgiri langur, that are endemic to this region, have hence become highly endangered. Animals like the

elephant, tiger and leopard are increasingly reaching closer to human settlements owing to the shrinking of forest areas.

(ii) **Development of monoculture plantations:** The Nilgiris, which support a variety of tree species, are threatened by the monoculture practices taking place in the area. The valuable sholas are being destroyed for development of such commercial plantations. Monoculture of eucalyptus, wattle, blue gum, cash crops like tea, coffee, cardamom and food crops like potato have degraded the soil quality along with excessive use of fertilizers. Heavy tillage in the sloppy areas has made the soil porous and prone to erosion. During heavy rains, these slopes are easily washed away resulting in landslides.

(iii) **Grazing:** The sholas have been used for grazing cattle for centuries. Though the livestock population within the reserve is very low, its peripheral areas, particularly the Nilgiri zone, possess significant populations of sheep, goat and cattle. Overgrazing has led to the degradation of low and high level grasslands which harbour a sizable number of endemic species. Further, the destruction of the sholas has often resulted in the disappearance of perennial streams, apart from causing soil erosion and micro climatic changes.

(iv) **Forest fires:** Forest fires are more common in the shola-grassland zones and in dry deciduous forests. They are both accidental as well as deliberate. The annual fire set off during the summer months for a better pasture in the ensuing monsoon is a notable threat to the biological diversity.

(v) **Development projects:** Large areas of forests have been cleared in and around reserve for various developmental projects. Better connectivity of remote forest areas with the nearby urban centres through black topped roads has resulted in increased human influx in the fringe areas. Construction activities like road building have unleashed widespread landslides and slope destabilization. Further, the construction of the Kabini reservoir has submerged the valley between Nagarhole and Bandipur.

(vi) **Horticultural and agricultural practices:** Extension of agriculture in areas unsuited for cropping, and other unscientific land use practices have accelerated soil erosion, particularly in the upper reaches. Human settlements on the uplands have destroyed the sholas. Soil erosion is severe in the east and southwest areas of the Nilgiris where the monsoons are heavy. In the Mysore plateau, development of a network of irrigation canals has led to a large scale shift in land practices.

(vii) **Tourism:** The Nilgiris is an important tourist centre in South India, which attract a large number of tourists every year. A large number of hotels, clubs, resorts, gardens and roads have emerged during the last few years, degrading the natural vegetation. Extensive pollution and water scarcity are the result affecting the entire ecology of Nilgiri Biosphere Reserve. The Ooty Lake has been ruined accumulating garbage and disposal of sewage into it.

2.8. Perspective Plan

At present the Nilgiri Biosphere Reserve spreads over to the states of Karnataka, Kerala and Tamil Nadu. All the three states have already prepared and put in practice a 10 years management plan prepared for respective States (2002-2012). These action plans have considered the scientific inputs derived from various R&D projects implemented in the BR. Of late realizing the need for developing a five year perspective plan which incorporates emerging challenges in management of the Biosphere Reserves with a common format is under preparation as suggested in Madrid Action Plan put forward by UNESCO. While preparing the action plan for next 5 years the priority is being given to address the issues of (i) Cooperation, management and communication, (ii) Zonation-linking functions to space, (iii) Science and capacity enhancement, (iv) Partnerships building, etc.

> **While considering action plan for next 5 years the priority would be to address issues pertaining to: (i) Cooperation, management and communication, (ii) Zonation-linking functions to space, (iii) Science and capacity enhancement, (iv) Partnerships building, etc.**

AG Pandurangan
Co-ordinator, BR. Programme
Tropical Botanic Garden and Research Institute Palode
Thiruvananthapuram, 695 562, Kerala
Phone: + 91-472 2869226, 2869246
Fax: + 91-472 2869646

WS Suiting
Kerala Forest Department
Thiruvananthapuram, 695 014, Kerala

RK Rai
Ministry of Environment and Forests
CGO Complex, Lodi Road, New Delhi 110 003

Gulf of Mannar Biosphere Reserve

UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION

MaB

Man and the Biosphere Programme

By decision of the International Co-ordinating Council of the Programme on Man and the Biosphere,

Gulf of Mannar - India

has been designated for inclusion in the World Network of Biosphere Reserves.

The world's major ecosystem types and landscapes are represented in this Network, which is devoted to conserving biological diversity, promoting research and monitoring as well as seeking to provide models of sustainable development in the service of humankind.

Participation in the World Network facilitates co-operation and exchanges at the regional and international levels.

Date 10 NOV. 2001

Director-General of UNESCO

3
Gulf of Mannar Biosphere Reserve East Coast, India

3.1. Introduction

The Gulf of Mannar Biosphere Reserve (GMBR), established in 1989, represents a marine national park in the State of Tamil Nadu (India). This reserve is the first of its kind in South East Asia. Located in the Indian part of the gulf between India and Srilanka it covers an area of about 10,500 km^2 running south east and parallel to main coastline to a distance of 170 nautical miles. The Reserve comprises of 21 islands on the eastern coast of Rameswaram to Kanyakumari (Cape Comorin). Being situated in the Indo-Malayan realm, it represents world's richest region from a marine biodiversity perspective, the reserve is known for its unique biological wealth which forms a store house of marine diversity of global significance. The Gulf's 3,600 species of plants and animals ranging from primitive to higher forms make it one of the biodiversity rich coastal regions in India. The Marine Reserve is rich in estuaries, beaches, coral reefs, salt marshes, mangroves and many small island ecosystems. Each of these marine ecosystems, with varied habitats, support a wealth of marine resources which in turn provide physical protection to the coastal environment and benefits directly to the local population.

Designation Date	: 18 February 1989
Total Area	: 10,500 km^2
Core Area	: 21 Islands
Buffer Area	: 20 x 160km aquatic area
Extent	: 8° 47' and 9° 15' N 78°12' and 79°14' E

3.2. Area Description

The reserve is located on the southern tip of India in the State of Tamil Nadu and falls within the Indo-Malayan realm, Tropical dry or deciduous forest biome and Coramandal biogeographical provinces. It lies along the south-eastern coast of India and extending from Rameswaram island in the north to Kanyakumary in the south. The 21 islands that constitute the reserve lie between 8° 47' to 9°15' N latitudes and 78°12' to 79°14' E longitudes. They spread over the coast of Ramanathapuram and Chidhambaranar districts of Tamil Nadu (Figure 3.1).

3.2.1 Zonation details

The Gulf of Mannar Biosphere Reserve is comprised of a core area containing 21 islands and the surrounding shallow

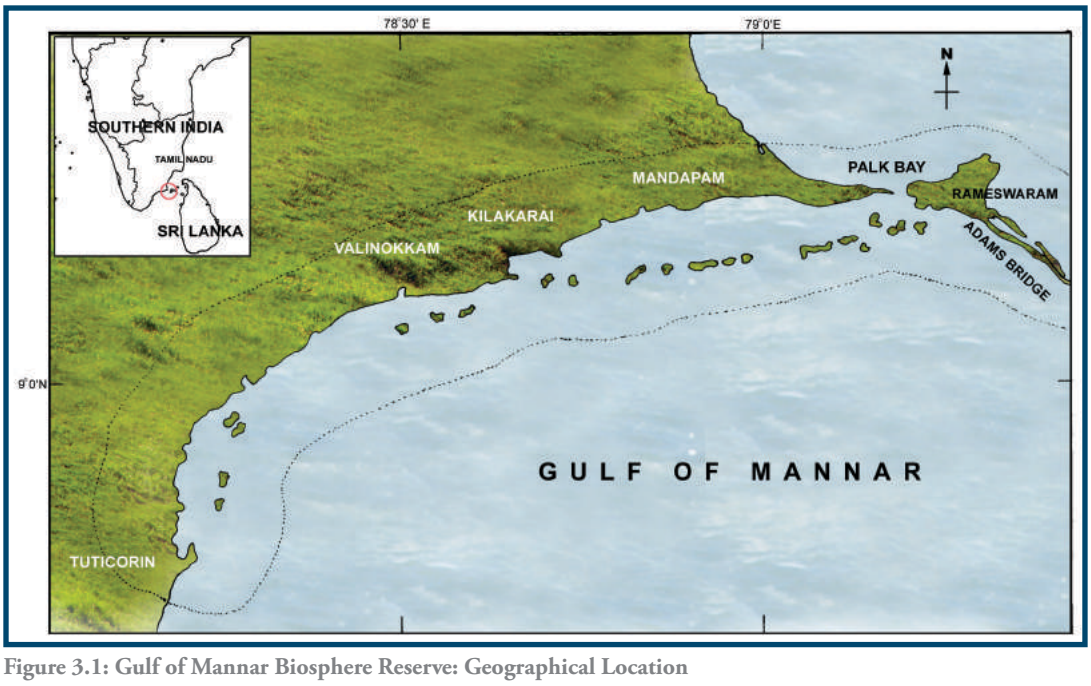


Figure 3.1: Gulf of Mannar Biosphere Reserve: Geographical Location

marine habitats. The core is surrounded by 20 km wide and 160 km long aquatic buffer zone comprising of gulf waters in the south and inhabited coastline in the north. Though strictly protected, fishing activity does takes places in the core areas as the locals traditionally enjoy their fishing rights for their livelihood. However, their activities are being monitored by the Wildlife Warden to reduce over exploitation. The fisher folks living in and around the reserve heavily depend upon marine resources available in the gulf. The use of crude techniques while fishing such as fish traps, bottom trawls, dynamites etc. affect species diversity and composition. This activity in fact poses a series threat to the marine environment.

The buffer zone consists of both main land and gulf waters. The coastal land is greatly inhabited and approximately one lakh people live in 47 villages. They are mostly depending on the gulf waters for their marine catch and which is well reflected by the fact that this coastal land has about 150 fish landing centers. This does not include the urban people living in and around major towns viz. Kilakkarai, Rameswaram, Tuticorin, Mandapam, etc. Further the local people depend on the mangroves and other coastal vegetation for collecting fire wood and other allied day to day requirements. The sea environment apart from fish catches provides diversity of resources such as coral collection, limestone quarrying, seaweed collection, ornamental fishes, shells, etc. These activities form a major trade associated with sea and keep people engaged round the year and facilitate a better income. In fact buffer zone serves as a main utilization zone and considerably reduces the pressure on the core area. Further, it serves as cradle for research, education, demonstration and manipulation activities that help in better understanding of BR concept and evolving an integrated management for coexistance of man and environment.

The area around buffer zone is transition/utilization zone which includes the areas of Appa Tivu, Talairi Tivu, the sea near Kilakarai and the immediate sea between the main land and the island. The transition zones in different regions are rich in prawn beds, pearl beds, chank beds etc. and serves as a genetic reservoir for the future fisheries activities. This zone is both on land and offshore and extensively used by the local as well as urban communities for their requirements (Figure 3.2).

3.2.2. Biogeographic characteristics

The Gulf of Mannar Biosphere Reserve is characterized by four specialized ecosystems, namely sea grass, coral reefs, mangroves and islands (Figure 3.3). The sea grass beds are extensively distributed in the islands and are very rich in terms of species diversity and abundance. The members mostly belong to Hydrocharitaceae and Potamogetonaceae (*Cymodocea serrulate, Enhalus arcoides, Halodule*

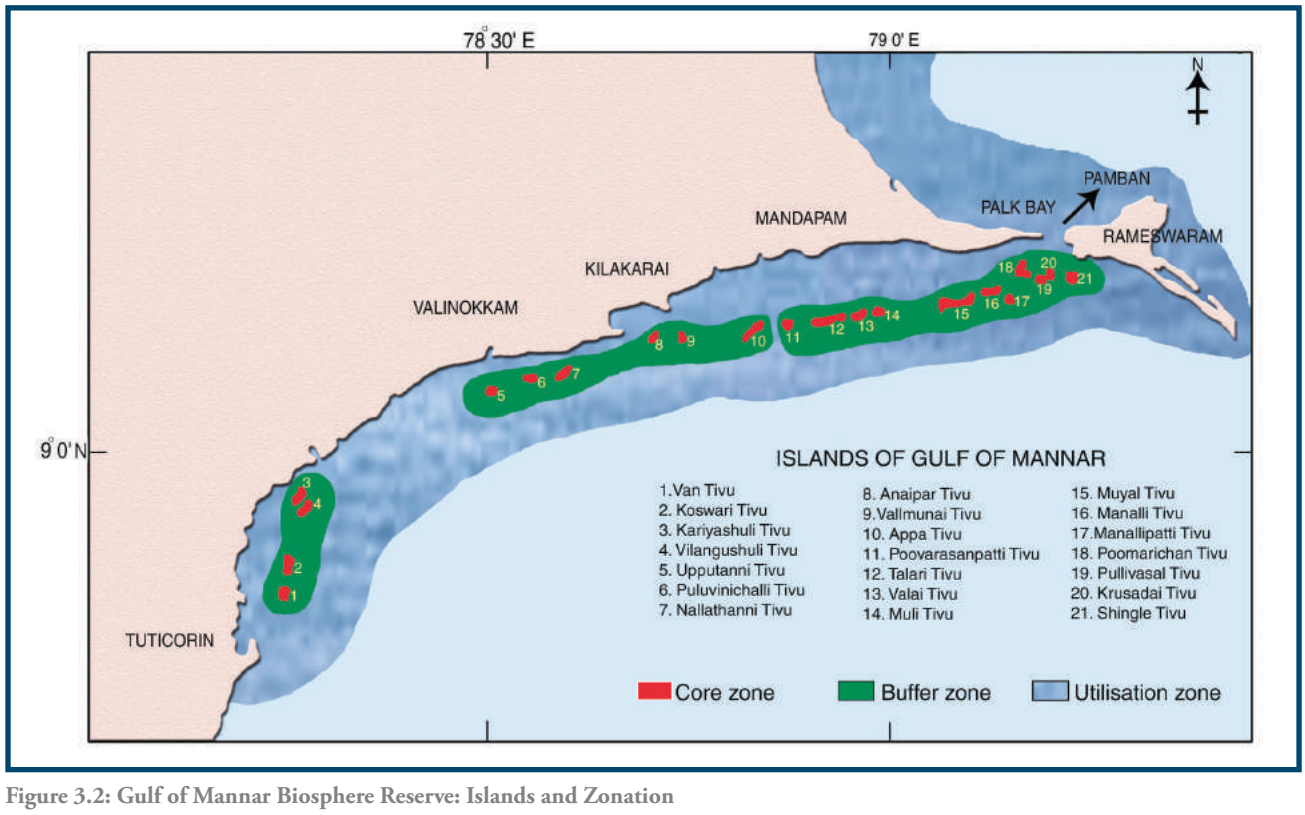


Figure 3.2: Gulf of Mannar Biosphere Reserve: Islands and Zonation

uninervis, Thalassia hemprichii,). Interestingly, among sea grass species, *Halodule uninervis* dominates the system and plays an important role both as stabilizer and sediment accumulator. It occurs either as a pure bed as monospecific community or in a mixed vegetation with *Cymodocea rotunda, C. serrulata, Halophila ovalis* and *Enhalus acoroides. Cymodocea serrulate* occurs extensively in most of the islands of the reserve and forms a significant browsing ground for the endangered mammal Dugong.

Coral reefs have been distributed on the shelves of 21 islands. It forms the basis of a very elaborate and functional ecosystem which supports a series of other ecosystems. Coral reefs provide shelter to a great variety of algae, sponges and fishes, etc. Apart from algae, the reefs also harbour boring sponges, molluscs, worms, echinoderms, common shrimps, fishes etc. There are about 120 species of corals in the Gulf of Mannar, belonging to 33 genera of which 110 species grouped into 26 genera belonging to hermatypic. The conspicuous dominant species belong to families Acroporidae, Poritidae and Favidae are *Acropora formosa, Porites compressa, P. somallensis, Favia valenciennesi* and *Tubipora* sp. They play very important roles in protection of marine organisms and function of other ecosystems.

The vegetation of the island is not uniformly spread and it generally consists of thorny shrubs consisting of species of *Acacia, Capparis, Tamarix, Thespesia* and *Vitex*. The

The Gulf of Mannar Biosphere Reserve is characterised by four ecosystemes namely sea grass, coral reefs, mangroves and island.

mangroves exist along with other production ecosystems such as, sea grasses and Coral reefs. It is believed that the reserve was once covered with extensive mangrove forests and even now the remnants are seen as relics. The mangrove vegetation includes *Rhizophora conjugata, Avicennia alba, Bruguiera gymnorrhiza, Ceriops tagal, Lumnitzera recemosa,* etc. Although mangroves are developed on a good majority of the islands, this vegetation on Manolli is striking for its luxuriance and diversity. They are not tall trees, probably the height is curtailed owing to the stray winds lashing here regularly and with greater velocity during monsoons and periodic cyclones (Figure 3.4).

3.3. Background Information

The entire gulf region has been reckoned since time immemorial for the highly productive pearl banks. The

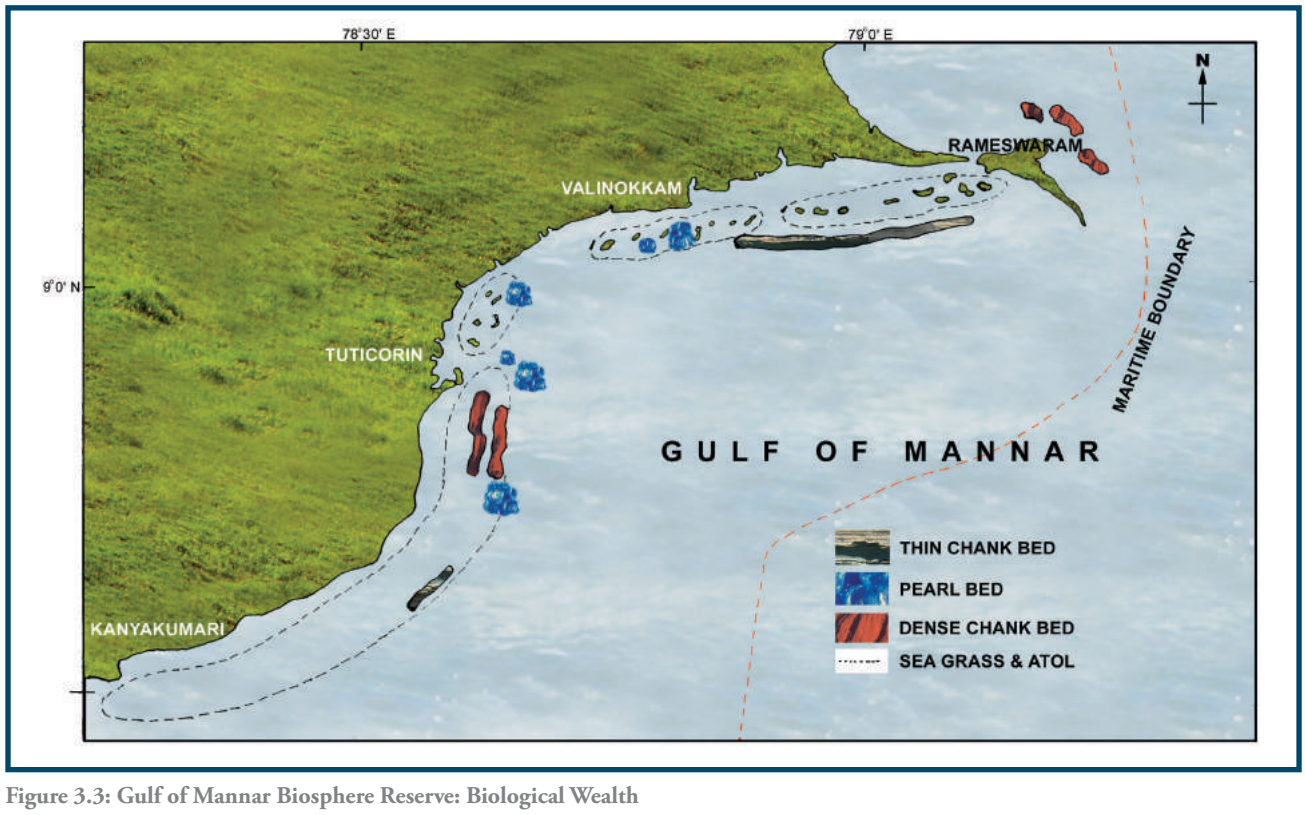


Figure 3.3: Gulf of Mannar Biosphere Reserve: Biological Wealth

Pandyan Kingdom, in whose domain the coastline falls, were actively engaged in maritime trade with the Greek and Roman empires from the days prior to Augustus Ceasar (63 BC-14 AD). The people from the Roman empire visited east coast which included the biosphere reserve area for procuring spices, textiles, precious stones, birds and animals such as peacock and monkey in exchange of gold. The Tuticorin port was well known as a salt trading centre for several centuries. Later on during the first 3rd or 4th centuries the famous kingdoms namely, the Cholas (AD 850-871), the Pandyas (AD 1251-1314) and the Cheras emerged in the southern peninsular India and culturally dominated for over 500 years. The Chola and Pandya kings used the east coast for their trade and operating navel fleets. In fact at one point of time, the Pandya and the Chola kingdoms expanded their territory to the neighboring islands like Sri Lanka, Andaman and Malayan peninsula. The environs of Rameswaram, and places like Dhanushkodi, Kandamadhana, Parvatham, Navabashanam, Villundal etc. mentioned in the great epic Ramayana still cherish this memory and drawing thousands of pilgrims daily from all over India. In fact the main land coastline of Ramanad district (the district is also named after Rama) too is associated with the places like Tirupalani, Devipatnam, Darbasayanam etc. where the events mentioned in Ramayana are supposed to have taken place.

The Raja of Ramanad during the medieval times, with the title "Sethupathi" ruled over Rameswaram and thus the islands in the region of the Gulf of Mannar came to be his possession. He later parted away some of the islands either as gifts or for use in trade to the businessmen. Hence some of the islands like Muyal Tivu and Nalla Thanni Tivu are still either fully or partly owned by individuals (businessmen) and now the State Government are taking steps to acquire from them for conservation. Some of the islands like Krusadai and Shingle were given to British for trade related activities and since their departure these island are rested with the State Government. Out of the total area 101.20 ha of Nalla Thani Tivu, an area of 32.31 ha possessed Patta land in the name of one Syed Sara Uma, wife of Mohamed Meera Sahib (Patta No. 225). The remaining area was 'laid' as Government land till 1972. In the year 1972, an area of 59.62 ha was assigned to 48 persons, but all these assignments have been cancelled subsequently. Apart from this, an extent of 8.37 ha is registered as "Assumed Waste Dry" and 0.25 ha as "Koil Poromboke". There are many coconut (about 2,500 nos) and palmyra (about 1,700 nos) grooves, beside many others trees on the private land of this island. In the Island there is only one well supplying drinking water to the people visiting the temple. The entire extent of the Muyal Tivu consisting of 129.04 ha had registered in the name of (late) PRM Muhamed Abdul Rehman Marakkayar of Mandapam (Patta No. 214). Now it belongs to his sons PRMKM Abdul Kadhar Marakkayar and PRMKM Kasim Mohamed Marakkayar and their relations ("Pangalies"). There are large no. of coconut trees on this island. On the Krusadi island there is one, "Marine Biological Research Centre", which is being maintained by the State Fisheries Department. At present the 21 islands lie in the biosphere reserve remain uninhabited. However, fishermen use these islands to dry their fish nets and anchor travelers for resting during day time. All the above islands have been notified and included as core area during the formation of Marine National Park under the Wildlife Protection Act (of 1972) by the Tamil Nadu Government Gazette dated 16 April 1980. Action has already been initiated to acquire the private islands as mentioned above especially on Nallathani, Muyal Tivu Shingle, Pulli (islet) and Pullivasal Reefs for effective

conservation and realization of objectives as envisaged in the biosphere reserve programme.

3.3.1. Landscape features and land use history

There are no hills on any of the 21 islands. There are swamp regions in Van Tivu, Kasuwar, Mulli, Poomarichan, Pullivasal and Krusadai Tivu. For better understanding of the characteristics of these islands, notable features are given below on each of the islands.

i. **Van Tivu** with an area of 16.0 ha is characteristically sandy representing sparse vegetation of low bushes, mostly grassess and xerophytic plants. The southern half of the island is a swamp of an area of 0.5 ha. The substratum is composed of dead corals, broken shells, sand stones and coarse to fine sands.

ii. **Kasuwar Tivu** occupies an area of 19.50 ha and is mainly sandy with small sand mounds here and there and highly strewn with shingles; a few scattered bushes but, devoid of trees. The whole island is covered with xerophytic grasses and small plants. Swamp on the south-western side and a small saline water pond near the western shore are seen.

iii. **Karaichalli Tivu** has an area of 16.46 ha, mostly a sandy island, thickly set with tall bushes in the centre and on the western side. The whole island is covered with grasses and small plants.

iv. **Vilanguchalli Tivu** is a small island with an area of 0.95 ha. The soil is completely strewn with coral rubbles and calcareous deposits. Some bushes and grasses covered towards the middle of the island. Mangrove associates form a thin mat on the fringe areas.

v. **Upputhanni Tivu** is a fairly large sandy island with plenty of coral rubbles all over. The entire island is covered with seasonal grasses, tall bushes and a few trees here and there.

vi. **Puluvinichalli Tivu** covering an area of 6.12 ha possess good sandy beach. A good portion of the island is fairly covered by thick vegetation. The island is surrounded by live coral reefs (atoll) all around except a small stretch on the eastern side.

vii. **Nallathanni Tivu** has an area of 110 ha and is a big island containing coconuts, palmyrah and other woody trees. Coral reefs and coral boulders spread all around the island at a distance of 0.5 km on the southern side and very near the northern shore.

viii. **Anaipar Tivu** with an area of 11.0 ha is fully covered with tall shrubs and Acacia trees. A good amount of dead coral blocks partly exposed on the southern shore up to a distance of 200 m, with good growth of seaweeds. Live corals are seen near the western side of the island up to a distance of 200 m from the shore.

ix. **Vellimunai Tivu** is a sandy shore, streun with coral rubbles and has an area of 6.72 ha. The island is completely covered with Acacia trees and tall bushes of *Zizyphus jujuba*. Live coral reefs are found at the south-western corner of the island to a distance of 200 m from the shore.

x. **Appa Tivu** is traversed on the southern side by an intervening coral stone studded sandy flat which is flooded during high tide preventing accessibility from one end to another. The southern portion of the island is elevated up to 6m and standing on fossilized coral

stones of large dimensions. The northern portion like other islands has an average elevation of only 2.5 m from spring tide level. The total area of island is 28.63 ha but more recently estimated as 40.25 ha as per satellite image.

xi. **Poovarasanpatti Tivu** is a narrow sandy flat of about 0.25 ha exposed during low tide and submerged by high tide. Live reefs surround the area up to a distance of 100 meter except on the northern side. Apart from a few boulder type corals occurring on the eastern side, the rest are of branching type of corals at a depth of two meters.

xii. **Talairi Tivu** with an area of 75.15 ha (101.75 ha as per the 1994 Satellite image) is an extensively elongated island with linear axis parallel to the shore; the broadest portion of the island is on the western tip. Thickly covered with trees and meadows which are often used for grazing. There is a narrow strip of foreshore on the northern side and a restricted foreshore on the southern side. Live corals exist very close to the shore to the entire length of island on the north-western edge. Continuous fringing reef exists at a distance of 0.75 km all along the Southern side.

xiii. **Valai Tivu**, a small linear island parallel to the mainland and connected to Talairi Tivu by a channel, remains submerged during high tide. The western side of northern shore has a good portion covered by boulder reef as well as branching coral types. The southern reef is far out beyond the breather zone and lies at three meter depth.

xiv. **Mulai Tivu**, a small sandy island completely covered with tall shrubs and bushes, occupies an area of 10.20 ha (16.00 ha as per the 1994 satellite image). Boulder reefs are observed on the northern portion of the island, while on the eastern side, low fringing reef continues outward up to three meter depth. The southern reef is far outside at a distance of 1.25 km from the shore and extends westwards.

xv. **Hare Tivu** occupies 129.04 ha (179.00 ha as per the 1994 satellite image) and is an extensive island completely covered by thick vegetation of Acacia trees, palmyrah, coconut plantations and other trees. Very interesting assemblage of coral reefs are found around the island. For example, boulder reef and fringing reef are seen all along the southern and western sides. On the eastern side fringing reef is continuous, but becomes discontinues as it proceeds northwards. Coral boulder commonly noticed on the northern side of the island.

xvi. **Manoli Tivu** with an area of 25.90 ha (87.50 ha as per 1994 satellite image) is a small island surrounded by sand and mud flats which get exposed during low tide. It is well covered by trees and shrubs. Extensive branching and boulder reefs found on southern and northern sides at 250m distance. Mangroves are observed here and there at best, inspite of the coral substratum, which is a unique factor.

xvii. **Manoliputti Tivu** is a very small island of 2.34 ha. Patchy distribution of live coral reef and boulder reef are seen all around the island. The mangrove vegetation reaches its peak showing a considerable amount of diversity.

xviii. **Poomarichan Tivu** forms an almost horseshoe shaped island with scanty foreshore, surrounded by marshy areas, broken coral stones and thick woodlands. It occupies an area of 16.58 ha (27.50 ha as per the 1994 satellite image). Extensive reefs are formed on the western and eastern sides of the island at a distance of 150 m from the shore. On the southern side continuous reefs of dead and live corals found close to the shore.

xix. **Pullivasal Tivu** has an area of 29.5 ha and is covered by thickly wooded and swampy areas. On the northern side of the island loose mud is formed around the mangroves. Fringing coral reef is developed on the southern side at a distance of 200 m. A similar patchy reef distribution is also noted beyond the muddy area on the northern side.

xx. **Krusadai Tivu** with 65.80 ha area (82.00 ha as per the 1994 satellite image) is densely covered with trees and bushes. A continuous fringing reef is seen on the southern side and extends up to 500m. The lagoon in this area contains true coral patches. On the northern and eastern side there are a few patches of branching corals and their varieties have been established.

xxi. **Shingle Tivu**, an island full of shingles and coral rubbles heaped all along the shore to a height of 0.75 m, is fully covered by bushes and trees. Fringing reef and patchy distribution of live coral boulders found on the eastern, northern and western sides of the island, swamps in the eastern and southern portions of the island possess mangroves.

Some of the geographical and geo-morphological features seen around the island locations of Gulf of Mannar Biosphere Reserve are: (a) shingle seen around Manolli, Pulli and Margarita; (b) Patches around Batt, Mansfield;

(c) Promontory at Kundagal and Raman points (d) Pass at Pamban pass; (e) Channel at Puma; (f) Shola near Pullivasal (g) Reef at Manalli and Pullivasal. Also many sandstone and sandunes formations are seen all along the coast line. In low lying areas, rain water filled pools and depressions are common around and off Ramanad coasts. These features are high scientific and phytogeographical importance. The deepest parts of the gulf are situated of Valinokkam and off Pamban islands. The shallowest part of the area is found south of Kanyakumary (Devil point) and extends from Vaipar to Pamban.

3.3.2. Reserve inhabitants, demographic trends and dependence

The inhabitants are chiefly Marakeyars, the local fisher folks mainly engaged in fishing activities. There are over 47 fishing villages along the coastal part of the reserve in 160 km long buffer zone with a population of approximately 1,00,000 people. Fishing is the main activity and source of income for the inhabitants of the coastal region. Exploitation of fishery resources in the inshore waters had been the sole occupation of thousands of fishermen families along the coast. Of 47 fishing villages, 38 are in Ramanathapuram district and 9 in V.O. Chidambaranar district bordering the reserve area. About 50,000 fisher folks mainly depended on fishing for livelihood. The fisher women folks are engaged in allied activities such as curing of fishes, marketing, and net mending. Nearly 90% of all fisher folks are artisanal and the remaining 10% are mechanized trawler fishermen. The traditional crafts such as catamarans, vallams, masula boats and dugout canoes are employed along with small engine powered crafts and mechanized boats for fishing. The fishing gears such as trawl nets, gill nets, shore scines, drift nets, long-lines, bottom set gills net, olavalai, karavalai and kalamkatti valai are mainly operated by the fishermen in and around these islands. The fishery around the biosphere reserve is dominated by lesser sardine, silver belly, sciaenid, mackeral, brean, holthurian, lobuters, molluscs and prawns. The average fish landings per year from the marine park area between 80-95 thousand tonnes and consists of mainly demersal and pelagic fishes. The prawn fishery

There are about 47 fishing villages along the coastal part of the reserve in 160 km long buffer zone with a population of approximately 1,00,000 people.

and holothurian fishery commands both in national and international markets and has become an important activity.

Mechanized boats exploit these resources by using multi-gear systems such as fish trawling, pair trawling, drift netting, gill netting and bottom set gillnetting etc. The surroundings of Rameswaram alone, there are thousands of men engaged in fishing prawns, crabs, etc. They have been for generations carrying out fishing activities at Mukkauyur, a haven for prawn beds. The introduction of mechanized trawlers cut into their livelihood forcing them to seek new pastures. As a consequence, the only available alternate options have been over harvesting of other resources viz., seaweed collection, coral collection, diving for pearl oysters and chanks, fire wood collection etc. The mechanization of fishery has also displaced women from their traditional role in processing and marketing, forcing them to take up alternate jobs for livelihood. At present the existing livelihood related programmes in the buffer zone are not concerned with developing sustainable alternatives and merely focusing on some woman's issues which do not adequately meet the needs of women fisher folks. The seaweeds that are commercially valuable like *Sargassum, Turbinaria, Gelidiella* and *Gracilaria* are in great demand and bulk quantities are being harvested from the reserve. Other than corals, diving for pearl oysters and chanks are other important occupation. Drift wood and dry twigs are collected from islands by fisher women as fire wood and sold in local markets.

3.3.3. State of knowledge

The islands and associated systems constituting the Biosphere Reserves have been investigated by various institutions and study groups for biological and physiognomic



characterization. The gulf is a haven for marine algal communities especially their abundance, development and diversity. The study conducted within the reserve has confirmed occurrence of 147 species of marine algae. These algal beds and sea grasses form a specific niche and support a complex of ecological communities that provide feeding grounds for many organisms including the globally endangered marine mammal "dugong" (*Dugong dugon*). This mammal is the last refuge of an invertebrate, the unique "living fossil", that links vertebrates and invertebrates. Its occurrence in the gulf, therefore, increases the conservation value of the biosphere reserve. The reserve is known for its rich sea grass resources. All six genera and 11 species of sea grasses so far recorded in India are growing which forms 50% of genera and 22% species so far known (out of 12 genera and 50 species) around the globe. A monotypic sea grass species *Enhalus acoroides* luxuriantly grows in the beds of islands is an endemic to this reserve. The coral reefs which form patches along the fringes of islands consists of 96 species belonging to 37 genera. The islands and salt marshes in the reserve are known to be used by 168 species of migratory birds. The sandy shores of most of the islands provide nesting habitat for sea turtles and all five species of marine turtles have been recorded to nest on these islands. Further, of the 2,200 fish species reported in Indian water, 450 species (20%) are found in the Gulf, making it single richest area in the Indian subcontinent in terms of fish diversity. Interestingly, the occurrence of 79 species of crustaceans, 108 sponges, 260 molluscs and 100 echinoderms signify the importance of the Gulf.

Coastal mangroves constitute an important nursery habitat for hatching a variety of marine organisms and thus serve as a biodiversity reservoir. Within the reserve, 17 different mangrove species occur and play an important role in maintaining the ecosystem balance. The habitat in the gulf promotes a luxuriant growth of mangrove species and this is evident from the fact that 6 species endemic to peninsular India naturally grow in the reserve.

3.4. Global and National Significance

Most of the islands in GMBR have exuberant growth of mangroves on their shore line and offer an excellent ground for turtle nesting. The sea bottom of the inshore islands is carpeted with seagrass beds which not only serve as feeding grounds for the endangered sea cows (*Dugong dugon*), but also harbors most of the marine organisms. The fringing and patchy coral reefs that surround the islands are the most complex and delicate ecosystems which are often referred to as, "under water tropical rain forests", are a treasure house of marine ornamentals. This unique marine ecosystem forms one of the richest biodiversity areas in the Indian subcontinent. The gulf waters with a variety of habitat and complex diversity has been subjected to varying degree of routine human interference and even threatened of its very existence. Thus this reserve has been selected as an international priority site based on their bio-physical nature, ecological uniqueness, economic, social, cultural and scientific importance at national and global levels.

3.5. Biodiversity Values

Occurrence of 79 species of crustaceans, 108 sponges, 260 molluscs and 100 echinoderms signify the importance of the Gulf.

The biological significance of the area is more than epitomized by Krusadai Island where representatives of every animal phyla (except amphibians) are known to occur and hence the island is often referred to as "biologist's paradise". The oceans in this region are very rich in terms of species, their complexity and population size, and thus considered to be a cradle of marine life. They have the potential to meet the protein requirements of exploding human population. Therefore protection of coastal ecosystems, which form a natural barrier between land and sea, is of utmost important and in turn they would preserve life support systems on which mankind has depended since time immemorial.

The GMBR hosts a number of important groups of lower and higher plants species and diverse habitats. They are of immense significance both ecologically and economically. The varied ecosystems form an ideal habitat favoured for unhindered evolutionary process of both plant and animal kingdoms. Thus the entire marine system is unique in the east cost of India. These habitats host rich variety of flora and fauna including rare, endangered and endemic species which are unique to the reserve. The Gulf of Mannar is a natural unit and buffer zone compatibility conditions are ideal. The area is large and permits dynamic changes, which favour biological and physical viability, defensibility and integrity of the system for maintaining resilience. Most of the islands are in close proximity with the mainland and the local people exploited the resources for their livelihood.

The rich biological diversity of Gulf of Mannar is largely attributed to the presence of diverse habitats as mentioned. The reserve serves as a protective shelter for many larval forms and adults and is well known for its biotic wealth. The

productivity of the system is estimated to be 7.3 g cm^2d^{-1}. This has been judged by the fact that nearly 5000-7000 tons of dry seaweeds are regularly being harvested and exported as raw materials for various industries to other regions of Tamil Nadu. It has also been recorded that the marine fishery production of more than 1 lakh tonnes with a production rate of 14 tons per km^2 from this area is very high as compared to the national average of 9 tons per km^2. The reserve is considered to be the hot spot of marine diversity and density. The floral components comprise of 126 species of phytoplanktons, 160 species of sea-weeds, 13 species of sea grasses, 13 species of mangroves and 78 species of flowering plants. The faunal components include 91 species of sponges, 14 species of gorgonids, 19 species of echinoderms, 263 species of mollusces, 6 species of pearl oysters, 5 species of chanks, 4 species of sea turtles, 10 species of mammals and 117 species of corals. Above all, occurrence of 450 species of fin fishes makes the Gulf of Mannar a fertile ground for fishery resources. Such impressive species diversity and abundance of multifarious species is mainly due to high organic carbon production from the sea grass meadows of the Gulf.

3.6. Issues and Concerns

Nearly one lakh people residing in the coastal buffer zone and earning their livelihoods from the gulf waters, exert heavy pressure on reserve resources. Due to heavy exploitation by the local communities, the mangrove systems are getting fragmented thereby affecting the regeneration of the vegetation as well as the dependent marine organisms. The buffer zone is affected by the cumulative effects of various human activities such as fragmentation of mangrove habitats, coral/limestone mining, pollution from untreated sewages, thermal power plant, silting as result of erosion, etc. The marine environment is disturbed due to over harvesting of resources, drudging operations, improper trawling practices etc. which hampered algal beds, sea grass beds and coral communities.

The coral reefs of reserve are fast deteriorating because of erosion and greater silt inflow from mainland, human activities such a lime stone quarrying, coral collections, industrialization, urbanization, pollution, etc. The sea grass system presently is under a major environmental stress due to over exploitation, changes in salinity and nutrients, light penetration and mechanical disturbances. The organic wastes generated due to fishing and other marine collections such as seaweeds, sea grasses, etc., pollution from sewage and thermal power station further pose serious threat to the reserve.

3.7. Management Interventions

Although Gulf of Mannar does have potential to support moderate level of ecotourism, at present the facilities are kept at minimum level to ensure a better protection. On an average of 1.4 million people visit the pilgrim centers of Rameswaram and about 1.1 million visit Tuticorin, Thiruchandur, Kanyakumary, etc. Managing such a huge

The mangrove systems unique in many ways get affected by heavy exploitation and thus affect regeneration of the vegetation and dependent marine organisms as well.

Formulation and implementation of management plans is well thought off and local community is being taken into confidence at every step for getting desirable results.

tourist inflow causes great concern to the BR authorities.

The successful management of the Gulf of Mannar Biosphere reserve depends on the harmonious relationship between the inhabitants and the immediate sea environment on which the pulse of life is based on. As of now, formulation as well as implementation of management plans is well thought off and the local community is being taken into confidence at every step for getting desirable results. The Lead Institution is involved in collection, synthesis and dissemination of research based information. This information forms a base for BR management authorities for taking appropriate management decision for the reserves and also to maintain the biological resources and reserve as renewable resources.

AG Pandurangan
Co-ordinator, BR. Programme
Tropical Botanic Garden and Research Institute
Palode, Thiruvananthapuram -695 562, Kerala
Phone: + 91-472 2869226, 2869246
Fax: + 91-472 2869646

RK Rai
Ministry of Environment and Forests
CGO Complex, Lodi Road
New Delhi 110 003

Nanda Devi Biosphere Reserve

UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION

CONVENTION CONCERNING THE PROTECTION OF THE WORLD CULTURAL AND NATURAL HERITAGE

The World Heritage Committee has inscribed

Nanda Devi and Valley of Flowers National Parks

on the World Heritage List

Inscription on this List confirms the exceptional and universal value of a cultural or natural site which requires protection for the benefit of all humanity

DATE OF INSCRIPTION

17 July 2005

DIRECTOR-GENERAL OF UNESCO

4
Nanda Devi Biosphere Reserve – West Himalaya, India

4.1. Introduction

The Nanda Devi Biosphere Reserve (NDBR), the second Biosphere Reserve designated by Government of India, represents unique combination of mountain ecosystems including traditional agro-ecosystems, mixed temperate and sub alpine forests, alpine meadows and glaciers. In recognition of its uniqueness, the reserve has been included in World Network of Biosphere Reserves (WNBR) by UNESCO since 2004. Also, the Nanda Devi and the Valley of Flowers National Parks, forming core zone of NDBR, have been inscribed on the World Heritage List by UNESCO under Natural Criteria vii and x.

Designation Date	: 18 January 1988
Total Area	: 6,407.03 km^2
Core Area	: 712.12 km^2
Buffer Area	: 5,148.57 km^2
Transition Area	: 546.34 km^2
Extent	: 30° 05′ and 31° 02′ N 79°12′ and 80°19′ E

4.2. Area Description

Nanda Devi Biosphere Reserve (30°05'-31°02'N Latitude, 79°12'-80°19'E Longitude) is located in the Northern part of the West Himalaya and comprises of parts of Chamoli district in Garhwal; and Bageshwar and Pithoragarh districts in Kumaun in the Uttarakhand State.

4.2.1. Zonation Details

The core zone, which includes two National Parks (the Nanda Devi National Park: IUCN Management category Ia-

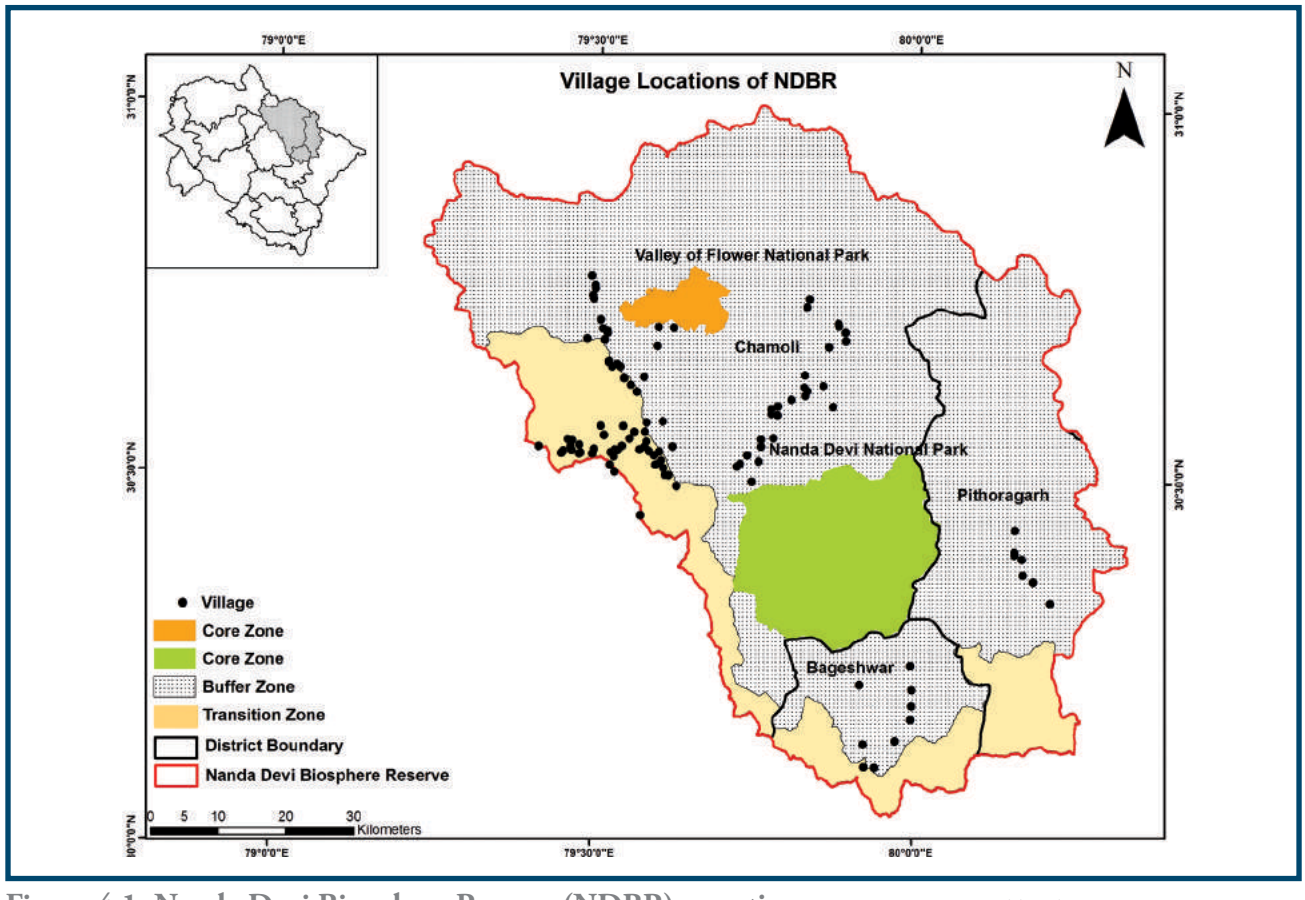


Figure 4.1: Nanda Devi Biosphere Reserve (NDBR)-zonation map (Source: Uttarakhand Forest Department)

Strict Nature Reserve; the Valley of Flowers National Park: IUCN Management Category II- National Park), represents diverse floristic communities and richness of species with many rarities of both flora and fauna. The vast buffer zone includes nearly 10% as reserve forest, 1.0% as panchayat forests and 89% as revenue land wherein 47 settlements (villages) inhabited by indigenous communities belonging to Indo-Mongoloid (Bhotiya) and Indo-Aryan group are located. The transition zone includes over 55 human settlements.

4.2.2. Biogeographic characteristics

NDBR falls in the west Himalayan biogeographic province of zone Himalaya. Some areas in Northern extreme represent Trans Himalayan cold desert characteristics. Geologically most of area falls within the 'Central Crystalline' of Heim and Gansser (1939). However, the upper most horizon of the Nanda Devi peak itself is formed by the Tethyan sediments. Greater Himalaya or Himadri System and Zanskar range. The central crystalline in the area comprises of low grade metamorphic rocks belonging to green schist facies with grade upwards up to almandine-amphibolites facies. These rocks are bounded by two major shear plane viz. the Tethyan thrust in the North and Main Central Thrust (Vaikrita Thrust) in the south, striking in the NW-SE direction with moderate dips towards NE. One of the most striking features of the reserve includes existence of the glaciers and associated water resources.

> Nanda Devi Biosphere Reserve (NDBR) falls in the west Himalayan biogeographic province of zone Himalaya.

4.3. Background Information

The reserve has a wide altitudinal range (1,800-7,817m asl) and covers an area of 6,407.03 km^2. The unique topography, climate and soil support diverse ecosystems, habitats, communities and species. The prevailing representativeness (richness), naturalness (nativity) and uniqueness (endemism) of biodiversity elements in the reserve highlight its conservation value. Likewise, preponderance of economically important species (medicinal plants, wild edible plants, etc.) and traditional knowledge and practices of resource use and management makes the reserve a site important for eco-development.

> The reserve has wide altitude range (1,800-7,817 m asl) and covers an area of 6407.03 km^2

4.3.1. Landscape features and land-use history

The core zone of the reserve is completely protected. Nearly 80% of it is under snow and glaciers; 10% forests; 5% alpine meadows and 5% waste land. The human activities, confined in buffer and transition zones, include agriculture and sheep rearing as major occupation. The buffer zone of the reserve

include 27% forests, 5% alpine meadows, 7% waste land and 60% as snow and glaciers. Settled terrace farming is confined to <1% area of the zone. Inhabitants heavily depend on forests for fuel, fodder, timber and leaf litter as organic manure, and on meadows for pastoral activities. Collection of medicinal herbs and wild edibles is yet another nature dependent activity of the local communities.

4.3.2. Reserve Inhabitants, demographic trends and dependence

The inhabitants mainly belong to the Indo-Mongoloid (Bhotiya tribe) and Indo-Aryan groups.

A total of 47 villages of indigenous communities fall within buffer zone of the reserve. The inhabitants mainly belong to the Indo-Mongoloid (Bhotiya tribes) and Indo-Aryan Groups. As per the 2001 census, the total population of buffer zone was 10,909 (male 6,234; Female 4,675). The demographic trends in buffer zone over last four decades are depicted (Figure 4.2). The transition zone is inhabited by over 55 villages. The most of the settlements are permanent except the settlements located in Pithoragarh district, which are winter settlements. The native communities of the reserve are socially, culturally and emotionally attached to the area. Among others, two famous pilgrimage sites (e.g., the Hindu religious shrine-Badrinath, and the Sikh religious shrine – Hemkund Saheb) are major settlements with sizable number of moving population in the reserve, especially during summer season.

Inhabitants are dependent on the biological resources for use as medicine, food, fodder, fuel, timber, fiber, agricultural tools, etc. Studies indicate that over 193 species of plants in Lata-Tolma-Malari area (Garhwal part of NDBR) and 242 species in Pindari area (Kumaun area of NDBR) are used for various purposes by native communities in the buffer zone. For enterprise development they are dependent on temperate and subalpine bamboos, mainly *Thamnocalamus spathiflora* (Tham) and *Arundinaria falcata* (Ringal). The buffer and transition zones of the reserve are the manipulation zones where native communities are allowed to use natural resources and to carry out the developmental activities. Various activities such as eco-restoration,

The Hindu shrine – Badrinath and the Sikh shrine – Hemkund Saheb are two major pilgrimage destinations within the reserve.

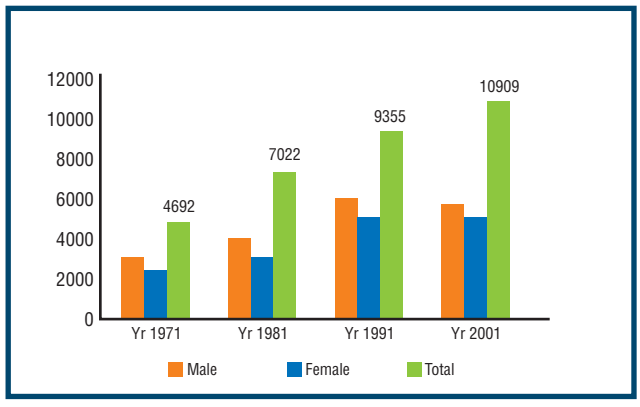


Figure 4.2: Demographic trends in NDBR

cultivation of medicinal plants, apiculture, animal husbandry, ecotourism, land stabilization, etc., have been implemented by the Biosphere Reserve Authorities, Research Organizations, etc.

The tribal community – Bhotiyas, in the reserve have adapted to an inter-linked production system of agriculture, animal husbandry and forest products.

The Bhotiya tribal community of buffer zone; traditionally the trans-border traders who traded in agro-products from Indian side and woolen and livestock from Tibet prior to 1962 Sino-Indian conflict when trade was called off; have adapted to an inter-linked production of agriculture, animal husbandry, and forest products. They largely follow a transhumance life style to survive in the extreme environmental conditions of higher Himalaya. Except a few villages (e.g., Reni and Peng) most of the Bhotiya households in the reserve have two settlements, one in the valley for winters and another at higher reaches as summer settlement.

4.3.3. State of knowledge

Among Himalayan Biosphere Reserves, NDBR is relatively well explored. Analysis of 658 studies during 1990-2008 which pertain to different BRs of Indian Himalayan reveal nearly 42% (276) studies alone are for NDBR (Figure 4.3). Distribution of Knowledge base in NDBR under diverse fields is given (Figure 4.4). This analysis reveals that the reserve is well explored for its floral and development & management aspects but other important areas such as fauna, socio-economics, ethno-biology and geophysical features have not been undertaken adequately.

While considering the scientific information base for the reserve, the decadal biodiversity monitoring exercises (1993 - 2003) conducted by a joint team of scientists from different research organizations and Uttarakhand Forest Department have been the significant effort, which generated real time field evidences on status of biodiversity.

Considering review of information for the reserve, following gap areas have been identified for priority attention towards undertaking R&D activities:

Flora & Fauna: (i) Diversity-distribution and grid maps; (ii) Habitat relation and status assessment of threatened taxa;(iii) Quantification of ethno-biological values;

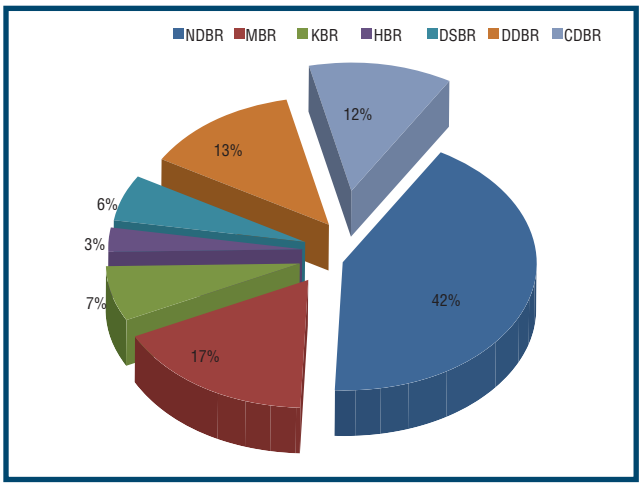


Figure 4.3: Comparative level of studies in BRs of Himalaya

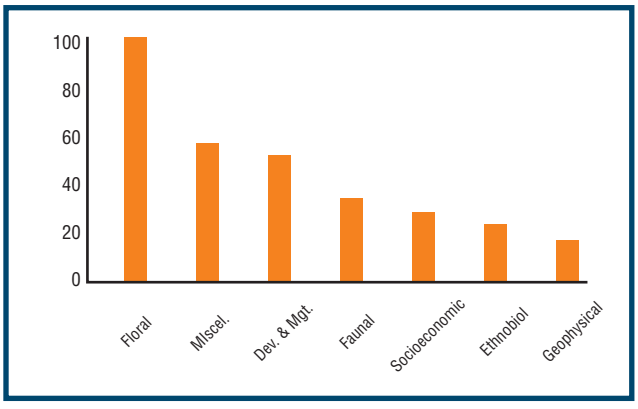


Figure 4.4: NDBR knowledge base - diverse aspects

(iv) Inventory and assessment of lower groups (pteridophytes, bryophyts, algae, fungi, lichens, etc.).

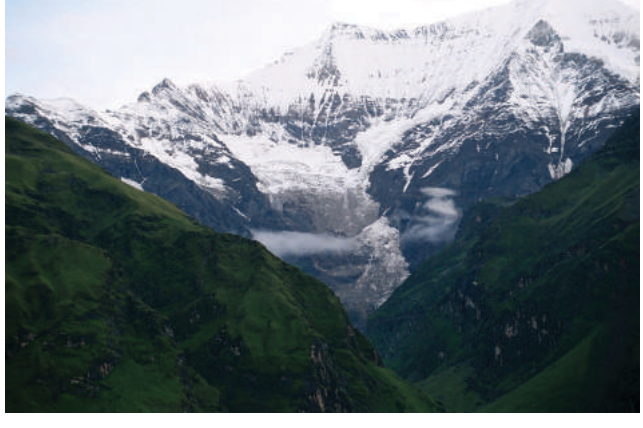
Socio-ecological: (i) Human dependence and consequent impact on resources; (ii) Valuation of ecosystem goods and services; (iii) Change detection (spatio/temporal); (iv) Eco-tourism potential assessment; (v) Best practices - societal adaptation to changing scenarios.

Geo-physical: (i) Glacier retreat and impacts on downstream ecology; (ii) Hydrological systems; energy options; (iii) Weather monitoring and climate change evidences.

Development & Management: (i) Optimal use of scientific evidences in management strategies; (ii) Man animal conflicts and their resolutions; (iii) Needs assessment, public awareness, and negotiations; (iv) Alternative livelihood options and income generation; (v) Protection and communication network.

4.4. Global and National Significance

The identified core zones (Nanda Devi and Valley of Flowers NPs) of the reserve represent unique landscapes with outstanding naturalness value. While the Nanda Devi NP, the catchment of basin of the Rishi Ganga, an Eastern tributary of the Dhauli Ganga which feeds as a major tributary of the Ganges – the Alaknanda, represents a vast glacial basin. The basin displays rugged topography and one amongst the deepest gorges of the world. Virtually no human intervention has kept the park one of the most wilderness areas in the Himalaya. These features of the park, accompanied by several others, have long been recognized globally. As a result, the Park was inscribed on the World Heritage List in 1988. The Valley of Flowers NP is one of the most picturesque hanging alpine valleys in the West Himalaya that has been acknowledged by renowned mountaineers and botanists over a century for its exquisite floral diversity. It is India's first national park exclusively designated for the conservation of Himalayan flora. Nature has bestowed this area with most heterogeneous land formation ranging from low flat and gentle valley areas and gentle moraines to steep slopes, unstable glaciers, stream bands, forest-meadow edge and snow bound areas within a compact area of 78 km^2, making it very exciting site for nature lovers. Realizing this value of the park, it was included in the list of World Heritage Site in 2005. The NDBR area has been recognized



> The reserve represents unique landscapes with outstanding naturalness value. Both the core areas (Valley of flowers and Nanda Devi NPs) have been inscribed on the World Heritage List.

> Ecological integrity of core zones has been maintained thoroughly and no biotic intervention is permitted inside core zones. As a result, the status of populations of rare endangered biodiversity elements of the region is remarkably good inside core zone.

as an important bird area (IN 105) by Birdlife International and also it represents one of the identified Endemic Bird Areas in west Himalaya.

Ecological integrity and authenticity of the core area has been maintained thoroughly ever since they have been declared as National Parks (Valley of Flowers – 1980; Nanda Devi – 1982). As per the provisions of the Wildlife (Protection) Act, 1972 biotic interventions are not permitted inside the National parks except for habitat management of wild flora and fauna. Tourism is encouraged in a regulated manner keeping in view the conservation needs of the area. As a result of protection measures, the status of otherwise rare and endangered floral and faunal elements of the region exhibit remarkably good populations in these areas.

The reserve, besides fulfilling the livelihood needs of indigenous communities, is as important for its unparallel ecological services. The glaciers contribute significantly to the mighty Ganges river system. The pristine plant communities protect the delicate soil systems of higher Himalaya and thereby decreasing intensity of damages downstream.

Religious and cultural significance of the area is very high. In Hindu mythology, Nanda Devi is a manifestation of Goddess Parvati, consort of Lord Shiva. Hence the entire area enjoys sacred status, especially from Hindus. They have defined the entire basin sacred and every twelfth year devotees make the Nanda Devi Raj Jat pilgrimage to the foot of Trisul to worship their patroness the 'Bliss-giving Godess' Nanda Devi. Among others, the Badrinath Dham (the Hindu shrine at 3200 m asl) and the Hemkund Saheb (the Sikh Shrine at 4150 m asl) are very revered pilgrimage destinations in the country.

The NDBR fits in very well in the context that Biosphere Reserves are a perfect foil for UN Secretary-General's 'WEHAB' initiative for sustainable development (Table 4.1).

4.5. Biodiversity Values

Being located at the juncture of Great Himalaya and Zanskar range, the western part of the reserve represents flora of both the regions with several elements unique to this ecotone. Also, the reserve as a whole represents an ecotone between eastern and western Himalayan phytogeographic regions thereby contributing to richness and uniqueness of biodiversity elements.

> Being associated with Bliss-giving Godess – Nanda Devi, the entire area enjoys sacred status, especially for Hindus.

Table 4.1: NDBR as a Perfect Foil for 'WEHAB' Initiative of UN

- W(water): being a glacier/snow dominated landscape it acts as perennial source for many small and large streams which ultimately contribute to the Ganges river system. Therefore, reserve acts as foci of research and management on water and ecosystems, including mighty Ganges system. Under changing climate scenario the dynamics of snow and glaciers in the reserve has assumed greater significance.
- E(energy): reserve and its peripheral sites contain great hydropower potential and over 7 sites have been identified with nearly 1000 MW capacity under 50,000 MW hydropower initiative for the region. Also, it may act as an experimentation site for solar and wind energy.
- H(health): NDBR is rich repository of medicinal plants and traditional knowledge on health care system. Abundance of unique (endemic) medicinal plants keeps the possibilities very high for new molecule/drug discovery. The pristinely environment contributes greatly towards wellness of inhabitants and downstream populations as well.
- A(agriculture): diverse and unique traditional agro-ecosystems, crop species, and livestock in the reserve have not only helped indigenous communities to sustain but also in the maintenance of autochthonous breeds of livestock and land races of crops.
- B(biodiversity): NDBR contributes significantly for the protection of representative and unique biodiversity elements of western Himalayan high altitude ecosystems ranging from cool temperate to sub-alpine forests and ecotone, moist alpine meadows to dry cold-deserts, and the traditional high altitude agro-ecosystems.

The recorded floral elements include: angiosperms 699 species; gymnosperms 11, pteridophytes 137; bryophytes 146; lichens 77, and fungi 128. Some plant rarities are: *Allium stracheyi, Aconitum balfourii, A. heterophyllum, Angelica glauca, Arnebia benthamii, Dactylorhiza hatagirea, Hedychium spicatum, Paeonia emodi, Picrorhiza kurrooa, Podophyllum hexandrum, Saussurea costus, S. obvallata, Taxus baccata,* etc.

The known faunal diversity includes species of- mammals 29; birds 243; insects 229; molluscs 14; amphibian 8; annelids 6; reptiles 3; and pisces 1. Notable faunal rarities are: *Panthera uncia, Moschus chrysogaster, Selenarctos thibetanus, Pseudois nayaur, Lophophorous impejanus, Pucrasia macrolopha, Tragopan melanocephalus, Tetragallus himalyensis, Gyps bengalensis, Sarcogyps calvus, Gypaetus barbatus, Catreus wallichii,* etc.

Besides wild, reserve supports a large number of traditional crops, fruits and vegetables. Among these, *Fagopyrum esculentum* (Ogal), *F. tataricum* (Phaphar), *Phaseolus vulgaris* (Rajma), *Eleusine coracana* (Manduwa), *Amaranthus paniculatus* (Chaulai), *Hordeum himalayense* (Uwa), *H. vulgare* (Jau), *Glycine max* (Bhat) and *Panicum miliaceum* (Chena) are important for sustenance of the inhabitants. A large number of medicinal and wild edible plants in the reserve are being used both for sustenance and income generation.

NDBR Recorded Species Diversity:

Floral–

Angiosperms	-	699
Gymnosperms	-	011
Pteridophytes	-	137
Bryophytes	-	146
Lichens	-	077
Fungi	-	128

Faunal–

Mammals	-	029
Birds	-	243
Insects	-	229
Mollusca	-	014
Amphibia	-	008
Annelids	-	006
Reptiles	-	003
Pisces	-	001

4.6. Progression of Conservation and Management

The area enjoys a long conservation and management history which begins with mountaineers E.Shipton & W. Tillman forging their way to inner basin of Nanda Devi through the steep and narrow Rishi Gorge in 1936 and drew attention of mountaineers and trekkers throughout the world

Basin was declared as Nanda Devi Sanctuary – 1939

The Valley of Flowers was declared as National Park -1980

Basin was declared as Nanda Devi Sanctuary – 1939

630 km^2 area of the Nanda Devi basin was declared as Nanda Devi National Park – 1982

Notified the area of 2236.74 km^2 as Nanda Devi Biosphere Reserve – 1988

Nanda Devi National Park was inscribed in the list of World Heritage Sites – 1992

Area of Nanda Devi Biosphere Reserve was extended; both National Parks were included as core zone of reserve – 2000

Nanda Devi Biosphere Reserve was included in the MAB- World network of Biosphere Reserves – 2004

Valley of Flowers National Park was also included in the list of World Heritage Sites - 2005

to this spectacular mountain wilderness. This resulted into a significant increase of mountaineering and trekking activities in the area which also started affecting its naturalness. This realization was the beginning of conservation initiatives in the basin.

Besides the Government initiatives, the Nanda Devi Biosphere Reserve area has exhibited important public movements not only for maintenance of resources but also to reinstate their rights over resources. For example, in 1974 the proposed clear-cutting of the trees in Reni prompted the world famous Chipko (hug the trees) movement amongst inhabitants led by the local resident Gaura Devi. The movement spread across the region resulting in halt on Government efforts of harvesting trees. Similarly, in 1998 the villagers of Neti valley united for Japto Cheeno (swoop and grab) movement against the reserve management and the forest Departments' restrictions on mountaineering and grazing. The Lata village council in 2001 set-up the Nanda Devi Development Authority to convince the Government to reconsider the ban on mountaineering so that local community rather than outside interests might once again benefit from ecotourism. As a result 9 km stretch inside Nanda Devi Park has been opened up for regulated tourism from the year 2003. Yet another initiative which deserves mention was community based trail management and eco-tourism activity in Valley of Flowers National tourism zone. This initiative, began in 2002, is one example of coordinated participatory action both by the inhabitants and the park management.

As such the management responsibility is with state forest department. The department is currently following a ten year landscape management plan (2003-04 to 2012-13) which is being implemented in association with local inhabitants to promote following initiatives:

Eco-Development activity

Value addition

Rehabilitation of landscape

Ecotourism- Policy and infrastructure support

Social welfare activity

Protection and communication system

Compensation for wild animal victims

4.7. Issues and Concerns

In-spite of the above successful initiatives, the reserve has several issues, some of these listed below, deserving immediate attention so as to make the reserve a true success model (Box 4.1).

Towards effectively addressing above issues and considering the fast change global thinking on the issues of sustainable management of reserves resources following would assume priority:

(i) Development of a Perspective Plan (5 year) and its effective implementation

(ii) Improving monitoring and networking of BR through use of modern tools

(iii) Development of specific training capsules for diverse groups of stakeholders considering their needs and relevance with BR specific issues

(iv) Development of user-friendly information portal for NDBR

(v) Establish baseline information on value of ecosystem services emanating from the BR

(vi) Developing alternate modals/strategies for sustainable use and management of BR resources under changing climate and economic scenarios

(vii) Strengthen participation of communities and private sector in reserve management

4.8. Perspective 5 year plan – major components

Considering the effectiveness and relevance of the Landscape Management Plan (2003-04 to 2012-13), being

Box 4.1: Issues and Concerns in NDBR

- Poor infrastructure for management and conducting long term studies
- Un-regulated mass religious tourism in certain sites (e.g., Badrinath & Hemkund Saheb)
- Increasing frequency of Park-People conflicts
- Lack of appropriate marketing channels for agricultural/ horticultural produce and traditional crafts
- Non existence of mechanisms for integration with international projects/protocols
- Rare use of modern tools/technologies (i.e., IT) for information generation, dissemination and management
- Inadequate capacity building (as per international standards) mechanisms for BR personnel and researchers
- Unaccounted value of ecosystem services generated by the reserve
- Increased vulnerability of reserve resources and people under changing climate
- Lack of alternate options to ensure sustainable use and management of reserves' resources under changing climate and economic scenarios

implemented by the Forest Department Uttarakhand in and around NDBR, it would form the major component of the perspective plan. However, realizing the need for developing a 5 year perspective plan which incorporates issues of the Madrid Action Plan following action areas would deserve priority inclusion in the perspective plan for NDBR (Table 4.2).

4.9. Success Stories

Among others, following can be highlighted as success stories for the reserve which can be replicated in other BRs of the region:

(a) Successful implementation of participatory processes for planning and management

(b) Remarkable waste management in Hemkund-Valley of Flowers area

(c) Successful initiatives to provide alternatives to natural resource dependencies

(d) Systematic documentation and dissemination of information on BR

(e) Successful protection of Core Area leading to its recognition as World Heritage Site (Natural site) and nomination in UNESCO MAB Net of Biosphere Reserves

Of these, a case of managing non-degradable waste through participation of inhabitants has received wide popularity (Box4.2).

4.10. Conclusion

Nand Devi Biosphere Reserve (NDBR) in the Indian Himalaya sets a case having potential of becoming a potential mountain Biosphere Reserve to fulfill all the functions as conceptualized. While representing a classical case for absolute conservation of core zone, the participatory eco-development activities in buffer zone have resulted into increased co-operation between inhabitants and management. Unique bio-physical values of the reserve and its sensitivity towards changing climate and human interventions, however, calls for improved attention from different stakeholders.

The authors thank Shri B.K. Gangte, Director NDBR, for his inputs on manuscript and support during studies.

Table 4.2: Proposed Components of Perspective Plan for NDBR

S.N.	Relevant Action Areas/Targets of Madrid Action Plan (MAP)
I.	**Cooperation, Management and communication** ❖ Effective implementation of the Seville Strategy by integrating the reserve into conservation planning wherein support and involvement of local people is secured. ❖ Increase cooperation and coordination of the reserve with existing international programmes and initiatives. ❖ Integrate information and communication strategy (i.e. creation of a web based information clearinghouse and information centre for the reserve, to exchange and share technology, research, training, education and cooperation opportunities finding and experience, and to help to solve problems at local , regional and international levels) and link it with programmes at national and international level. ❖ Enhance cooperation between experts and practitioners in relevant key issues. ❖ Increase linkage between Biosphere Reserve activities and sustainable development initiatives at multiple scales.
II.	**Science and capacity building** ❖ Ensure exchange of educational resources for widespread adaptation and application. ❖ Implement site based policy –relevant research programmes specifically focusing on analyses of ecosystem services and their management through stakeholder participation. ❖ Enhance scientific training of BR managers and other relevant stakeholders. ❖ Use NDBR as learning sites for research, adaptation, mitigation in relation to climate change. ❖ Use NDBR as field observatories of global change impacts on the environment, economy and human well being , based on the GLOCHAMORE Research Strategy.
III.	**Partnership** ❖ Develop mechanism for effective exchange between Biosphere Reserves of the region. ❖ Improve financial mechanisms for BR and its regional network. ❖ Support study tours /site visits between stakeholder groups in BR. ❖ Establish cooperation plans including all sectors of society to champion cooperative activities ranging from ecotourism and research to sustainable use of environmental goods and services.
IV.	**Zonation – Linking functions to space** ❖ Carry out a survey on the present zoning system and investigate how well it fulfill the three functions in each zone, particularly with regard to the transition area and the development function. ❖ Make efforts to establish national recognition of BR zonation schemes as an important planning tool for programmes linked to protected areas in production landscapes.

Box 4.2: Building Partnership – a case of Solid Waste Management in NDBR

Two community based Eco-development committees (EDCs), namely, Bhyundhar-Ghangaria and Govindghat, in Bhyndhar Valley buffer zone of NDBR, have helped the reserve management in successfully conducting various management functions, particularly Solid Waste Management along the heavily used route to the Valley of Flowers National Park and the Sikh pilgrimage site- Hemkund Saheb.

Dedicated Reserve Manager, Ms Jyotsna Sitling, IFS, and her team in NDBR painstakingly evolved this community-based Waste Management Programme. The successful implementation of programme yielded Ms Sitling, Director of NDBR, the Indira Gandhi Paryavaran Puruskar, the highest national award in the field of environment.

Ranbeer S Rawal
Nodal Person Lead-BR centre

Balwant Rawat
Researcher
G.B. Pant Institute of Himalayan Environment & Development
Kosi-Katarmal, Almora 263 643, Uttarakhand (INDIA)
Phone: +91-5962-241041
Fax: +91-5962-241150
eMail: ranbeerrawal4@gmail.com

Photo Credits: Balwant Rawat

Sunderban Biosphere Reserve

UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION

MaB

Man and the Biosphere Programme

By decision of the International Co-ordinating Council of the Programme on Man and the Biosphere,

Sunderban-India

has been designated for inclusion in the World Network of Biosphere Reserves.

The world's major ecosystem types and landscapes are represented in this Network, which is devoted to conserving biological diversity, promoting research and monitoring as well as seeking to provide models of sustainable development in the service of humankind.

Participation in the World Network facilitates co-operation and exchange at the regional and international levels.

Date 10 NOV. 2001

Director-General of UNESCO

5
Sunderban Biosphere Reserve – East Coast, India

5.1. Introduction

Sunderban Biosphere Reserve (9630 km²) is the third largest reserve in India which got its status as Biosphere Reserve in 1989 from the Government of India. The core of reserve, Sunderban National Park, was included in the World Heritage list in the same year. The reserve has also been included in UNESCO's World Network of Biosphere Reserves since 2001.

Designation Date	: 29th March, 1989
Total Area	: 9,630 km²
Core Area	: 1,692 km²
Buffer Area	: 2,233 km²
Transition Area	: 5,705 km²
Extent	: 20°30′ and 22°15′ N 88°05′ and 89°10′ E

5.2. Area Description

5.2.1. Zonation Details

Located in the North and South 24-Parganas districts of West Bengal state (Figure 5.1), the reserve lies between 20°30′ and 22°15′ N latitudes and 80°05′ and 89°10′ E longitudes. It consists of three zones viz. Core Zone (1692 km²), Buffer Zone (2233 km²) and the Transition Zone (5705 km²). (Figure 5.2).

> Sunderban is the only mangrove in the world which is inhabited by tigers.

The Core Zone is represented by Sunderban National Park and the Buffer Zone includes three wildlife sanctuaries [viz. Sajnekhali (362 km²), Lothian Island (38 km²) and Haliday Island (6 km²)], which makes Sunderban the largest mangrove forest in the world. Its origin is very recent and falls under the Gangetic delta, as a result reserve ecosystem is in very dynamic state. The boundaries of Sunderban under West Bengal's

Figure 5.1: Location of Sunderban

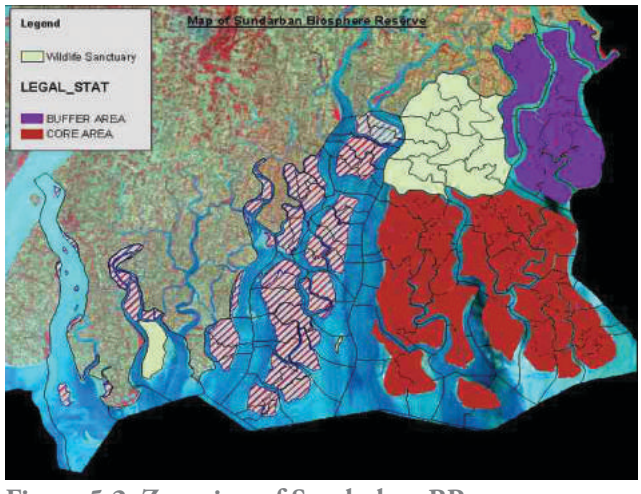


Figure 5.2: Zonation of Sunderban BR

share extended from the river Hoogly to the Raimangal. Sunderban is hardly 7000 years old and rose by the gradual deposition of silt carried down by the 2 rivers the Ganga and the Brahamputra. Sunderban Biosphere Reserve is characterized by embroidery of tidal creeks, encompassing the islands and offshore linear tidal shoals, aligned perpendicular to the shore line and separated by swales. The 9 main rivers flowing from North to South of Sunderban are Matla, Bidya, Ichamati, Raimangal, Herobhanga, Thakuran, Gosaba, Saptamukhi and Baratala. All these rivers change their flows remarkably, as a result, the rate of delta formation and degradation is very rapid in the Sunderban. The river water of the western and southwestern portions is more saline than those of the eastern side. Frequent inundation of land as well as vegetation during the high tide with saline water is a normal phenomenon in the Sunderban. The Bay of Bengal along with the network of rivers like Saptamukhi, Thakuran, Baratala, Matla and Gosaba are the chief sources of water and form this brackish water estuary.

5.2.2. Biogeographic characteristics

The reserve falls within the indo-Malayan Realm, province No. 4.3.1 (Bengalian Rain Forest) and Tropical Humid Forests Biome. In more recent biogeographic classification of India, it falls in biogeographic zone 8B: Coast, and represents East Coast province.

5.3. Background Information

5.3.1. Landscape features and land-use history

The forests of Sunderban were considered initially common land and were subjected to unrestricted use as per historical records. Shah Sujah, a local king, in 1658 for the first time used the Sunderbans as a source of revenue by imposing a levy on the export of wood from the forest. The society under the force of circumstances to be founded upon Hindu-Muslim unity and a blend of Hindu and Muslim culture. Out of common fear from nature and ferocious animals the Hindus and Muslims of Sunderban used to worship Banbibi, Dakshin Rai, Baba Thakur, Gorachand Pir, Bara Khan Gazi, Panchanan Pir, Kalu Rai, Sha Junguli, Manasa, Sitala, Olabibi, etc., irrespective of their religious belief. Tribal peoples are absent here. The people inhabiting in here came from the adjacent districts but they have a different cultural and social interactions.

5.3.2. Reserve Inhabitants, demographic trends and dependence

According to 2001 census, the total population of Sunderban Biosphere Reserve is 37, 55, 934 which is strictly distributed in the Transition Zone. The people living in Sunderban are directly dependent on the forest and forest based resources and fishery because agriculture does not fulfill their need due to high salinity of soil. The forest products like timber, fuel woods, thatching leaves, honey and wax are the main sources of commerce to local people.

5.3.3. State of knowledge

The floristic work on Sunderban has been started since 1903 with the publication of Flora of Sunderbans by Prain. In last two decades Naskar has made significant contribution on the floristic account of Sunderban Biosphere Reserve. Later workers like Chakraborty (1985), Guha Bakshi et al. (1969), Pal (1988), Patil (1961), Banerjee (1985) have made significant contributions in the floristic survey of different parts of Sunderban. Various aspects of ecosystems of Sunderban are studied by Banerjee (1985), Chakraborty (1985), Datta



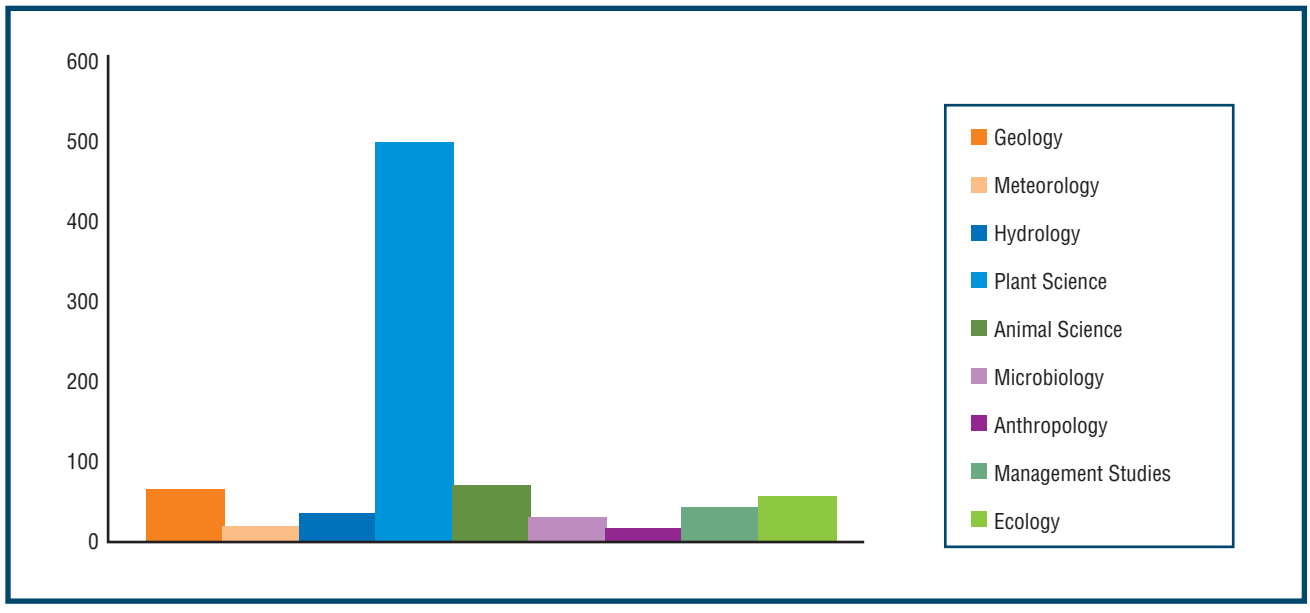


Figure 5.3: Distribution of studies across subject areas in Sunderban BR

et al. (1978), Guha Bakshi et al. (1987), Nasker (1985) and many more. Distribution of studies across various subject areas is given (Figure 5.3).

5.4. Global and National Significance

Sunderban constitutes 63% of total Indian Mangrove and entire eastern India Fishery is dependent on the input from Sunderban. It is the only mangrove tiger land on globe along with largest mangal diversity on earth with 81 mangrove species. Reserve saves Kolkata and suburbs from the rage of annual high gales from the sea and also acts as the sink for the 800 million liters of effluents per day without any treatment. This region harbours a rich diversity in terms of species content, ecosystem and habitat types.

Sunderban is the largest contiguous mangrove patch (along with Banladesh) on the globe.

Mangrove swamps are important in retarding coastal erosion and protecting the coast. Mangrove vegetation protects land from erosion and helps to build and consolidate silt. The mangrove swamps act as a system in which trees in all the zones have different role to play. Damage to the system can result in irreversible coastal erosion.

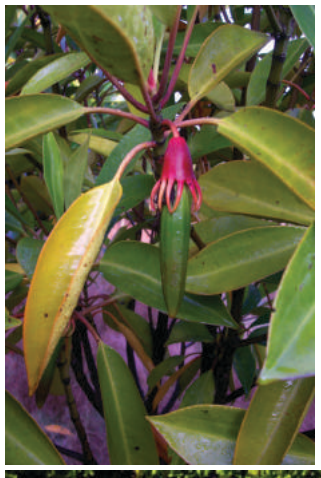
5.5. Biodiversity Values

In addition to about 964 flowering plants, including 81 mangrove species, 24 species of medicinal plants and 150 species of algae occur in this area. More than 163 species of birds, 40 species of mammals, 56 species of reptiles, 165 species of fish, 15 species of prawns, 67 species of crabs and 23 species of molluscas have

Sunderban represent the largest mangal diversity on globe with 81 plant species.

Uniqueness of Sunderban:

- Sunderban is the largest contiguous mangrove patch (along with Bangladesh) on globe.
- It is the only mangrove tiger-land on globe.
- It represents the largest mangal diversity on globe with 81 plant species.
- The reserve has been included in the World Heritage list in 1989, and included in UNESCO World Network of Biosphere Reserve in 2001.
- It constitutes 63% of total Indian Mangrove and entire Eastern Indian Fishery is dependent on the input from Sunderban.
- Sunderban saves Kolkata and its suburbs from rage of annual high gales from the sea.



so far been reported. Globally important rare mangrove plant species, e.g., *Acanthus volubilis, Amoora cucullata, Bruguiera parviflora, Heritiera fomes, Kandelia candel, Nypa fruticans, Rhizophora apiculata, Scyphiphora hydrophyllaceae* and *Sonneratia caseolaria* are available in the reserve. The reserve represents only mangrove tiger-land of the planet which also harbours rare and endangered mammals like: *Panthera tigris tigris, Prionalius bengalensis, P. vivirrina, Platanista gangetica, Neomeris phocaenoides, Manis pentadactyla*. The rare birds include *Ardaea golioath* (Goliath heron), White bellied Sea Eagle, Greater, Lesser Kite, Adjutant Storks, Osprey, Fishing Eagle, Hawk Eagle and Brakhiny Kite. Among the reptiles *Batagur baska, Crocodylus porpsus, Chelonia mydas, Chitra indica, Eretmochetys imbricata, Kachuga tecta, Lepidochelys oleracea, Lissemys punctate, Python molurus, Trionyx bengalensis, Varanus salvator, V. flavescence, V. bengalensis* are endangered.

5.6. Progression of Conservation & Management

Sunderban Biosphere Reserve has every potential to fulfill the objectives of an ideal reserve, viz. conservation, development and logistic support, in terms of its varied resources, rich biodiversity and representative ecosystems/ habitats. In this context, collaboration with other reserves inside and out side the country for sharing the information is being established.

Core Zone is strictly protected from all developmental activities. Post fencing and freshwater pond have been prepared for tigers. Buffer Zone is being used by the local inhabitants for agriculture, honey, timber, fish, prawn and crab collection. Along with the restoration of mangrove vegetation, silviculture, pisciculture, apiculture, prawn cultures are other sources of income. The Transition Zone is the development zone and being used for settlements, agriculture and for the alternative and sustainable use of local ecosystem resources. However, the management interventions are required in the following aspects: (i) Awareness among local people through education and publicity campaign about the values of ecosystem; (ii) Protection to preserve the wildlife and flora; (iii) Restoration of mangrove vegetation; (iv) Purification of sewage water and industrial affluent prior to its discharge in the estuary; (v) Improvement of source of income through apiculture, fish or prawn culture, etc.

Following the principles of joint forest management (J.F.M.) voluntary protection to mangrove forest has been provided by the Forest Protection Committee (F.P.C.) which are formed with members from among villagers living in the fringe of the forests. These members enjoy different benefits from the forests ensured under government orders.

5.7. Issues and Concerns

(i) Increasing pressure of woodcutting and firewood poaching to meet the needs of local and urban people.

(ii) Collection of large-scale shrimp/ prawn seed causes tremendous detrimental effect on the aquatic environment of the estuaries of the Sunderban.

(iii) Integrated fisheries/ shrimp farms have been developed by conversion of mangrove forests and brackish water fisheries, which also has adverse effect on the ecosystem of the mangals in the Sunderban.

(iv) Repeated damage of deltic areas has been done by diversion of river flow and chocking of estuarine rivers which causes flood and makes the water ways in unwanted situation for tidal flow.

(v) Repeated flooding of the human habitation areas,

agricultural fields and collapse of the river dyke is common due to rapid deforestation and soil erosion from this deltic land.

(vi) Rapid degradation of mangroves due to the high rate of population growth. Pollutants such as sewage discharge, leaching of pesticides from agricultural field are contributing to the pollution of Sunderban. In addition, open tourism has also several detrimental effects on Sunderban mangrove ecosystem.

5.8. Perspective 5 Year Plan- Major Components

While considering major components for a five year plan, it may consider including: (i) Dissemination of existing research paper and utilization of information for finding out the management options; (iii) Regular interaction with the managers for addressing the problems and to take appropriate decisions on actions; (iv) Monitoring of vegetation patterns in each of the island to understand trends and pace of change; (v) Regular and systematic observations on the succession pattern of different islands and to compare the patterns for identification of island specific issues of management; (vi) Finding out the dominant species of each island in relation to their soil and water parameters; (vii) Special emphasis on water quality to know the turbidity, pH, temperature, salinity, electrical conductivity, total dissolved solids, transparency and the result of which will be compared with the previous literature, which will reflect any change in water quality due to climate change; (viii) Bringing out complete flora of Sunderban Biosphere Reserve consisting of about 964 flowering plant species.

5.9. Success stories

1. Jambu Dwip is an isolated island situated towards south west of Fazerganj in Muriganga. Jambu Dwip is classified as forests and declared as reserve forests vide Government Gazetted Notification no 7737-For dated 29.05.1943. This area is uninhabited and contain mangrove forests. Fish Merchants from Kakdwip area used to dry their fishes on the strength of permits issued from forest department. Initially this fish drying was seasonal activity. They used to dry their fishes from October to February as the river Muriganga used to get turbulent during the summer and during rains. Gradually, these fish merchants started to establish their labour camps on the southern portion of Jambu Island by clearing forests and without taking any permission from the forest department and instead of their seasonal activity they used to carry this fish drying operation almost throughout the year. Forests over 300 ha were destroyed for setting up labour colony, Godown for keeping fish drying accessories and over the period of a decade or so these fish merchants became the controller of the situation prevailed at Jambu Dwip. It was very difficult for a Forest Guard or a Deputy Ranger, Forester to bring these culprits under books single handedly. During 2002, the Director Sunderban Biosphere Reserve directed the Divisional Forest Officer, 24 – Parganas (South) Division to take suitable measures to get the reserve forest area free from the grab of the fish merchants as the fish drying operation in reserve forest area without permission of the appropriate authority is an offence and not permitted under Forest Conservation Act 1980. The Divisional Forest Officer, 24 – Parganas (South) Division initially issued notices to the persons by name, who had occupied the reserve forest area and get settled over there by erecting their houses and started using forest lands for their domestic purpose along with fish drying. He had made requests to the encroachers to leave the reserve forest area within a specified date but in vain. On seeing that their requests are not paid heed to, punitive measures were taken. The encroachers were made to leave their houses and were taken to Frazerganj which is located opposite to Jambu Island across the river. The godowns and other establishments were demolished with the help of the staff of this division along with FPC members who mustered strong on the affected portion of Jambu Island over a period of three months or so in temporary camps, taking all pains, pangs and inconviences in their stride. The forest staff did not allow any one to enter the reserve forest area until and unless they were permitted by the Divisional Forest Officer, 24 – Parganas (South) Division. The fishery Department took serious exception to this and wanted to lend a hand to the fish merchants of Kakdwip area, who under the aegis of political quarter and District administration

lodged serious complaints against so called atrocities made by the forest officers. The matter was taken up for discussion at the highest level in the Ministry but no fruitful solution was obtained. Centrally Empowered Committee inspected the area and immediately after their inspection, a committee consisting of 40 MPs came to Jambu Dwip to grasp the prevailing circumstances. However, National Fish Workers Forum went to Hon'ble Supreme Court and filed a writ petition bearing no I.A. 920 seeking certain relief. The Hon'ble Apex court heard the lawyers from both sides and issued an order in this respect depicted below:

I.A. No 920

A report of C.E.C. dated 2nd – 4th December 2002 is placed before us.

Learned counsel appearing for the Union of India and the State of West Bengal pray for and are allowed four weeks time to file their response.

In the meantime, we direct that no trawler or mechanized boat shall enter the water adjoining Jambu Dwip Island until further orders.

2. Sunderban Biosphere Reserve which includes Sunderban Tiger Reserve and 24 Parganas (South) Forest Division is the only mangrove tiger land in India. The survival of tiger in such harsh condition is dependent on the survival of entire mangrove eco-system.

During post independence period, this region witnessed sudden influx of population mainly due to migration. This persons forcibly occupied vested lands, cleared forests for habitation and agriculture, which has exerted tremendous negative impact on the entire mangrove eco system. The threat to the mangrove eco system in Sunderban has been arisen due to biotic pressure from the surrounding environment. People living in the fringes are very poor, mainly landless labourers, who usually resort to fishing and do enter forest area for collection of timber, pole, fire wood, honey even risking their lives from man eating tigers. The women folk do get down in the river and do spend almost the whole day for collection of tiger prawn seeds.

It is experienced that no Government efforts to conserve and create assets can be successful unless the people concerned actively participate in planning and management of the resources. Joint Forest Management is thus the basis of sustainable conservation of mangrove eco-system. In 24 Parganas (South) Division, 40 (forty) Forest Protection Committee have been formed from 1996 to 2004 and the forest officials started implementing different development schemes with the assistance and cooperation of the forest protection committee members. But sometimes in the middle of this decade, it has been perceived that large section of forest fringe dwellers, specially the women folk had not been actively participating in the joint forest management venture and had been going to the forests for carrying out all those detrimental activities like collection of tiger prawn seedlings, collection of poles and fire wood etc to earn subsistence of their livelihood.

As an initiative, the Divisional Forest Officer, 24 Parganas (South) Division started a programme of involving all these women folk in conservation of forests. Formation of Self Help Group with these forest fringe dwelling women folk was one such initiation. Initially 25 Self Help Groups (SHGs) belonging to Binodpur Baikunthapur Forest Protection Committee under Raidighi Range of 24 Parganas (South) Division was formed by the State Forest Department in the year 2004. This was with an objective to save the biodiversity of the area. These groups were finally made to contribute substantially towards the challenge of greening the Sunderban delta and took many initiatives for successfully planting the vacant land, along village roads, irrigation canals and river embankments, which is depicted below.

The Divisional Forest Officer, 24 Parganas (South) Division started a venture under the name and style of AMAR BON (My forests) in the year 2006 asking the women folk to raise nurseries and subsequently to undertake afforestation programme. 25 Self Help Groups undertook afforestation programme under the direction of Divisional Forest Officer, 24 Parganas (South) Division and raised one lakh seedlings. They were remunerated a sum of Rs. 2,00,000/- for raising one lakh seedlings in the nurseries. These women folk took immense enthusiasm in planting and protecting the seedlings as they were told that after each successfully regenerated seedling, they will be given a remuneration of Rs. 5/- . Out of 80,000 seedlings planted on either side of village road, canal bank etc, they were able to protect 62,500 seedlings in March 2007 when rate of survival of seedlings were examined. Subsequently, a sum of Rs. 3,12,500/- were remunerated to these 25 self help groups in a meeting chaired by Hon'ble Minister – In – Charge Forest Department Government of West Bengal. They were also given cash prize on the basis of their performance. Rs. 10,000/- was given as first prize while Rs. 5,000/- to the Self Help Groups who stood second.

All these efforts created huge enthusiasm amongst all other women folk in the adjacent villages who volunteered to come forward and undertake plantation programme. More than five lakh seedlings were planted in the year 2007 by the

members of different SHGs existing over Binodpur, Baikunthapur, Nagenabad, Ambikanagar, on their own. Presently a trend is noticed amongst the village women folk to try to stand on their own and not to go to the forests for collection of tiger prawn seedlings, pole and fire wood. etc. It would be worthwhile to mention that they believe that the Department of Forests can give them necessary support and required impetus for earning necessary subsistence of their livelihood and to improve quality of their life.

Meanwhile, training in different vocational activities were imparted to the members of other SHGs who have also been given inputs to start and run those vocational activities on their own. All the members are actively engaged in protection of forest from illicit felling and other influences which resulted in reduced Man – Animal conflict in the locality. A number of income Generating Activities (IGA) have also been carried out by the group to provide sustainable livelihood options to the people.

In 2007, National Afforestation and Eco Development Board, Ministry of Environment & Forests, Government of India was requested to examine the work and to consider the names of these 25 women Self Help Groups under Binodpur Baikunthapur Forest Protection Committee as one of the awardees under Joint Forest Management Committee category for their initiative in the year 2006.

National Afforestation and Eco Development Board, Ministry of Environment & Forests, Government of India had examined the work. These 25 women Self Help Groups have been awarded the Indira Priyadarshini Vriksha Mitra Award in the 'Joint Forest Management Committee' category for the year 2006, for their exemplary works.

Himadri S Debnath
Nodal Person Lead-BR Centre
Botanical Survey of India, AJC Bose Indian Botanical Garden, Howrah-711103 (India)
Phone: +91 – 33 – 26680554
Fax: +91 – 33 – 26685096
eMail: hs_debnath@rediffmail.com

Director
Sunderban Biosphere Reserve
Bikash Bhavan, Salt Lake, Kolkata (India)
Phone: + 91-33 - 23211529
Fax: + 91-33 - 23211750
eMail: dirsbr@vsnl.com

Photo Credits: S Reddy, NRSC, Hyderabad

Similipal Biosphere Reserve

UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION

MaB

Man and the Biosphere Programme

By decision of the International Co-ordinating Council of the Programme on Man and the Biosphere,

Similipal · India

has been designated for inclusion in the World Network of Biosphere Reserves.

The world's major ecosystem types and landscapes are represented in this Network, which is devoted to conserving biological diversity, promoting research and monitoring as well as seeking to provide models of sustainable development in the service of humankind.

Participation in the World Network facilitates co-operation and exchanges at the regional and international levels.

Director-General of UNESCO

Date

26 May 2009

6

Similipal Biosphere Reserve - Chotta Nagpur, India

6.1. Introduction

Similipal Biosphere Reserve is one of the first eight Biosphere Reserves designated in India as per recommendations of Core Advisory Group of Experts, under the Man and Biosphere (MAB) programme, for improvement of relationship between man and environment. Considering biodiversity value and cultural richness, the reserve has been included in World Network of Biosphere Reserves (WNBR) by UNESCO since 2009. The reserve draws attention of nature lovers, wildlifers and conservationists for its rich and diverse flora, fauna and splendid natural beauty.

Designation Date	: 21st June, 1994
Total Area	: 5,569 km^2
Core Area	: 1,194.75 km^2
Buffer Area	: 1,335.86 km^2
Transition Area	: 3,038.39 km^2
Extent	: 20°17′ and 22°34′ N 88°40′ and 87°10′ E

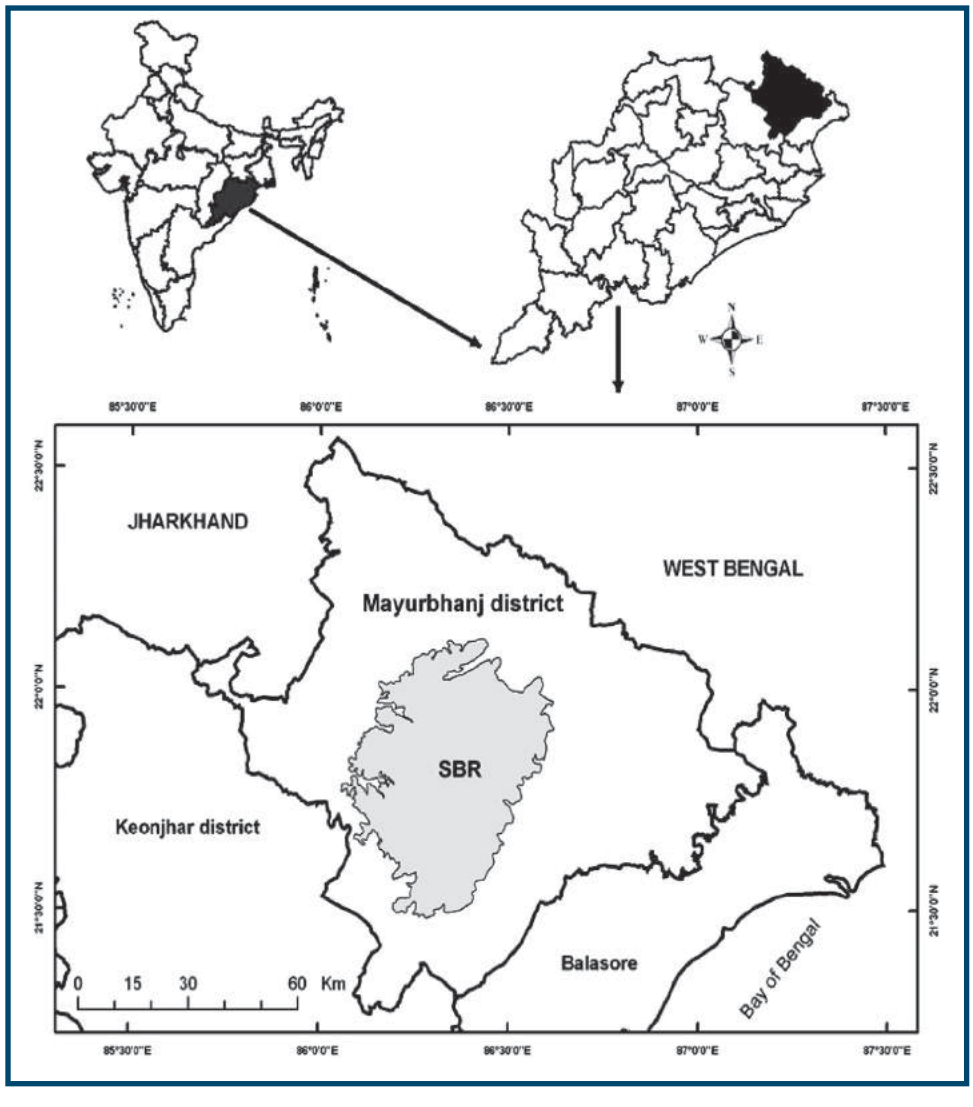


Figure 6.1: Location of simlipal Biosphere Reserve

6.2. Area Description

Similipal Biosphere Reserve is located in the Mayurbhanj district of Orissa (20°17' to, 22° 34' N Latitude and 85°40' to 87°10' E Longitude) at the north eastern corner of the state where it borders with the state of West Bengal and Jharkhand. The reserve spreads over an area of 5,569 km^2, and includes within it a proposed national park, a wildlife sanctuary and greater part of a tiger and elephant reserves.

6.2.1. Zonation details

The core area (critical tiger habitat) of Tiger Reserve with an area of 1,194.75 km^2 forms the core area of the reserve. This is managed strictly for conservation and efforts to make it inviolate are continuing.

The buffer zone of 1,335.86 km^2 is managed for both biodiversity conservation and sustainable development and permitted activities include limited recreation, tourism, fishing, grazing, etc., aiming to reduce pressure on the core zone (Figure 6.2).

The outermost transition zone of 3,038.39 km^2 is the area of collaboration where conservation knowledge and management skills are applied primarily to foster alternate livelihood and reduce dependence on consumptive use of the forest.

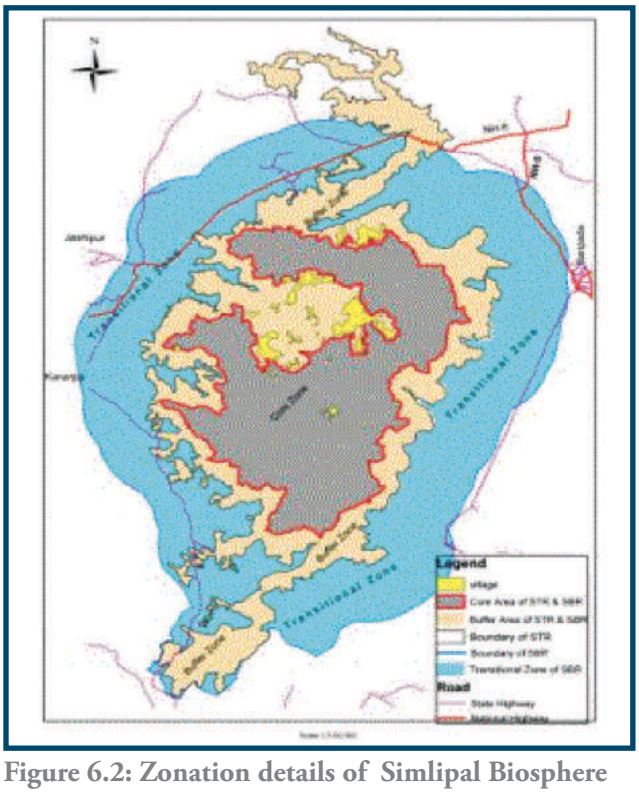


Figure 6.2: Zonation details of Simlipal Biosphere Reserve

6.2.2. Biogeographic characteristics

According to biogeographic classification by Rodgers and Panwar (1988) the three hierarchical levels of planning units under which Similipal has been classified are as follows:

Biogeographic zone : Deccan Peninsula

Biogeographic Province : Chotta Nagpur

Biogeographic Regions : Mahanadian

However, Similipal represents features of all the four Biotic Provinces for which Orissa is the junction. These provinces are Eastern Plateau, Chhotanagpur, Lower Gangetic Plain and Coastline.

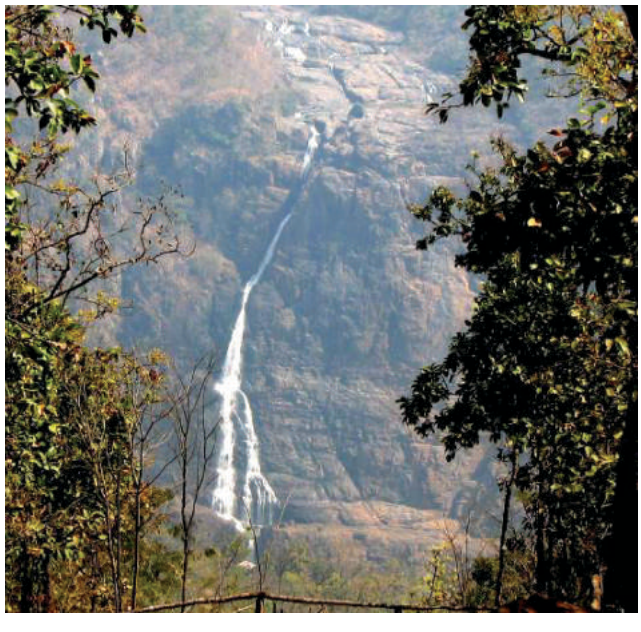
> The Similipal Biosphere Reserve (SBR) falls in Chotta Nagpur province of zone Deccan Peninsula.

6.3. Background Information

6.3.1. Unique Features

Though Similipal mainly represents moist deciduous forests, its large area, table land and hilly terrain varying in altitude from 40 to 1168 m asl bestow it an unparalleled array of habitat types including tropical evergreen, moist-deciduous, dry deciduous with their numerous sub-types. All this make it a vast repository of diverse wild genes with wide adaptability to diverse climatic and ecological conditions.

The biodiversity rich Similipal has unique geological formation that gives it enormous water holding capacity making it the richest watershed in the state of Orissa. The reserve gives



rise to 10 perennial rivers like the Budhabalanga, Khadkei, Khairi, Bhandan, West Deo, Salandi, Tel, East Deo, Sanjo and Palpala. These rivers are the lifelines for the people of Mayurbhanj, Keonjhar, Balasore and Bhadrak districts. Among the waterfalls of Similipal, Joranda (150 m) and Barehipani (400 m) are important.

6.3.2. Landscape features and land-use history

Physiography: Similipal lies almost on the tropic of cancer. It is a high plateau with steep slopes all around its lenticular outline overlooking the plain surfaces. The hills are steeper towards south and east. The area has innumerable crests and valleys, rivers and streams. The hill rises abruptly from coastal plains from southern and eastern side and after extending towards north and north western side merges with Chhotanagpur plains.

Geological features: There are three concentric bowls of impervious quartzite layers formed of sedimentary rocks with their interspaces filled with pervious volcanic rocks made of Spilitic lava. These formations dip towards the Centre forming a basin structure. These typical concentric bowl like formations of impervious and pervious rocks help in holding large amount of ground water that feeds the river system and waterfalls in the reserve.

Soil: The soil varies from red loam, clay, and clayey loam to red sandy soil. It is generally acidic with pH varying between 4.8 to 6.8. The extensive weathering of volcanic, sedimentary and metamorphic rocks under humid tropical climate has produced thick soil cover.

Climate: The climate is warm and humid. Temperature varies from 2° in winter to about 39° in summer with mean temperature varying between 21° C to 28° C.

The annual average rainfall is about 185 cm and it largely occurs between June to September (south –west monsoon) and November (north west monsoon). The southern Similipal receives more rainfall than northern Similipal.

During winter (mid-October to January) some high altitude valleys experience frost during severe cold giving typical shape and vegetation to these frost valleys in central and southern Similipal. Spring is pleasant and summer is tolerable though relative humidity is high throughout the year.

6.3.3. Reserve Inhabitants, demographic trends and dependence

There are 4 villages inside core area of Biosphere Reserve [Jenabil, Kabatghai, Jamunagarh and Bakua along with 2 human settlements (they don't own any land and don't perform only agriculture; are food gatherer] at Upper Barakamuda and Bahaghar.

Reserve has plans to relocate all core area villages outside the tiger reserve to provide undisturbed area for the wildlife. In the process of relocation 72 families were relocated from 1994 to 2003, and 61 remaining families of Jenabil village were relocated in 2010. After relocation of Jenabil village in 2010, core area has now three inhabited villages which are to be relocated outside the reserve.

There are 62 villages inside the Buffer area of the Biosphere Reserve (all inside buffer area of Tiger Reserve) and their population as per 2001 survey is around 15,000.

The 10 km radius around Similipal sanctuary is the transition zone of the reserve which supports about 4.5 lakh people as per 2001 census in 1200 villages.

Tribes constitute about 73.44% of the total population living in the Biosphere Reserve. More than 50% of the population earn their livelihoods in full or part from Similipal.

6.3.4. Tribes of Similipal Biosphere Reserve

Similipal is a predominantly tribal landscape with a heavy dependence on forest resources for their livelihood. The major tribes include Bathudi, Bhumija, Kolho, Santal, Ho, Munda, Gonda and Pauri Bhuyans. They mostly depend on agriculture, daily wage earning, hunting and collection of forest products such as fuel wood, sal leaves and seeds, honey, arrow root, lac, mahua flowers, mushrooms, sabai grass, etc. Two primitive tribal groups Khadias and Mankadias from the reserve are still forager and food gatherer. They sell the forest products in the local market for their livelihoods. The Erenga Kharias consider Similipal as their primordial home.

6.3.5. Cultural significance

Many places inside the BR have religious and cultural value for different tribes and also for general Hindus. References of Similipal in the Ramayana, the Mahabharata and the Puranas, have indicated that various mythological events took place in areas found in the reserve like Deokund in respect of Goddess Ambika (52nd Shakti peeth), Sitakunda and Ramatirtha the bathing place during Banabasa of 'Lord Shri Ram' and a sacred grove named Shami Vrikhya where Arjuna supposedly had kept his arrow and bow in a secret place during 12 years of 'Banabasa' of Pandavas.

There are also some historical traces of camps of soldiers who escaped during First World War. Besides being a hunting ground for the Maharaja of Mayurbhanj these forests have also sheltered the king away from his enemies during battles and other critical times.

6.4. Biological Importance

An assemblage of a number of ecosystems such as mountains, forest, grassland and wetlands congregate into "Similipal Biosphere Reserve" with their diverse land cover and vegetation types. The rich floristic and faunal account of many associated indicator species makes the region a hotspot of biodiversity and very interesting for ecological studies. Similipal stands as a link between the flora and fauna of southern India and sub Himalayan North-east India.

Identified species of reserve include 1076 species of flowering plants (168 families), 60 pteridophytes, 23 bryophytes. 12 species of amphibians, 62 species of reptiles, 304 species of birds, 55 species of mammals. Many species of flora and fauna, especially the lower groups, are yet to be identified.

Tiger and Asiatic elephant are two important flagship species of Biosphere Reserve for which it also enjoys the status of a tiger and elephant reserve. 50% tigers and 25% elephants of Orissa state are found in this reserve.

Among other biological values, of the known 27 endemic taxa in Orissa, 6 taxa belong to Similipal. Likewise of 130 orchids occurring in the state 92 species exist in Similipal.

Besides, there are many species of rare, endangered, threatened and vulnerable plants and animals.

Among mammals, Similipal is known for its population of the rare melanistic Tigers and good sex ratio of the Asian Elephants. The reserve is home to rare species like Chousingha, Wolf, Leopard Cat, Ruddy Mongoose, Giant Squirrel and Mouse Deer. A rare colour morph of the Common Palm Civet, earlier thought to be endemic

to this range of hills and hence was named Joranda Palm Civet (*Paradoxurus jorandensis*) is also found here. Among birds, 3 species of Hornbills, excellent population of Hill Myna and presence of Himalayan elements like Collared Falconet, Thick-billed Green Pigeon are of special interest. Raptor population is also very good with rare species like Jerdon's Baza, Black Eagle, Rufous-bellied Eagle. As far as herpetofauna is concerned, Similipal is one of the

Among mammals, Similipal is known for its population of the rare melanistic Tigers and good sex ratio of the Asian Elephant.

Tiger and Asiatic Elephants are two important flagship species of Biosphere Reserve for which it also enjoys the status of a tiger and elephant reserve.

sites for 'breed and release' programme of the Mugger Crocodile. The reserve, also has good populations of King Cobra, Python and many interesting reptiles. Species like *Melanochelys tricarinata, Psammodynastes pulverulentus* and some unidentified species of lizards and snakes are of great conservation interest. Among various species of frogs, the Similipal Bush Frog (*Philautus similipalensis*) is of great interest. The fish fauna of the water-rich Biosphere Reserve is correspondingly rich, with the Mahseer population being of high conservation value. Though research on invertebrates are yet to be conducted systematically, recent research on butterflies and odonates have recorded 189 species and 92 species respectively, among which there are several Himalayan and North-eastern elements.

The reserve harbors many economically important plant species which are grouped under timber, fuel wood, paper and pulp, fodder grass, fiber, dyes, gums / resins, essential oils, food and medicines. Among the 41 species of medicinal plants of Orissa, prioritized for conservation action, over 30 species are known to occur in Simlipal alone that includes two Critically Endangered species, viz., *Saraca asoca* and *Symplocos racemosa.* The important medicinal plants in the reserve are *Andrographis paniculata, Asparagus racemosus, Celastrus paniculatus, Centella asiatica, Cordia macleodii, Chlorophytum tuberosum, Costus specious, Curculigo orchioides, Cymbopogon flexuosus, Dipteracanthus suffruticosus, Hemidesmus indicus, Holarrhena antidysenterica, Homalium napalense, Helecteres isora, Terminalia arjuna, T.bellirica, T. chebula,*

Nyctanthes arbortristis, Pterocarpus marsupium, Pueraria tuberosa, Rubia cordifolia, Oroxylon indicum, Saraca asoca, Smilax zelanica, Schebrera swietenioides, Scindapsus officinalis, Rauvolfia serpentina, Gloriosa superba, Solanum surattense, Strychnos nux-vomica, Swertia angustifolia, Symplocos racemosa, Vitex peduncularis, Woodfordia fruticosa, etc. Among the food plants the inhabitants consume many wild tubers, roots, leaves and fruits.

Eria meghasaniensis, Aspidopterys tomentosa, are endemic taxa from similipal. *Cirrhopetalum panigrahianum* an endemic orchid from the state also finds its distribution in the reserve. Wild native cultivars like *Oryza officinalis* and *Oryza granulata* are important genetic source for crop improvement.

6.5. Conservation and Management

The Biosphere Reserve is being managed by Wildlife wing of Forest Department, Govt. of Orissa. The overall management of the Biosphere rests with the Field Director, Similipal Tiger Reserve with headquarters at Baripada. He is also the Director Biosphere reserve. The proposed National Park, within the core area, measuring 845.70 km^2 is being looked after by the Deputy Director, Similipal Tiger Reserve. For ease of administration and protection this area has been divided into 7 Ranges, 23 Sections and 75 Beats headed by Range Officer, Forester and Forest Guard respectively.

The entire buffer area is being managed by the three territorial divisions namely Baripada Division, Karanjia Division and Rairangpur Division. The area administratively comes under 12 Ranges, 30 Sections and 85 Beats of these divisions.

The promotion and development of eco-tourism society is being looked after by Similipal Eco-tourism Society, Registered under the Society Act from 2006-07.

6.6. Progression and Conservation Importance

Simlipal originated mainly as a hunting ground for the royalty. It was formally designated a tiger reserve in 1956, and included under Project Tiger in 1973. 'Muggar Crocodile Scheme' was initiated in the year 1979 at Ramatirtha, Jashipur. Government of Orissa declared Simlipal as a Wildlife Sanctuary in 1979 with an area of 2,200 km^2 . Later in 1980 Government proposed 303 km^2 of sanctuary as National Park. Government of India designated Simlipal as Biosphere Reserve in 1994.

The conservation importance of the reserve can be gauged by the fact that it harbours 7% flowering plants, 8% orchids, 7% reptiles, 20% birds, and 11% mammals of India.

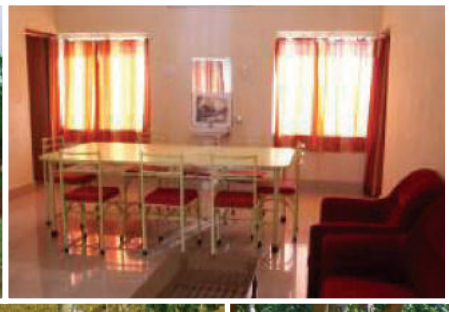
Wild native cultivars like *Oryza officinalis* and *Oryza granulata* are important genetic source for crop improvement.

Further, 73.44% human population of Biosphere Reserve is tribal. Tribes like Santhal, Ho, Bathudi, Kandha, Kolha have made the reserve their home. Some primitive tribal groups like Birhors, Hill Kharias & Ujias have their home in the reserve. Traditional farming systems and knowledge held by the people in the reserves is the product of centuries of human innovation and experimentation with nature. It is grand repository of indigenous knowledge pertinent to conservation of biodiversity; ethno biological study & traditional ecological knowledge.

This reserve contains genetic elements evolved over millions of years that hold the key to future adaptations and survival and have tremendous potential for future economic development, especially as a result of emerging new trends in Biotechnology.

6.7. Eco-Tourism Activities

Similipal Biosphere Reserve attracts about 25,000 tourists per year, including many foreigners. Normally the Biosphere Reserve is open to visitors from 1st November to 15th June. However, after the leftwing extremist attack in March –April 2009 it remained close for tourism in 2010. With improvement


in security environment it was again opened for tourists on December 22nd, 2010 but the tourism is now restricted to day tourism only. The visitors are to leave the park by 5 pm.

The types of tourism include research teams for study of flora and fauna, excursion studies of students, academic faculties, recreation, bird and animal sighting, etc.

6.7.1. Tourist facilities

The park infrastructure was destroyed to a very large extent during series of attacks (29 attacks) by left wing ultras (naxalites) between March 28th 2009 and April 15th 2009. Almost all tourist accommodation was destroyed. The remaining rest houses at Nawana and Gudgudia are now used as police camps hence tourist can now stay only at Ramtirtha (Jashipur) near the gateway to the park from Jashipur side. There also exists a tourist lodge at Lulung (under repair) maintained by Orissa Tourism Development Corporation near the other gateway from Baripada side.


6.8. Benefits of Economic Activities to Local People

The local inhabitants of the reserve get employed in various forestry & developmental activities in meadow development, road repairing, development of water harvesting structures and other related works. They also act as guides and drivers for tourists. Many of them are employed as Anti-poaching watchers. The park management helps in upgrading their skills, training and taking up various income generating schemes.

6.9. Logistic Support Function

6.9.1. Research and monitoring

A number of research and development organizations, Wildlife wing of Forest Department and many Universities have conducted research in the past. Many of them have received financial support from Ministry of Environment & Forests, Government of India, Dept. of Science & Technology, Department of Culture Government of India, and state Forest

Department. Some studies taken in the past include: The studies on flora (1989), orchids (1997), rare / endangered species (1997), plant diversity in a preservation plot (1997), long term biodiversity assessment (2001), survey of medicinal plants (2005), reproductive biology of pet –tigress, Khairi (1999), tigers with aberrant colours (1997), Population biology of elephants (1997 & 2004), giant squirrel (1997 &2005), herpeto-fauna (2005)), avi-fauna and invertebrate fauna (2004), tassar eco-races (2003) and leeches (2004), tribal population and settlement (2003).

Several research projects are in progress in diverse fields from flora, fauna to geology to tribal art, etc. These research activities are useful in throwing new lights on biological importance of this reserve and would be of immense help in both economic development of people and conservation of biodiversity.

6.9.2. Environmental education and public awareness activities

The Forest Department conducts such programmes with the help of Eco-development committees, NGOs and other department. The activities include nature camps, audio-visual shows, exhibitions, seminars, workshops, meetings and guided tours in the nearby villages and towns; and distribution of pamphlets, street dramas involving the school and college students, local volunteers, Panchayat (local government) members, tribal peoples, tourists, etc. The subject matters include control of forest fire, preventing poaching, illegal forest cutting, biodiversity value, etc.

6.10. Issues and Concerns

- The inhabitants are mainly poor tribals. They have been hunting traditionally for years in the Similipal forests and this has become very much part of their culture. Their education level is very low and livelihood is fully forest oriented.
- As Similipal is surrounded by villages all around it and its boundary is porous, protection is the most serious problem faced by the reserve.
- Commercial benefits from preserving such rich biodiversity has not been realized by people.
- The earning from conservation activities are minimal.
- Large number of species still remain unidentified.
- Commercial importance of many medicinal plants is to be explored.
- Pilferage of rare plants is becoming a big problem.

6. 11. Management Principle

The principles of management of Similipal Biosphere Reserve are as follows:

1. Elimination of all forms of human exploitation or disturbances from the core and rationalization of such activities in the buffer.
2. Habitat management to repair damages done by man with the aim of restoring the ecosystem as close to its natural functions as possible.
3. Researching facts about habitat and wild animals and careful monitoring of changes in flora and fauna.

6.12. The Components of Long Term Plan

While considering development of a long term plan for the reserve, there is a need to consider the following:

- Authentic base line data on animal and plant diversity.
- Studies on: (i) meterological aspects (data generation), (ii) trends of tiger and leopard populations, (iii) trends fo muggar crocodile population, (iv) sighting trends of elephants, (v) tiger habitat occupancy, (vi) patterns of animal use in vegetation plots, and (vii) patterns of animal use for fixation of doses in salt licks.
- Long term studies to improve census techniques for large cats and elephants.
- Biological studies on giant squirrel and black headed munia and arrival patterns of fruit bats.

The Management Action Plan of the biosphere is formulated on the basis of the following strategies to achieve the objectives.

(i) Protection of forests from illicit felling of trees, fire and grazing.

(ii) Prevention of poaching and elimination of Akhand Shikar (annual mass hunting by tribal) of wild animals.

(iii) Eco-development activities.

(iv) Enriching the socio economic condition of the people living inside and around the reserve.

(v) Development of Eco-tourism.

In addition, the strategy for the reserve should consider focusing on the following:

Core Zone: (i) complete prevention on Akhand Shikhar & fire, (ii) substantial control over short time poaching and timber smuggling, (iii) status survey for lesser known flora

and fauna, (iv) study of ecological processes and ecosystem changes, so as to identify sensitive area for immediate action.

Buffer Zone: (i) exploring sustainable livelihood options for enclaved villages, (ii) eco-restoration through participation of local communities, (iii) motivation of villagers for improved participation in conservation activities, and (v) creation of model villages.

Transition Zone: large scale awareness campaigns and targeted eco-development work.

6.13. Critical Issues Being Addressed Through Management Intervention

- The poverty and dependence on the forests is the main cause for destruction of habitats. The people enter inside the forests and collect timber and firewood to supplement their main income. The problem is being addressed through various antipoverty programmes, educational and vocational initiatives and alternate livelihood options by various agencies of government. Improvement in agricultural output through improved technique, inputs and irrigation is aimed at increasing income from their land holding. But the problems is very daunting and defies any easy solution.
- People are being made more aware of the role of forests in providing and regulating water and its role in improving economic condition and well-being. Conservation is essential for their own survival is being reiterated through various forums and engaging the local villagers in forest protection and anti-poaching activities.
- Local participation is being ensured through formation of Eco-development committees in buffer areas and Vana Sangrakhyana Samittee (VSS) in the peripheralvillages. Each eco-development committee is vested with responsibility of certain areas for protection and conservation in lieu of crtain benefits.
- There is a local committee chaired by the Director, Biosphere Reserve which have district level officers of various departments, public representative and NGOs of Mayurbhanj district as members. The Committee deliberates on various issues of local interest and formulate suitable annual plan of action for the reserve.

HS Upadhyay, IFS
Field Director, Similipal Tiger Reserve,
Bhanjpur, Baripada-757002, Dist.-Mayurbhanj,
Orissa, India.
Phone: +91-6792-259126
Fax: +91-6792-256705

The Chief Executive, Regional Plant Resource Centre Lead Coordinating Centre for Simlipal BR
Nayapalli, Bhubaneswar 751015, Orissa, India.
Phone: +91-674-2557925
Fax: +91-674-2550274
email: rprcbsr@gmail.com

Photo Credits (Besides Authors): Photo Library/bank, Simlipal Tiger Reserve

Pachmarhi Biosphere Reserve

UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION

MaB

Man and the Biosphere Programme

By decision of the International Co-ordinating Council of the Programme on Man and the Biosphere,

Pachmarhi · India

has been designated for inclusion in the World Network of Biosphere Reserves.

The world's major ecosystem types and landscapes are represented in this Network, which is devoted to conserving biological diversity, promoting research and monitoring as well as seeking to provide models of sustainable development in the service of humankind.

Participation in the World Network facilitates co-operation and exchanges at the regional and international levels.

Director-General of UNESCO

Date
26 May 2009

7
Pachmarhi Biosphere Reserve - Central Highlands, India

7.1. Introduction

Pachmarhi was designated as Biosphere Reserve by Government of India (vide notification no J-22016/17/94-BR dtd. March, 3rd 1999) largely due to its unique Sal forests, diverse and rich flora and fauna, topography and geographic location and prevalent tribal population. The reserve has now been included on the World Network of Biosphere Reserves by UNESCO on 26th May 2009.

Pachmarhi Biosphere Reserve has been designated for inclusion in the World Network of Biosphere Reserves on 26th May 2009.

Designation Date	: 3 March, 1999
Total Area	: 4,981.72 km²
Core Area	: 1,555.23 km²
Buffer Area	: 1,785.58 km²
Transition Area	: 1,640.91 km²
Extent	: 22°11′ and 22°50′ N 77°47′ and 78°52′ E

The credit of discovery of Pachmarhi, as sanatorium, is generally attributed to Captain J. Forsyth (1862). The name 'Pachmarhi' has probably originated after Panch Math (Five huts) and is derived from ancient caves, which have been known as small hills rising abruptly from open part of the country.

Historically, the Ramayana and the Mahabharata speak of the entire tract, South of Jamuna as a land of wilderness inhabited by demons, while religious hermits of Aryan races dwelt in hermitages in their midst. By 14th century the area had come to be called as `Gondwana' after the Gond tribe, who chiefly inhabited it. Conservation history of the area goes back to 1865, with the formation of Bori Reserve forests.

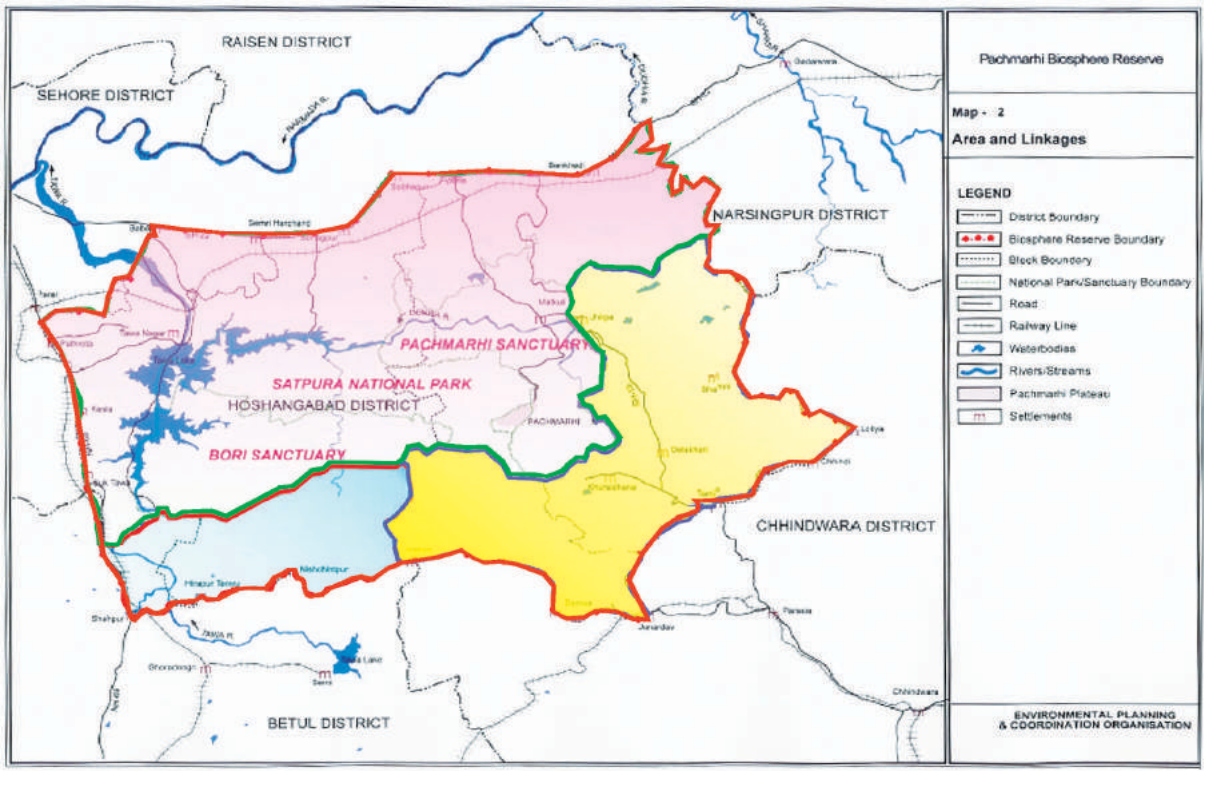


Figure 7.1: Location of Pachmarhi BR

7.2. Area Description

The Pachmarhi Biosphere Reserve (22°11' to 22°50' N latitude and 77°47' to 78°52' E longitude) lies in central part of India covering parts of Hoshangabad, Chhindwara and Betul districts of Madhya Pradesh. The area falls almost in northern part of biogeographic zone (6) and biogeographic province (6A) viz., Deccan Peninsula - Central Highlands. It falls almost in the centre of zone 6A. The entire area falls in Satpura hill ranges, which is one of the major geographical features of the central India, running across the country in the middle (Figure 7.1). Three major water courses that drain the area are Tawa, Dudhi and Denwa rivers. Tawa dam built at the confluence of the Tawa and Denwa rivers and the consequent Tawa reservoir is within the reserve area.

7. 2.1. Zonation

The total area covered by Pachmarhi BR is 4981.72 km^2, of which an area of 1555.23 km^2 has been designated as core. This comprises three protected areas [viz. Satpura National Park (524.37 km^2), Bori (485.72 km^2) and Pachmarhi (439.15 km^2) Sanctuary] and adjoining area of 105.99 km^2 belonging to Reserve and Protected Forests. Thus an area of 1449.24 km^2 falls under Satpura Tiger Reserve and the remaining area (105.99 km^2) lies outside Satpura Tiger Reserve (PAs). An area of 1785.58 km^2 has been designated as buffer zone intended mainly for research, education, demonstration and development of proper techniques for eco-restoration and other positive manipulative methods to utilize the existing natural resources in an ecologically sound and economically viable manner for creating a harmonious interaction with local people. The transition zone covers 1640.91 km^2 area, which surrounds the buffer zone. In this zone open types of forests are founds and agriculture is predominant in this zone (Figure 7.2).

7.3. Background Information

7.3.1 Topography and geology

The altitudinal range of reserve varies from 320 to 1352 m above msl, with a general hilly configuration, undulating terrain and having deep narrow gorges around Mahadeo hill at Pachmarhi plateau.

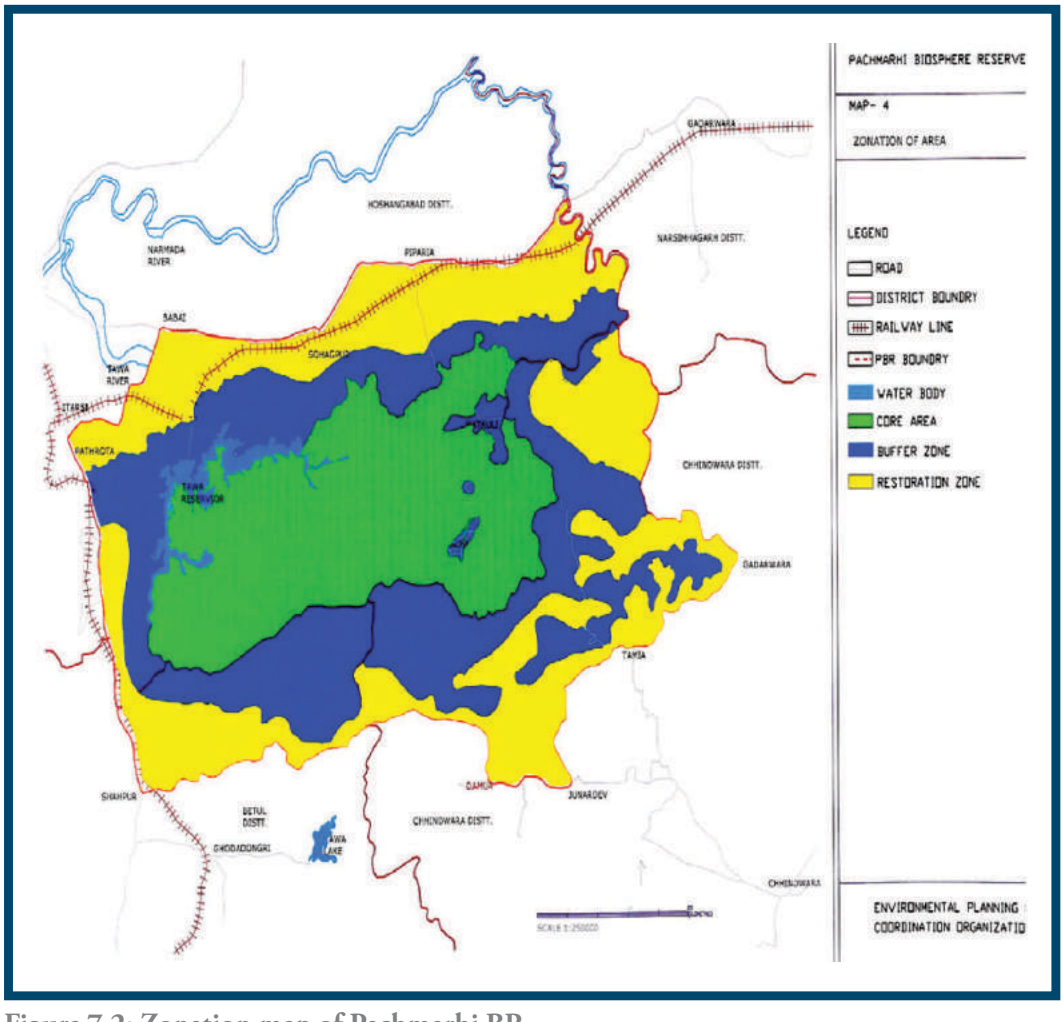


Figure 7.2: Zonation map of Pachmarhi BR

The area of the Pachmarhi biosphere reserve exhibits a wide variety of geological rock and soil formations. The Archaean phyllites and Schists, the Jurassic Permian Gondwana Sandstone formations of Bagra, Denwa and Pachmarhi series, the Crustaceous-Eocene-Deccan trap sills and dykes, and recent alluvium are found in the area.

The Satpura hill ranges run from east to west and the Pachmarhi Plateau is practically placed in the centre of area having an elevation of around 1050 m. The Pachmarhi hills have steep slopes in the north and in the south it is straight exposing the bare rocks. Some of the conspicuous hilly areas are Jambudweep, Dhoopgarh, Handikho, Mahadeo, Chauragarh and Bee Fall. Amongst these, the Dhoopgarh is highest point (1352 m above msl) in the State.

Patalkot, which is also one of the major tourist spot in the area, is located in Tamia block of Chhindwara district. The area lies 300-400 m below the escarpment. It is famous for its natural landforms on the northern edge of Satpura hills. It is an area of geographical isolation.

The Tawa reservoir created by a dam on the Tawa river is situated in the north- western sector of the area, and spreads its tentacles of backwaters far into the forests comprising the Bori Sanctuary and the Satpura National Park.

The various geological formations in the area are Alluvium, Sandstone's, Deccan trap flows, Deccan trap, Barakar sandstones, Denwa conglomerates, Motur Sandstones, Phyllite Rocks, Calcareous Sandstones and Talchir Rocks. The Pachmarhi and Denwa rivers comprise of Pachmarhi sandstone, while the Bori river and the adjoining parts comprise of Bagra/ Denwa conglomerates. Chhindwara district is mostly made up of Deccan trap flows and Motur sandstones, while Betul district comprises of Bijori sandstones. These various types of rocks give rise to various types of soils, from very sandy light soils incapable of sustaining agriculture to heavy black cotton soils, which are very suitable for agriculture (Figure 7.3).

7.3.2. Climate

Pachmarhi Biosphere Reserve with variation in elevation and topography, has a varied climate. The area has a typical monsoon climate with three distinct seasons of summer (March to June), rainy season (July to October) with heavy rains and winter (November to February). Lowlands in the Narmada basin are uncomfortably hot in summer with light rain and warmer winters than Pachmarhi. The intermediate hill slopes and valleys exhibit different climates at every intermediate stage in between depending on elevation,

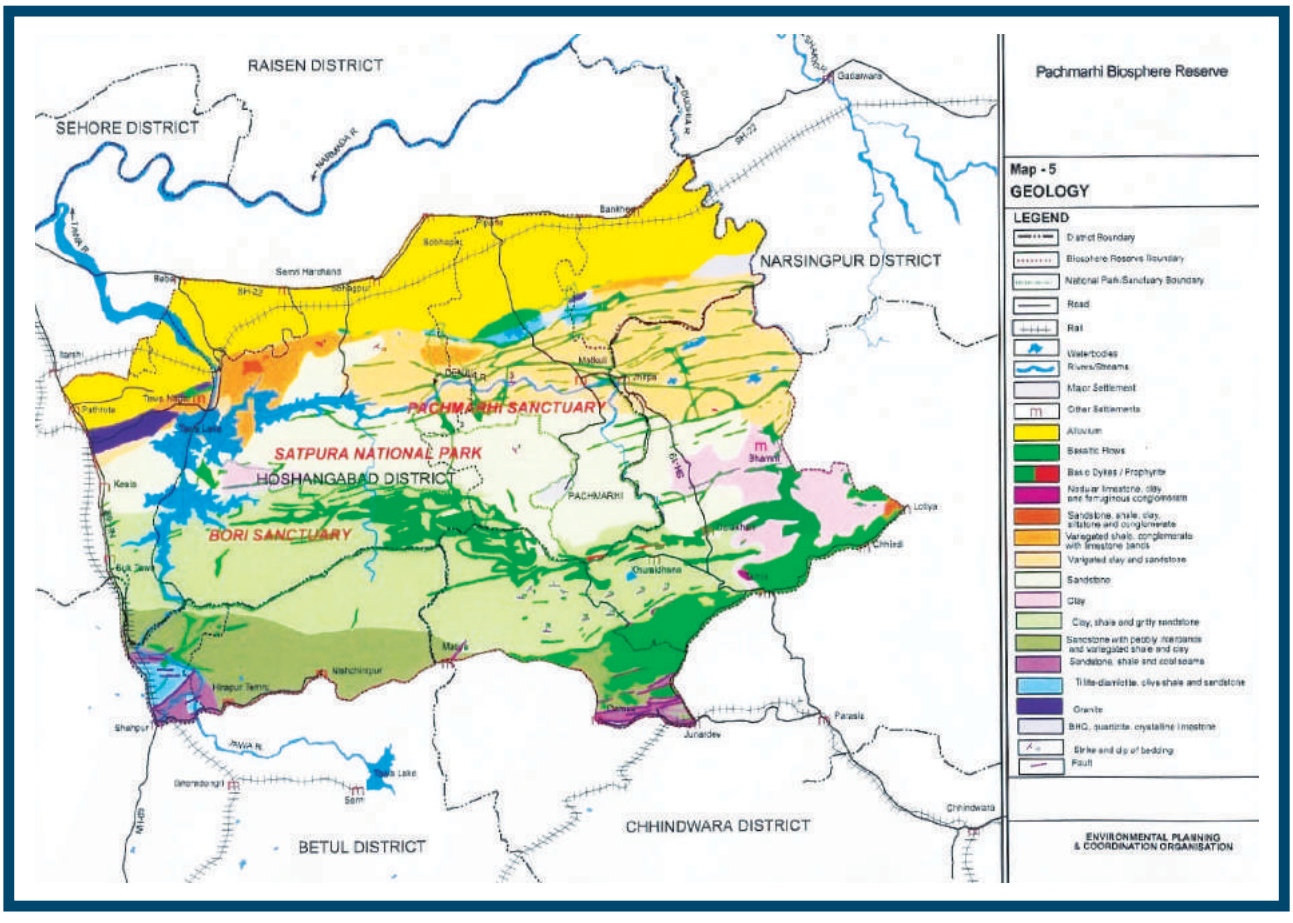


Figure 7.3: Geology of Pachmarhi BR

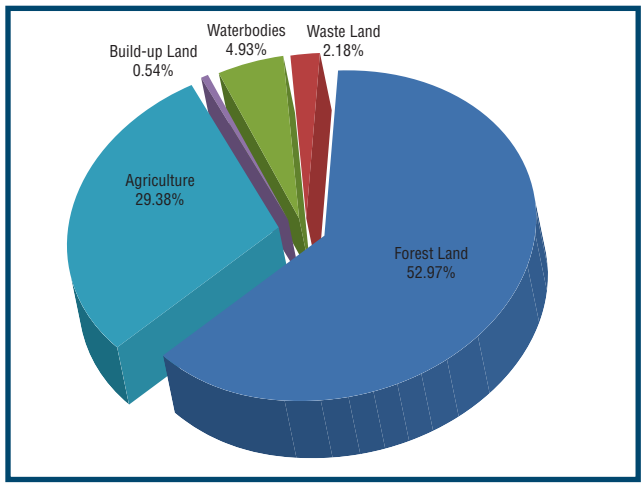


Fig 7.4: Land-use in Pachmarhi Biosphere Reserve

configuration and vegetative cover of the area. Pachmarhi hills at the head of the valley opening out westwards, receives the heaviest rain with an average of 2067 mm, as compared together low lying areas in the region of Chhindwara and Hoshangabad districts having 1135 mm and 1290 mm, respectively, while in Betul district it stands for 1172 mm. A maximum of 75 to 95% of total rainfall occurs during the rainy season. The scant rainfall coupled with high diurnal temperature variation causes high stress conditions in plants during summer. During the Southwest monsoon, the relative humidity is remarkably high but during summer, it ranges between 20-25%.

7.3.3. Land Use

The history reveals that this area was well inhabited by human almost 10,000 years back. The formation of Bori Reserve forests in 1865 was the beginning of conservation practices in the area. The slash and burn agriculture widely practiced before, was banned in general and allowed in specific marked area.

The land use and land cover of the area based on IRS-ID LISS III Data of Jan 2000 clearly revealed that majority of area is comprised of forests (62.97%), agriculture (29.38%), Built-up land (0.54%), wasteland (2.18%) and water bodies (4.93%). The spatial distribution of the landuse is presented below (Figure 7.4).

Out of the total forest cover, dense forests constitutes 75.4%, open forests 10.63%, degraded forests 9.83 % and forest blank 4.14 %. The Tawa reservoir is the major constituent of the water bodies. This indicates a bit of consistency in the effects of human use on the ecosystem. Thus, the area is large enough to be effective for a conservation unit as a whole.

7.3.4. Reserve inhabitants and dependence

The area comprises 581 human settlements (villages & urban agglomerations) which include 509 revenue villages, 65 forest villages and 7 semi urban settlements. Out of total settlements, 322 falls in Hoshangabad district, 190 in Chhindwara and 69 in Betul. Of the total settlements 47 falls in core, 224 in buffer and 310 in transition zone. Out of 47 villages falling in core zone, 45 are located within Satpura Tiger Reserve and 2 villages are located outside the Satpura Tiger Reserve. It is to be mentioned here that 63 villages are found in Tiger Reserve, (Bori Sanctuary 16, Satpura NP 7 and Pachmarhi Sanctuary 40). Of the total core zone villages 27 belong to forest villages and remaining 20 belongs to revenue villages. Of the total settlements in buffer zone, 192 falls under revenue villages, 30 forests villages and 2 in

semi urban settlements. Pachmarhi town surrounding core zone is the major urban settlements. Similarly, in transition zone there are 297 revenue villages, 8 forests villages and 5 semi urban settlements. These entire towns are located on periphery of BR area. Tamia, Sohagpur, Piparia, Babai, Junnardeo etc., are the semi urban settlements.

The total population of the reserve is 4.75 lakhs (2001, Census). Out of total population, the rural population is 67.937 %. Semi urban population 29.37 % and forest villages' population 2.94%. The schedule castes account for 14.70% and the scheduled tribes for 31.52%. The average land holding is only 3-4 ha. The literacy rate is 53.31%. The cattle and goats are reared in large numbers. The main income generation is based on agriculture. Working in the forest area is the supplementary source of income for the villagers lying in the close vicinity of the forests. In villages, the houses are generally constructed with muds and wooden poles. The area is largely an agricultural rural setting with preponderance of forest indicative of its hinterland situation. Patalkot area covering 12 villages is mainly inhabited by Bharia tribes which is most primitive tribal population of the area.

7.4. Global and National significance

7.4.1. Archaeological Caves/ Centres

In the vicinity of the Pachmarhi plateau there are a large number of cave shelters of great archaeological interests, contained in them are a number of rock paintings executed by the tribes. Some of these may be around 10000 years old while a majority of these paintings belong to historical age, being 2500 to 1500 years old. A total of 55 rock painting sites have been identified in and around Pachmarhi, depicting the life style and civilization of that era.

Pachmarhi BR is often recognized as "Genetic Express Highway" linking two biodiversity hot spots of the country, viz., Eastern Himalaya and Western Ghats.

Among these, Mahadeo, Catacomb, Jumbudweep, Madai, Dorothideep, Jatashankar, Pandav caves, Bazar caves, Maradeo, Kaila Khurd, Taptka - Pani, Kanjighat, Rajat Prapat, Kharilanes Tamia etc., are important from archaeological point of view. The painting found in the BR area depicts warrior with sword and shields, bows and arrows and also elephants, tigers, panthers, Cheetals, dogs, peacock, horses etc. Paintings of women are less common.

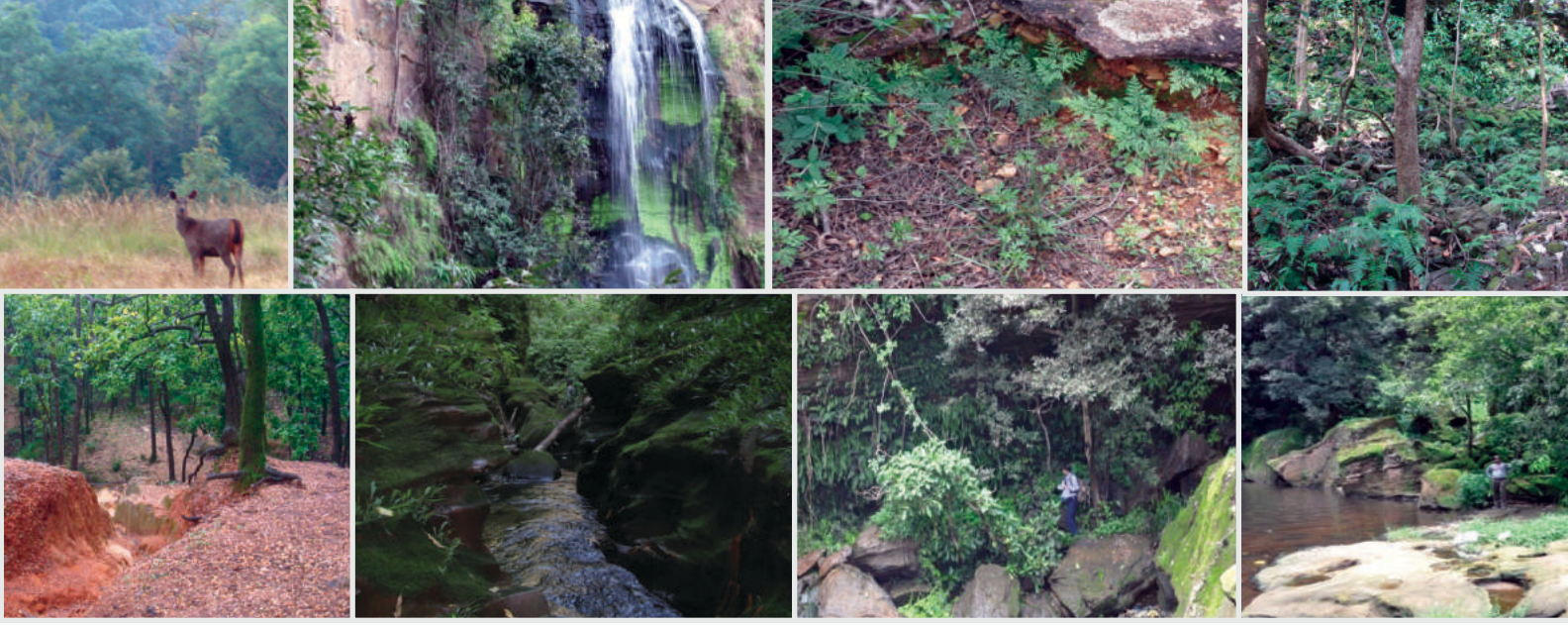
7.4.2. Manmade heritage

The old public buildings at Pachmarhi plateau constitute the most valuable cultural heritage handed down from the past. Amongst them are a several furniture and antiques placed at Raj Bhawan, Champak, Madhuban, Prasthal and old Church, Military Church, St. Joseph and Fox Rock, Building of AEC house, several buildings of centre HQ Pachmarhi, Officers Mess (Hill Hall), Medical officers residence, Bison Lodge, Bori Forest Rest House, Civil dispensary, Churna Forest Rest house, Madhuban, Dhoopgarh Rest House (now converted to interpretation centre), Glane View Bungalow, Pachmarhi Clubs, Champak are important manmade heritages.

7.4.3. Cultural attributes

The area is rich from cultural point of view. It was mainly inhabited by tribal in past. Among these, the most primitive tribe 'Bhariya' are found in Patalkot region. The hills around Pachmarhi were supposed to be sacred because of Mahadeo or Lord Shiva of Hindus. The Handi-Khoh, a deep gorge, is said to be the retreat of a monstrous serpent. Jambu-Dweep is also a gorge cut into the soft rock at the bottom of which is a cavern in the rock, which has been cut by water action to resemble a giant lock of matted hair and sure enough called 'Jatashankar'.

In geological terms, these structures are called Stalactites and Stalagmites. Two important Hindu festivals are observed



in this locality with great fun. Nagpanchmi is observed in Shravan (July-August) and Maha Shivratri is held in month of March. Generally 3-5 lakhs pilgrims attend these festivals.

7.4.4. Aesthetic attributes

The Pachmarhi plateau is famous for its beautiful landscape. It is also famous as hill station for those who wish to retreat the busy life of urban cities. The hilltops and slopes are fully clothed with vegetation, whereas the flat land on the plateau is vast open grassy glades (meadows), the likes of which are not to be found at other hill station. These ecological glades, are the unique phenomenon of Pachmarhi.

The area includes Dhupgarh, Chauragarh and Mahadeo Hills. The Dhoopgarh, the highest peak of Central India, presents beautiful and scenic landscape. It also provide scenic place for sunset and sun rise. Chauragarh is a spectacular flat topped peak and with a Shiv Shrine much venerated and visited by people from surrounding plain specially from Maharashtra.

The hills of Mahadeo, which is made of soft rock, is cut into deep gullies by water erosion creating spectacular waterfalls all around Pachmarhi plateau, aided by rifts in the geological strata. Patalkot, close to Tamia in Chhindwara district, is a small hamlet of Adivasis (Primitive Bhariya tribe) approachable by a steep footpath and hence considered as a paradise for anthropological studies. The Asirgarh Fort (in ruins) in Betul district is an old seat of Gond / Korku rulers.

7.4.5. Tourism

Most of the places of tourist attraction are located at Pachamrhi plateau, inside the national park or adjacent to Pachmarhi Sanctuary. The title “Queen of the Satpura” is undoubtly well deserved by Pachmarhi. The place is Madhya Pradesh’s most verdant Jewel, a place where Nature has found exquisite expression in a myriad enchanting ways. On the way to Pachmarhi beyond Matkuli, the visitor enjoy the sheer calm beauty of the plateau as a paradise.

The places worth visit at and around Pachmarhi area includes Priyadarshani point, Handi Khoh, Bee Fall, Apsara Vihar, Rajat Prapat, Raj Giri, Lanjee Giri, Dutches Fall, Sundar Kund, Jatashankar, Chhota Mahadeo, Mahadeo, Chauragarh, Dhoopgarh, Pandav cave, cave shelters, Bison lodge and Padmini lake, etc. In Bori sanctuary, Churna and Madai are bases for wild-life tourism. For a truly wilderness experience, the visitor can reach upto Neemghan through Pannarpani gate. The flat land and good visibility along with rich wildlife makes excursions here unforgettable. Badi Anhoni and Chhoti Anhohi, the natural hot water springs, also provide beautiful spots for local tourists. Satdhara located at Denwa near Jhirpa, is worth scenic spot.

7.5. Biodiversity Values

7.5.1. Flora

Pachmarhi Biosphere Reserve area, which constitutes the Central part of India, is one of the highly biodiversity rich areas with high floristic diversity and unique plant life forms. Pachmarhi BR is often recognized as “Genetic Express Highway” linking two biodiversity hot spots of the country, viz., Eastern Himalaya and Western Ghats, also as confluence of northern and southern type of vegetation.

The area is virtually a junction of forest representative types prevailing in the State. It is a natural junction of two most important timber species (i.e.,Teak and Sal).

The entire forest area can be broadly classified into three major types viz., moist deciduous, dry deciduous, central Indian sub tropical hill forest. However, it can further be classified into seven sub types based on microclimatic conditions, soil types, topographical features, etc. The moist deciduous forest can further be classified into moist teak forest, slightly moist teak forest, and moist mixed deciduous forest. The dry deciduous forest can be classified as southern tropical dry teak forest, southern tropical dry mixed deciduous forest and dry Peninsular Sal forests. The Central Indian subtropical hill forests are confined to hill top of

Floral Diversity of PBR	
Angiosperms	1190
Gymnosperms	07
Bryophytes	97
Pteridophytes	75
Thallophytes	30
Total	**1399**

Pachmarhi Plateau, especially in Pachmarhi sanctuary.

These sites are exposed and having very poor soil. The area supports more xerophytic vegetation, which closely resembles the tropical dry deciduous forests though rather enriched by higher proportion of evergreen vegetation.

The Pachmarhi Biosphere Reserve is the first representative biosphere of Central India with significant and distinct habitats for wide range of species including various endemic, rare and endangered species.

The floral diversity of this area is represented by 1399 plant species (1190 species of Angiosperms in 633 genera and 127 families).

The indiscriminate harvesting and overexploitation of several species have resulted in rapid loss of several angiospermic species. Species in commercial collection include: *Gloriosa superba, Hygrophila auriculata, Gymnema sylvestre, Drosera indica, Drosera burmanni, Dioscorea bulbifera, Dioscorea sp., Litsea glutinosa, Acorus calamus, Alangium salvifolium, Buchanania lanzan, Chlorophytum borivilianum, Curculigo orchiodes, Curcuma angustifolia, Curcuma aromatica, Rauvolfia serpentine, Strychnos nux-vomica* are now becoming rare in reserve area. Several other species such as *Andrographis paniculata, Asperagus recemosus, Bacopa monnieri, Centella asiatica, Aegle marmelos, Pterocarpus marsupium, Gardenia gummifera, Hemidesmus indicus, , Plumbago zeylanica,Terminalia arjun, Terminalia bellirica, Terminalia chebula, Tinospora cordifolia, Tribulus terrestris, Tylophora asthmatica, Vitex negundo, Withania somnifera, Zingiber officinale* are being continuously commercially exploited at large scale and the conditions are alarmingly serious. However, medicinal plant species like *Andrographis paniculata, Vitex negundo, Withania somnifera, Asparagus racemosus, Barleria pronititis, Phyllanthus amarus, Solanum nigrum* and *Sphaeranthus indicus* are freely distributed over the BR area.

In Pachmarhi BR, about 07 species of Gymnosperms (*viz., Cupressus torulosa, Thuja occidentalis, Araucaria bidwilli, Pinus caribaea, Pinus patula, Pinus roxburghii, Cryptomeria* sp.) belonging to 05 genera under 03 families have been reported.

There are about 75 species of Pteridophytes belonging to 40 genera and 28 families reported from reserve area. Whereas, a recent conservation assessment studies on Pteridophytic flora of Pachmarhi BR reveals that, about 06 genera of Pteridophytes are found growing very scarce in distribution with only few individuals in each population *viz., Angiopteris evecta, Arachniodes amabilis, Bortrychium lanuginosum, Actiniopteris radiata, Bolbitis appendiculata, Psilotum nudum* representing extreme rarity. In Bryophytes, there are about 97 species, representing admix composition of species [i.e., western Himalayan (53 species), eastern Himalayan (65 species) and south India (52 species)]. The rarities in Bryophytic species include *Exormotheca tuberifera*, *Marchantia palmate*, *Reboulia hemisphaerica* and *Asterella khasiana*. The species composition of Thallophytes includes 8 species of algae, 22 species of fungi. Presently, a detailed account on floral diversity of Pachmarhi Biosphere Reserve is available, but the comprehensive studies on lower plants viz, Thallophytes (Algae, Fungi and Lichens) are still lacking.

Faunal Diversity of PBR	
Vertebrates	
Amphibia	08
Aves	255
Fishes	71
Mammalia	63
Reptilia	18
Sub total	415
Invertebrates	**410**
Total	**925**

The earlier study of the floral diversity in the area carried out by State Forest Research Institute, Jabalpur in 1993, reported 1381 plant species, which comprise 8 species of algae, 22 of fungi, 83 bryophytes in 34 families, 71 Pteridophytes in 16 families, 07 species of gymnosperms and 1190 species of flowering plants (angiosperms).

The occurrence of relict form of Sal (*Shorea robusta*) in the predominant teak (*Tectona grandis*) bearing area is a unique ecological phenomenon in this biosphere reserve. This patch is separated by a distance of about 160 km from the nearest major belt of Sal forest in East Mandla and North Balaghat Divisions. The area is the upper limit for the growth of Sal. It is also the western limit of Sal growth, thus making the area unique.

Out of the more than 15 preservation plots identified in the State covering various representative forest types, 4 plots are localed in the Pachmarhi BR. The Government of India has identified 26 endemic centers all over the country. The Pachmarhi Satpura ranges located in Pachmarhi BR stands as one of such endemic centers. The occurrence of sub tropical hill forest at Pachmarhi also makes the area special.

Teak is found to be rich and abundant on trap formations and absent on Gondwana sandstones, which are covered by mixed forests of deciduous species. The finest quality of teak is found in Pachmarhi area especially in Bori sanctuary.





Pachmarhi plateau is well considered as a Botanist's paradise. Presence of deep gorges on the Pachmarhi plateau have resulted in creation of several waterfalls, marshy places, perennial streams and hills of various elevations. Some of gorges are deep enough with narrow bank resulting in stoppage of the sunrays at the bottom of perennial streams. Such perennial streams and dark shady gorges have resulted in growth of several moisture loving species of ferns, orchids, bryophytes, algae and many tiny herbs of immense ecological and economic values. Some of the rare and important species, which are observed to be localized, may be considered as "gene bank" of rare species in these localities.

The existence of several species like *Psilotum nudum, Lycopodium clavatum, Lygodium flexuosum, Cyathea spinulosa, Polysticum ambile* and several medicinal plants is in danger due to constant botanical excursion of students and researcher of universities/ research institutions.

Drocera indica, an insectivorous plant, is also found in this region. A few clumps of rare and endemic species of bamboo (*Bambusa polymorpha*) occur in the moist teak forest of Bori Reserve. In Pachmarhi BR, there are several species like *Melastoma melabaricum, Murraya paniculata, Holmskioldia sanguinea, Blumea lanceolaria and Sophora interrupta*, which are not found anywhere else in the State. It is one of the areas where natural forests support large sized wild mango trees, whose off springs have arisen along suitable site, dispersed by man and animals. Besides, Patalkot which is famous for its unparallel beauty, has the occurrence of more than 150 species of medicinal plant in such a small area also provides uniqueness to the area.

Along streams and watercourses, fine riparian forests are encountered with rich Mango, Jamun, Arjun and Manilkara tree. The "gene pool" rich sites are visited by tourists constantly and local medicinal plant collectors for harvesting, thus threatening the existence of these rare and endemic species in the area.

7.5.2. Fauna

The faunal composition represents the Deccan Peninsular zone of biogeographic classification of India. The great diversity of geo-morphology and vegetation give rise to multitude of habitats and ecological riches that support rich wildlife. The Satpura National Park as well as Bori and Pachmarhi Sanctuaries have a much better population of wildlife than other reserved forest areas. The area has long history and tradition of wildlife conservation.

Most of the Pachmarhi BR is covered with dense forest vegetation and forms an ideal habitat for wild animals. As per the latest assessment of faunal diversity of Pachmarhi BR, Zoological survey of India, about 63 species of mammal, 255 species of birds, 18 species of reptiles, 78 species of butterflies, 08 species of amphibians, 71 species of fishes and numerous other forms of animals are found in the area.

The steep vertical scarps are home to numerous raptors like honey buzzard, barn owl, crested serpent eagle and black eagle and hawks. These forests have both grey as well as the red jungle fowl, which are usually found separately either in north or south India, respectively. Among the other eye-catching birds represented are Malabar pied hornbill, Indian grey hornbill, Malabar whistling thrush and Paradise fly catcher, Darter, White-necked Stork, Black Ibis, Small-blue Kingfisher, White-breasted Kingfisher, Spotted Dove,

etc. The presence of numerous streams, dense foliage, wild flowers, woodland edges and damp patches attract numerous colorful butterflies including Lime Butterfly, Common Rose, Spot Swordtail, Blue Tiger, Common Crow, Common Gull, Twany Coster, Blue Pensy, Yellow and Lemon Pancy, Danaid Eggfly, Orange Oakleaf, Common Pierrot, Dark Palm Dart, Grass Demon, Indian Skipper, Bright Sunbeam, etc.

The wildlife belonging to schedule I, II, III & IV also occur in the area. As per wildlife census (2006), the tiger population has increased from 35 in 2004 to 35-39 in 2006. Based on 2004 wild life census, 69 Leopards, 300 Barking Deers, 1900-2100 Indian Bison (Guar), 2300-2500 Axis Deer (Cheetal), 3500-3600 Sambar, 210-235 Sloth Bear, 35-40 Chinkara (Indian Gazelle), 25-30 Black Buck (named as Harna for male and female as Harni) and several other animal species have been reported in Pachmarhi BR.

Tiger, being top carnivore, are generally confined to deep forests of National Park and sanctuaries. However, leopards are found to be well distributed in the entire forest area of BR. Gaurs are the largest wild herbivore in the area and are localized in the moist and semi-moist forest having bamboo underneath. Sambhar and Chital are found to be abundantly distributed in the area. Barking deer and four horned antelopes are also reported to be well distributed in the entire area. Nilgai, being a larger herbivore are localized in the drier area, where the growth of forest is thin. Bears are also frequently seen in the scrub forests. Langurs are quite common and distributed widely but Rhesus monkeys are found at localized places in Pachmarhi plateau particularly near habitations. Altogether, 14 species of mammals and reptiles are reported endangered including Tiger, Gaur or Indian Bison. Several species like Rhesus monkeys, Indian giant squirrels and flying squirrels are endemic to the area. The crested serpent eagles, giant squirrel, flying squirrel are also rare species found in the region.

The reptile's population, especially lizards, geockloes, skinks, amphibians, etc., have yet to be thoroughly studied. Submergence area of Tawa reservoir and Denwa River provide ample habitats for fishes, crocodiles and otters.

Ministry of Environment and Forests, Govt of India has recognized Environmental Planning and Coordination Organisation (EPCO) as Lead/ Coordination Institution for Pachmarhi BR for collection, compilation and dissemination of research based information and to coordinate with research Institute and BR managers as per the aims and objectives of the Lead Institution project.

The major fishes found in these reservoirs are *Notopterus notopterus, Catla catla, Cirrhinus mrigala, C. reba, Labeo bata, L. fimbriatis, L. rohita, Ompok pabda, Wallago attu, Mystus aor, M. bleekeri, M. seenghala, Rita rita, Heteropneustes fossillis, Xenentodon cancila, Channa garua, C. marulius, C. punctatus, C. striatus,* etc.

7.6. Management Aspects

At State level, the Housing and Environment Department is responsible for implementation of Management Action Plan (MAP) of Pachmarhi BR. The State Government has appointed Environmental Planning & Coordination Organization (EPCO), Bhopal as Nodal Agency for preparation and implementation of Management Action Plan. The Govt. of MP has constituted State Level Steering Committee (SLSC) under Chief Secretary, and main line state departments being member of the committee. The Executive Director, EPCO is the Member Secretary of the committee. For implementation of the project activities related to various departments/ organizations at district level, a District level Coordination Committee (DLFCC) has also been constituted under chairmanship of respective collectors, the line field departments/ organizations and NGOs being members of the committee. The Officer-in-Charge, Biosphere Reserve is member secretary of the committee.

The proposals are identified in the DLFCC meeting and thereafter prepared by the line departments/ organizations/ NGOs and subsequently approved by the DLFCC. The proposals received by implementing agencies are compiled by EPCO in form of Management Action Plan (MAP). Subsequently it is placed in the SLSC meeting for approval. Based on the approval and direction of the SLSC, the final report of MAP is sent to Ministry of Environment and Forests, Government of India for its sanction. The ministry sanctions and releases the fund directly to EPCO which again provide these to concerned implementing agencies.

The rigorous monitoring is done through timely review progress of the projects in the DLFCC which is generally held 3-4 times in a year. Field level monitoring of the projects are also carried out by EPCO from time to time.

7.7. Initiatives for conservation and development of PBR area

Various initiatives have been taken for conservation and management of biodiversity in the reserve area by implementing various projects through different departments, organizations, schools and NGOs.

Events like Awareness campaign, Documentation & Information, National seminar on Biodiversity, Nature

camp, Publication & exhibition, Training for Implementing Agencies, Workshop on eco-tourism are organized for creating Awareness Education and Training among general public, teachers and students. Alongwith, Development of Eco-tourism Information Center, Initiative for Replacing Polythene Bags, Installation of Publicity Boards/ Signages, Development of Interpretation Centre at Pachmarhi, Construction of Nature trails and Trekking routes, Promotion of tourist facilities at Patalkot, Solid waste management at Pachmarhi has been taken for Promotion of Eco-Tourism.

The schemes like Fisheries Development, Fuel/Fodder in degraded Areas, Honey Bee Rearing, Promotion of Traditional Crops, Vermi-composting, Development of Alternative project for Fuelwood Bricketing, Development of Pasture /Grassland, Distribution of Vegetables Seed Packets, Integrated Pest Management, Intensive Plantation Campaign on Private Community, Micro- irrigation Works, Micro-credit revolving funds, Plantation for sericulture at Pachmarhi, Promotion of Bio-villages & Bio-centre concept, Promotion of Lakh, Promotion of local Fuit Plants, Promotion of Mushroom cultivation, Promotion of Sericulture (Ericulture), Stall Feeding, Utilization of Biomass for production of Farm Yard Manure have been taken up to uplift the socio-economic status of the people by promoting their livelihood. The projects viz., Catchment Area Treatment, Conservation of Landscape & rehabilitation of Degraded Areas, Conservation of Natural Heritage Sites, Desilting & Deeping of Existing Water Holes in Forest Area, Environmental Management of Natural springs near Anhoni, Lantana Eradication at Pachmarhi Plateau, Restoration of Meadow, Water & Soil Conservation at Mahadeo Hills & Caves have been taken under Habitat Improvement. Animal Health Camp, Genetical Improvement Livestock, Organisation of Health Camps, Promotion of LPG, and Providing Drinking Water Facilities are taken for the Social Welfare of the people living in the reserve area. In order to promote the use of Non-Conventional Sources of Energy, the projects are promoted among the local people of the area (e.g., installation of Biogas Plants and Smokeless Chulhas).

Several other activities and short term studies are taken by different departments, scientists and organisations to improve the biodiversity conservation and management practices in the reserve. Some of these are Communication facilities, EMP of Pachmarhi special Area using GIS technique, Monitoring & Evaluation. Also, short term studies have been undertaken for management of Anhoni spring, shifting of research institutions, fuelwood demand & supply at three places, ground water resources at Pachmarhi, Tamia, solid waste management at Pachmarhi, Water Pollution, Conservation of man-made and Natural Heritage sites.

7.8. Major Environmental Threats

- Excessive exploitation of Natural Resource and Threat to Gene Pool Reserve Areas
- Threat to meadows/open glades of Pachmarhi and Medicinal Plants & indigenous knowledge
- Habitat destruction & deformation of ecosystem
- Domination of invader and decline of indigenous species
- Migration of indigenous species, Soil Erosion, threats to Indigenous Fruit trees, Indigenous Crop & vegetable & fruit Varieties
- Water Pollution Problem at Pachmarhi, Impacts of tourism, threats to Wildlife
- Increased Use of Chemicals, destruction of Rock Paintings & Archaeological Sites
- Lack of Employment Opportunities and Awareness

7. 9. Success Stories

Implementation of various activities related to Livelihood Development, Habitat Improvement, *In-Situ/Ex-Situ* Conservation, Rehabilitation of Landscape, Eco Tourism, Awareness Campaign, and Nature Camp can be highlighted as success stories for Pachmarhi BR. Some of these include: Construction of Ponds for providing Water to Wildlife, Conservation and Management of Old Lake at Pachmarhi, Promotion of Ericulture, Promotion of Lakh for Economic Upliftment of the local people, Successful cultivation of Medicinal and Economically important plants in order to conserve the plant species, *In-situ* Conservation of Biodiversity Rich Areas and Rare/Threatened Species, Development of Tamia Area as a potential area for Eco-Tourism, Successful Restoration of Old Church at Pachmarhi. Also implemented the Social Welfare Activities by Organising Animal Healthcare Camps and Health camps for General Public and School Children, strengthening of Wireless Facilities for forest patrolling camps, successfull organization of Nature Camps for school children, and successfull conservation of Indigenous Species of Fruit plants can fall in the category of success stories for the reserve.

RP Singh
Coordinator & Officer-in-Charge BR

Faizan Rasheed, Project Manager

Ajit K Sharma, Reasearcher
Environmental Planning &
Coordination Organization (EPCO)
Paryavaran Parishar E-5, Arera Colony
Bhopal- 462 016 (India)

Phone: + 91-755-2460104 (DIRECT)
EPBX: 2466970, 2464318, 2465686
Fax: +91-755-2460104, 2462136
Email: rpsingh@epco.in, rps_br@rediffmail.com; Website: www.epco.in

Nokrek Biosphere Reserve

UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION

MaB

Man and the Biosphere Programme

By decision of the International Co-ordinating Council of the Programme on Man and the Biosphere,

Nokrek · India

has been designated for inclusion in the World Network of Biosphere Reserves.

The world's major ecosystem types and landscapes are represented in this Network, which is devoted to conserving biological diversity, promoting research and monitoring as well as seeking to provide models of sustainable development in the service of humankind.

Participation in the World Network facilitates co-operation and exchanges at the regional and international levels.

Director-General of UNESCO

Date

26 May 2009

8

Nokrek Biosphere Reserve - North East Hills, India

8.1. Introduction

Nokrek Biosphere Reserve (NBR) is the second smallest of 18 BRs in India, which got its status in 1988 from the Government of India and included in UNESCO Man and Biosphere World Network on 26th May, 2009. Located in the lap of Tura range, Nokrek is an adobe of rich flora, fauna and natural beauties that attracts researchers, scientists, philosophers, naturalists, tourists and many more to get a taste of its natural ness. Presence of endemic *Citrus indica* Tanaka, a progenitor of *Citrus* sp. gives the reserve unique importance. Moreover, endowed with the pristine vegetation and species richness, Nokrek offers an excellent natural laboratory that has conserved many rare, endangered and endemic plant and animal species.

Designation Date	:	1 September, 1988
Total Area	:	820 km^2
Core Area	:	47.48 km^2
Buffer Area	:	227.92 km^2
Transition Area	:	544.60 km^2
Extent	:	90°13′ to 90°35′ E 25°20′ to 25°29′ N

Nokrek is the only biosphere reserve in Meghalaya comprising the parts of East, West and South Garo Hill districts.

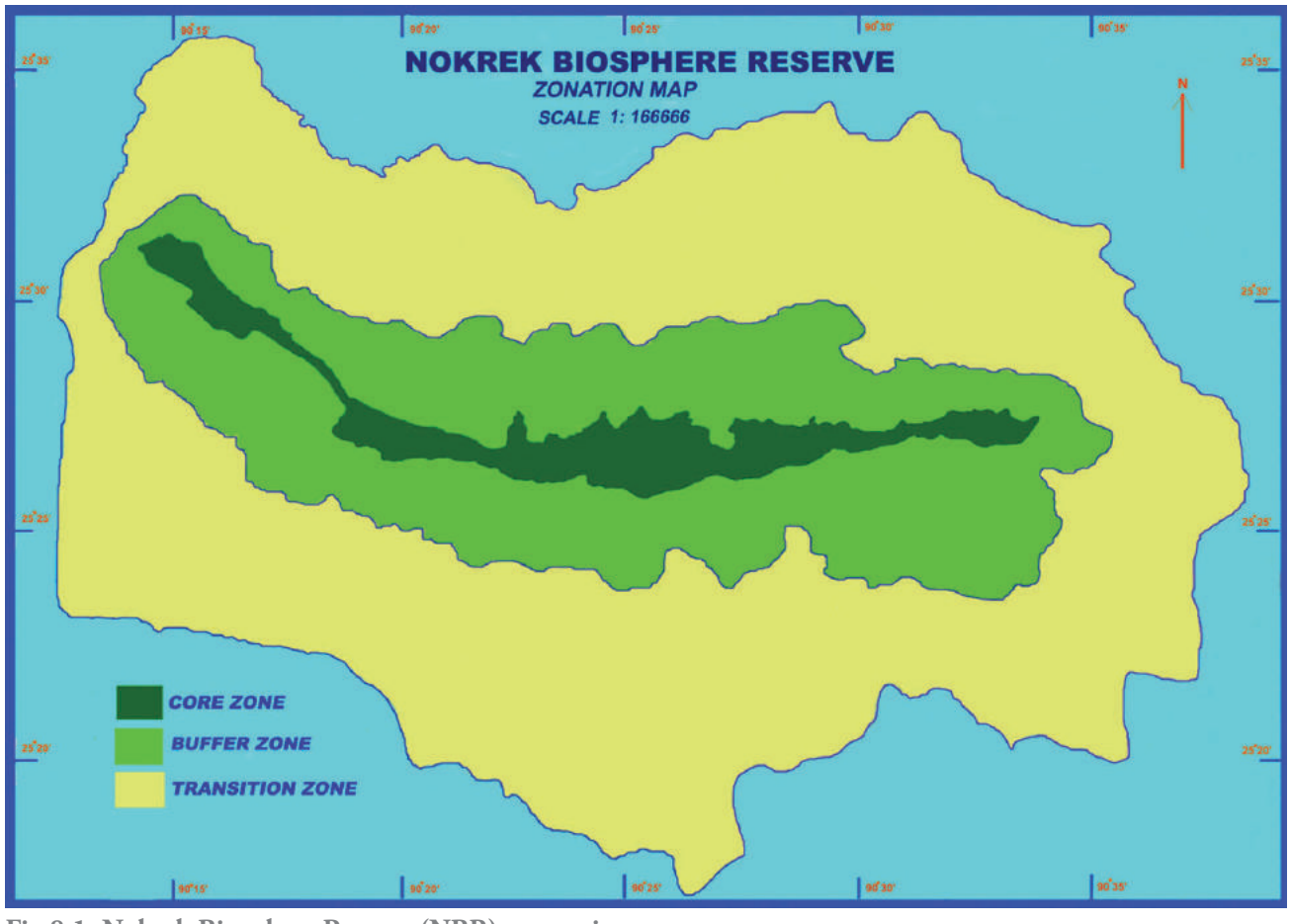


Fig 8.1: Nokrek Biosphere Reserve (NBR) – zonation map

8.2. Area Description

Nokrek Biosphere Reserve is located in the North-Western part of Meghalaya comprises of parts of East, West and South Garo Hill districts and lies between 90°13' to 90°35' E Longitude and 25°20' to 25°29' N Latitude.

8.2.1 Zonation Details

Covering an area of 820 km^2, the reserve has core zone of 47.48 km^2, buffer zone of 227.92 km^2 and transition zone of 544.60 km^2. The core zone is represented by the Nokrek National Park (Figure 8.1).

> Nokrek falls in Burma monsoon forest biogeographic unit and represents biogeographic province 9B Meghalaya Hills.

8.2.2. Biogeographic characteristics

Nokrek Biosphere Reserve falls in 4.09.04 (Burma monsoon forest) biogeographic unit and represents biogeographical province 9B (Meghalaya Hills) in the North East India. The forests approach the type Eastern Sub-montane Semi-evergreen forests (Sub-type 26/c 16) grouped under Tropical Semi-evergreen forests, described by Champion and Seth (1968). The altitude of Nokrek varies from 55 to 1412 m. Nokrek Peak is the highest point in Nokrek Biosphere Reserve and also in whole Garo hills. The southern side of the biosphere reserve is moderately of low altitude.

8.3. Background Information

8.3.1. Landscape features and land-use history

> Reserve has wide altitude range (55 – 1412m) and covers an area of 820 km^2.

The reserve forms a part of one of the global hot spots of biodiversity. It is endowed with natural beauty, diverse flora and fauna and varied human cultures. The vegetation of Nokrek Biosphere Reserve consists of evergreen, semi evergreen, deciduous species, bamboo patches and grassland including riverine forests. About 90% of the National Park area is covered by evergreen forests. The density of the forest is very high along the ridges making the entire area dark even during day time. Very little

information is available about the land use history of the Garo Hills. On the basis of archeological findings it is said that men inhibited the Garo hills Ecosystems sometimes in Lower Paleolithic period of the middle Pleistocene Age. Dutta (1968) has mentioned approximately 30,000 years for human existence in the Garo Hills, prior to that, this ecosystem been animal's kingdom. After settlement the Garo started agriculture and hunting for their livelihood. In Neolithic period man became food producers by cultivating plants by employing slash-and-burn technique in shifting cultivation. On the basis of presence of wild species of rice and maize in the north-eastern India, Sauer (1952) considered this area as one of the hearths where origin of first domestication of these species took place. During Mughal Empire, the land was used for cultivation by cleaning some patches of forest lands. The tribal brought cotton, agar timber, wax, rubber, lac etc. and exchange for the items of daily consumption. After the establishment of East India Company's rule, this land was considered as an additional source of supply of cotton to the cloth mills in Manchester. The British were also interested in the extraction of minerals from Garo hills mainly coal and lime. The Nokrek is the highest peak of the entire Garo hills. This peak is amongst the few where the British used to celebrate their victory after the First World War once in a decade. This victory was celebrated by lighting bonfires on the peak. Prior to the acquisition, the whole area belonged to the private owners (clan land). The concept of Biosphere Reserve came in the state of Meghalaya during the year 1977-78 while making attempts to identify suitable areas in Meghalaya for resource conservation and maintenance of genetic diversity. The concept of *Citrus* gene pool sanctuary within the network of a BR significantly came to the lime light when as a result of intensive investigation and research carried out for a number of years by a team of experts of National Bureau of Plant Genetic Resources of regional centre Shillong. They ultimately discovered that this area is the reservoir of large variety of wild relatives of cultivated *Citrus* fruits.

Poverty and lack of adequate alternate facilities have led the villagers to depend mainly on forest resources for their requirements. They use forest products like timber, fuel wood, thatching leaves, honey, wax, etc., and also cultivate betel nut, cashew nut, banana, maize, rice, pulses, jack fruit, pine apple, cinchona, litchi, pear, tea, etc., at commercial scale in the buffer and transition zones of the Reserve. Most of the villagers are interested to keep livestock like cattle and goats. Some small scale industries for making fruit juice, prickle and sauces are also set up at certain villages in the transition zone by the inhabitants.

8.3.2. Reserve inhabitants, demographic trends and dependence

According to the 2001 census the human population of the reserve is 22,084 which is distributed in 166 villages. The population of villages varies from 20 to 2,200. Reserve area is mainly dominated by the Garo tribes.

But other tribes like Koches, Robhas, Hajjons, Banias and others are also there in the biosphere reserve area but with very low frequency. These people are mainly involved in shifting cultivation. About 17% of total reserve is under such cultivation and 85% of the people are engaged in shifting cultivation. In this way they use to grow maize, rice, squash, banana, areca nut cashew nut, litchi, tea, coffee, pear, jack fruit, cinchona, orange, in vegetables tomato, ginger, potato, chilies, rubber, coconut, tapioca, etc. The main source of income of the people comes mainly from forest and forest based resources. Some people are engaged in agriculture and fish catching. Some villagers are involved in the small scale industries located in the biosphere reserve. Animal

husbandry is also common. They use to domesticate cows, goats, hens, pigs etc. The brewed liquor prepared from rice, millet and maize plays an important part in the daily life of the Garo. The liquor is always brewed and never distilled. Fish forms an essential part of their diet. Many kind of edible wild roots and fruits are found in the forests, which the Garo makes use of particularly in terms of food scarcity.

8.3.3. State of knowledge

Many botanists have made their collections from the forests of Meghalaya. The first collector from this region seems to be Mr. M.R. Smith. Sir J.D. Hooker and T. Thomson. They collected several specimens from Meghalaya and included it in 'Flora of British India'. C.B. Clarke has made significant contributions on the floristic of Meghalaya. Gaustav Mann was the first to make organized collections mainly for understanding the rich forest flora of North East India. He was succeeded by U.N. Kanjilal, A. Das, C. Purkayastha and R.N. De and whose efforts resulted in the publication of the 'Flora of Assam'. N.L. Bor has made elaborate collections particularly grasses from N.E. India. M.M. Srinivasan has made his collections from the Garo hills.

> The tribes of Nokrek are dependent on the forest resources for their livelihood and their mode of collection is very much conservation oriented.

Establishment of the North-Eastern Hill University in Shillong has boosted the floristic research activity in this region and numerous scientists made their contributions on the flora of Meghalaya. The above accounts deal either with the flora of N.E. India as a whole or on certain specialized groups, families or genera or mainly restricted to the Khasi and Jaintia hills of Meghalaya. Very little emphasis has been given to the complete floristic account of the Nokrek Biosphere Reserve (Figure 8.2).

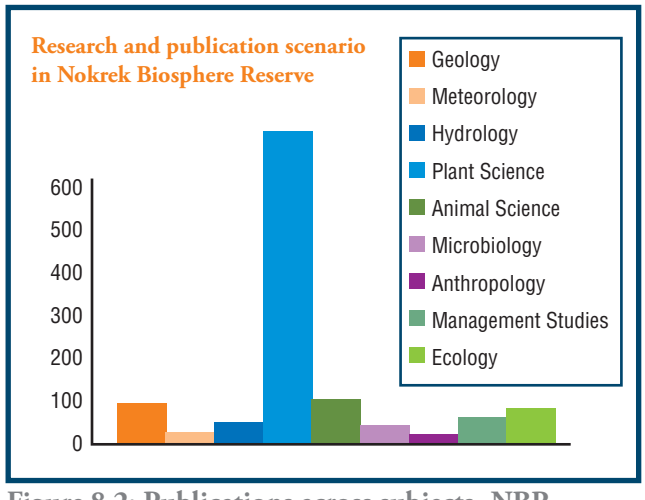


Figure 8.2: Publications across subjects- NBR

8.4. Global and National Significance

Nokrek Biosphere Reserve is one of the most important reserves in India from conservation point of view because of diverse flora and fauna and varied human cultures. Keeping in view the objectives of natural resource conservation and maintenance of genetic diversity, the Nokrek range of Garo hills was identified as Biosphere Reserve and more importantly due to the fact that the area forms the primary catchments of all the major rivers and streams in the three districts of Garo Hills.

At the same time it is one of the global biodiversity 'hot spots'. The special feature of the area is the abundant natural occurrence of *Citrus indica* Tanaka. The area, therefore, is considered to constitute an important gene pool for future hybridization programme for evolving disease resistant *Citrus* plants. The area also harbors many rare, endangered and endemic faunal species. Hoollock gibbons the only Apes in India is considered as an endangered species (Table 8.1).

8.5. Biodiversity Values

Endowed with natural beauty, diverse flora and fauna and varied human cultures Nokrek is globaly important reserve. The vegetation of Nokrek Biosphere Reserve consists of evergreen, semi evergreen, deciduous species, bamboo

Table 8.1. Uniqueness of Nokrek Biosphere Reserve

- Undisturbed natural biomes with natural protective barriers.
- Remnant representative of vegetation type in the region.
- Occurrence of genetic diversity of *Citrus* spp. specially the *Citrus indica* Tanaka population and also other related cultivars like *C. latipes* Tanaka., *C. reticulate* Blanco., *C. aurantifolia* Swingle, *C. grandis* Osbeck., *C. jambhiri* Lushington and *C. limon* Burm. in the transition and buffer zones.
- Unique floral and faunal diversity as well as landscape features which forms a natural laboratory of evolution. Hollock gibbon, the only Apes in India, is found in the reserve.
- Harmonies relation between nature and people within the region, which maintains the balance of ecosystems.
- Several perennial streams constitute the basic catchments of all the major river systems of Garo hills. Considerably large area facilitates free movement of inhabiting wild life population.
- Non-manipulative core zone which allows monitoring and integrating the research, education and training on the natural ecosystems.

patches and grasslands including riverine forests. The major forest types include tropical moist evergreen forests, tropical semi-evergreen forests, tropical moist deciduous forests, sub-tropical broad leaves hill forests and bamboo forests. The plant species include trees, bamboo, grass species, medicinal plants, climbers, orchids and a great variety of rare, endemic and threatened ground vegetation. This area is the reservoir of large variety of wild relatives of cultivated *Citrus* fruits, which are grown in different parts of the region by the villagers. Occurance of *Citrus indica* seems to be most primitive and perhaps the progenitor of the *Citrus* spp. This is an endangered and endemic species to Nokrek Biosphere Reserve. The area, is therefore, considered to constitute an important gene pool for future hybridization program. The area of National Park as well as the entire Tura Range is very important from conservation point of view because of its richness in floral and faunal diversity and more importantly due to the fact that the area forms the primary catchment of all the major rivers.

The Biosphere Reserve is also blessed with variety of animal species which are rare, endangered and endemic. Some of the important animals include elephant, leopard, clouded leopard, tiger, rhesus macaque, pig tailed macaque, giant squirrel, barking deer and variety of butterflies and birds.

8.6. Conservation and Management

The state level steering committee has been constituted for co-ordination between various government departments, non-government organizations, research and scientific institutions and local universities. District level steering committee has also been set up by the state government appointing representatives from the local communities called

Entire reserve is blessed with a rich floral diversity including nearly 804 species of angiosperms. *Ficus* with 15 species is the most diverse species in the reserve.

Besides state level Steering Committee, District level Steering committees have been set up by the state government appointing representatives from the local communities called Nokmas.

Nokmas. Six such Nokmas are there in the reserve area. They help in local coordination. Representative six Nokmas (village headmen) of District Level Steering Committee (DLSC) are appointed by the State Government. They decide about the development activities in the Biosphere Reserve. Joint Forest Management Committee is also framed by the Social Forestry Division of Forest Department along with the members from the villages within the Biosphere Reserve to find out the problems faced by the people and for the proper management of the forests. Meetings with the villagers (Entry Point Activity Programme) are also conducted by the Social Forestry Division, Tura.

Facilities for undertaking research programmes funded by different National organizations on conservation, eco-restoration, pollution and related areas have been created. Seminars, Nature Education Camps, Aforestation, Health Camps, and Public Awareness Programmes are organized by different NGOs, voluntary organizations and forest departments.

8.7. Issues and Concerns

The people of the Biosphere Reserve area are socio-economically very poor and economically backward. Jhum cultivation (shifting cultivation) is the major means of livelihood. Almost 85% of the families are practicing shifting cultivation and about 17% of the total Biosphere Reserve comes under shifting cultivation. Poverty and lack of adequate alternate facilities have led the villagers to depend mainly on forest resources for their requirements. They use forest products at commercial scale in the buffer and transition zones of the Biosphere Reserve area.

8.8. Perspective Plan (5 Years) – Major Components

With respect to lead Institution following major components would form the part for five year plan: (i) Dissemination of existing information (research publications); (ii) Find out the management action plan; (iii) Ensure regular interaction with the managers to short out the problems, causes of problems and to decide the action that should be taken; (iv) Monitoring of vegetation patterns to know any changing pattern of

vegetation; (viii) Publish complete flora of Nokrek Biosphere Reserve.

8.9. Success Story

Forest department and other government agencies are helping the people to change their livelihood from destructive shifting cultivation to more sustainable alternatives. Many villagers in the Reserve area have started raising plantations of horticultural species like oranges, areca nut, cashew nut, pear, tea, cardamom, rubber, jackfruit, etc. This activity has emerged as more productive than shifting cultivation and

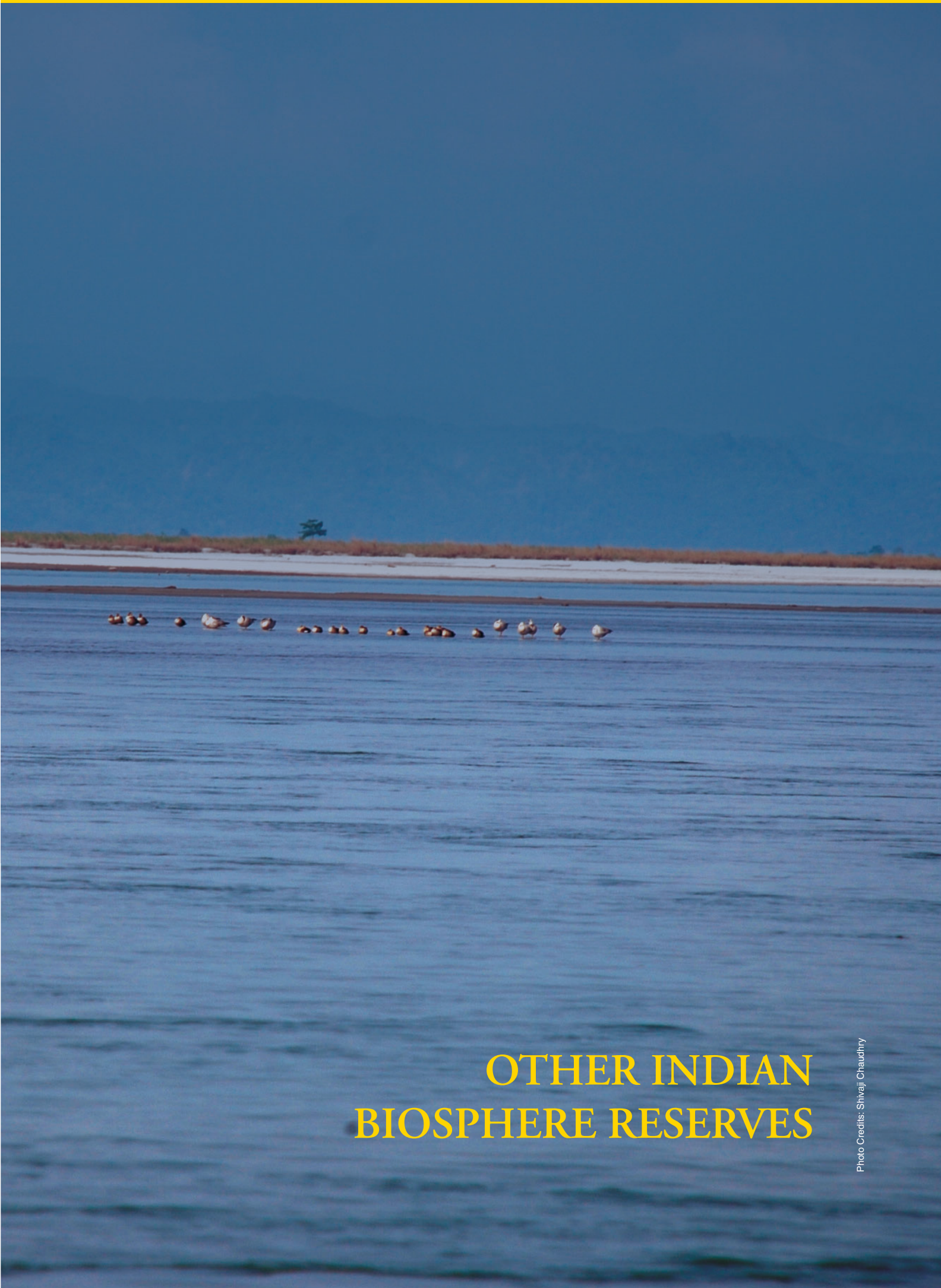
Forest department is supplying bee boxes, metallic skeletons for cultivating squash to the villagers to reduce the practice of shifting cultivation under the Joint Forest Management Committee.

offers better returns. Tea, coffee, brittle nut, rubber, orange, pear cultivation has been introduced in permanent lands.

Some small scale industries are also flourishing inside the Biosphere Reserve wherein bamboo, cane and other forest products are used as the income source. Forest Department is supplying bee boxes, metallic skeletons for cultivating squash to the villagers to reduce the practice of shifting cultivation under the Joint Forest Management Committee. Entry Point Activities are under taken by the Social Forestry Division of Forest department to understand the problems of villagers. These initiatives will definitely reduce the dependency of people on shifting cultivation and also solve the problem of unemployment to some extent.

Himadri S Debnath
Nodal Person Lead-BR Centre
Botanical Survey of India,AJC Bose Indian Botanical Garden
Hawrah - 711103 (India)
Phone: +91-33 - 226680554
Fax: +91-33 - 226685096
Email: hs_debnath@rediffmail.com

Director
Nokrek Biosphere Reserve
Dakopgre Tura, West Garo Hills
Meghalaya (India)
Phone: + 91-3651-232225; Fax: + 91-3651-232225
Email: dfo.tura@rediffmail.com



OTHER INDIAN BIOSPHERE RESERVES

Photo Credits: Shivaji Chaudhry

Photo Credits: HK Badola

9
Great Nicobar Biosphere Reserve – Nicobar Islands, India

9.1. Introduction

The Great Nicobar Biosphere Reserve (GNBR) comprises of a large portion of terrestrial and coastal ecosystem which encourages for developing sustainable practices for the core area and zone of cooperation at varying degrees. The reserve also helps in preserving the integrity of cultural resources and heritage in the region. The Great Nicobar Biosphere Reserve represents tropical forest biome and is located in the tropical Indo-Malayan biotic zone. Biogeographically, Great Nicobar Island is amongst the most important regions of the world and represents one of the noted areas for speciation in the tropics.

It is represented by unique and threatened tropical evergreen forests including a host of forest systems, ranging from seasonal rain forests in the low hills, the tropical mountain forests and moist deciduous to scrub through dry-deciduous ones. The region is noted for its rich biodiversity. It houses 650 species of angiosperms, ferns and gymnosperms. The fauna consists of over 1800 species of animals. In addition, 200 species of meiofauna have also been recorded from its coastal habitats.

Designation Date	:	6 January 1989
Total Area	:	885 km^2
Core Area	:	705 km^2
Buffer Area	:	180 km^2
Transition Area	:	159 km^2
Extent	:	7° and 7° 20′ N, 93°37′ and 93°46′ E (Zone –I); 6°46′and 7°′ N, 93°37′ and 93°56′ E (Zone –II)

9. 2. Area Description

9.2.1. Zonation details

The entire northern part of the island and the area between Alexandra River and Chengappa Bay forms Zone-I with 520 km^2 of Core zone and 90 km^2 of Buffer Zone. The buffer zone consists of 180 km^2 spread with over 90 km^2 in each of the two zones (Figure 9.1).

The southern part between the Sahini and Mani hill ranges including the Galathea River is Zone-II with 185 km^2 of Core Zone. This zone represents the least disturbed region existing more or less in its natural state. An outer area of 159 km^2 is designated as transition zone for management requirements of the area such as providing sustainable livelihood to the indigenous people. This includes provisioning of safe drinking water to local people, compensation for damages to life and crop, setting up of biogas plants to ensure the involvement of local people in conservation efforts. Eco-tourism activities are also in practice in other fringe areas and eco-development works like compatible agriculture, recreation and other relevant sectors are in progress with the participation of local people.

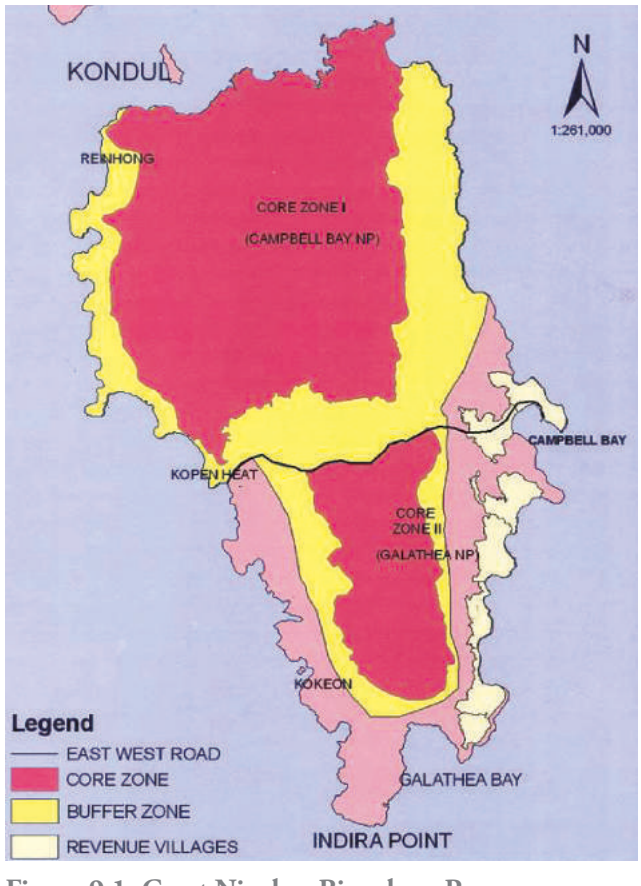


Figure 9.1: Great Nicobar Biosphere Reserve (GNDBR)-zonation map

9.2.2. Biogeographic characteristics

The Biosphere Reserve falls within the Island (10 B) Biogeographical zone of India. As such the Biosphere Reserve is located in the Great Nicobar Island (Province-10B) of the Union Territory of Andaman and Nicobar Islands.

9.3. Background Information

9.3.1. Landscape features and land use history

The Great Nicobar Island is the southernmost Island of Andaman and Nicobar Islands located about 482 km south of Port Blair, the capital of the Union Territory. The total geographical area of the island is 1044 km^2 with a length of 55 km from Murray Point in the North to Indira Point in the South. The greatest width of about 30 km is in the north which narrows down to about 3 km in the southern tip.

9.3.2. Reserve inhabitants, demographic trends and dependence

Immigration of mainlanders began in 1969, when 337 families were settled on the southeastern coast of Great Nicobar Island. The total population of Great Nicobar Island was 6831 in 1991 of which 3745 resided in Campbell Bay. The economy of the settlers is based on agricultural production and fishing. Paddy, coconut, arecanut and spices constitute the major agricultural produce. Rice is grown on a subsistence basis. Income generating horticulture crops include coconut and arecanut plantations. Fishing is done mainly by the fisher-folk who migrated from Andhra Pradesh and have now settled in Campbell Bay and Shastri Nagar. Fishing in the creeks and bays is carried out using gill nets and hook and line.

Historically, the Great Nicobar Island is the land of Shompen and Nicobarese Tribes. The Shompen inhabit the interior forest. They are shy in nature and avoid contact with outsiders. They live around and along the perennial freshwater rivers and construct huts using palm and pandanus leaves. The Shompens are hunters and food gatherers leading a semi-nomadic life. They cultivate yams, pandanus, coconuts, arecanuts and bananas. They maintain small herds of pigs and also hunt wild pigs with spears and fish with harpoons.

The Mongoloid Shompen Tribe, about 200-250 in number, live within the Biosphere Reserve. They also rely on the marine resources for sustenance. Another Mongoloid Tribe - Nicobarese, about 310 in number, live in the villages along the west coast of the Transition Zone.

The Nicobarese are horticulturists. Coconut, pandanus, banana, papaya, yam and other starchy roots and tubers are their principal items of crop. They also depend for food on hunting and fishing. Pig rearing is an important traditional job of Nicobarese. They live in villages located along the coast. The huts are made of wooden logs, stems of areca palm, coconut palm, etc., while the roof is thatched with grass, canes, bamboo and coconut leaves. At present their traditional beliefs and customs are changing and modern education and Government jobs are readily accepted, provided these are made available in their own place. Over 6000 settlers and mainlanders live along the southwest coast of the island practicing agriculture, horticulture and fishing. The Shompens live wandering in the Core and Buffer Zones. The settlers and the Nicobarese live in settlements spread along the coast in the Transition zone.

9.3.3. State of knowledge

The Great Nicobar Biosphere Reserve has received relatively little attention from the researcher largely owing to its remoteness. Analyses of literature reveals that 224 research papers have been published pertaining to flora and fauna of GNBR. Of the published information, it is revealing that most of the studies have been conducted on floristic aspects of this Reserve (Figure 9.2).

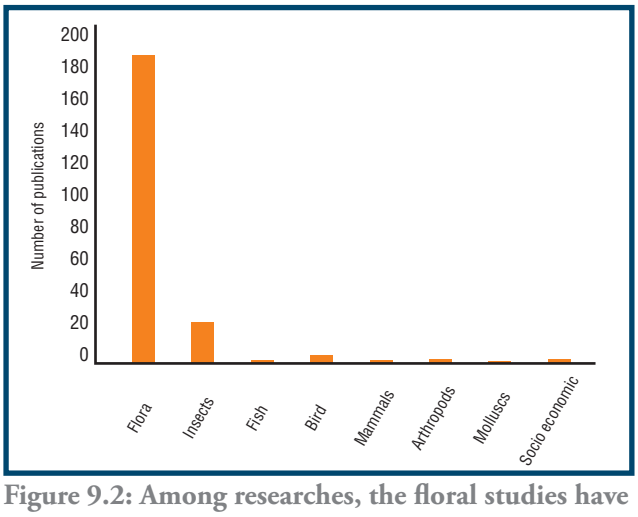


Figure 9.2: Among researches, the floral studies have been most common in the reserve

However, most of the published information regarding GNBR deals with taxonomy and distribution of flora and fauna, and effectively very little quantitative information exists.

Among gap areas following can be indicated for immediate attention: (i) detailed quantitative studies on fauna and flora; (ii) assessment and quantification of crop damage by wild animals; (iii) in-depth socio economic studies.

9.4. Global and National Significance

The Great Nicobar Island has remained in global focus and in the priority of leading conservation agencies due to its rich and unique biodiversity. The richness of flora and fauna of this region reflects the diversity of wide range of habitats associated with. The Great Nicobar Island has been identified as an Endemic Bird Area by the Royal Society for Protection of Birds. This reserve is home for several endemic species namely Nicobar Megapode (*Megapodius nicobariensis*), Edible-nest Swiftlet (*Aerodramus fuciphagus*), Nicobar Tree Shrew (*Tupaia nicobarica*), Long-tailed Macaque (*Macaca fascicularis*), Saltwater Crocodile (*Crocodylus porosus*), Giant Leatherback Sea Turtle (*Dermochelys coriacea*), Reticulated Python (*Python reticulates*), Coconut Crab (*Birgus latro*), etc.

> Great Nicobar Island has been identified as an Endemic Bird Area.

9.5. Biodiversity Values

Great Nicobar Biosphere Reserve represents the tropical forest biome, and is located in the tropical Indo-Malayan biotic zone of the world. Biogeographically, Great Nicobar Island is one amongst the most important region and one of the noted areas for speciation in the tropics. The Biosphere Reserve is represented by unique and threatened tropical evergreen forest ecosystems including a host of forest systems. Barring the North Andaman there is no area in these islands where such large contiguous forests still exists.

9.5.1. Flora

Based on the reports available, the reserve houses 650 species of angiosperms, ferns and gymnosperms. The tree fern, *Cyathea albosetacea* is dominant in many parts of the Reserve. Other important plant species include *Scaevola sercea, Heritiera littoralis, Pandanus* sp., *Terminalia bialata*, *Barringtonia andamanicos, Rhizophora* spp.,*Gnetum gnemon, Sterculia macrophylla, Elaeocarpus aristatus*. The

knowledge of the lower plants is, however, limited.

9.5.2. Fauna

The known vertebrate fauna of the reserve includes: 14 species of mammals, 71 species of birds, 26 species of reptiles 10 species of amphibians, and 113 species of fishes. Invertebrates are represented by 7 species of annelids, 417 species of insects including 73 species of butterflies and 132 species of moths. A large number of other invertebrates such as mollusks, and many more species that await discovery. The important faunal elements of the Biosphere Reserve include the Nicobar Tree Shrew, Wild Boar, Crab eating Macaque, Nicobar Civet, Nicobar Pigeon, Nicobar Megapode, Serpent Eagle, Marine Turtle, Reticulated Python. Among the birds Nicobar Megapode, Nicobar Sparrow hawk, Nicobar Serpent Eagle, Blyth's Parakeet and Nicobar Bulbul are endemic to Nicobar. Whereas Andaman Woodpigeon, Andaman Cuckoo Dove, White-bellied Mynah and Andaman Hawk Owl are endemic to Andaman and Nicobar Islands.

The reserve is also a home for many rare and endangered species of flora and fauna and helps them rear in nature.

The Biosphere Reserve holds a remarkable genetic diversity of plants, animals and other lower life forms, with an estimated 24 per cent endemism over the number of species of some faunal groups. The economically important species, including the traditionally used ones, could be categorized as timber, edibles, fodder, plants and animals with medicinal value, apart from the wild progenitors of cultivated crops and domesticated animals. There are several important timber yielding plants, fruit trees, food plants and number of medicinal plants have also been reported from the reserve.

9.6. Issues and Concerns

Many of the scientists working on species within the Great Nicobar Islands ecosystem have established study sites within and outside of the reserve boundaries. The creation of GNBR has provided further opportunity for applied research which monitors changes within the designated zones: core, buffer, cooperation. An extended geography implies the need for more measurement of human activities and also generalization up to the landscape scale.

One of the most pressing needs would be to have a consensus on the ecosystem units, their size and distribution across Great Nicobar Island. This would also provide us with a framework for species level research in the region.

9.6.1. Sustainable development issues

- Protect and enhance the quality of life enjoyed by citizens of the Great Nicobar Biosphere Reserve.

- Promote increased recognition and understanding of the cultural heritage of the Great Nicobar Biosphere Reserve.
- Promote demonstration sites to illustrate traditional sustainable practices of the regional economy.
- Encourage development of innovative resource use and conservation techniques to explore new approaches to local resource issues.
- Encourage development of appropriate nature-based recreation that is ecologically sustainable (eco-tourism).

9.8. Major Achievements

Among others the following achievements have been made by the lead Institution w.r.t. the Great Nicobar Biosphere Reserve.

- Literature pertaining to ecology and diversity of faunal and floral communities of Great Nicobar Biosphere Reserve has been collected.
- Nomination Form for UNESCO-MAB Net for the consideration of Great Nicobar Biosphere Reserve (GNBR), Andaman and Nicobar Islands under the World Network of UNESCO has been prepared and submitted for necessary action.

7. Perspective 5 year plan – major components

S.N.	Relevant Action Areas/Targets of Madrid Action Plan (MAP)
1	Collection, synthesis and dissemination of research based information in respect of Great Nicobar Biosphere Reserve. ❖ Carryout detailed inventories to collect datasets of the fauna and floras, socio economic data, meteorological and hydrological data for assessing the need for site specific management of the Reserve.
2	Create and implement a system of recognizing performance of the Seville Strategy Ten key directions of the Seville Strategy would be implemented and monitored in the Great Nicobar Biosphere Reserve. ❖ The contribution of biodiversity in respect of Convention on Biological Diversity and other agreements on climate change, desertification and forests would be strengthened in the GNBR. ❖ The biosphere to be developed by considering wide variety of environmental, biological, economic and cultural situations. ❖ The emerging regional, inter-regional and thematic networks of GNBR to be strengthened ❖ Strengthen scientific research, monitoring, training and education in GNBR. ❖ Assess through research and monitoring the contribution of each zone. ❖ Explore and demonstrate at local and regional level through meeting/seminar the sustainable development mechanism of GNBR. ❖ The linkages between culture and biological diversity of GNBR need to be understood through field studies, questionnaire surveys and available literature. ❖ Increasing frequency of awareness camps, meetings, seminars for local communities for strengthening conservation of Biosphere Reserve. ❖ Development of a network of the interested groups and sectors for adequate information sharing. ❖ Improving public awareness through media, publications, environmental education on both long term and short term basis.
3	Produce regional, sub regional (country) and ecosystem specific publications on GNBR ❖ Bringing-out ecosystem specific publications based on the field surveys and review of available published information. Ensure proper distribution of the same amongst the public and policy makers.

4	Implementation of communication strategy on environmental, economic, social, spiritual, cultural and political important and benefits of Biosphere Reserve to National Governments, policy makers, journalists, local communities and other targets groups ❖ Organize training workshop for BR Managers, National/State Government officials, Policy makers, Journalists, Local communities and other targets groups.
5	Carry out a survey on the present zoning system of the GNBR (including the proportions of the different zones) and investigate how well they fulfill the three functions in each zone ❖ Conduct detailed surveys in different zones to collect the information on biodiversity.
6	Use BRs to manage large biome as a BR system and for extensive terrestrial and marine areas as a series of units linking up relatively small protected core areas with significantly larger buffer zones and transition areas ❖ Conduct separate surveys in terrestrial and marine areas.
7	Cooperative conservation and development strategies for biosphere reserve ❖ Conduct periodic reviews in respect of Great Nicobar Biosphere Reserve and assist the BR managers to ensure proper functioning of reserve and also develop detailed strategy documents.
8	Provide training to BR managers on science-policy practice interaction and participatory management for science and other relevant areas The following aspects should be included in the training programme of BR managers ❖ Introduction (BR concept, its progression and current thinking; Indian scenario); Structure and functions of Biosphere Reserve (BR). ❖ Research needs in BRs (Research priorities, use of research outcomes). ❖ Eco-development activities in BRs (needs assessment, livelihood options, new scopes). ❖ Quantitative methods for Biosphere Managers to collect the data under field conditions using well structured experimental designs. ❖ Data generation, management and interpretation. ❖ Conservation of critical species and habitat, participatory management. ❖ Practical wildlife management and GIS for Biosphere Reserve Managers. ❖ Wildlife management and environmental impact assessment. ❖ Sustainable agriculture and land management for wildlife conservation. ❖ Conventions or agreements on biodiversity and legislation on biodiversity.
9	Promote capacity enhancement programmes for BR administrators and managers, such as on adaptive management, including conflict resolution and negotiation skills ❖ Identifying the root causes of the conflict. ❖ The analysis of stakeholder representations based on order of magnitude. ❖ Concentrating on the reality of the conflict. ❖ Review the issues of conflict and alternative control measures.
10	Use of research results to assist countries in developing and implementing policies for Sustainable development ❖ Frequent publications of the research results in the form of reports and also in peer reviewed journals. The findings need to be incorporated by researchers, wildlife managers and other forest administrators especially by the forest department for preparing the management action plan. Suitable conservation measures to emerge from these studies for conservation of ecosystem.

11	Carry out training courses for different ecosystem types related to climate change, in particular using the ERAIFT regional flagship project for tropical forests and certified forestry as a climate change mitigation Approach The following training courses need to be organized ❖ Biodiversity conservation and participatory management. ❖ Social mobilization, leadership and community development. ❖ Forest management and social mobilization. ❖ Tools and techniques for participatory rural appraisal. ❖ Communication techniques, tools and principals.

- Interaction with regional research organizations viz. Pondicherry University, University of Calcutta, Annamalai University, Central Salt and marine Chemical Research Institute, Central Agricultural Research Institute, National Institute of Ocean Technology, Wildlife Institute of India, and Salim Ali Centre for Ornithology and Natural History to undertake holistic research on GNBR. In this respect, 11 proposals have been submitted to the Ministry.
- Frequent interactions with BR managers to assess research needs and crucial issues requiring research efforts, to assist in preparation of management plans, and to document the faunal wealth of GNBR.
- Preparation of detailed research projects for consideration of the Ministry to implement the Madrid Action Plan.

C Raghunathan
Officer-in-Charge
Zoological Survey of India
Andaman and Nicobar Regional Centre
Port Blair-744 102, Andaman and Nicobar Islands
Phone: +91-3192-230115/237582/23148
Fax: +91-3192 - 230115
eMail: anrszsi@gmail.com

K Venkataraman
Director
Zoological Survey of India
M-Block, New Alipore
Kolkata - 700 053

10

Manas Biosphere Reserve - Brahmaputra Valley, India

10.1. Introduction

Manas Biosphere Reserve (MBR) is located along the Himalayan foot hills on the north of Brahmaputra Valley and belongs to Tropical Humid Forest Biome under Burma Monsoon Forest Biogeographical Province. Manas with its spectacular landscape is one among most stunning pristine wildlife habitats in the world. The area has a unique distinction of being Natural World Heritage site, Tiger Reserve, Elephant Reserve and an Important Bird Area.

The Core zone of reserve is the only representative of continuous Terai-Bhabar Grassland Ecosystem merging in to Burma Monsoon forests of the Bhutan outer Himalaya. The landscape is at a confluence of Indo-Gangetic and Indo-Malayan inflow. It is also on the Central Asian flyway.

10. 2. Area Description

Manas has unique distinction of being Natural World Heritage site, Tiger Reserve, Elephant Reserve and an Important Bird Area

The Reserve extends over an area 2837 km² between 89°51´ to 92°0´ E, 25°45´ to 26°50´ N. from the river Sankosh and Dhansiri in the east, with core area of 520 km², which includes World Heritage Site, Project Tiger, Elephant Reserve and Manas National Park (Figure 10.1). The buffer area which extends over 2300 km² consists of a number of Reserved Forests, and Barnadi Wildlife Sanctuary. The buffer area is managed under the forest divisions namely Kachugaon, Haltugaon, Aie-Valley, North Kamrup, East Darrang and Mangaldoi Wildlife division. The buffer zone is managed on a multiple use basis, allowing selective forestry, plantations, grazing and fire wood collection. Some 55,000 people live in 167 forest villages in this zone.

The reserve area is adequate to furnish the three functions of the Biosphere Reserve [i.e., conservation, development and research and monitoring].

Designation Date	:	14 March 1989
Total Area	:	2,837 km²
Core Area	:	520 km²
Buffer Area	:	2317 km²
Transition Area	:	949 km² (proposed within the existing buffer)
Extent	:	25°45´ to 26°50´ N 89°51' to 92°0' E

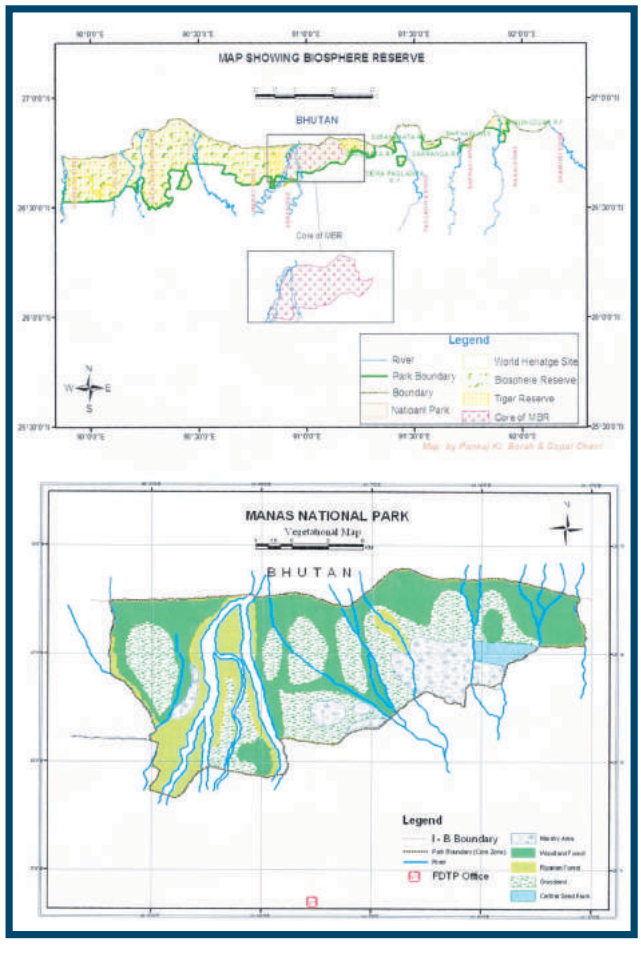


Figure 10.1: Location & Extent of Manas Biosphere Reserve

The conservation history of Manas starts at 1917 when a part of it was declared as Protected region and hunting, shooting and trapping of animals were prohibited except fishing for sport. The area was increased to 360 km^2 in 1928 and to further 391 km^2 in 1955. In 1977 it became the Core Zone of Manas Tiger Project; in 1979 area was identified as potential biosphere reserve by national MAB committee; in 1985 inscripted to World Heritage site (UNESCO); 1989 it was given status of Biosphere Reserve and finally National Park with an area of 519 km^2. In 2002 it was designated as the Core Zone of Buxa-Manas Elephant Reserve under Project Elephant.

10.2.1. Zonation Details

The core zone of the reserve includes the area of the Manas National Park established as per the provisions of Indian Wildlife Protection Act 1980 and its subsequent up-gradations. This zone is completely protected. The Project Tiger launched in 1972 includes the National Prak for conservation of *Panthera tigris tigris* and its ecosystem as a whole. The World Heritage Site Convention of UNESCO accorded criteria N (ii, iii, iv) for the attributes of the property and therefore their continuance is desired. Project Elephant in the proposed BR area has core zone in Manas National Prak with Elephant as a flagship species. With the minimum man-animal conflict, the area may be considered as sufficient to meet the objectives. However, a document by Wildlife Institute of India, Dehradun had suggested for increase in core area to attain long term conservation goal.

> The core zone harbours high diversity of tropical semi evergreen forests, tropical moist and dry deciduous forests and alluvial grasslands communities, rare, endangered, native and endemic species of both flora and fauna.

The core zone harbours high diversity of species, tropical semi evergreen forest, tropical moist and dry deciduous forests and alluvial grasslands communities, rare, endangered, native and endemic species of both flora and fauna. The complete protection of the core provides a safe natural site for survival of highly threatened biodiversity elements, such as Schedule -I Mammals [i.e., golden langur -*Trachiypithecus geei* (R), *capped* langur-*T. pileata*, clouded leopard - *Neofelis nebulosa* (V), tiger - *Panthera tigris* (E), leopard - *P. pardus*, golden cat - *Felis temmincki* (I), fishing cat- *F. viverrinus* , leopard cat - *F. bengalensis*, marbled cat *F. marmorata*, binturong - *Arctictis binturong*, sloth bear- *Melursus ursinus* (I), wild dog - *Cuon alpinus* (V), Ganges dolphin- *Platanista gangetica*, Indian elephant- Elephas maximus (E), Indian rhinoceros- *Rhinoceros unicornis* (E), pygmy hog -*Sus salvanius* (CE), swamp deer- *C. duvauceli* (E), sambar -*Cervus unicolor*, hog deer- *C. porcinus*, Indian muntjac- *Muntiacus muntjak*, water buffalo - *Bubalus arnee* (E), gaur- *Bos gaurus* (V), giant squirrel- *Ratufa indica*, hispid hare- *Caprolagus hispidus* (E) and Indian pangolin- *Manis crassicaudata*].

The buffer zone, surrounding the core zone, covers an area of 2373 km^2 represents the diversity of habitats, species, communities and ecosystems. The buffer zone is largely under Reserve Forests; some of these are under reservation for over a century. All the reserve forests are individually declared as per provisions of forest laws in vogue. They are documented and preserved. Now a day the working plans have kept them under Protection Working Circle for environmental amelioration.

Initially the reserve was not having a provision for transition zone, however, realizing the UNESCO needs an approximately 40% (i.e., about 949 km^2) area under designated buffer zone has been proposed to be considered as transition Zone of the reserve.

10.2.2. Biogeographic characteristics

The Biosphere Reserve, falls within Indo-Malayan Realm, is representative of the North East biogeographic zone (9A), Brahmaputra valley province, in the state of Assam, India.

10.3. Background Information

10. 3.1. Landscape features and land-use history

The entire area is also known as the Eastern Dooars. This was annexed in 1860 during the British period and put under reservation. The North Kamrup Reserve Forest became a game sanctuary (1918) and with addition over time has now become Manas National Prak. The buffer zones had considerable role in generating forest revenue from timber resources.

The reserve is noted for its spectacular scenery, with a variety of habitat types that support a diverse range of biodiversity. The vegetation of Manas has tremendous regenerating, self-supporting and self-sustaining capability due to high fertility index. Tall grasslands form Manas as very important habitat for biodiversity conservation and home of most threatened species like hispid hare, pygmy hog. These grasslands are maintained as edaphic climaxes by annual controlled burning. MBR acts as a corridor for larger mammals,







particularly elephants from West Bengal and Bhutan as well as residential elephants. The forest of Manas is the important catchment area of a number of rivers and rivulets like Sonkosh, Saralbhanga, Hel, Aie, Champamati, Manas, Beki, Phumara, Pagladia and Dhansiri and perennial source of water resulting in unhindered downstream irrigation which sustains economic prosperity of the region.

The Manas Biosphere Reserve gets its name after the serpent Goddess 'Manasa' (Durga). Previously also known as North Kamrup was declared a sanctuary on 1 October 1928. Encroachment pressures from local people led the government to set aside 809 ha area from the sanctuary for a seed farm in 1971. It was established as the core of the Manas Tiger Reserve with effect from April 1973.

The Manas River is the largest Himalayan tributary of the mighty Brahmaputra. Its contributive net, spread over Tibet, Bhutan and Arunachal Pradesh, collects into a single channel in sub-Himalaya and flows through Mathanguri site of the Park, where it splits into three rivers and joins the Brahmaputra some 64 km further south. These and other rivers running through the Tiger Reserve carry an enormous amount of silt and rocks debris from the foothills, resulting from the heavy rainfall, fragile nature of the rock and steep gradients of the catchments. This leads to the formation of alluvial terraces, comprising deep layers of deposited rock and detritus overlain by sandy loam and then a thin layer of humus. The 'terai' tract in the south consists of fine alluvial deposits with underlying pans. Here, the water table lies very near to the surface. The area of the Beki basin, in the west of the Park, is sometimes inundated during the monsoon but never for very long due to the sloping relief. There is a well marked 'Bhabhar' track of rocky soil towards the boundary of the National Park which contains sandstone, lime stone and shale, and have very little moisture retaining capacity. The Bhabhar tract generally remains drier. It is characterized by maximum relief, dissection and drainage density within it. The flood plain is frequently flooded by the streams and rivers that become turbulent in the rainy season. However, there are few fast drying areas of brown soil or sandy loam which stand above the flood level in this area, which support deciduous forests and extensive grass-lands. There are a number of standing water bodies locally known as 'beels'. The major source of water in beels and rivers in the area is rainfall during the period of fire months between mid May and mid October. Except for a few perennial rivers like Manas/Hakua/Bispani, most of other smaller and shallower water bodies dry up during winter and summer months in the Bhabhar area.

10.3.2. Reserve inhabitants, demographic trends and dependence

The local communities residing in and around the Buffer zone of Manas Biosphere Reserve generallay belong to Bodo, Adivasi, Bengali, Rahha-Hasang, Koch- Rajbongshi, Muslim and Nepalese. Due to their traditions and ethnospecific practices, they are heavily dependent on various kind of

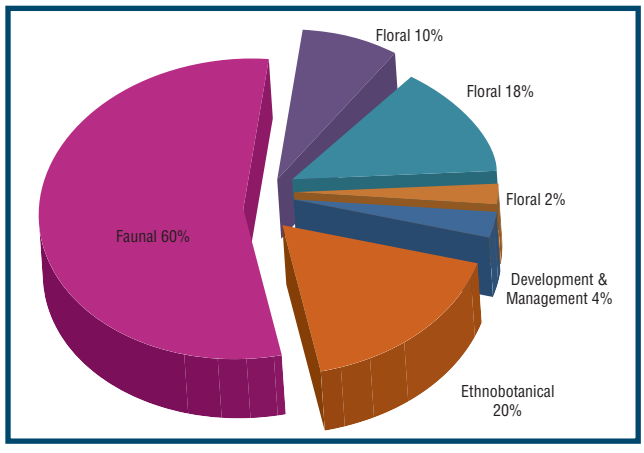


Figure 10.2: Faunal components have been most widely studied in MBR

forest from neighbouring forests. It includes fodder, cattle (grazing), timber, firewood, thatch, wild vegetables and fruits, fish and occasional wild animal hunting for meat.

Bodo tribe, who comprise 47% to 65% of the population in the individual villages forms major part of population. This is followed by other communities like Assamese, Bengali, Nepalese, Rabha-Hasang, Koch-Rajbongshi and a negligible number of Adivasis. Besides, minority community such as Muslims also inhabit the area.

large portion of population (66.1% to 88.1%) in the respective fringe villages is illiterate. The percentage of people who have undergone primary and secondary education in the individual hamlets mostly remains <20%. Very few are educated up to the higher secondary level. A major part of the income, ranging from 60% to 81% of the total household income, originates from the main occupation which varies considerably. The second important source of income is divided equally between crop production and forest resources. Income ranging between 9% and 25 % originates from crop production. Paddy is the major crop which contributes 75 to 96 % of the production. Other crops are jute, mustard and vegetables. Organized horticultural production and cultivation of marketable vegetables are mostly absent inspite of favourable climate. The people of this area draw 6 to 20 % of their income from forests.

The Bodo communities, dominant in fringe villages, are traditionally dependent on the forests of immediate vicinity. Due to their traditions and ethno specific practices they are heavily dependent on various kinds of forest produces. It includes cattle grazing, timber, firewood, thatch, wild vegetables and fruits, fish and occasional wild animals hunting for meat. Such biological pressure had been a part and parcel of Manas due to the existence of these villages since time immemorial.

10.3.3. State of knowledge

Among the Himalayan Biosphere reserves, MBR scores second highest number of studies after Nandadevi Biosphere Reserve (NDBR). Interestingly, contrary to the NDBR, the focus of studies in MBR has been more on fauna (60 studies out of total 114). Other aspects of studies have remained grossly neglected (Figure 10.2).

10.4. Global and National Significance

Golden langur (*Presbytes geei*) and Pigmy hog (*Sus salvinus*) are endemic to reserve. The hispid hare (*Caprolagus hispidus*) is yet another unique animal of the reserve.

- Manas Biosphere Reserve (MBR) is located along the Himalayan foot hills on the north of Brahmaputra Valley and belongs to Tropical Humid Forest Biome under Burma Monsoon Forest Biogeographical units. Manas with its spectacular landscape is one among most stunning pristine wildlife habitats in the world. The area has a unique distinction of being Natural World Heritage site, Tiger Reserve, Elephant Reserve and Important Bird Area.
- The Core zone of reserve is the only representative of continuous Terai-Bhabar Grassland Ecosystem merging in to Burma Monsoon forest of the Bhutan's outer Himalaya. The landscape is at a confluence of Indo-Gangetic and Indo-Malayan inflow. It is also on the Central Asian flyway. Diversity of the germplasm in family Rutaceae, Orchidaceae has high use value. Likewise, many common species have medicinal use, of which species like *Rauvolfia serpentina*, *Oroxylum indicum, Garcinia* spp., are notable.
- The reserve vegetation mainly comprises of Sub-Himalayan High Alluvial Tropical Semi-Evergreen Forests, Eastern Bhabhar Type Forests, East Himalaya Moist Mixed Deciduous Forests, Assam Valley Semi-Evergreen Forests, Eastern Wet Alluvial Grassland (Terai Formation).
- The unique topography, climate and soil supports diverse habitats, species, communities and ecosystems. As a result, the reserve supports a large number of native, endemic, rare-endangered and charismatic species. A total of 543 species of plants (374 dicots, 139 monocots, 30 pteridophytes and gymnosperms) and 589 faunal species including mammals-76 (29 Scheduled – I), birds-327 (37 –Scheduled –I), reptiles-

42, amphibians-7, fishes-54 and invertebrates-83 have been reported from the core zone (National Park Area) of the reserve (Figure 10.3).

- The endemic plant species of Manas comprises of *Cucurmorpha longifolia*, *Echinocarpus assamicus, Paspalum longifolium var. lorirhachis* and *Parakaempferia synantha*. Among animals, two species viz. Golden langur (*Presbytes geei*) and Pigmy hog (*Sus salvinus*) are endemic to MBR. The hispid hare (*Caprolagus hispidus*) is yet another unique animal of the reserve.
- The reserve landscape, which is contiguous to Bhutan Hills, with its rich species diversity, has potential to serve as a benchmark ecosystem where extensive research works can be carried out in areas like ecology, ethno-medicine, biochemistry, etc.

10.5. Biodiversity Values

As indicated earlier, reserve represents a unique Tropical Humid Forest Biome under Brahmaputra valley (9A) province of the biogeographic zonation of India, in the Indo – Malayan realm. The entire reserve is spread along the Himalayan foot hills to the north of Brahmaputra valley, in a linear belt of about 40 km wide at the broadest portion in the west and gradually narrowing in the east.

Manas Biosphere Reserve represents two major biomes - the grassland biome (Savannah and Terai) and the tropical forest biome (Bengal Rain Forests). The forest habitats of Manas Biosphere Reserve are classified into C/s-Sub- Himalayan high alluvial semi-evergreen forests; 3C/cb-Eastern Bhabar type forests; 3C/c3-East Himalayan Moist mixed deciduous forests; 2B/C.(a.b)- Assam Valley semi- evergreen forests; 4D/252-Eastern Wet alluvial grasslands. The unique climatic and soil conditions support diverse habitats, forest/ community types and a large number of ecologically and economically important species of plant and animals.

The Buffer and Core zone forest vegetation of the reserve mostly comprises of various tree associations of species like- *Aphanomixis polystachya, Anthocephalus chinensis, Terminalia chebula, Syzygium cumini, S. formosum, S. oblatum, Bauhinia purpurea, Mallotus philippinensis, Cinnamomum tamala, Bombax ceiba, Ficus religiosa, F. roxburghii, F. benghalensis,Gamelina arborea, Dillenia indica, D. pentagyna, Musa paradisiaca, Musa balbisiana, Holarrhena pubescence, Spondias pinnata.* The grasslands include species like- *Imperata cylindrica, Saccharum narenga, Phragmitis karka, Arundo donax, Vetiveria zizanioides*.

Kings, the Kalita dynasty, and the British and Mughal invaders, thus resulting in composite culture and history.

The scenic spot Mothanguri owes its name due to the typical proximity of an old Math (a kind of Hindu Temple). The river Manas actually has a Bhutanese name: Dang-Me-Chu. Though lost in antiquity the name Manah (not Manas as is usually known) is derived from Assamese word Man meaning the Burmese army popularly known as Man raided Assam for 3 times spreading terror. This river was the western limit

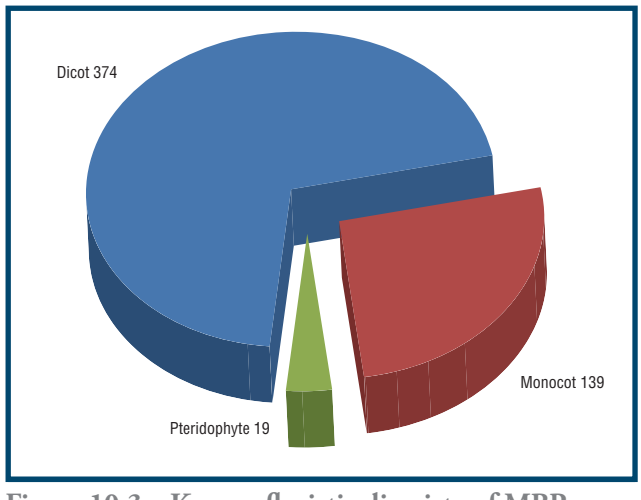


Figure 10.3a: Known floristic diveristy of MBR

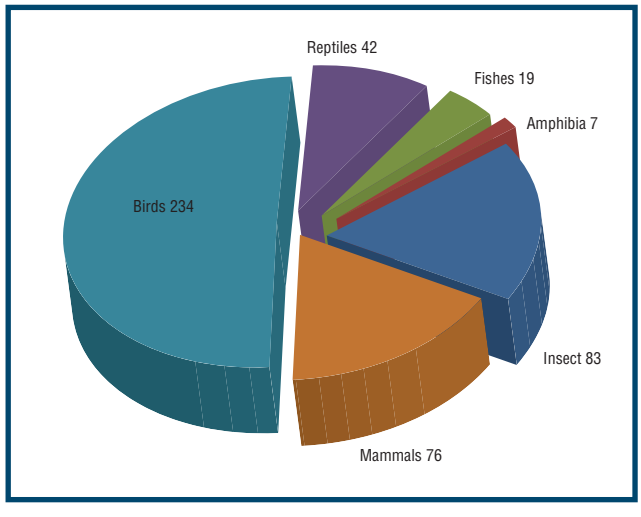


Figure 10.3b: Known faunal diveristy of MBR

The large proportion of wet alluvial grasslands in Manas, with patches of Dillenia swamp forests, semi-evergreen forests and riparian fringe forests, harbour some of the most endangered species of wildlife in India such as the Hispid hare, Pygmy hog, Bengal florican and Indian Rhinoceros.

10.5.1. Cultural Significance

This area has been under the rule of various dynasties, starting from Kings of Bhutan, Kings of Cooch Behar, Ahom

of Burmese advance (Man + Ah meaning to come).

Overall conservation significance of Manas BR is summarized (Box 10.1).

10.6. Progression of Conservation and Management

Among the oldest protected areas in the State, Manas BR has a long conservation history. It used to constitute, and still constitutes, a part of the largest conservation area in the region with contiguous forests in Bhutan (Royal Bhutan National Park) in the north and the Buxa Tiger Reserve of West Bengal in the west. The Sonkosh river in Kokrajhar district marks its official boundary in the west. Towards the east, the Manas Tiger Reserve extends up to the Dhansiri river in the district of Darrang.

The conservation process of Manas began during the days of British rule in India. They realized the importance of protecting these virgin forests and in 1905 Manas was accorded the position of a Proposed Reserve Forest (PRF). Soon it became a Reserve Forest RF (RT) in 1908 and was upgraded to a Wildlife Sanctuary in 1928, covering an area of 360 km^2 (Manas and North Kamrup RFs). Importance of the area is reflected in one of the note of a British officer (1915) when he categorically wrote that the proposed road to Bhutan through Bhuyanpara and North Kamrup should not be allowed as it would affect wildlife rich habitat. In 1928, Manas was upgraded as North Kamrup Game Sanctuary and in 1950 it became a wildlife sanctuary. It was further extended to over 391 km^2 in 1955. In spite of it being a mega biodiversity hotspot, Manas did, however, attained the status of a National Park only in 1990. Its area was enhanced to nearly 520 km^2 with the addition of Panbari, Kahitama and Kokilabari Reserve Forests.

However, UNESCO recognized the value of the reserve and listed Manas Wildlife Sanctuary as World Heritage Site as early in 1985. Further, Government of India in 1989 designated Manas as a Biosphere Reserve.

10.7. Issues and Concerns

The Manas World Heritage site was inscribed on the World Heritage list in 1985 under natural criterion (ii), (iii) and (iv). However, due to threats related to an insurgency in and around the Wildlife Sanctuary, which resulted in significant depletion of forest habitats and wildlife populations and destruction to the reserve infrastructure the area was inscribed in the list of World Heritage Site in Danger in 1992.

The southernmost part of Manas BR is thickly covered with human settlements dominated by Bodo tribes and other ethnic communities who heavily depend on reserve resources for sustenance and income generation as well. This has caused considerable degradation of natural forests and ecosystems.

Box 10.1: Conservation Significance of Manas BR

- Unique location of Manas at the confluence of Indian, Ethiopian and Indo-Chinese realms makes this one of the richest Biodiversity area and also outstanding for its spectacular scenery.
- So far 60 mammals, 42 reptiles (11 families), 7 amphibian (5 families) 54 fishes (19 families) have been identifies in Manas. Among them 21 species of mammals alone, recorded in Manas, are in the Schedule-I of the Wild life (P) Act, 1972.
- Several endemic species are unique to this BR and are not found outside this area anywhere else in the world. The Pygmy hog and Golden Langur are classic example. The sudden surfacing of the Assam Roof Turtle (*Kachua sylhetensis*) in the area in 1987 is yet another example of the still un-explored fauna. The avifauna is also equally rich. The Bengal Florican and three varieties of Hornbills may be considered as an example.
- The vegetation of Manas has tremendous regenerating, self-supporting and self-sustaining capability due to high fertility index.
- The tall grasslands of Manas are very important habitat for biodiversity conservation and home of most threatened species like Hispid hare, Pygmy hog. These grasslands are maintained as edaphic climaxes through annual controlled burning.
- The BR area is a part of significant conservation area in the region with continuous habitat with forests of Bhutan in the north and Buxa Tiger Reserve in the West Bengal. It acts as a corridor for larger mammals, particularly elephants from West Bengal and Bhutan as well as residential elephants.
- The Manas is the important catchment area of a number of rivers and rivulets like Sonkosh, Saralbhanga, Hel, Aie, Champamati, Manas, Beki, Phumara, Pagladia and Dhansiri and perennial source of water resulting in unhindered downstream irrigation which sustains economic prosperity of this area.

Box 10.2: Community participation helps in removing danger tag of Manas World Heritage Site

The political instability for greater autonomy of Bodo community caused a severe destruction of biodiversity and infrastructure in Manas Biosphere Reserve; part of which also represented as UNESCO World Heritage Site since 1985. Heavy damage to heritage property resulted in declaration of this site as World Heritage Site in danger since 1992. The opportunities generated through mistrust between inhabitants and forest department were exploited by the outsiders, including international forest mafias. As a result, during the period 1987-2003, the one horned Rhinoceros was totally eliminated from the reserve, and a significant decrease in population of Royal Bengal Tiger and Asian Elephant and other endangered flora and fauna was noticed. At this juncture, in 2003 Bodoland Territorial Council (BTC) was formed to provide greater autonomy to the tribal people, and peace gradually returned to the region.

Till 1999, there was a gross lack of long term systematic conservation works, including assessment of biodiversity loss during political turmoil. At this point of time, a team of researchers lead by Prof. C.K. Baruah of Botany department, Gauhati University, took the challenge of conducting biodiversity evaluation in Manas Biosphere Reserve with financial support from Ministry of Environment and Forests, GoI. The researchers even reached areas that were badly affected by insurgency problem. Besides assessment of biodiversity status, this team initiated conservation education programmes with support of local tribal people and other organizations. Encouraged with the progress, other researchers and conservation workers of few other institutions gradually began activities in the reserve around mid 2000. It was noticed, in spite of political instability and all blames put on indigenous community for forest destruction by the outside media, the tribal communities were always engaged with various conservation activities. The poor villagers encouraged researchers by way of providing food and shelter during difficult times.

As the peace started setting in by 2003, and with the support of authorities in forest department, local Bodo community developed a unique model of conservation in Manas landscape. In eastern part of Manas National Park, one newly formed conservation group from local community helped more than 200 poachers to surrender (during 2004-2007) and involved them in petrolling the park day and night to protect wildlife and their habitats. Significant success was achieved in gathering critical information on poachers, illegal wildlife trade and swift actions. They extended support to forest department to rebuild park infrastructure. Active community participation helped in minimizing the management cost. Gradually this initiative was replicated throughout the southern fringe of Manas Reserve. As the BTC strongly supported this unique model, and considering its overall value, around 2004 many other regional, national and international NGOs, government institutions came forward to support these activities. Presently there are 6 local groups covering the southern side of the core zone while other 5 groups work in eastern and western buffer of the reserve. Among others, Grasshopper also has been working with these local NGOs in promotion of alternative livelihood options, especially for forest dependents and ex-poachers families. It provided training and in kind support for piggeries, bee keeping, horticultural crops, vermicompost activities that benefited about 200 families. In addition, the organization helped local NGOs in promoting ecotourism.

This community lead effort helped in natural recovery of major animal populations and the forests of Manas. The department of forests, Assam, with support of regional, national and international organizations initiated a major programme for reintroduction of one horned rhino in Manas since 2005. Towards monitor the progress of overall restoration of biodiversity and heritage property, UNESCO mission visited Manas during 2005, 2008 and 2011. Finally, recognizing the overall progress, UNESCO removed the danger tag on Manas World Heritage Site in June 2011 at UNESCO's 35th World Heritage Committee (WHC) meeting in Paris. Credit largely goes to the local community.

Pranjal Bezbarua, Ph. D.
Grasshopper
Guwahati

As reflected from the available literature on MBR, the reserve is grossly under researched. This suggests a serious lapse in our scientific understanding regarding the reserve.

10.8. Success Stories

- Of being the World Heritage Site, the Manas Biosphere Reserve is important for tourists, naturalists, researchers, wildlifers and trekkers, etc. The Assam Forest Department is responsible for the administration and development of the Biosphere Reserve. The reserve has an essential wilderness zone and forms the Manas National park, the core zone of the tiger reserve. Normal forestry operations were carried out in the core area prior to its designation as a sanctuary, but these were confined mostly to the southern belt. Traditional hunting practices persisted but without any noticeable adverse effects on wildlife populations. Hunting ceased with the establishment of the area as a sanctuary and very little logging has been permitted since 1950. The last timber operation took place in 1964. Much stone was extracted from the area during the construction of the National Highway in 1963-1964. Plantations were established along the southern border to provide a buffer against agricultural encroachment but this work ceased in 1977. Grazing by livestock was phased out from 1963 to 1965. No exploitation is allowed in the park but tourists may visit the Mothanguri-Bansbari area. Such restrictions do not apply to the surrounding buffer zone of the tiger reserve, which is managed on a multiple-use basis. Here residents are allowed to selectively remove timber, collect firewood, cultivate land and graze their domestic livestock. They benefit from inoculation of their cattle, to prevent diseases being transmitted to the wildlife, but this is offset by damage to their crops by elephants, wild boar and deer). Under the management plan for the tiger reserve, controlled burning continues as the most important management practice, thus maintaining the composition of different habitats.
- International cooperative efforts have also been made by the governments of India and Bhutan to manage the Manas ecosystem as a whole. The regular work carried out under the Project Tiger scheme includes: providing accommodation to the staff; development of roads and a wireless network to improve the efficiency of administration and anti-poaching operations; activities in both the core and buffer zones. Boundaries have been clearly marked and the staff is more vigilant than previously, leading to several successful prosecutions being brought against poachers. Following recent successful breeding in captivity of gharial, there are plans to restock all the water channels in the area.
- A three-year rehabilitation programme prepared by the Ministry of the Environment and Forests, the State Forest Department of Assam and the Directorate of Manas aimed to restore protection infrastructure. As a result eco-development schemes for surrounding villages and habitat improvement programmes have been launched. The eco-development programmes in the area with a humble beginning has been made for welfare works in the fringe villages for seeking people co-operation in protection of flora and fauna of Manas Biosphere Reserve. The broad objective of this scheme are: (a) to mitigate the pressure of the people on the natural resource of the reserve by creating alternate source of livelihood outside the reserve and other income generating activities which are not deleterious to Protected area value; (b) to undertake welfare works in fringe villages for providing basic amenities to the people and collaboration of local people in conservation.

Lalit K Rai and **Kaushal K Singh**
Sikkim Unit, G.B. Pant Institute of Himalayan Environment & Development, Pangthang, Sikkim (INDIA)
Phone: + 91-3592 237328
Fax: + 91-3592 237415

Kishor Kumar
G.B. Pant Institute of Himalayan Environment & Development
Kosi-Katarmal, Almora 263 643, Uttarakhand (INDIA)
Phone : +91-5962-241041
Fax : +91-5962-241150

11

Dibru-Saikhowa Biosphere Reserve - Brahmaputra Valley, India

11.1. Introduction

Designation Date	:	28 July 1997
Total Area	:	765 km^2
Core Area	:	340 km^2
Buffer Area	:	425 km^2
Transition Area	:	Not Defined
Extent	:	20°30′ and 22°15′ N 88°05′ and 89°10′ E

Dibru-Saikhowa Biosphere Reserve (DSBR), which enjoys a tropical monsoon climate with a hot and wet summer, is situated in the south bank of the river Brahamaputra in the extreme east of Assam state. Reserve is known for its vibrant wilderness. The reserve's core area currently includes the Dibru Saikhowa National Park in its entirety, administratively DSBR is further divisible into two forest ranges, i.e., Guijan and Saikhowa. The reserve, with numerous island pockets and water bodies, provides unique habitats for varied wildlife and aquatic fauna, including water dependent avifauna. As a part of biodiversity 'hotspot' this reserve provides a suitable habitat for a large number of globally threatened faunal and floral elements, which include endangered white winged wood duck (*Cairina scutulata*) and wild feral horses. This reserve is unique because the ecological succession of this BR is driven through water by way of recurrent flooding and inundation. In addition, the diversity of colorful birds and orchids make the reserve a unique destination for researchers, naturalists and many more groups of stakeholders.

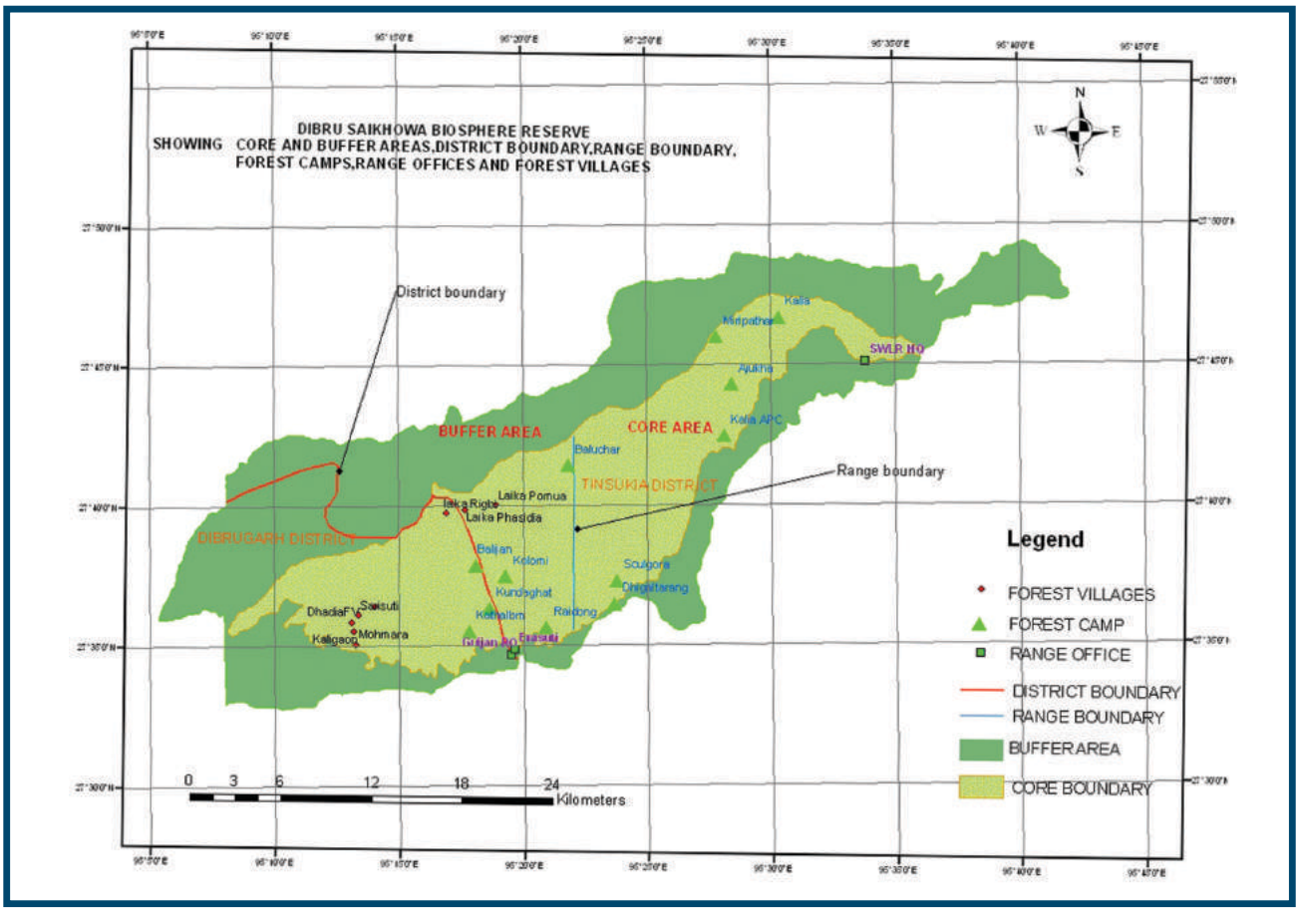


Figure 11.1: Zonation map of Dibru-Saikhowa BR

11. 2. Area Description

The reserve, which covers part of two districts-Tinsukia and Dibrugarh, in Assam, is situated on the floodplains of the Brahmaputra and the Lohit rivers. The entire reserve is on flat terrain. Reserve represents a large number of perennial and seasonal channels namely Kolomi, Salbeel nala, Dadhia nala, Chabru nadi, Laikajan, Ananta nala, Hatighuli nala, Dimoruhola and Nayanadi. On its northern side, flows the main course of river Brahamaputra (Figure 11.1). The area is, therefore, considered for conservation of representative ecosystems and long term *in situ* conservation of genetic diversity. There are around 38 villages in the buffer zone of the reserve. The forest types of the reserve comprise of semi-evergreen, deciduous, littoral and swamp forests and patches of wet evergreen forests.

11.2.1. Zonation

Biosphere Reserve with total area of 765 km^2 has a defined Core Zone of 340 km^2, which includes the entire area of the Wild Life Sanctuary, and a Buffer Zone area of 425 km^2 surrounding the core zone.

11.2. 2. Biogeographic characteristics

Biogeographically the area exhibits the properties of both the Indian and Malayan sub regions. Following the biogeographic classification of India, the reserve falls in Biogeograhic zone 9 – the NE region and represents biogeographic province 9A – the Brahmaputra valley. The Reserve lies in the Indo-Burma Global Biodiversity Hotspot and the Assam Plains Endemic Bird Area.

11.4. Conservation History

The conservation history of the area dates back to 1920, when an area of 250 km^2 was declared as Dibru Reserve Forest. In 1928, some more area in the same region was declared as Saikhowa Reserve Forest which had an area of 69.06 km^2. With further realization of biodiversity values of the areas, a preliminary notification for establishing a Dibru-Saikhowa Wildlife sanctuary was issued in 1986, which proposed inclusion of an area of 640 km^2 comprising of Dibru Reserve Forest, Saikhowa Reserve Forest areas, and some non-cadastral areas. However, in the final notification issued in 1995, the area was reduced to 340km^2 which forms the core of the current Dibru-Saikhowa Biosphere Reserve.

11.5. Biodiversity Values

11.5.1. The floristic attributes

As indicated, the forest types in Biosphere Reserve ranges from semi-evergreen, deciduous, littoral and swamp forests to patches of wet evergreen forests. The original natural vegetation of the area was tropical wet evergreen forests. The core area of the reserve has about 35.5% moist mixed forests, 9.5 % degraded forest, 21.3% grassland, 0.02% orchards, 1.8% agriculture land, 4.1% barren land, 10.3% water and 17.1% sand area.

> **Occurrence of several primitive species of vascular plants in the reserve signifies the area as remnant of the luxurious tropical wet evergreen forests of the past.**

Diverse vegetation types of the reserve support a variety of floristic elements that accounted for over 680 species (464 genera and 143 families) of flowering plants that represents an array of life forms like tree (126 spp.), shrubs and under shrubs (155), herbs including aquatics (295), climbers and twiners (81), epiphytes (19) and parasites (4). Of the total, dicotyledonous plants accounted for 511 species (350 genera and 169 families) while the rest 169 species under 114 genera and 27 families are monocotyledonous plants. The legume family Fabaceae is the largest family with 35 genera and 66 Species. Poaceae (39 genera & 50 species) and Asteraceae (27 genera & 32 species) are the other largest families in the reserve. The fig plants (i.e., *Ficus*) is the largest genus among the dicotyledons and *Cyperus* among the monocotyledons. The biosphere reserve is well represented by a diversity of orchids.

Of the total, 174 species are occasional and scattered throughout the area, 11 species are rare and 104 species are cultivated. Some of the biggest Salix-swamps, remaining in northeastern India are found in DSBR. Some characteristic tree species include *Salix tetrasperma, Dillenia indica* and *Terminalia myriocarpa*. The grassland and reedbeds are covered by tall elephant-grass such as *Arundo donax, Phragmites karka, Erianthus ravennae, Imperata cylindrica, Saccharum procerum, S.spontaneum*, etc.

Presence of *Gnetum montanum* (a gymnospermic plant) in the flora of the reserve signifies that the area harbours some important floristic element of evergreen forests. *Podocarpus nerifolius*, another very rare gymnosperm, is also recorded from the reserve. Although the fern communities in the biosphere reserve are poorly represented, however, profusely growing climbing fern *Stenochlaena palustris* attracts the attention of all. Other ferns like *Asplenium nidus, Microsorum punctatum, Huperzia squarrosa, Pyrrosia* spp., etc., are also common as epiphytes. The records on the other lower groups of flora are scanty. Among others, the wetlands of the reserve are the storehouse of diverse algal flora.

Occurrence of several primitive species of vascular plants viz. *Cyathea gigantea, Helminthostachys zeylanica, Cinnamomum bejolghota, Dipterocarpus retusus, Magnolia hodgsonii, Sarauia nepaulensis, Vatica lanceaefolia,* etc., in the Biosphere Reserve signifies the area as remnant of the luxurious tropical wet evergreen forests of the past. The conservation importance of the area is also enhanced by the presence of several rare and threatened species of plants viz. *Angiopteris evecta, Dipteris wallichii, Psilotum nudum, Aponogaton appendiculatus, Dendrobium nobile, Hydnocarpus kurzii, Magnolia griffithii, Rauvolfia serpentina, Dischidia benghalensis, Zingiber zerumbet*, etc. The flora of the reserve shares remarkable affinities with that of Indo-Malaya and other Southeast Asian floristic elements. The Malayan elements include *Aristolochia bracteolata, Catharanthus roseus, Cordia dichotoma*, etc., and Sino-Himalayan genera are: *Camellia, Eurya, Hoya, Maesa, Magnolia, Michelia, Sarauia*, etc.

Submerged plants (e.g., *Hydrilla*) are the oxygen-generators of the aquatic system. Over 65% of the macrophytes, recorded in Dibru-Saikhowa, have medicinal values and some plants are already in use in traditional therapies. Several species are used as food and fodder.

The piscicidals plants such as *Polygonum hydropiper* and *Spilanthes calva* formerly used by Mishing fishermen are hardly used now because of the easy availability of chemical fish poisons. Unfortunately, chemical piscisides have adverse impacts even on non-target aquatic organisms. The commercially important *Trapa*, which was very common in the wetlands of Dibru Saikhowa until recently, are now restricted to some wetlands only. Another important aquatic macrophyte, *Euryale ferox* (locally known as nikori or utkal), has been wiped out from the wetlands. Fortunately, the unique *Sagittaria* which has become scarce in other parts of the state can still be found in Dibru-Saikhowa.

The aquatic plants of Dibru-Saikhowa provide opportunity for alternative livelihoods of the people dependant on the forest. There is a scope for harnessing potential of biological oxygen demand increasing plants which are used in waste water treatment system for bio-filtration of organic wastes in other parts of India. Several species having high-value as ornamental aquarium plants yet need proper use for commercial benefits. Among such species notable are: *Euryale ferox, Trapa vallisneria, Nymphaea* spp., Nymphoides spp., Nelumbo spp. and Azolla sp. Among others, there are 75 species of wild food plants of traditional use (26 - herbs, 18 - shrubs and under shrubs, 22 - trees, 6 - climbers and 2 –ferns).

11.5.2. Faunal attributes

The Dibru - Saikhowa provides an ideal habitat for many animals and birds. A total 36 species of mammals (10 orders, 19 families and 27 genera) are recorded from the Biosphere Reserve, of which 12 are carnivores. Among the mammals recorded, 2 belong to the schedule I of Indian Wildlife Protection Act 1972. Royal Bengal tiger, leopard, clouded leopard, leopard cat, jungle cat, sloth bear, golden jackal, dhole, small Indian civet, small Asian mangoose, common mangoose, common otter, Malayan giant squirrel, Pallas's squirrel, Himalayan mole, ground shrew, Gangetic dolphin, slow loris, pig tailed macaque, Rhesus macaque, capped langur, Hoolock gibbon, Asian elephant, feral horses, wild boar, sambar, hog deer, barking deer and Asiatic water buffalo are the larger animal in the area. The Royal Bengal tiger population in the core zone of the reserve is estimated to be 31. The number of feral horses is about 79. The reserve is equally rich and diverse in herpeto fauna. Two species of monitor lizard, water monitor lizard and common monitor lizard, 8 species of turtles and 8 species of snakes have been recorded form the reserve. The turtles, which are listed from the biosphere reserve are Malayan box turtle, Asian leaf turtle, spotted pond turtle, brown roofed turgle, Assam roofed turtle, Indian tent turtle, Indian soft-shell turtle and narrow headed soft-shell turtle. Apart from these, 103 species of fishes are known. A total of 104 species of entomofauna have been identified, distributed within different orders, i.e., Lepidoptera (69 spp.), Coleoptera (12), Hemiptera (9), Hymenoptera (7), Orhoptera (6) and Diptera (1 spp.) About 350 species of birds have so far been recorded form the reserve. These include Great crested grebe, Spot billed pelican, White bellied pelican, Lesser adjutant stork, Greater adjutant stork, White winged duck, Bear's pochard, Greater spotted eagle, Bengal florican, etc.

11.5.3. Gene Pool Reserve

Dibru-Saikhowa Biosphere Reserve is a part of the global biodiversity hotspot that provides a unique habitat for some globally threatened species like the Clouded Leopard, Asiatic water buffalo, Hoolcock Gibbon, Slow Loris, Asian elephant, Gangetic river dolphin, White-winged Wood duck, etc. There is also a rich diversity of avifauna and entomo fauna. Reserve is also famous for the free ranging ferral horses, which are direct off shoot of the domestic horse. These wild horses are still found in several pockets of the forest areas. Of the eight critically endangered species of birds listed for the Indian subcontinent, White-backed Vulture (*Gyps bengalensis*), Slender-billed Vulture (*Gyps tenuirostris*) have been recorded from DSBR. Of the 10 endangered species, White-bellied Heron (*Ardea insignis*), Greater Adjutant Stork (*Leptoptilos dubius*), White-winged Wood Duck (*Cairina scutulata*), Bengal Florican (*Houbaropsis bengalensis*), Spotted or Nordmann's Greenshank (*Tringa guttifer*) occur in DSBR. The 57 vulnerable species, Spot-billed Pelican (*Pelecanus phillippenis*), Lesser Adjutant (*Leptotilos javanicus*), Baer's Pochard (*Aythya baeri*), Pallas's Fish Eagle (*Haliaeetus leucoryphus*), Greater Spotted Eagle (*Aquila clanga*), Swamp Partridge or Swamp Francolin (*Francolinus gularis*), Sarus Crane (*Grus antigone*), Masked Finfoot (*Heliopais perosnata*), Purple Wood or Pale-capped Pigeon (*Columba punicea*), Marsh Babbler (*Pellorneum palustre*), Jerdon's Babbler (*Chrysomma altirostre*), Black-breasted Partobill (*Paradoxornis flavirostris*), Finn's Baya (*Ploceus megarhynchus*) have been spotted in DSBR. Among near threatened, Oriental Darter (*Anhinga melanogaster*), Painted Stork (*Mycteria leucocephala*), Black-necked Stork (*Ephippiorhynchus asiaticus*), Ferruginous Duck (*Aythya nyroca*), White-tailed Sea Eagle (*Haliaeetus albicilla*), Grey-headed Fish Eagle (*Icthyophaga ichthyaetus*), Himalayan or Lesser Grey-headed Fish Eagle (*Icthyophaga nana*), King or Red-headed Vulture (*Sarcogyps calvus*), Cinereous Vulture (*Aegypius monachus*), Black-bellied Tern (*Sterna acuticauda*), Blyth's or Great Blue Kingfisher (*Alcedo hercules*), Great Pied or Giant Hornbill (*Buceros bicornis*), Long tailed Grass Warbler or Rufous-vented Prinia (*Prinia burnesii*) are present.

DSBR provides unique habitat for some of the globally threatened species like including Clouded Leopard, Asiatic water buffalo, Hoolcock Gibbon, Slow Loris, Asian elelphant, Gangetic river dolphin, White-winged Wood duck.

Among others, this reserve is also rich in many threatened and endangered medicinal plants which include *Rauvolfia serpentina, Hydnocarpus kurzii, Holarrhena antidysenterica, Costus speciosus, Dioscorea alata,D. bulbiflora,* etc.

11.5.4. Cultural attributes

(i) Socio-economic Attributes

The 38 villages situated in the buffer zone of the reserve support total population of about 13405 that includes Assamese, Bengali, Bihari and Tea Garden labours. The literacy rate in the villages is about 58.4%. The cattle population in the villages is 6122. Apart from these, several thousands of cattle are there in the "Khutis" which keep changing their locations within core of the reserve. In core,

there are two forest villages (Dodhia and Laika), inhabited by Mishings, a major tribe in Assam. The people of other communities are also heavily dependant on the Biosphere Reserve for their basic needs.

The Mishing tribes belong to the Tibeto-Burman family of Mongoloid group. They are distributed in the Brahmaputra valley in the upper Assam districts. Basically being agriculturist they rear cattle for their livelihood. Large part of their livelihood is, however, drawn from the wild plants. They built their houses on bamboo platform above the ground and prefer to establish clusters near riverbank. There are four smaller settlements namely Mohmora, Tengabari, Charisuti and Kuligaon under the forest village Dadhia while Pamua, Rigbi and Phasidia are the three villages under Laika forest village.

There are two forest villages (Dodhia and Laika)in core, inhabited by Mishings, a major tribe in Assam. They belong to the Tibeto-Burman family of Mongoloid group. Large part of their livelihoods is drawn from the wild plants.

(ii) Resource users vs. Resource managers

Prior to declaration of DSBR the area was notified as National Park (NP) without giving due consideration to the fact that the area already had settlements inside. Being a conservation reserve very little to no infrastructural support is, therefore, a hindrance in the development of the local community and also ensuring effective forest monitoring. With little support from the government due to obvious reasons the locals have diversified their livelihood opportunity by way of using the available natural resources. They raise large number of livestock and poultry, wet rice cultivation; home gardens besides they use the forest resources for their day to day sustenance. The increase in human and livestock population in the reserve also shows adverse effects on the forests and its resources and therefore, seems unsustainable in the long run. The locals argue that they paid the land revenue to the state government and that they have already settled in the reserve much earlier than declaration of NP in bygone days, they cited inclusion of their population in the voter list and census report too. Being an indigenous community (a scheduled tribe under protection from forest dweller, act.) They showed their willingness to relocate at compensation of Rs. 10, 000, 00 (Ten lakh) for each household. The Mishings also informed that they are willing to give up forest harvesting and other activities provided enough livelihood and infrastructural support in forthcoming. The forest department on the other hand is facing shortage of ground staff and adequate funds to monitor the forest and the reserve being surrounded on all sides by river is a major problem for monitoring. Therefore, increased human welfare to rope them into conservation framework looks promising on the long run. This calls for an urgent attention and involvement of national and international funding agencies to help address both issues of conservation and development in DSBR.

(iii) Tourism Potential

Being diverse and unique in many ways than one, the reserve is amongst most important tourist destinations in the State. Dibru-Saikhowa is generally kept open for tourist form month of November to April or as notified by the National Park Authorities. However, during summer seasons most of the fringe areas could be seen using boat due to inundation. No entry after sunset and before sunrise is permitted in the Park. Guijan Ghat and Saikhowa ghat are the two entry points for tourist. Night halt and picnicking inside the Park is strictly prohibited. Lodging facilities are available out side the Park at Guijan Forest Boundary for which advance booking is necessary. However, private Hotels are also available at Tinsukia Town at a very reasonable rate. The reserve, however, has greater tourist potential, that needs to be harnessed in the right perspective of conservation and sustainable development.

11.6. Gaps in Research & Development

The increasing loss of biodiversity even in the reserves is a great threat. The idenitfied gap areas include:

- Study on, Arthropoda, Mollusca, Annelida, and microbial diversity, with many other unexplored groups.
- Assessment of current status of biodiversity using approaches of quantification and mapping of vegetation classes in the area and establishing linkages for wildlife/ habitat relationship databases.
- Undertaking studies on socio-economic dimensions, especially targetting income generation, human dependence, medicinal plant cultivation, value addition, etc.
- Conducting base line research on the geology and geomorphology.
- Investigating population dynamics of both plant and animal species and their interrelationships.
- Conducting applied research for increasing production of food crops, animal husbandry and other domestic sectors to reduce the pressure on forests.

- Promoting ethnobotanical studies so as to integrate knowledge of the tribal and traditional groups and their cultural practices in resource management.
- Inventorization of reserve's natural resources using RS and GIS tools.
- Development of long term management plans for sustainable use and maintenance of resources in the reserve.

11.7. Issues and Concerns

- In spite of the proven values, Dibru-Saikhowa is threatened by both natural and anthropogenic factors. Being located in the floodplain of the Brahamaputra River, the area is subject to three to four waves of flood every year. These recurring floods often change the river course itself, causing both soil erosion and siltation, and playing a significant role by way of modifying the habitat. Deposits of silt carried down by the rivers from the upstream mountainous area have shrunk the existing wetlands considerably besides changing the course of rivers, streams and nallahs with concomitant changes in the landscape. Heavy siltation adversely impacts the natural regeneration of local plant species and also affects wildlife habitats. The extent of damage of change brought in over time are not known. As a result, long term strategies for addressing such issues are not in place.
- The existence of two forest villages with a substantial human and cattle population within the core and their resource dependency is a major concern. The inhabitants of the fringe villages of the reserve also pose a serious threat to conservation of biodiversity. Anthropogenic activities like agriculture and grazing, have caused migration of large mammals to safer areas. The Khutis (cattle camps), with thousands of livestock, established in the non-forest areas adjacent to the core. is yet antoher source of disturbance. The heavy grazing pressure has defintely affected the natural intigrity and severly hampered natural regeneration through large-scale mortality of seedlings.
- Among others, illegal felling of trees is also a major problem in the reserve. The residents of forest villages traditionally construct their houses on stilts with timber. They also collect timber for making agricultural implements and construction of country boats. The energy needs are also met by way of firewood from the reserve area which causes tremendous damage to the forest habitat.
- Being located in remote area, and having no proper logistic facility, keeps research community away from the reserve as a result science based information regarding resource management is grossly inadequate.

11. 8. Major elements of perspective plan

- Systematic relocation of villages from the core area, proper wetland management, addressing issues of grazing by cattle, appropriate capacity building for Human resource development, promoting eco-development activities, and promotion of ecotourism, should form priority areas & plan.
- In addition, comprehensive biodiversity assessment, population biology studies of sensitive taxa, Impact assessment studies, grassland habitat studies, effective use of space technology in assessment would form the priority areas of research in the reserve.

The reserve's management plan needs to be aligned properly with the work areas of Madrid Action Plan keeping in view the feasibility aspects.

Shivaji Chaudhry
G.B. Pant Institute of Himalayan Environment & Development
Itanagar, Arunachal Pradesh (INDIA)
Phone: + 91-360 - 2211773
Fax: + 91-360 - 2211773
eMail: shivaji.chaudhry@gmail.com

Kishor Kumar
G.B. Pant Institute of Himalayan Environment & Development
Kosi-Katarmal, Almora 263 643, Uttarakhand (INDIA)

Vaibhav Chandra Mathur
Divisional Forest Officer, Tinsukia Wildlife Forest Division
Tinsukia, Assam (INDIA)

12

Dehang Dibang Biosphere Reserve - East Himalaya, India

12.1. Introduction

The Dehang Dibang Biosphere Reserve (DDBR), declared by Government of India in 1998, probably forms one of the largest transboundry landscapes sharing most of its boundary with China (Tibet) and Myanmar. The BR covers three districts of the state of Arunachal Pradesh, i.e., Upper Siang, West Siang and Dibang Valley. Administratively the reserve is divided in to five forest divisions, i.e., Along, Yingkiong, Anini, Mouling and Dibang. The reserve is managed by the Department of Environment and Forest, Government of Arunachal Pradesh.

Designation Date	: 02 Sept. 1998
Total Area	: 5,111.5 km^2
Core Area	: 4,094.8 km^2
Buffer Area	: 1,016.7 km^2
Transitation Area	: Not defined
Extent	: 28°27′ and 29°03′ N 94°29′ and 95°49′ E

12.2. Area Description

12.2.1. Zonation Details

Of the total BR coverage (5111.5 km^2), a considerably large proportion (68.1%) forms the Core Zone, it represents a legally protected area. Over 1016 Km^2 area of the reserve has been designated as the buffer zone wherein about 50 villages are located (Figure 12.1).

The Core Zone, the Mauling National Park, is completely protected and it has also been proposed for Project Snow Leopard for conservation of the apex predator, the Snow Leopard (*Uncia uncia*) and its ecosystem as a whole. The core zone is a large tract of land sufficiently available to address the objectives in terms of strict conservation.

12.2.2. Biogeographic characteristics

The DDBR falls under Indo-Malayan Realm (after Takhtajan, 1960). Biogeographically (following Rodger & Panwar 1988) it represents part of Zone - Himalaya and Province 2D (i.e,

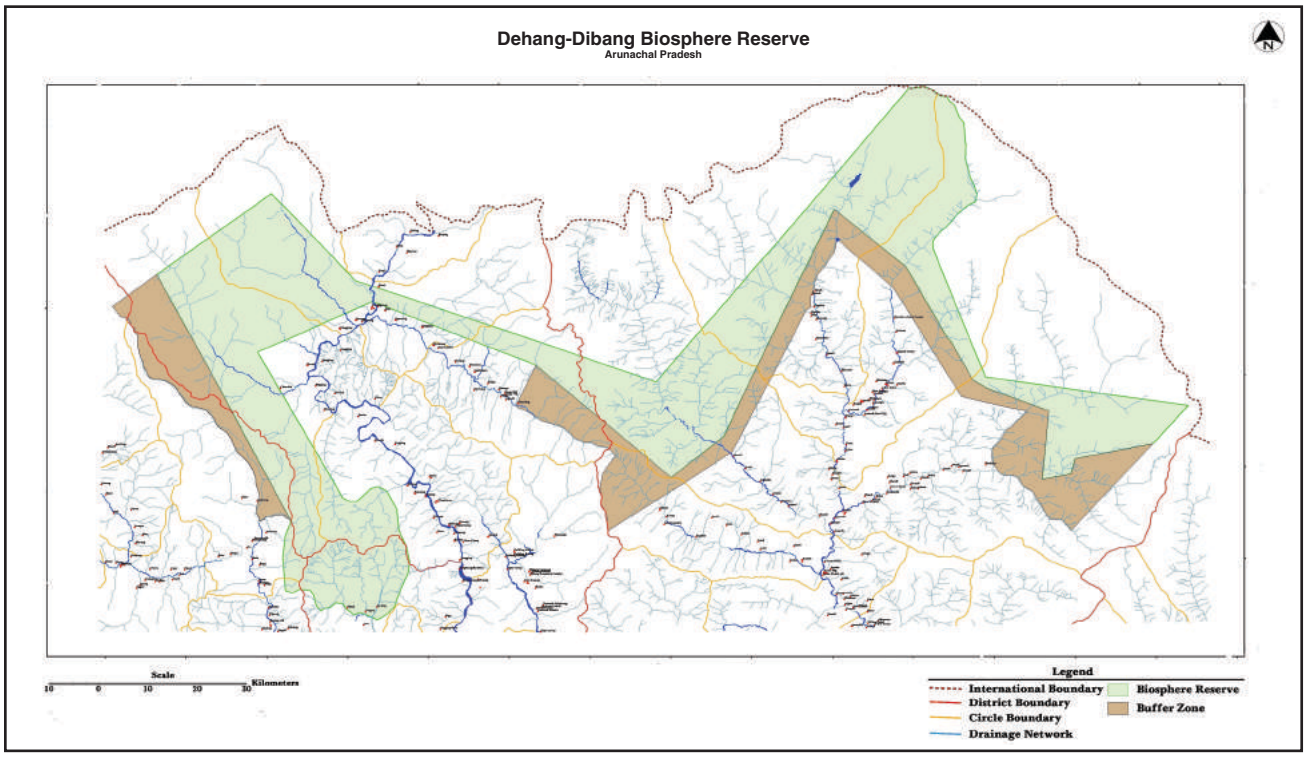


Fig 12.1: Dehang Dibang BR - different zones, fringe villages and forest divisions

East Himalaya) in India. It is located in the state of Arunachal Pradesh, India, bordering China in the north and Myanmar in the south East. This region is also a trijunction of Oriental, Indomalayan and Paleartic components and represents the East Himalayan biodiversity hotspot.

12.3. Background Information

The reserve comprises of unique geomorphic features of mountain and steep terrains with a very sparse human population. DDBR is endowed with one of the highest ecosystems in the world and covers varying eco-clines from sub-tropical to tundra, with vast land of natural forest in different biomes between 500m to 6000m above mean sea level. This BR covers terrestrial vegetation ranging from Tropical to Alpine due to large elevational gradient. Owing to its remoteness and scarce population density; the floral and faunal elements have remained grossly undisturbed in the reserve.

Broadly, the vegetation comprises of sub-tropical broad leave, temperate conifer, sub-alpine woody scrub, alpine meadow, bamboo brakes and grass land. This BR is an important conservation area with ecological, faunal, floral, geomorphological, natural and zoological significance. It harbours over 1500 floral, 888 faunal species and is unique from the point of view of being home to a number of endangered, threatened and restricted range species. Interestingly, 80% of the hornbill population of Arunachal Pradesh are found in the BR.

12.3.1. Geology and soils

The whole of BR is situated over the Himalayan trans-axial belt. The inner belt consists of Pre-Cambrian Daling and Maryiang group of meta-sediments and inner development of Buxa group of rocks. The Axial belt is exposed to show the crystalline rocks of the central region and intrusive granites. The predominant groups of rock are gneiss and the Daling series of rocks along with some intermediaries, which build up the body of the Himalaya. The soil is predominantly acidic and rich in humus, with dark brown to reddish brown in colour on slopping hills and fine loamy soil with dark grayish brown to dark brown in colour on steep low hill slopes. Water-holding capacity of the soil is medium. The erosion and deposition by glaciers and rivers have resulted in a sandy to sandy loam, clayey soil often mixed with heterogeneous matrix in some places.

12.3.2. Topography

The land area in the reserve is generally mountainous made up of steep terrain and snow cover alpine zone in the northern and eastern parts and sub-tropical forest towards the south. In between these sub-alpine scrublands, woodlands are found. The DDBR harbours a number of rivers, which are deeply venerated by the locals. The mighty Siang River attracts numerous tourists and religious activities. The most common constituents found within the region are valleys with numerous ravines, deep gorges and gullies, saddles, crests, knolls and river-terraces. These are mostly found in the lower part of the mountains, i.e., at the temperate and sub-tropical belt. At the high reaches the hill slopes are moulded into gentler alpine meadows. Several lakes of different sizes include also found at this belt. Further up, the important topographic features are rocky outcrops at the base of Himalaya, with glacial moraines, scarps, talons, etc., while the glaciers, mountains and peaks take up permanent position at the higher reaches of the BR.

12.3.3. Climate

Located in the North Temperate Zone, DDBR represents enormous climatic variations, which is because of altitudinal variations. The climate is quite hot and humid in the south matching almost tropical condition while in the north and on higher reaches it is more of temperate to alpine type. It resembles arctic conditions in the higher mountains which are perpetually snow-claded. In winter, the BR enjoys snowfall down at an elevation up to 2100 meters with damp and foggy weather in the lower regions occasionally with light showers of rain. Above the temperate zone, the climate becomes cooler and comparatively low air moisture is found. In the higher zones of the BR, the precipitation is

mostly in the form of snow, frost and hailstorms. Here the air mostly becomes drier and ambient temperature never rises above 15°C. Annual rainfall ranges from 2000 mm to 5000 mm. The rainfall is not uniform in distribution and varies from drizzling to torrential rains. Humidity is excessive and ranges from 77% in December to 92% in July, the annual mean being 82%. The lofty mountains and peaks have influenced the climate of the reserve that they come in the path of monsoon clouds resulting in prolonged rainy season rendering conditions conducive for profuse vegetation growth. The greater part of the rainfall is received between April to September with peak around July/August.

12.3.3. Biomes

As per Champion and Seth, there are 7 biomes discernible in DDBR [i.e., (i) East Himalayan bamboo brakes forest 16C1, (ii) East Himalayan sub-tropical broad leave forest 8B/C1, (iii) East Himalayan sub-tropical pine forest 12C3, (iv) East Himalayan temperate broad leave forest 13C6, (v) East Himalayan temperate conifers forest 14C2, (vi) East Himalayan sub alpine woody shrub forest 15C2, (vii) East Himalayan alpine meadow forest 15C3].

Bamboo brakes (500-600m): occur along the foothills and river banks. The upper elevations consist of deciduous trees while evergreen trees, shrubs, climbers, and lianas constitute the rest. Also Grass land forests (200-300m) occur at the foothills area where the most conspicuous grazing is seen. Grasses and herbs are the permanent species of this area.

Sub-tropical broad leave forest (1000-2100m): This range of the BR receives average annual rainfall of 1000–2500 mm with moderately hot summer with maximum temperature 24°C and cold winter. The dominant tree species in this zone are *Schima khasiana, Castanopsis* spp., etc. Some medicinal plants found in this zone are *Dioscorea* spp., *Sapindus mukrosii, Datura stramonium,* etc. The faunal elements in the region are *Prionailurus bengalensis, Martes flavigula,Viverra zibetha, Prionodon pardicolor, Ailurus fulgens, Nemorhaedus goral,Capricornis sumatraensis*, etc.

Sub-tropical pine forest (1200-1800m): dominated by the plant species of *Pinus roxburghi, Pinus wallichiana* and *Tsuga dumosa* in association with other tree species like *Alnus nepalensis, Betula alnoids*, etc. The herbaceous species found in this zone are *Ajuga, Elsholtzia, Pogostemon* and *Potentilla*. The mammalian fauna in this zone include *Martes flavigula, Prionodon pardicolor, Ailurus fulgens, Presbytes pileatus*, etc.

Temperate broad leave forests (1800-2800m): Tree species like *Acer pectinatum, A. oblongum, Alnus nepalensis, Exbucklandia populnea, Rhododendron* spp., *Castanopsis indica, Populus gamblei*, etc., occupy the upper zone whereas *Prunus, Rubus, Spiraea, Symplocos, Rhododendron*, etc., dominate in the middle zone. The dominant mammalian fauna in this biome are *Panthera pardus, Prionailurus bengalensis, Pardofelis mormarata, Canis lupus, Vulpes vulpes, Martes flavigula, Nemorhaedus goral, Macaca assmensis, Ratufa bicolor, Dremomys lokriah*.

Temperate conifer forest (2800-3500m): These forests experience regular snowfall during winter months. The top canopy is dominated by mixed conifers types that include *Abies densa, Tsuga dumosa, Taxus wallichiana*, etc. Sometimes broad leave species of *Rhododendron, Photinia, Betula, Ilex*, etc., are also found associated with the conifers. Pure stand off *Cupressus torulosa* are also present. Shrubs like *Agapetes, Hypericum, Mahonia, Rosa, Sambucus*, etc., dominate the lower zones, while the faunal elements comprise of *Panthera pardus, Neofelis nebulosa, Prionailurus bengalensis, Lutra lutra, Hemitragus jemlahicus, Mustela sibirica, Moshus chrysogaster* and many others.

Sub-alpine woody shrub forest (3500-5500m): occupying higher elevation areas of BR these forests are characterized by tree species like *Abies spectabilis, Cupressus torulosa, Juniperus recurva, Larix grifi lihiana*, and *Rhododendron* spp. The common shrubs are *Berberis asiatica, Berberis wallichiana, Eurya acuminata, Gaultheria fragrantissima and Vaccinium venosum, etc. Dominant mammalian fauna include Moshus chrysogaster, Budorcus taxicolor, Lutra lutra, Selenarctos thibetanus, Ochotona roylei, Hystrix hodgsoni*, etc.

Alpine meadow (3000-4000m): at this elevation the woody vegetation is scarce and comprises of shrubby rhododendrons. The zone has herbaceous elements with spectacular coloured and attractive flowers like *Aconitum ferox, Aconitum nagarum, Meconopsis napaulensis, Arenaria* spp., etc. The dominant faunal elements are *Uncia uncia,*

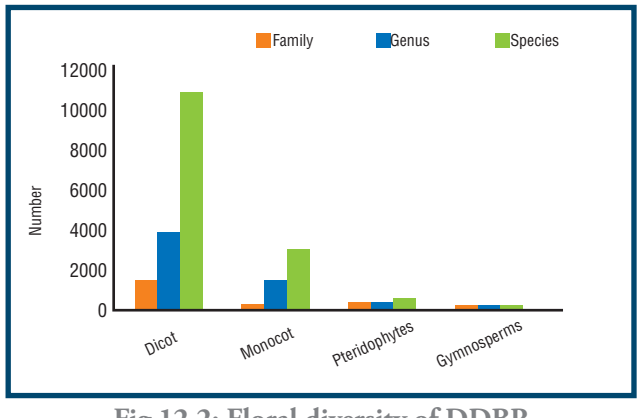


Fig 12.2: Floral diversity of DDBR

Neofelis nebulosa, Panthera pardus, Selenarctos thibetanus and *Lutra lutra*.

12.4. Biodiversity Values

12.4.1. Important floral elements

The reserve harbors wide diversity of floral elements as a result of variation in elevational range and micro climates. Dicotyledenous are the dominant floral group having 1002 species (100 families and 371 genera) followed by monocots having 195 species (15 families and 111 genera). Till now, 56 species of Pteridophytes (23 families and 34 genera) and 6 species of Gymnosperms have been reported from the reserve (Figure 12.2). DDBR harbours 29 endemic plant species belonging to 12 families and 23 genera; 15 wild relatives of cultivated plants, which include *Amaranthus hybridus L., Achyranthus aspera* Linn., *Chenopodium album* Bosc. ex Moq., *Trichosanthes cordata* Roxb., *Dioscorea bulbifera* L, *Musa velutina* Wendl. & Drude, *Musa acuminata* Colla, *Musa sapientum* L., *Rubus insignis* Hook.f., *Citrus aurantium* L, *Citrus medica* L., *Zanthoxyllum rhetsa* DC., *Solanum kurzii* Brace ex Prain., *Vitis himalayana* (Royle) Brandis and *Zingiber zerambet* (L.) Smith.

Primitive angiospermic plants of Mouling National Park, that forms part of DDBR, include *Altingia excelsa, Betula utilis, Rhododendron camelliaeforum, R. baileyi, R. ciliatum, R. grande, R. lanatum, R. lindleyi, Magnolia grifithii* and *Michelia kisopa*.

Among others, 16 species of ornamental plants like *R. camelliaeforum, R. baileyi, R. ciliatum, R.grande, R. lanatum, R. lindlleyi, Aresaema album.*, *Aresaema griffithii.*, *Impatiens laevigata*, *Begonia josephii*, *B. griffithiana*, *B. annulata*, *B. palmata*, *Kalanchoe pinnata*, *Tacca integrifolia*, *Hedychium* gracile are found in the DDBR.

Major economically important plants species of DDBR include: *Acorus calamus* L., *Amaranthus hybridus* L, *Eryngium foetidum* L., *Centella asiatica* (L.) Urban, *Colocasia esculenta* Schot., *Artemisia minima.*, *Canarium strictum* Roxb., *Carica papaya* L., *Terminallia chebula* Retz., *Terminalia bellerica* Roxb., *Costus speciosus* (Koen.) Sm., *Dioscorea alata* L., *Elaeocarpus aristatus* Roxb., *Vitex negundo* L., *Cinnamomum zeylenicum* Bl., *Litsea cubeba* (Lour.) Pers., *Cinnamomum tamala* (Buch.-Ham) Nees & Ebarm., *Allium sativum, Murraya paniculata* (L.) Jack, *Musa velutina* Wendl. & Drude, *Psidium guajava* L., *Piper betel* L., *Plantago erosa* Wall., *Dendrocalamus strictus* Nees, *Eleusine coracana* Gaertn., *Fagopyrum esculentum* Moench, *Aconitum heterophyllum* Wall., *Coptis teeta* Wall., *Rubia manjith* Roxb.ex Flem., *Citrus limon* L., *Zanthoxyllum armatum* DC., *Clerodendrum colebrookianum* Walp., *Zingiber zerambet* (L.) Smith.

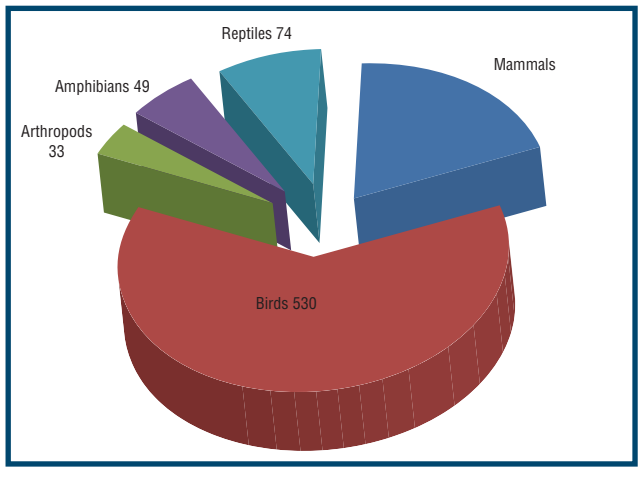


Figure 12.3: Faunal diversity of DDBR

12.4.2. Faunal elements

DDBR is a very important from the point of view of its faunal assemblages. Based on the available reports, it has 530 species of birds, 164 species of mammals, 74 species of reptiles, 49 species of amphibians and 33 species of arthropods (Figure 12.3). Besides, there are 133 species of butterflies belonging to 8 families and 81 genera found in the BR. Out of the 133 species of the butterflies, 18 species are rare [i.e., *Papilio paris paris* (Paris peocock), *Chilasa clytia clytia* (Common Mime), *Paranticopsis xenocles xenocles* (Great Zebra), Delias pasithoe (Redbase Jezebel), *Delias acalis* (Red Breast Jezebel), *Appias lyncida* (Chocolate Albatross), *Danaus chrysippus* (Plain Tiger), *Parantica sita* (Chestnut Tiger), *Orsotrioena medus medus* (Nigger), *Zipaetis scyllax* (Dark Catseye), *Cirrochroa aoris* (Large Yeoman), *Vanessa indica indica* (Indian Red Admiral), *Doleschallia bisaltide* (Autumn leaf), *Kallima inachus* (Orange Oakleaf), *Dichorrhagia nesimachus nesimachus* (Constable), *Athyma zeroca* (Small staff sergeant), *Sumalia daraxa daraxa* (Green commodore), *Euripus nyctelius* (Courtesans), *Libythea myrrha* (Club beak), *Curetis dentate* fortunatus (Angle Sunbeam), *Jamides alecto eurysaces* (Metallic cerulean), and *Caleta elna* (Elbowed pierrot)].

A total of 13 pheasant species are found in DDBR out of which four species are threatened as per the IUCN threat categories [i.e., Blyths Tragopan (*Tragopan blythii*), Sclater's Monal (*Lophophorus sclateri*), Tibetan Eared Pheasant (*Crossoptilon harmani*) & Chestnut-breasted Partridge (*Arborophila torqueola*)].

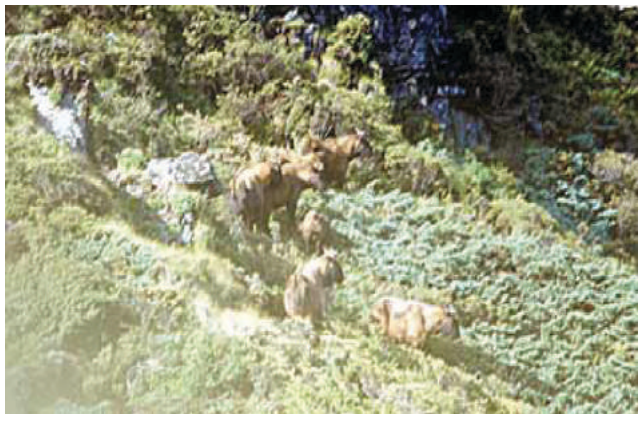
DDBR is transversed by numerous streams and drainages, which all join the Siang River. The fishes of Siang and its

tributaries have been surveyed by various workers. Following the reports of these workers, there are 72 species of fishes (50 genera, 7 orders and 18 families). As per the CAMP 1998 report, the following fish species are endangered: *Exostoma labiatum* (McClleland, 1842), *Pereuchiloglanis kamengensis* (Jayaram, 1966), *Ompok pabda* (Hamilton, 1822), *Tor tor* (Hamilton, 1822), *Tor putitora* (Hamilton, 1822), *Cyprinion semiplotum* (McClleland, 1839); the vulnerable species are *Schizothoax richardsonii* (Gray, 1932), *Aspidoparia jaya* (Hamilton, 1822), *Barilius vagra* (Hamilton, 1822), *Puntius chola* (Hamilton, 1822), *Bangana dero* (Hamilton, 1822), *Cirrihinus reba* (Hamilton, 1822), *Garra gotyla* (Gray, 1830), *Aborichthys kempi* (Chaudhuri, 1913), *Mystus bleekeri* (Day, 1877), *Mystus vittatus* (Bloch, 1794), *Bagarius bagarius* (Hamilton, 1822), *Euchiloglanis hodgarti* (Hora, 1923), *Pseudecheneis sulcata* (McClleland, 1842), *Heteropnuestes fossilis* (Bloch, 1794), *Channa orientalis* (Bloch and Schneider 1901), *Glossogobius giuris* (Hamilton, 1822), and *Anabas testudineus* (Bloch, 1792).

Of the known 87 species of reptiles in DDBR, 66 species are protected under different schedules of Indian Wildlife Protection Act (IWPA), i.e., Schedule I (3 species); Schedule II (one species) and Schedule IV (62 species). Global Assessment for IUCN threat status of reported 87 species shows 3 species, i.e., *Cuora mouhotii*, *Batagur dhongoka* and *Pangshura sylhetensis* as Endangered (EN); 3 species, i.e., *Cuora amboinensis*, *Melanochelys tricarinata* and *Nilssonia hurum* as Vulnerable (VU) and 3 species, i.e., *Pangshura smithii*, *Cyclemys dentate* and *Python molurus*

Table 12.1 Comparative assessment of restricted range bird species in Himalayan BRs.

Restricted range species	BRs where present	IUCN status*
Catreus wallichii	NDBR	Vulnerable
Paradoxornis flavirostris	MBR, DSBR,DDBR	Vulnerable
Pellorneum palustre	DSBR, DDBR	Vulnerable
Tragopan melanocephalus	KBR	Vulnerable
Harpactes wardi	DDBR	Near Threatened
Spelaeornis caudatus	DDBR	Near Threatened
Spelaeornis badeigularis	DDBR	Vulnerable
Brachypteryx hyperythra	DDBR	Near Threatened
Tragopan blythii	DDBR	Vulnerable
Lophophorus scalteri	DDBR	Vulnerable
Stachyris oglei	DDBR	Vulnerable
Actinodura waldeni	DDBR	Least Concern
Yuhina bakeri	DDBR	Least Concern
Phylloscopus cantator	DDBR	Least Concern
Heterophasia pulchella	DDBR	Least Concern
Alcippe ludlowi	DDBR	Least Concern
Arborophila mandellii	DDBR	Vulnerable
Sphenocichla humei	DDBR	Near Threatened
[NDBR - Nandadevi BR; MBR - Manas BR; DSBR - Dibru Saikhowa BR; KBR - Kangchendzonga BR]		



as Near Threatened (NT).

Out of the 530 species of birds reported in DDBR, 1 species, i.e., *Gyps indicus* is Critically Endangered (CR); 11 species, i.e., *Aquila clanga*, *Aquila heliacal, Haliaeetus leucoryphus, Falco naumanni, Lophophorus sclateri, Arborophila mandellii, Tragopon blythii, Aceros nipalensis, Sitta Formosa, Stachyris oglei, and Spelaeornis badeigulari* are Vulnerable (VU); 15 species, i.e., *Anhinga melanogaster, Circus macrourus, Icthyophaga ichthyaetus, Icthyophaga humilis, Arborophila rufogularis, Arborophila atrogularis, Tragopan satyra, Crossoptilon harmni, Crossoptilon crossoptilon, Harpactes wardi, Alcedo hercules, Buceros bicornis, Brachypteryx hyperythra, Spelaeornis caudatus, Sphenocichla humei* are Near Threatened (NT). Some of the species are restricted range species like Common Hill-Partridge (*Arborophila torqueola*), Rufous-throated Hill-Partridge (*A. rufogularis*), Long-tailed Thrush (*Zoothera dixoni*) Grey-cheeked Flycatcher-Warbler (*Seicercus poliogenys*), White-spectacled Flycatcher-Warbler (*Seicercus affinis*), Rufous-faced Flycatcher-Warbler (*Abroscopus albogularis*), Blackfaced Flycatcher-Warbler (*A. Schisticeps*), Maroon-backed Accentor (*Prunella immaculate*), Black-backed Forktail (*Enicurus immaculatus*), Lesser Necklaced Laughingthrush (*Garrulax monileger*), Greater Necklaced Laughingthrush (*G. pectoralis*), Rufous-necked Laughingthrush (*G. ruficollis*) and Sultan Tit (*Melanochlora sultanea*).

As compared to other Biosphere Reserves in the region, DDBR is unique in terms of representation of number of rstricted range bird species (Table12.1)

Of the reported 164 mammals in the reserve, 2 species are Critically Endangered, 8 Endangered, 23 vulnerable, and 43 in Schedule-II of Wildlife (Protection) Act, 1972. Also, 19 species are listed in Appendix-I and 14 species in Appendix-II as per CITES criteria. The most threatened and endangered species under Global assessment for IUCN threat status revealed 8 species, i.e., *Manis pentadactyla, Axis porcinus, Moschus chrysogaster, Elephus maximus, Cuon alpius, Panthera tigris, Uncia uncia, Prionailurus viverrinus* as Endangered (EN); 12 species, i.e., *Trachypithecus pileatus, Cervus unicolor, Budorcas taxicolor, Bos frontalis, Lutrogale perspicillata, Anonyx cinerea, Arctictis binturong, Neofelis nebulosa, Felis marmorata, Ursus thibetanus, Helarctos malayanus* and *Melaursus ursinus* as Vulnerable (VU) and 9 species, i.e., *Manis crassicaudata, Naemorhaedus sumatraensis, goral, Arctonyx collaris, Lutra lutra, Viverricula zibetha, Panthera pardus, Catopuma temmincki* and *Ratufa bicolor* as Near Threatened (NT).

12.4.3 Diversity of people and culture

The BR is home to about 10,000 native people belonging to diverse tribal communities like the Adis (with its sub-tribes namely Ramo, Bokar, Bori, Shimmong, Karko, Minyong, Ashing, Tangam), Memba, Khamba and Idu. This diverse tribal assemblage provides a cultural diversity that is equally as rich as its biological diversity. There are 21 villages within the reserve with a population of about 1715, and 29 villages on the fringe of the reserve with a population of approximately 8285, who are the effective users of the biosphere reserve's resources. Most of the interior villages lack basic social infrastructure and are connected only by foot trail. About 80% of the households lead a subsistence living and are dependent on the Biosphere Reserve for their livelihood. They mostly depend on traditional farming, horticulture, and tourism, which is a low-key enterprise with ephemeral income. The populace of the 21 inner villages is dependent on shifting cultivation for their livelihood. Rice bear or Apong is the popular drink amongst the different communities.

(i) Customary laws and natural resource utilization

The Memba and Khamba tribes are Buddhists. These two communities and the other one the Mishmi permit each and every adult male individual in the society to acquire land for cultivation, forest land for hunting and streams for fishing, which are called "Apu-Aba" or "Kepu-Neeli". Further, with the permission of the landowners, the other persons of the village can hunt and fish on temporary basis. Among the Adis, the Kebang (the socio-political traditional institution) controls the land, forest and other natural resources. Socio-politically, it resolves inter- and intra-village disputes, and checks and controls overexploitation of natural resources. Land is the most precious commodity of the Adi tribe; social status of a person belonging to this tribe is generally ascertained by size of land holding. The Adi tribe generally divides their land

into 11 different type of landuses; the largest land holding is under wet rice cultivation locally known as Asi Arik. The other major land uses of the community are forests, home gardens, jhum cultivation and orchards. Land ownership pattern of this tribe can be categorized into (i) individual, (ii) clan and (iii) community holding.

(ii) Economy of the people

Agriculture and livestock: The agricultural practices of the two communities viz Adi and Mishmi living in the vicinity of the biosphere reserve could broadly be divided into two distinct practices, i.e., the wet rice cultivation and shifting cultivation. The staple cereal food of the people is rice and millet. A meal usually consists of boiled cereal and some boiled green leaves seasoned with chillies and salt. Adi tribe is the most dominant tribal group in the region and they are known to be cultivating 10 different species on regular basis with distinct agricultural calendar (Table12.2). Leaves of various wild trees and vegetables are eaten in large quantities. The Adi tribe, it is reported, cultivate about 46 different species of crops, which could be divided into fruits and vegetable

(47.8%), spices and condiments (19.6%), pulses (13.4%), rhizomes (10.9%) and pseudo cereal (8.7%). The livestock is one of the status symbols for the communities inhabiting in DDBR and they are known to rear diverse livestock such as Mithun (*Bos frontalis*), pigs, cattle, goat and chicken for their meat requirement. Meat of Mithun and Pig is served in every occasion or ceremony.

Forest dependency: Generally the villages in and around DDBR are widely scattered over a large area. The houses in the villages are commonly made up of timber, leaves, thatching grass, bamboo, etc., that are obtained from forests. Further, the food of the communities is rich with animal meat, where almost every kind of animal from the forests is eaten except Hollock gibbon and tiger. Meat is preserved for a long period either by roasting it or by smoking it over fire. Hunting and fishing is the way of life of the people in and around DDBR. Every tribe and every village has forests and streams over which it claims hunting and fishing rights. Inter and intra-village disputes are often observed, which result out of infringement.

A recent study on ethnobotany of Memba tribe and others in the region revealed that out of documented 88 species of plants, 24 species were used as vegetable, 18 for medicinal properties and 13 as fruits. The most dominant community is the Adi tribe, who are known to be efficient users of the natural resource. The Adi people have rich ethno- medico-botanical knowledge. They use as many as 53 plant species belonging to 49 genera in 31 families. Leaf is used as a predominant material (45%), followed by entire plant (11%), rhizome and fruit (10% each) and stem (8%). Adi tribes are known to use 43 different types of fruits; the fruiting plants are distributed into 31 different genera belonging to

Table 12.2: Agriculture calendar of Adi Tribes in DDBR

Months												
Crops	1	2	3	4	5	6	7	8	9	10	11	12
Rice												
Maize												
Millet												
Soybean												
Cucurbits												
Chilli												
Beans												
Brassica												
Ginger												
Arums												

22 families. Further, it is also reported that the Adis use 40 different plants as vegetables belonging to 35 different genera representing 28 plant families. A total of 18 genera and 58 species of bamboos are found here. Similarly the cane species comprise of 4 genera and 17 species; the dominant species are *Bambusa tulda, B. balcooa, Dendrocalamus hamiltonii, D. gigenteus, Psedostachyum polymorhum* and *Cephalostachyum pergracile*. The principal source of harvest of bamboo is forest (60-80%) followed by plantation (20-30%), while in case of cane it comes 100% from wild source. The tribal communities also consume a number of wild vegetable and depend on non-timber forest produces for their livelihood.

Hunting: Hunting is a general practice for the people in and around DDBR to rear a semi domestic bovid species locally called Mithun (*Bos frontalis*); normally it is sacrificed in almost all the ceremonies and rituals like marriage, festivals, etc. Further, in addition to land, number of mithuns owned is a status symbol and indicator of prosperity and richness. In the reserve, as reported, 33 mammals, 18 birds and 2 reptiles are hunted, which is not exclusive. This is mainly carried by snare traps, which are set besides vegetation with bait; most of these traps are indigenously prepared. Almost every villager owns a gun, which is commonly used for hunting. The preferred season of hunting is winter when the animals come down to lower altitudes. The main hunting season is from November to February. Meat is an essential part of diet of all the tribal communities and it is also learnt that animals are also required to perform the rituals by these communities. Skull trophies of animals like Skulls of barking deer (*Muntiacus muntjak*), wild boar (*Sus scrofa*), goral (*Naemorhedus goral*), serow (*Capricornis sumatraensis*) takin (*Budorcas taxicolor*) were the most common displays in the houses of the communities. The bile of Himalayan black bear (*Ursus thibetanus*) is valued for its medicinal and curative property. Traditionally, hunting was carried out for consumption with indigenous traps, and was neither a serious concern of conservation nor of BR managers. However, of late, hunting is becoming a commercial trade, thereby posing a serious threat to the faunal elements of DDBR. One tola (10 grams) of musk pod is sold for Rs. 5000 ($113) and one tola (10 grams) of Black bear gall bladder is sold for Rs. 1500 ($34). Hunting, has not only posed a threat to fauna but also a management challenge to the Managers of the BR. A number of mitigative and protective measures such as prohibition of hunting by laws and acts, patrolling of the BR by the Forest guards, etc., are in force by Department of Environment and Forests, Govt. of Arunachal Pradesh. Other efforts include is community based resource management, where communities are provided incentives

to conserve the bioresources being part of conservation initiatives.

12.5. Issues, Concerns and the Way Forward

The development and conservation of the natural resources of DDBR, particularly its fauna, needs to take an integrated approach that is ingeniously developed and ingrained with innovations focusing on community based natural resource management. The communities living in and around the BR are to be focal stakeholders in management and are to be involved in the planning from formulation to implementation stages. In order to translate the ideas of conservation in to action, the communities, apart from being part of the planning process, need to be provided with sustained incentives that will not only promote their participation in conservation, but transform them as a major partner in conservation. The major concerns of conservation are hunting, shifting agriculture, lack of social well being and livelihood options.

Infrastructure development and eco-tourism: A good infrastructure like road network would promote community based tourism as an alternative to livelihood. Community based tourism (CBT) can be promoted through household based restaurant that would help maximize family income. Community based cultural tourism has enormous potential to be a sustained source of income. To accommodate the expectations of vacationing tourists, the hotels and restaurant facilities of the area need to be improved. This will include a need for training for capacity building of hotel and restaurant owners in food preparation, sanitation, and the maintenance of clean toilet facilities. The local youths need to be trained to work as tourist-guides. Helipads and gliding may be encouraged in the foothills so as to facilitate tourists' interest and avocation with less time and effort. The home restaurants, when operational, must have to maintain a desired standard to sustain tourists aspiration.

Table 12.3: R & D needs and priorities in DDBR

SN.	Research & Development Needs	Priority
1	Floral diversity study	***
2	Ecological study	**
3	Population study of threatened plants	*
4	Human dependence study	
	· Medicinal	**
	· Wild Edible	*
	· Fodder	**
	· Fuel	*
5	Valuation and value addition	**
6	Faunal diversity	
	· Mammals	***
	· Birds	***
	· Reptiles	**
	· Fishes	**
	· Amphibia	*
	· Annelida	**
	· Arthropoda	*
7	Population study of threatened fauna	*
8	Habitat ecology of fauna	**
9	Microbial diversity	**
10	Remote Sensing/GIS	**
11	Hydrology	**
12	Geology	*
13	Meteorology	*
14	Eco-tourism and other livelihood options	**
15	Integrated farming including shifting agriculture	**

*** Very high; ** Medium; * Low

The reserve provides a host of opportunities to become a tourist's paradise, particularly in winters. There have been attempts by the government to promote this as one of the ecotourist destinations. Efforts have been made to initiate rafting on the Siang River; Angling on the Siang and its tributaries is also on the rise, as are winter trips to the Snow Belt at Mayudia in the Mehao wildlife sanctuary.

Poaching: Poaching within the reserve continues to remain as a major problem. The endangered musk deer is especially sought after for the high value of its musk gland in traditional medicinal practices. Hunting and poaching is often found linked to indebtedness as it is adopted as a mechanism to repay debts; where poaching is the only way for poor villagers to earn enough money to pay off the debt. The only way to combat this problem is through community based conservation with adequate options for alternative livelihood and to improve economy. CBT can come handy here.

Fostering conservation: DDBR is known for its rich floral and faunal components and it is clearly reflected from its comparison with other BRs in India. However, there are many threats to this biosphere reserve, which could be mitigated though appropriate measures like imparting conservation education to diverse stakeholders, particularly to its residents in addition to involving them in the planning process of conservation. The areas of detailed investigation for ensuring conservation, according to their priority, are presented (Table 12.3).

> The development and conservation of the natural resource of DDBR, particularly its fauna, needs to take an integrated approach that is ingeniously developed and ingrined with innovations focusing on community based Natual Resource Management.

Cultural documentation: The traditional ecological knowledge of the communities plays an important role in sustainable use of nature and natural resources. The qualitative relationship of the Adi and other tribal communities living in and around DDBR, its immediate environs and natural resources has evolved through strenuous experiences of difficult survival. This experiences, being governed by ecology and culture, helped evolve tools, technologies and practices for sustenance of the production systems of these communities in balance with their social heritage, economic conditions

and ecological specificities. These eco-culturally evolved ecosystem specific tools, technologies and practices in the form of indigenous knowledge constitute integral parts of appropriate innovative strategies that effectively conserve resources and allow options for their optimal use also. Among the communities of DDBR, the indigenous knowledge governs important productive resource sectors such as agriculture, forestry and animal husbandry. It revolves around their traditional values of resource use that include subsistence values (food, clothing, housing, medicine, energy), socio-cultural values (ritual, spiritual, aesthetic, educational, psychological), economic-commercial values (agricultural, tourism), and traditional practices of resource use (agri-diversity, wild edibles, medicinal plants and ethnomedicine, forest and grasslands, ethnoveterinary, etc.). The indigenous knowledge of the tribal communities serves as a cultural and natural capital, and therefore, the role of indigenous knowledge is vital in the sustainable living of the tribal communities in and around DDBR and conservation of the BR itself. These systems have evolved with respect to making the most of the available resources and hence needs to be documented. Traditional garments, dances and festivals are most appealing to the outside tourists and hence need to be preserved. The cultural landscape should be the basis for biodiversity conservation of the BR and sustainable development of the communities in and around the BR.

Information dissemination: DDBR is a rich source of biotic wealth, which is commonly used by the local people. A locally useful plant and animal guide book needs to be prepared in local dialect giving conservation implications for the information of the local people. A museum containing most of the local art and crafts found in the region should be developed for benefit of the tourists, which would promote tourism. Video documentary of culture, i.e., religion, faith, beliefs and rituals should be done for the twin purpose of attracting to the tourists and for posterity. More importantly, there is a necessity of developing a website on DDBR to help tourists to learn about the BR and places to be visited. Efforts may also be done to patent the IKS of the communities as well.

12.6. Perspective Plan and Conclusion

Efforts have been made to document and describe community conserved practices of bioresources and defined approaches and activities required to be undertaken to promote participation of local communities in biodiversity conservation measures and resource management in DDBR. Community participation in biodiversity conservation could be promoted through increased incentives for local communities and also by promoting use of alternate sources of energy to reduce pressure on BR's forests and other natural resource dependency. Shifting agriculture continues to be subsistence livelihood of the tribal communities in and around the BR. Till date there is no viable technology to address the needs of this traditional system, thereby, increasingly making this agro-ecosystem marginalized which compell for appropriate technological infusion to support productivity and management. Technologies for this agro-ecosystem, therefore, need to be adapted to local conditions and based on the principles of Low External Input for Sustainable Agriculture. Ecotourism and entrepreneurial skills among the local communities could be built by providing training and skill development courses. In brief, while thinking of developing a perspective plan for the reserve, the approach in biodiversity conservation of the BR may include landscape level system analysis, figuring out the linkages between natural and human-managed ecosystems, and the manner in which they are linked to the village ecosystem functions. The conservation efforts should also include developing effective and acceptable protocols to benefit the locals economically. To conclude, an integrated approach with focus on strengthening of community conserved practices for biodiversity conservation and assisting the communities in improving their economy through alternative/innovative livelihoods would promote biodiversity conservation of the BR and sustainable development of people.

Prasanna K Samal and **Shivaji Chaudhry**
G.B. Pant Institute of Himalayan Environment and Development
North East Unit, Itanagar
Arunachal Pradesh- 791 113 (INDIA)
Phone: + 91-360 - 2211773
Fax: + 91-360 - 2211773

Pekyom Ringu Director, DDBR and
BS Sajwan, PCCF & Principal Secretary
Department of Environment & Forests
Government of
Arunachal Pradesh,
Itanagar, Arunachal Pradesh- 791 111 (INDIA)
*Correspondence: prasannasamal@rediffmail.com

Photo Credits (Besides Authors): Department of Environmental and Forests
Government of Arunachal Pradesh

13
Khangchendzonga Biosphere Reserve – Central Himalaya, India

13.1. Introduction

The Khangchendzonga Biosphere Reserve (KBR) in Sikkim is an important conservation area with high ecological, floral, faunal, geomorphological, and other natural significance in the Indian Himalayan Region. The reserve was notified initially by the Government of India in the year 2000 and subsequently renotified in 2010. The core Zone of KBR, as the Khangchendzonga (High Altitude) National Park, a major transboundary area, represents unique habitat zone and high endemic biota.

Designation Date	:	07 February 2000
Re-notified Date	:	24 May 2010
Total Area	:	2931.12 km^2
Core Area	:	1,784.00 km^2
Buffer Area	:	835.92 km^2
Transition Area	:	311.20 km^2
Extent	:	27°15'-27°57' N 88° 02'-88°40' E

13.2. Area Description

The Khangchendzonga Biosphere Reserve, situated in the eastern part of Hindukush Himalaya, is located along 27°15'-27°57' N latitude and 88° 02'-88°40' E longitude. The biosphere reserve falls in the north and west district of Sikkim state in north-eastern region of India, bordering Nepal in the West and China (Tibet) in the North-West (Figure 13.1).

13.2.1. Zonation Details

The Khangchendzonga Biosphere Reserve (KBR), which extends its western limit to the India-China boundary in the Lhonak valley in north Sikkim and along the India-Nepal boundary in west Sikkim, represents one of the richest diversities of flora and fauna. Following the boundary of the notified Khangchendzonga National Park, the northern limit extends up to the confluence of Goma Chu and Naku Chu and includes the Lungnak La and the area west of Thangu. In the eastern part of Sikkim, KBR is bounded by the areas west of Teesta River from Thangu to Toong and in south it includes the reserved forests above Toong, Tholung valley, Hee, Taryang, Karchi, Yuksom, Lapdang, Khechopalri, Chhang upto Singalila Range covering the catchments' areas of Kalej, Kayam, Monmu, Ringyong, Prek, Relli, Rimbi and rivers and streams, etc. The KBR has three major notified zones, viz. one core and four buffer zones and recently defined transition zone.

Core Zone: Notified, as Khangchendzonga (High Altitude) National Park, in accordance with the State Government's Notification No. 1/KNP (WL)/F/27 dated 19 May, 1997,

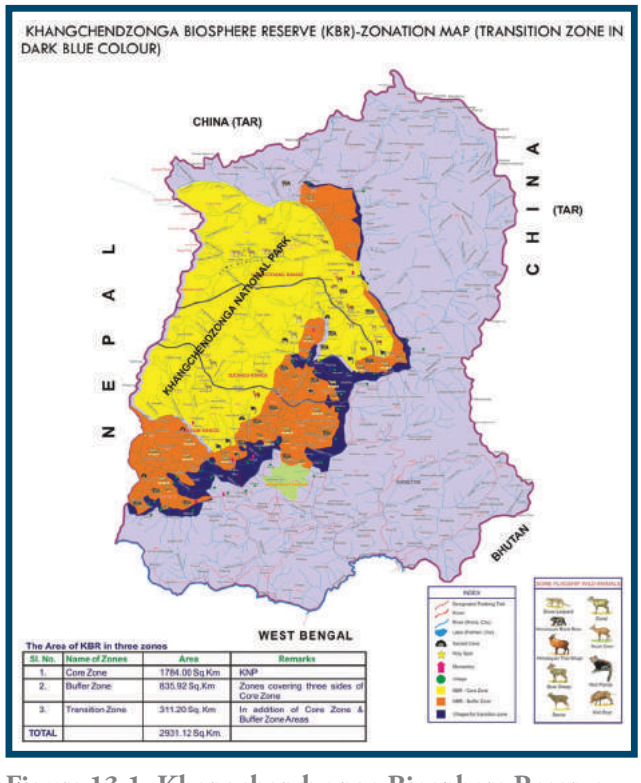


Figure 13.1: Khangchendzonga Biosphere Reserve - zonation map

core zone covers an area of 1784.00 km^2. The India-China boundary in the Lhonak valley in north Sikkim and India-Nepal boundary in west Sikkim mark the western limit of core zone. Further, the boundary limits in the north, east and south are in accordance with the above state Government's notification.

Buffer Zone: The buffer zone, in 4 parts, covers 835.92 km² area. Buffer Zone I, covering 154.48 km² areas, is a part of Lhonak valley (Trans-Himalayan Zone - cold desert area) falls in the catchments of Lhonak Chu, a tributary of Tista River. In the north, Lungnak La Ridge limits this zone; the Teesta River in the east, Zema in the south, Naku Chu and Lhonak Chu in the west further mark its boundaries. Buffer Zone- II, covering 55.29 km² areas, spreads in its boundaries in the west of Chungthang Valley and Teesta River from Lachen Ridge to Pakel outside the Core Zone. Buffer Zone-III covers 29.37 km² area extends over the portions of Tholung Valley in Dzongu Watershed and catchments of Tholung Chu. Buffer Zone-IV, with an area cover of 596.78 km², extends in its western limits along India-Nepal boundary. The Core Zone of KBR marks its northern boundary, whereas, the RF boundaries of Hee and Taryang represents the eastern limits. The boundaries of reserve forests of Chhange, Khecholpari, Yuksam, Lapdang, Karchi, and the northern boundary of Maenam Wildlife Sanctuary mark its southern limits.

Transition zone: With 311.20 km² spatial extent, it includes 44 fringe villages in the periphery of buffer zones, located in north, west and south districts of Sikkim. The transition zone has three parts, having 35,757 human population representing 8,353 households, which offers great opportunities for the communities to participate in conservation management and eco-developmental activities of KBR.

The following Box 13.1 provides the details of all three zones of KBR:

Box 13.1. Details of three zones of KBR

(a)	Area of Core Zone: (Khangchendzonga National Park)	1784.00 km²
(b)	Area of Buffer Zone: (i) Buffer Zone- I: (ii) Buffer Zone- II: (iii) Buffer Zone- III: (iv) Buffer Zone- IV:	 154.48 km² 55.29 km² 29.37 km² 596.78 km²
	Total Buffer Zone:	835.92km²
	Total area of Core & Buffer zones:	2,619.92 km²
(c)	Area of Transition zone: (i) Transition zone Part I: (ii) Transition zone Part II: (iii)Transition zone Part III:	 28.58 km² 111.15 km² 171.47 km²
	Total area of Transition zones:	311.20 km²
	Total area of KBR [(a) Core, (b) Buffer and (c) Transition zone]:	2,931.12 km²

13.2.3. Biogeographic characteristics

Khangchendzonga Biosphere Reserve (KBR) lies partly within bio-geographic province IC, the Sikkim Trans-Himalaya and largely within bio- geographic province 2 C, the Central Himalaya.

The wide range of altitude in KBR (1220-8586 m) supports diversity of forest types and habitats resulting in high species diversity and endemism.

Khangchendzonga Biosphere Reserve is considered amongst few of the highest mountain eco-systems in the world. KBR contains floral and faunal elements akin to Palaearctic and Oriental regions. It lies partly within the bio-geographic province IC, the Sikkim Trans-Himalaya (cold desert steppe with Tibetan wild animals such as the Great Tibetan Sheep, Tibetan Gazelle, Tibetan Antelope, Tibetan Wild Ass or Kiang) and largely within the bio-geographic province 2 C, the Central Himalaya. It possesses unique geomorphic features of high mountains and peaks, glaciers and lakes. Representing with the third highest peak of the world, Mount Khangchendzonga (8586m) which literally means the abode of Gods consisting of five treasure houses indicating five peaks and the guardian deity of Sikkim, KBR landscape exhibits stunning wilderness. The core zone is the origin of some very important rivers- Tista, Rangit, Rathong Chu, College Khola, etc; these high land watersheds bear wide-ranging effects on areas located downstream. Survival of thousands of people living at lower elevations depends upon the conservation of such freshwater reservoirs. The improved ecological health of associated forest systems indicates the availability of ample stream water, resulting greater production of Large Cardamom, Rice, Potato, Peas, Zinger and other horticulture crops. Further, KBR is a natural in-situ gene bank for a number of economically important biota. Situating over Himalayan

trans-axial belt, the inner belt consists of pre-Cambrian Daling and Darjeeling group of meta-sediments and inner development of Buxa group of rocks. The crystalline rocks of the central region and intrusive granites are exposed from axial belt, with gneiss and Daling series of rocks along some intermediaries, as predominant features. The erosion and deposition by glaciers and rivers have resulted in a sandy to sandy loam, clayey soil mixed with heterogeneous matrix in some places; the soil is predominantly acidic and humus rich. At alpine regions, glacial moraines are found and the glacier-cut box-shaped valleys are widespread.

13.3. Background Information

Upholding the Himalayan biota and located in the eastern part of Hindukush Himalaya, the Khangchendzonga Biosphere Reserve covers varying eco-clines from sub-tropical to arctic, vast land of natural forests, virtually undisturbed, in different biomes. Vast vertical amplitude supports tremendous range of habitat niches and associated fascinating biodiversity. The vegetation mainly comprises of east Himalayan sub-tropical broad-leaf hill forest, east Himalayan moist temperate forest, east Himalayan mixed Coniferous forest, east Himalayan sub-alpine Birch/Fir/Rhododendron forest, moist alpine scrub forest and alpine pastures. A unique physiography of the reserve supports great diversity of biota and associated forest communities, which makes the ecosystems as highly potential reservoirs of natural resources. The uniqueness of the reserve is further manifested by the presence of high nativity and endemism of the species. Variety of high value and useful taxa, including medicinal plants, and existing indigenous knowledge of the reserve people on practicing resource management for their livelihood presents KBR as an ideal case for introducing various socio-economic interventions by the reserve managers.

13.3.1. Landscape features and land-use history

As the case should be, the core zone Khangchendzonga National Park (KNP) of the reserve is managed under complete protection, in which 90% area falls above 3000m altitude. Whereas, about 70% area is located above 4000m and the glaciers, perpetual snow and ice-sheets form 34% land cover. Historically, the trans-Himalayan ranges (of currently KBR and adjacent areas) were used by nomadic Yak herders. The forests in Sikkim during early 20th century were demarcated as protected forests to provide accessibility to villagers for their needs of fuel, fodder and minor forest produce. Whereas, to sustain eco-systems' stability and long-term ecological safeguard, the reserve forests were marked out separately. The past six decades witnessed a change in sheep grazing to Yak grazing, which descends only up to the multi-layered temperate and sub-alpine forests in winter; and due to this practice yak herders extensively manipulated these forests in order to enhance availability of fodder. Owing to increased human and livestock population and augmented severe forests' degradation, in 1999, Government of Sikkim had to ban the open grazing in reserve forests. However, still, there are instances of illegal grazing in some parts of KBR come to picture. However, due to governmental ban on grazing in reserve forests in Sikkim the livestock population has been drastically reduced. Further, the KBR management has made intensive efforts in recent years to evacuate the herders' camps from the core zone and close surroundings. In some parts, especially in west district along India-Nepal border of KBR, transboundary problem of grazing is still an issue need to be sorted out.

During 1969, the then Government of Monarch had allotted 10 hectares area to 10 families in the core zone in west district, the settlement named Tsoka village. However, the relocation process for the families has been completed. Four buffer zones have some mild human activities. The eco-tourism activities are practiced in a big way within monitoring by the biosphere reserve management. However, the close surrounding areas, outside buffer zones, have recently been officially notified as a transition zone, comprising of three parts. Forty four fringe villages have been included in the transition zone; the numbers may change in due course of time, depending upon the needs. The core and buffer zones are used under forestry and wildlife management, research and nature conservation and eco-tourism.

13.3.2. Society, demography and reliance

The village Tsoka in the core zone was inhabited by 10 families, with around 89-90 individuals, since 1969, of Tibetan tribal communities, the Thomopas, which have been relocated outside KNP at Tuksom village in 2011 and provided with necessary logistic support by the State Government. Located in the close vicinity outside the buffer zone, 44 villages making part of transition zone, comprise of about 35757 people. They belong mainly to three major ethnic communities, viz. Lepcha, Bhutia and Nepalese, supporting livelihood of many sub-communities. These are considered as transition zone villages for social activity and eco-development programs linked to the reserve.

As for Sikkim, the people in fringe villages reflect a mix of ethnic diversity, representing main ethnic groups like Lepchas, Bhutias, Nepalese and Limboos having varied traditions and cultures. The Lepcha is the most primitive tribe of Sikkim. The Nepali society is a heterogeneous assemblage of casts. These inhabitants are socially, culturally and emotionally attached to KBR. Need for the biological resources such as fodder, fuel, timber, agriculture tools, medicinal herbs, food crops and wild edibles are largely met from outside core areas, and often found within village territories; however, instances of extraction from reserve are seldom heard. The natural resources such as water and tourism are other important livelihood resources for the natives, which are met out from core and buffer areas.

The tourism sector is rapidly gaining popularity amongst villagers settled in hamlets close to the reserve boundaries and along the designated trekking routes of KBR. For example, the 'Yuksom-Dzongri trekking corridor' is one of top economy provider to local folk. Another important and potential, hitherto, least practiced, but officially designated trekking route, 'Tholung-Kisong (Dzongu landscape)', for both religious tourism and adventure trekkers, is recently highlighted for its tremendous potential, for having uniqueness in several ways. There are many other areas of high religious significance; many Mountains/ Peaks, Lakes, Caves, Rocks, Stupas (Shrines) and Hot-Springs are sacred and pilgrimage sites. Amongst religious places of worship and events of high religious importance in the KBR, the Traditional Lecpha house and museum, and Tholung monastery in Dzongu valley, Sheda (Monastic school) at Lingza, holy cave (Lyari Nimphu), and various holy lakes and mountains and the Namsoong festival, etc, are some to name. Many Inhabitants are highly skilled workers for handicrafts using bamboos, handloom, wood craft, paper making, natural dyes, straw mats, etc.

The biological resources such as fodder, fuel, fiber, timber, wild edibles, medicinal plants and other minor forest produces are commonly used by the natives of reserve area or surroundings. These inhabitants practice diversified livelihood strategies connected to agriculture, horticulture, animal husbandry and NTFP. A recent study reports over 118 species of medicinal plants are traditionally used by the Lepcha tribe of Dzongu valley in buffer zone (north Sikkim) alone. The Lepcha community as well as other tribes in buffer and in close surrounding of KBR mainly perform agriculture for traditional food crops and cash crops. The animal husbandry and kitchen gardens are quite common in practice.

The major crops include Maize, Millets, Paddy, Potato, Barley and Soyabean; however, the Large Cardamom and Ginger are the major cash crops. Horticulture is another source of income; the important fruit crops are mandarin orange, guava, lemon and temperate fruits like pear, plum, peach, etc. Few local communities in the fringes of buffer areas are also engaged in pastoralism; the livestock consist of Yaks, DZOs (cross-bred of Yak and Cow suitable for pack animals), domestic sheep, horses and scrub cattle. The people have realized several options for entrepreneurship, such as cash cropping, handicraft, medicinal plant cultivation, food products from wild species, and above all, the recently growing eco-tourism, as one of the top priorities set-up by the state government.

13.3.3. Existing knowledge base

In spite of Khangchendzonga Biosphere Reserve (Sikkim) being vast landscape and the studies conducted so far mainly confined to few limited transects, with majority focused on Yuksom-Dzongri transects in west Sikkim. The reserve in northern Sikkim, which is comparatively a much tougher (physiographical, and socially too restricted for visitors without permit) and widely spread landscape, least touched upon for the scientific researches so far. However, anthropological and socio-cultural aspects on Dzongu are available. The review suggests the highest percentage of studies focused on socio-economic related issues (40%); faunal and ethno-botanical aspects covered 9% studies each, which were followed by floral aspects (11%). Whereas, 18% of the total studies were targeted on the management and development issues, and 13% focused on miscellaneous topics (Figure 13.2).

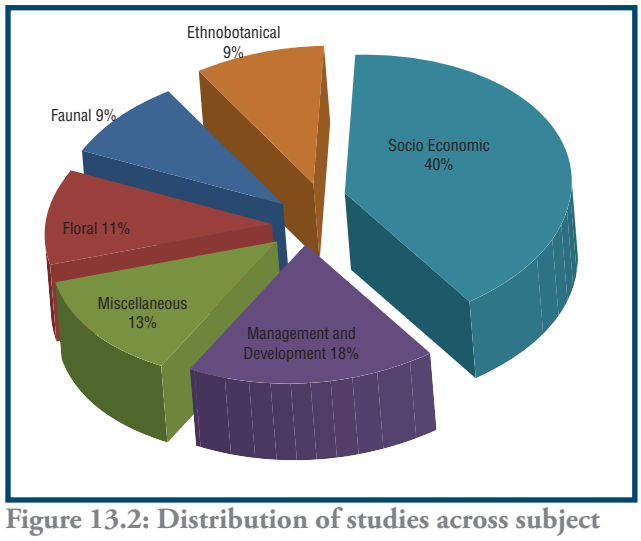


Figure 13.2: Distribution of studies across subject areas in KBR

Addressing to research and development, following major gaps have been identified in order to take up R&D studies:

(A) Biota: Species diversity pattern (floral and faunal, including inventories on lower groups); Distribution maps of species; Habitat assessment, including micro-habitat diversity, for threatened and rare taxa; Population assessment of endangered taxa, Ethnobiological knowledge and valuation (qualitative/quantitative);

(B) Socio-ecological: Peoples' dependency and resultant impacts on resource base, assessment and valuation of ecosystem services, and spatial and temporal change in biodiversity over time, eco-tourism potential and its impact, the ideal conservation practices over changing time;

(C) Geo-physical: Hydrology and energy; climate change indicators (both physical and phenological indicators on biota);

(D) Conservation and management: Science based conservation management, wildlife-human conflicts and options for management, conservation awareness and consultations targeting stakeholders, develop sustainable mechanism in livelihood options, etc.

13.4. Global and National Significance

The Khangchendzonga mountain system encompasses: (i) Ideal habitats for endangered and endemic bio-diversity elements; (ii) outstanding diversity of plants and animals; and (iii) distinctive ethnic groups, maintaining with traditional identities, cultures and religious ethos, and offers a cumulative conservation value, which is globally acknowledged.

KBR contributes for maintenance of its pristine form of globally significant biota and habitats and unique natural spots

A most excellent example of an independent mountain ecosystem, Khangchendzonga (third highest in the world) maintains has its own glacial system which radiates from several summits. The reports suggest core zone alone boost to have over 150 glaciers and 73 glacial lakes. Among prominent ones. the Zemu is huge, fearsome and turbulent glacier spanning to 300 m wide and 26 Km long. Similarly, around eighteen prominently known crystal high altitude lakes make Khangchendzonga Biosphere Reserve characteristically unique landscape; Green Lake, Nir Pokhari, Mujur Pokhri, Lam Pokhri, Dudh Pokhri, Lhunak Tso lakes are a few to mention.

For having trans-boundary location [Tibet (China), Nepal and India], perhaps the largest trans-boundary wildlife protected area in the Himalayan belt, harbouring many Scheduled - I high altitude species of animals and birds (mostly, listed for priority conservation by IUCN), the Khangchendzonga Mountain Range offers unique opportunity for joint collaboration in the conservation of biodiversity, addressing common but global conservation interests. Two major rivers, Tista and Rangit, originating from major glaciers, forms huge watersheds forming fresh water regime for a thousands of people living adjacent and down the streams, and provide refuge to a diversity of biota enriching rich habitat diversity. Many of the globally threatened fauna, listed under the Schedule - I of the Indian Wildlife (Protection) Act, 1972, such as, Musk dear (*Moschus moschiferus*), Snow Leopard (*Panthera uncia*), Red Panda (*Ailurus fulgens*), Leopard (*Panthera pardus*), Serow (*Capricornis sumatraensis*), Himalayan Thar (*Hemitragus jemlahicus*), Himalayan black Bear (*Ursus thibetanus*), Leopard Cat (*Felis bengalensis*), etc, are found here with very high protection and good population. KBR further indicates its unique significance by having great altitudinal amplitude, thereby supporting sub-tropical, temperate, sub-alpine forests to alpine scrub and grass-lands within a short reach. The core zone of Khangchendzonga Biosphere Reserve has served as home for endemic flora and faunal elements, and many of these are under high protection provisions of the Indian Wildlife (Protection) Act, 1972. The KBR complex has been identified as biggest Important Bird Area (IBA) in Sikkim, supporting over 212 bird species of conservation concern. Along Yuksam-Dzongri trekking corridor in west Sikkim alone 143 species of birds were observed that include recording of four species considered to be at risk and listed as threatened, viz. Satyra Tragopan, Nepal cutia, Short Billed Minivet and Little Pied Fycatcher. The entire KBR believed to have a multifold number of avian diversity than envisaged so far, which is still largely remains inadequately explored.

The KBR has following global values

- Representing a wet climatic type in the Himalaya which supports representative biodiversity elements of East Himalayan biodiversity hot spot.
- Biotic representation of south east Asiatic province and representation of diverse biomes ranging from Sub-Tropical and Temperate-moist evergreen to Alpine Pastures and cold Deserts.
- Assemblages of several unique and threatened biodiversity elements (both flora and fauna) of the Himalaya.
- Landscape diversity with exceptional beauty.
- Reservoirs of vast glaciers and wetlands.
- Safeguard ethnic communities especially the aboriginal tribe Lepchas.

Owing to mesmerizing natural beauty, typical physiography and unique biodiversity, Khangchendzonga Biosphere Reserve has emerged as one of the most favorite eco-tourism destinations with regulated mechanism in recent years. Besides, numerous lakes, mountains, caves, rocks, monasteries traditionally worshiped for their sacred status are the unique fascinations, which offer high religious tourism value to KBR. Tholung-Kisong landscape, is one of the potential religious and eco-tourism destinations, need special promotion for global attention. Dzongu valley, an officially designated restricted community landscape falls in buffer and transition zone of KBR and also make the gateway to core zone in north, an abode of ancient tribe of Sikkim, the Lepchas, has been a historical enthrallment to scholars, anthropologists, artists, devotees, scientists and adventurers from all over the world.

immediate conservation through *ex-situ* cultivation. Eastern Himalayan endemic flora includes, *Acronema pseudotenra, Anaphalis hookeri, Anemone demissa, Blumea sikkimensis, Inula macrosperma, Jurineae cooperi, Ligularia yakla, Mahonia sikkimensis, Rhododendron sikkimensis, Juncus sikkimensis, Podophdyllum sikkimensis, Ranunculus sikkimensis*, etc.

KBR- reported species diversity

Floral components

Angiosperms	- 1463
Gymnosperms	- 16
Pteridophytes	- 106

Faunal components

Mammals	- 144
Birds	-> 550
Butterflies and months	-> 627
Amphibians	- 16
Reptiles	- 16
Fishes	- 48

13.5. Biodiversity Values

Khangchendzonga Biosphere Reserve, being the Trans-Himalayan (cold desert) and partly as the central Himalayan steppe, supports a range of biotic diversity having with unique elements. Floral diversity is represented by estimated about 1463 species of angiosperm, 16 gymnosperms, and 106 pteridophytes. About 36 species of Rhododendrons and numerous orchids.

Khangchendzonga Biosphere Reserve represents many endangered and endemic biotic elements. Amongst many, *Aconitum ferox, A. heterophyllum, Bergenia ciliata, Dactylorhiza hatagirea, Nardostachys jatamansi, Cordyceps sinensis, Panax pseudoginseng, Swertia chirayita, Astilbe rivularis, Taxus baccata, Dioscorea bulbifera, Allium wallichii, Zanthoxylum* spp., *Podophyllum hexandrum, Picrorhiza kurrooa, Rhododendron arboreum, R. anthopogan, Juniperus recurva and Juniperus macropoda*, are some of the threatened and high value plants recorded in KBR. Of above, *A. heterophyllum, D. hatagirea, N. jatamansi, P. hexandrum, P. kurrooa, S. chirayita*, etc. are prioritized for

Amongst known mammals of the reserve, 39 species are endangered or rare and included in Schedule I of the Indian Wildlife (Protection) Act, 1972. The Musk Deer, Tibetan wolf, Red fox, Indian wild dog, Red Panda, Hog Budger, Snow Leopard, Tibetan Sheep, Serow-Goral, Tibetan wild Ass, etc. are some of them. Identified as one of the biggest Important Bird Areas (IBA), the Khangchendzonga Biosphere Reserve complex in Sikkim supports 130 endemic bird species of eastern Himalaya, and over 212 bird species of conservation concern including 7 globally threatened species, 120 biome restricted species (biome 5: Eurasian High Montane Alpine and Tibetan- 24 species; biome 7: Sino-Himalayan Temperate Forests- 67 species; biome 8: Sino-Himalayan Subtropical Forests- 26 species; biome 9: Indo-Chinese Tropical Moist Forests- 3 species).

The eastern Himalayan endemic bird species include, *Phylloscopus cantator* (Black-browed leaf-Warbler), *Actinodura nepalensis* (Hoary-throated Barwing), and *Phylloscopus cantator* (Black-browed leaf-Warbler), etc. Whereas, the *Falco naunanni* (Lesser Kestrel), *Haliaeetus leucoryphus* (Pallas's Fish-Eagle) and *Paradoxornis flavirostris* (Black-breasted Parrotbill) are amongst the vulnerable and/or rare bird species of KBR. The biosphere reserve is known for the high presence of state bird, the *Ithaginis cruentus* (blood pheasant) and other two important pheasants, *Tragopan satyr* (satyr Tragopan) and *Lophophorus impejanus* (Himalayan Monal). At domestic ground, KBR supports a huge variety of traditional crops, fruits and vegetable, viz. *Ammomum subulatum* (large Cardamom), *Eleusine coracana* (Kodra), *Fagopyrum esculentum* (Buckwheat), *Fagopyrum tataricum* (Phaphar), *Phaseolus vulgaris* (Rajma), *Hordeum vulgare* (Jau), Glycine max (Bhatmass), *Zea mays* (Maize) as significant part of native food.

13.6. Progression of Conservation and Management

Historical progression in Sikkim forestry has exerted a significant influence on the designation of Khangchendzonga Biosphere Reserve. Historically, some of the main events marked with Sikkim forestry in its beginning, appeared as foundation of conservation and management of protected areas in Sikkim. This included (i) Demarcation of Reserved Forest, 1902; (ii) Demarcation of Khashmal Forest out of Reserve Forests, 1905, notification issued by Political Officer, and (iii) Demarcation of Gaucharan Forests, notified by Forest Department, 1911.

In-spite of creation of forest department hundred years' ago, until 1950, Sikkim forestry was governed by dual management, both by local Kazis, responsible for management of the state forests in their Elakhas, following the directives given by the Forest Department; whereas, the high altitude forests, outside their Elakha were managed by the Forest Department. The private forests within the estate of the His Highness were also demarcated nearly the same time as that of the Reserved Forests. The management of some of private estate forests was given to Forest department after 1950. From then onwards, state forests have directly been administered by the Forest Department, thus eliminating powers of Kazis, etc. in management.

After the merger of Sikkim as integral part of India during 1974, the environment oriented policies appeared as priorities in the state. In current years, such efforts have been witnessed in the recently exercised Environmental Sustainability Index (ESI) for 28 states, which highlighted the Sikkim ranked first in the conservation of natural resources and second in the Environmental Sustainability Index. The strong conservation oriented policies of the Government of Sikkim, including the ban on felling of standing trees, ban on grazing, ban on the use of plastic, creation of Smriti bans (Memory forests), the State Green Mission, Ten Minutes to Greenery, etc., further registered an increase in the forest cover from 43.95% in 1993-94 to 46.28% at present. In the field of global warming and climate change, Sikkim took lead in constituting an exclusive Commission on the Glaciers and Climate Change, aiming reviewing current status of glaciers and snowmelts in Sikkim state along the eastern Himalayan belt, which will co-opt to achieve the national missions on Climate Change under National Action Plan unveiled by the Prime Minister of India in June, 2008.

After 1974, and taking over the complete charge of state forests, the Forest Department assessed the degree of pressure on forests and some of the biodiversity rich areas were brought under the protected area networking. In August 1977, considering the very high potential of biodiversity components, associated with immensely diversified ecological and geo-morphological importance, and for representing one of the most high altitude eco-systems in the world, initially, about 835 km^2, covering 70% of north Sikkim forested area and 30% of west and south Sikkim forest area was commissioned as Khangchendzonga National Park. Since over 60% of park is under perpetual snow covered peaks and glaciers, looking at the winter migration of animals to lower reaches, thus risking their lives from poachers, the protected area further extended to 1784 km^2 during 1997, following a justified study assessment of biodiversity rich areas. In view of giving space for eco-development activities as livelihood incentives to villagers inhabiting the close surroundings of KNP, on 07 February 2000, Government of India further added 04 buffer zones to KNP, and notified the Khangchendzonga Biosphere Reserve as an expanded total area of 2619.92 km^2. Recently, the entire KBR is re-notified on 24 May 2010, which incorporated an additional area of 311.20 km^2. as a Transition zone, in three parts; thus the total area of KBR extended to 2931.12 km^2. A revised document, jointly prepared by forest department of Sikkim and GBPIHED, is under process of UNESCO MAB nomination.

Providing high priority to conservation of biodiversity in Khangchendzonga Biosphere Reserve, some important and sensitive zones, though as smaller pockets, targeting specific objective, are notified in recent years, viz. Lampokhri Medicinal Plants Conservation area, Yongzodrak Blue Sheep Conservation area, Areylungchok Musk Deer Conservation area and Singalila Eco-tourism Promotion areas. Following the ban on grazing in the reserved forests in Sikkim, the pastoralism is gradually being removed. Through cooperation and support of the local communities, many parts in KBR have experienced dilution in grazing practices, resulting tending change in lifestyle of shepherds/herders from pastoral to agriculture. This has been possible partly due to recent initiatives of KBR management authorities and associated agencies that launched various income generating activities such as agriculture, pisciculture, piggery, animal husbandry, Angora rabbit farming, broom grass cultivation, knitting and cutting, handlooms and handicrafts productions, etc.

Recently, 03 new trekking trails and 27 camping sites were designated in view of providing alternative livelihood options to the villagers in remotely located places. To reduce the impact of trekking, a code of conduct for tourism was notified as legal basis, as Sikkim Wildlife Trekking Regulations. Institutionalization of the role of people inhabiting high altitude

or Himal in conservation was made in recent years through official notification for the appointment of Himal Rakshaks (honorary mountain guardians). The scientific awareness campaign of scientific organizations like G.B. Pant Institute of Himalayan Environment & Development (Sikkim unit) proved useful to motivate community in some parts of KBR and appeared as successful collaborative efforts with KBR management.

The KBR secretariat has recently developed a 'Management Plan of the Khangchendzonga National Park' for the year 2008 to 2018, and initiated implementing the same. There are many activities are being taken up through centrally sponsored schemes in the area, viz. Afforestation; improving communication; intensification of management and protection; habitat improvement; soil conservation and stream bank erosion control; site specific eco-development works; amenities for forest staff; research and monitoring; and reduction in man-animal conflict, etc.

13.7. Issues and Concerns

Over the years, Khangchendzonga Biosphere Reserve witnessed with several levels of triumphant programmes and initiatives, as discussed above; however, there are several conservation issues and concerns, either in the form of threats and/or the likely apprehension of disturbances over long run have been perceived and highlighted through different studies and during the course of interactions of stakeholders. The recent initiatives of GBPIHED (Sikkim unit), by studying, and organizing 04 stakeholders' consultations workshops, in collaboration with state forest department, Government of Sikkim, each in Yuksom, and Uttarey, Labdang and Rimbi (both in west Sikkim) and at Dzongu valley (north Sikkim) have drawn out several such issues and concerns relating biodiversity and conservation management of the reserve. Many of these need to be seen with instant priority consideration so that the necessary management actions can be taken up for a vibrant and successful reserve, as ideal case for the mountain eco-systems.

13.8. Perspective 5 year plan – major components

The recently prepared long term management plan of the Khangchendzonga National Park for the year 2008-2018 largely indicates the overall requirements of the Khangchendzonga Biosphere Reserve at this juncture. Various components highlight the current state of problems and issues vis-à-vis needs, such as from scientific, social and management point of view.

Developmental programs in the field are carried out as per the Management Action Plan which is drafted annually and implemented after due approval of the Centre and the State Governments.

Following are the planned on-going research and monitoring activities in Khangchendzonga Biosphere Reserve:

- Habitat and vegetation survey in west and north KBR: On-going
- Ecological study on pastoralism in the temperate and alpine forests in west and north KBR: On –going
- Wildlife population estimation survey: On-going
- Floral study in KBR: On-going
- Habitat ecology of Snow Leopard and its prey species : Planned
- Habitat ecology of Red Panda, Musk Deer and Himalayan Thar : Planned
- Medicinal plants resource assessment in KBR : Planned
- Birds diversity of the KBR: On-going
- Butterflies diversity of the KBR : Planned

On the management part, there are programmes and activities being undertaken by the forest department through the Schemes sponsored by MoEF, Government of India and State Government, aiming to improve the park from different ways of management, e.g. Habitat improvement, research and extension-education programme, protection of flora and fauna, welfare programme for field staff and local people. There are three centrally sponsored schemes, viz.

(i) Management Action Plan (MAP) for Conservation and Management of Khangchendzonga Biosphere Reserve –Sikkim,

(ii) Assistance to States for Development of Parks and sanctuaries- Khangchendzonga National park-Sikkim, and

(iii) Forest Development Agency (FDA) under National Afforestation and Eco-Development Board of National Afforestation Programme (NAP), Government of India.

As per the Annual Plan of Operation submitted by the Forests, Environment & Wildlife Management Department, Government of Sikkim, after careful consideration by the MoEF, Government of India, releases the resources for implementation of, (i) Eco-development activities, (ii) Social welfare activities, (iii) Habitat management, (iv) Forest

research, Extension and Education, (v) Forest Protection, and (vi) Infrastructure development are implemented in and around Khangchendzonga National Park. All the activities are carried out through the ECO-Development Committees including stakeholders and Panchayat members, representing all the buffer villages of reserve. In addition, the research organization, GBPIHED (Sikkim unit) is engaged in the research projects, including, 'Response assessment and processing of knowledge base to serve long term management and use of biodiversity in the Himalaya- focus on Khangchendzonga Biosphere Reserve (Sikkim)'.

13.9. Success Stories

Some of the successful initiatives and achievements relating conservation of biodiversity and management in the reserve are indicated below; some of these can further be adopted as ideal examples in other Biosphere Reserves in Himalaya and elsewhere:

- High level of conservation approaches practiced for the protection of biota of KBR by the area management.
- Huge acceptance of participatory practices amongst communities for management laid down by the KBR management. This includes successful community participation, especially, through formation of 'Himal Rakshaks', Eco Development Committees, etc.
- Initiation of successful eco-tourism and especially promotion to 'Home Stays' in fringe villages, as livelihood activity, and notification of various trekking routes and rules.
- Highly applauded livelihood initiatives launched by the KBR management for the community development and thus reducing pressure on natural resources.
- Documentation and wide dissemination of information on unique spots having both cultural and biodiversity values along Tholung-Kishong eco-trek, through publication of detailed technical brochure.
- Drastic reduction of herders/glaziers in the core zone of KBR, through joint efforts of management and community including SSB officials.
- Various successful campaigns along Yuksom-Zongri trekking corridors in KBR on waste management jointly conducted by KBR management and local NGOs.
- Collaborative stakeholders' consultations meeting/ workshops, especially at Yuksom and Uttarey (west Sikkim) and Dzongu valley (north Sikkim) have yielded concrete recommendations and highlighted the vital conservation and management issues.
- Acceptance of majority of the proposals made under Annual Plan of Action for the management and conservation of KBR put in before the Annual State Level Steering Committee meetings.
- Based on high level of core area protection, the preparation and submission of nomination document for UNESCO MAB Net of Biosphere Reserves for KBR, Sikkim

As such, Khangchendzonga Biosphere Reserve can be seen as an ideal example to follow, which needs better realization and support from wider array of stakeholders and policy makers.

The authors wish to thank Dr LMS Palni, Director, GB Pant Institute of Himalayan Environment & Development, Kosi-Almora, Shri ST Lachungpa, PCCF cum Secretary, FEWMD, Govt of Sikkim, Shri NT Bhutia, Chief Wildlife Warden, FEWMD, Govt of Sikkim for various levels of support and encouragements; and highly appreciate Shri Guth Lepcha, Conservator of Forests (Wildlife), FEWMD for sharing his experience on Khangchendzonga Biosphere Reserve, Sikkim.

Hemant K Badola
Nodal Person KBR
G.B. Pant Institute of Himalayan Environment & Development
Sikkim Unit, Pangthang-Gangtok, Sikkim 737 101 (INDIA)
Phone : +91-3592-237189 Ext. 203; +91-9609740419 (m)
Fax: +91-3592-237415
eMail : hkbadola@gmail.com, badolahk@yahoo.co.in

JB Subba
Additional Director KBR
Forest Environment & Wildlife Management Department
Forest secretariat, Deorali, Gangtok, Sikkim 737 101 (INDIA)
Phone : +91-9933114007 (m)
eMail : jbsubba@ymail.com, jblingdom@live.com

14
Agasthyamala Biosphere Reserve – Western Ghats, India

14.1. Introduction

Agasthyamala Biosphere Reserve was declared by the Ministry of Environment and Forests, Govt. of India on 12th November 2001 (Order No. 9/15/99-CS/BR) for Kerala portion and subsequently the BR was expanded by adding Tamil Nadu portion on 4th August 2005 due to phytogeographical similarity and significance. It falls within the Indo-Malayan realm and the Western Ghats biogeographic zone. Reserve is located in the southern end of the Western Ghats includes a towering peak, 'The Agasthyarkoodam' at 1868 m, and the adjoining forests in Tirunelveli and Kanniyakumari districts of Tamil Nadu and Thiruvananthapuram and Kollam districts of Kerala covering an area of over 3500km^2.

The reserve hosts one of the most diverse ecosystems in Peninsular India and is known as one of the important 'Hot Spots' in the Western Ghats. The BR has adequate area to serve its three functions namely conservation, development and logistic support. The reserve represents unique kind of forest ecosystems ranging from dry deciduous, evergreen and shola-grasslands. They are more productive in terms of biomass and provide special microclimatic habitat for a wide variety of biota. A number of tribal settlements are located in the core area of the biosphere. Non-tribal families are also living along the fringe area of the forests. These inhabitants are heavily depended on the reserve resources for sustenance. The reserve being a natural home for a variety of flora and fauna, as detailed below, it would go a long way to conserve the biodiversity of Southern Western Gahts.

Designation Date	:	12 November 2001
Total Area	:	3,500.36 km^2
Core Area	:	1,135 km^2
Buffer Area	:	1,445 km^2
Transition Area	:	920.36 km^2
Extent	:	8°5′ and 13° 0′ N 77°52′ and 77°34′ E

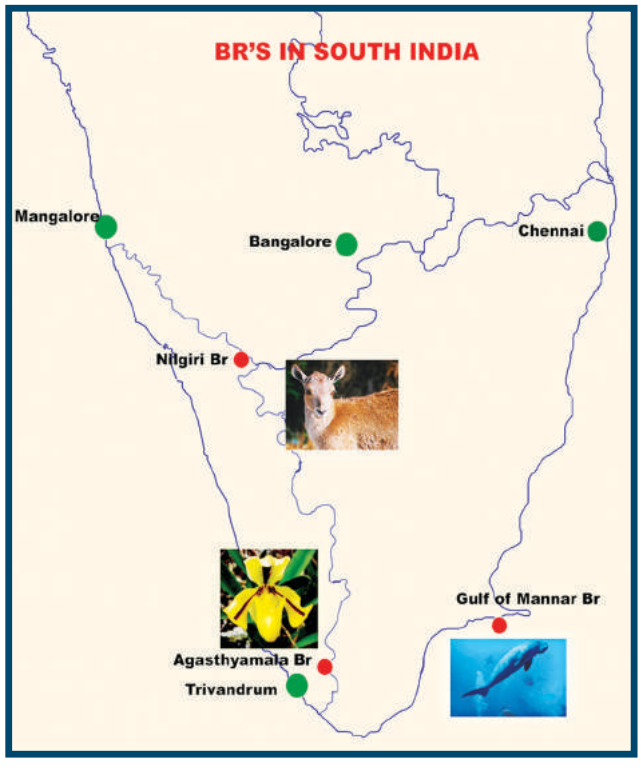


Figure 14.1: Location of Agasthyamala BR in South India

14.2. Area Description

The reserve falls in the Western Ghats mountain biogeographical provinces of India (Figure 14.1). It lies between 8°5' to 13°00' N latitudes and 77°52' to 77°34' E longitudes. The vast stretches of the forests distributed from 100-1800 m above m.s.l with a fabric of different forest types and habitats, dense flora, fauna and indigenous people make it an ideal gene pool reserve and hence the area aptly designated as biosphere reserve. It comprises of three wildlife sanctuaries – Shendurney, Peppara, Neyyar and one Kalakad Mundanthurai Tiger reserve. There are 159 tribal settlements located in this Biosphere Reserve, distributed in Kerala and Tamil Nadu. The reserve is drained by a good number of rivers, streams and their tributaries. The natural vegetation comprises of drydeciduous, semievergreen, evergreen from Eastern side and moist deciduous, semievergreen, evergreen on the Western side of the reserve. In the higher elevation the shola-grassland matrix is co-existed in a dynamic equilibrium.

14.2.1. Zonation details

The total core area of the biosphere reserve is 1135 km^2 and it is distributed between the two states of Kerala (352.00 km^2) and Tamil Nadu (783.00 km^2; Figure 14.2). Here all forms of interference are strictly regulated except very rare scientific studies contributing to better management and enhancement of the quality of the biodiversity. It houses a significantly diverse flora and fauna. The area coming under this core zone consists of Pandimottai, Alwarkurchi, Umayar, Aruliar, Narathar, Dharbhakulam, Ananirathi, Venkulammeedu, Pulivizhanthanchuna, Varayattumudi, Meenmutty, Theerthakkara, Kaduvappara, Chemungimottai, Kovilthermalai, Athirumalai, Nachiyarmottai, Kannan kunnu, Kadirumudimalai etc. The core area of Tamil Nadu portion has significant human presence and their activities are now regulated by the forest department. For example, the tea estate owned by Bombay Burma Trading Corporation (BBTC) and EB colony near Servalar dam continue to attract visitors. However, the main object this area is for preserving it in natural conditions by providing full protection to allow the ecological process to continue without disturbance.

The buffer zone is 1445 km^2, that is also distributed in the two states (Kerala, 754 km^2 and Tamil Nadu 691.00 km^2). The buffer zone consists of human inhabited areas of both tribal and non-tribal settlements. The vegetation of this zone mainly consists of southern secondary moist mixed deciduous forests, west coast semi evergreen forests, riparian fringe forest etc. Sorimuthaianar Koil in Mundanthurai Range attracts lakhs of pilgrims and tourists every year, particularly during "Aadi Amavasai" festival. Nambikoil in Thirukurungudi Range also attracts lakhs of pilgrims and tourists particularly during "Puratasi" month. Golaknath temple in Kadayam Range is also very important from pilgrim's point of view. About 35 km^2 is earmarked at eastern foothills side of the reserve for tourism purpose.

Figure 14.2: Agasthyamala BR Zonation

The transition zone is an outer area of BR and spreads over to 920.36 km^2 (Tamil Nadu 198.36 km^2 and Kerala 722 km^2), which is interspersed based on management requirements of the area, such as providing sustainable livelihood to the indigenous people. This includes providing safe drinking water to local people, compensation for damages to life and crop, setting up of biogas plants etc. Eco-tourism activities are also in practice in other fringe areas and eco-development works like compatible agriculture, cottage industry, recreation and other relevant sectors are in progress with the participation of local people.

14.2.2. Biogeographic characteristics

The biosphere reserve falls within the Indo-Malayan realm and the Western Ghats Biogeographical zone. The reserve is located between the States of Kerala and Tamil Nadu of the Indian Union. The biogeography of the reserve is unique in sharing common flora and fauna elements between India and Sri Lanka. The area harbours a rich diversity in terms of species content, ecosystems, habitats and cultural grounds. The biosphere reserve is accommodated Shendurney, Peppara, Neyyar sanctuaries from Kerala and Kalakad Mundanthurai tiger reserve from Tamil Nadu. The Shendurney wildlife sanctuary is a continuous stretch of vast, valuable forest area bounded on the east by the slopes of the Sahyadri hills, which act as a barrier separating the two states, Kerala and Tamil Nadu. The sanctuary lies on either side of the Shendurney River and is located on the north of Kulathupuzha valley separated by Churattumala ridge. Peppara Wildlife Sanctuary is located in the Western slope of the Ghats and the entire area lies within the catchment areas of Karamana river, which originates from the slope of Chemunjimottai, the highest peak of the sanctuary. The Neyyar Wildlife Sanctuary is adjacent to Peppara and the entire area lies within the catchment area of Neyyar River, which originates from the slopes of Agasthyarkoodam, the highest peak of the biosphere reserve. Most of the tribal settlements are located on the western portion. The reserve occupies a prominent place in the cultural heritage and history of India. The famous pilgrim centre, Agasthyamala which finds place in the epic Ramayana (One of the great

epics of Bharath) is situated in the Nedumangad Taluk of Thiruvananthapuram district. It is believed that the peak is named after the sage Agasthiar who lived and practiced Sidda system of medicine.

This area receives both southwest and northeast monsoon rains of which the former, with a longer duration, lasting from May to August and even extending up to September. The northeast monsoon is intermittent and usually occurs in the afternoon during late September to November. The rainfall is fairly well distributed almost throughout the year, but in certain years it is reported to be somewhat erratic. The average rainfall varies from 2,600 – 3,500 mm. The area has a typical tropical humid climate prevalent on the western slopes whereas in eastern side dry weather prevails for most part of the year due to less rain fall.

14.3. Background Information

Agasthyamala Biosphere Reserve is located in the Southernmost end of the Western Ghats with a towering peak of 1868 m from m.s.l. It extensively covers tropical forest ecosystems of Tirunelveli and Kanniyakumari districts in Tamil Nadu and Thiruvananthapuram and Kollam districts of Kerala. It hosts one of the most diverse ecosystems in peninsular India. Biogeographically Agasthyamala is one of the important local 'Hot Spots' in the Western Ghats.

14.3.1. Landscape features and land use history

The reserve is located in the tip of Peninsular India. The terrain is undulating with elevation ranging from 100-1868m. The important peaks of the sanctuary are Agasthyakoodam (1868m), Athirumala (1594m), Arumukhamkunnu (1457m), Kovilthermalai (1313m) etc. The western side falls in Kerala and includes 3 sanctuaries and northern portion extends upto Achankovil. The area is predominantly occupied by moist deciduous, semievergreen, evergreen and shola – grasslands. The eastern side of the Biosphere Reserve is bounded by Tirunelveli and south by Kanyakumari district of Tamil Nadu. The mountain system is abruptly steep towards eastern side and merges with Tamil Nadu plains. There are 5 reservoirs built within the BR which cater to the irrigation and drinking water needs of both the states.

Being distributed in the States of Kerala and Tamil Nadu, historically, the northern and eastern parts were under the control of Tamil Kings (Pandians) and their descendants and the Southern and Western portions under Travancore Kingdom. It was believed that Kanikkar or Kani tribe locally inhabited in forests area were created by Lord Siva in the presence of the sage Agasthya and they lived deep inside the forest areas. They nurtured healthy relationship and respect the governance of then Maharaja of Travancore, Maharaja Marthanda Varma. In the battle between Marthanda Varma and Ettuveetil Pillamar (splinter group with in the family of kingdom), the Maharaja had to flee from his kingdom and took shelter in the deep forest areas. During those days, it was the Kani tribal families who looked after Raja by providing all necessary facilities. In gratification to that service, when Raja regained his kingdom and power, he gave 36,000 acres of land to Kani families. The kani tribals are basically agriculturists and they were practicing shifting cultivation. This resulted in their encroaching upon new areas for cultivation. After a long period, when system of local administration changed, the court of registrar ordered the landholders to register their land area with immediate effect. Since the kani tribal groups were illiterate and lived deep inside the forest areas were unable to get this information and hence failed to comply with the orders. Consequently, 36,000 acres of land owned by kani families were included under government owned land. This land area is known as "kanipattu bhoomi". Kani tribes believe that they still own this land and its resources for their benefit. This belief even today creates serious issues for the forest department while implementing management policies for core and other forest areas. Majority of the tribal people have two to three acres of land in their possession. Very few families only possess bigger land area. Most of them are using their land for agricultural purposes. They usually cultivate pepper, areca nut, tapioca, coconut, sweet potato, rubber, coffee, yams, etc. Some of them are cultivate medicinal plants. In olden days they practice shifting cultivation, but now a days it is not permitted by the forest department. There were five major dams constructed for irrigation and electricity. The construction of dams have fragmented the forests of this biosphere, resulting in the loss of contiguity of the forests, animal corridors, and extension of wildlife.

14.3.2. Geology, geomorphology and soils

The reserve is dominant with precambrian metamorphic rock belonging to the Khondalite group. Charnokite is also exposed at different locations. The occurrence of Chrysoberyl, a semiprecious gemstone had led to illegal mining in the past which is completely stopped now. Magnetite quartzite is also seen in this tract. The underlying rock is principally gneiss and has undergone lateritic decomposition in regions of heavy rainfall. The foothills, at an elevation below 300 m, are often capped without crops of hard laterite. The soil is almost loamy and assumes sandy to clayey character depending on the accumulation of wash from elevated grounds, more in a large proportion of laterite gravel and unbroken pieces of other rocks under different

stages of disintegration. The depth of soil varies from place to place. In the valley and low lying areas, where the wash from the surrounding hills accumulates, the soil is fairly deep and often assumes a dark colour due to the presence of burnt or decomposing vegetable matter. In such places the soil is of friable and porous character and the trees that come up there flourish well. On the slopes of hills and on the elevated grounds subjected to heavy wash, the soil has a characteristic yellow or reddish yellow colour. Such soils are generally stiff and heavy, being clayey and containing very little organic matter. On the top and higher slopes of hills, where the wash is excessive the ground is rocky and hard.

14.3.3. Reserve inhabitants, demographic trends and dependance

Approximate number of people including tribal and non tribals living within the biosphere reserve is detailed below:

There is only one local community namely Kani tribes live within the BR from both Tamil Nadu and Kerala. In Tamil Nadu portion there are 7 settlements at Agasthiar kudiyiruppu, Kanikudiyiruppu, Injikuzhi, Kariyar, Servalar kudiyiruppu,

Zone	Permanently	Seasonally
Core Area(s)	3,000	1,500
Buffer Zone(s)	10,000	2,000
Transition Area(s)	20,000	5,000

Chinn Mylar kudiyiruppu and Periya Mylar kudiyiruppu, etc. and having 102 families. In addition, about 700 non-tribals live in BBTC tea estates located in core area. In Kerala part, there are 3 sanctuaries and here also tribal settlements are spread over in the core area. In the eastern part of Peppara Wildlife Sanctuary three tribal settlements are located at Podium, Kamalakam and Kombidi. Podiyakkadu colony is situated in the northern side of Peppara Wildlife Sanctuary. Altogether around 152 tribal families are living here. There are eight settlement situated in the north-eastern part of Peppara Wildlife Sanctuary at Cherumangal, Vlavila, Parundod, Aamoodu, Kunnatheri, Pattampara, Pothoodu and Erumbiyadu. About 78 families (Tribal's) are settled here. In Neyyar Wildlife Sanctuary, three settlements are at Anakal, Plathu, Chathencode and having 53 families. The Bonaccord tea estate is located at Peppara Sanctuary which contains 339 non-tribal families in the core area. In Shenduruny Wildlife sanctuary, three non-tribals settlements namely Rosemala, Kattilappara and Kallar estates are in the core area. About 360 families are living in Rosemala, 34 in Kattilapara and 56 in Kallar estates. These 450 families are heavily depended on the resources of the sanctuary to the their daily sustenance viz., fire wood, thatch poles, cane and reeds, medicinal plants, honey, resins and gums, fodder grass, sand, water (drinking and irrigation), manure, fish etc. The degree of dependency is very high with tremendous impact upon the resources especially on the excessive collection of medicinal plants and other NWFPs.

14.3.4. State of knowledge

The reserve has three Wildlife Sanctuaries – Shendurney, Peppara, Neyyar and one Tiger Reserve - Kalakad Mundanthurai. Situated within the Western Ghats, the region embraces wide range of floristic diversity and 9 rich faunal compositions. That is why the reserve is aptly considered as one the part of 34 biodiversity hotspots of the world. It is a treasure house of medicinal, ornamental and wild races of cultivated plants. The physiographic and ecologic characteristics make the region an ideal location for ecotourism. Concentration of 'Kani' tribals with counternance and unique rituals are remarkable features of the region. Their local wisdom on medicinal plants are well acknowledged and even earned UN equator prize for assisting in formulation of herbal drugs by using local medicinal plants "Arogya pacha" (*Trichopus zeylanicus*). They are socially, culturally and emotionally attached to the region and their sustenance is highly dependent on the biological resources such as medicinal plants, non-wood forest products etc. The tribals also get employment as fire watcher, forest guides, forest protection and also in afforestation programmes. Thus the inmates provide enough protection for sustenance to the ecosystem and inturn they are getting social and economic development. The biosphere reserve forms catchment areas for several rivers which play a major role in the development of the agriculture of states of Kerala and Tamil Nadu.

In view of long term maintenance of landscapes, ecosystem components and sustainable utilization of its resources, a set of research and monitoring programmes have been executed by R & D institutions, University departments, colleges, etc., with the financial support from state and central government organization. The research programmes includes climatology and edaphology, mapping and monitoring of vegetation and landuse, survey of flora, fauna, microorganisms, etc., ethnobiology, medicinal plants, wildlife corridors, ecology and phytogeographical affinities of floral elements, habitat monitoring, restoration of RET species, meteorological and hydrological monitoring, impact of human interference etc. The results obtained from these studies are incorporated in the working plans of the Biosphere Reserve.

14.4. Global and National Significance

The Agasthyamala Biosphere reserve occupies a prominent place in the cultural heritage and history of India. It is a

famous pilgrim centre for Hindus because it finds place in the epic Ramayana (One of the greatest epics of Bharath). The peak is known as Agasthyarkudam and is situated in the Nedumangad Taluk of Thiruvananthapuram district. It is believed that the name is derived after the sage Agasthya muni who lived and practiced Sidha system of medicine. He was also considered as legendary father of Tamil language and therefore closely linked with the culture of people living in the foot hills and plains. During the annual festival that falls in May, the devotees from both the sides throng to visit the peak and offer prayers.

The crowning glory of the Western Ghats in the reserve is Agasthyarmalai, otherwise known as 'Eka Pothigai' or 'Periyapothigai' to distinguish it from a smaller mountain adjoining it called Aindu-talai-Pothigai or Penta headed pothigai. The early Greek writers refer to this hill as Bettigo. It is second only to Kottaimalai in the district in height but it is most striking peak considered as the highly sacred mountain of the ghats. The Pothigaimalai is frequently referred to in Tamil literature as the distinguishing mountain of the Pandyas who were addressed as the 'Lord of the Pothigai'. 'Pothigai' literally means a place where many things have been concealed. The river Tamiraparani, the lifeline and the chief natural resources of the Tirunelveli district, originates from here.

Thiruvilaiyadal Puranam, a Tamil classical work which narrates the supposed sportive deeds of Lord Siva, mentions Pothigai Malai as the abode of Agasthiar, the dwarf Tamil sage, believed to have participated in the First Tamil Sangam and authored Agasthiam, an ancient Tamil philosophical work, which is not available now. It is said in the Purana

The crowning glory of the Western Ghats in the reserve is Agasthyarmalai, otherwise known as 'Eka Pothigai' or 'Periyapothigai' to distinguish it from a smaller mountain adjoining it called Aindu-talai-Pothigai or Penta headed pothigai.

(old tamil literature) that Agasthiar was commissioned by Lord Siva to bring about an equilibrium of the earth which had tilted downwards in the North (Himalayas) consequent of Lord Siva's marriage with His Consort Parvathi at Kailai (Himalayas) where thronged the whole of celestial beings. Agasthiar, obeying the order, came to the South, stayed at Pothigai malai and balanced the earth. Another tradition has it that the rishi Agasthiar having retired from the world after civilizing the South took up peak remained inaccessible for several years. Due to such religious belief people did not venture to climb hill for a long time. The Europeans during British period scaled it and subsequently the Travancore Government erected an observatory on the peak. On the aesthetic beauty of Agasthyamala, it was observed that, "a perfect cone shape standing on a low base in a wide gap on the sky like, Agasthyamala whether viewed from Travancore or Tinnevelly in the glory of March sun set, is the most striking peak in the whole range of the hills. Often for weeks together it is wreathed in clouds enjoying as it gets the full benefit of both monsoons". Next to Agasthyamala or Pothigamalai, on the south stands the great Aindu-thalai-Pothigai. If viewed from the east in the evening, the five heads of the peaks and along with the peak of neighbouring rugged Nagamalai form as six sentinels guarding the Agasthyamala. Therefore, these mountains have distinct religious and cultural traditions on the people of both the states.

14.5. Biodiversity Values

The reserve harbours a wide spectrum of ecosystem types such as Tropical Semi Evergreen Forests, Tropical Evergreen forests, Moist Mixed Deciduous Forests, Montane forests and specialized ecosystems such as Reed brakes, Myristica swamps, Riparian vegetation, etc. The significance of the reserve lies in its landscape, ecological, faunal, floral and geomorphologic features. The factors contributing to the significance of the area include.

- Abundance of *Gluta travancorica*, an endemic species of Agasthyamala region.
- About 2254 species of flowering plants belonging to75 families are reported, of which 475 species are endemic to Western Ghats.
- Occurrence of more than 150 species of threatened plants within the sanctuary. It is the type locality of several endemic and threatened species.
- Presence of wild population of lion-tailed macaque, a highly endangered species.
- Natural home for wild animals like elephant, tiger, leopard, bear, nilgiri langur, malabar giant squirrel etc.
- Diversity of avifaunal wealth – 337 species of birds were reported including migratory, endemic and endangered species.
- Presence of unique vegetation of *Myristica* swamps.

The biosphere is a treasure house of plant diversity with about 2254 species of flowering plants of which 405 species are endemic to Western Ghats. Among this 19 are newly described and 58 under threatened category as

per IUCN. A total of 79 species of mammals, 88 reptiles, 45 amphibians, 46 fishes, 337 Birds are also reported from this reserve which signifies the biological diversity. This region, in addition to Nilgiri BR, protects two endangered species namely Nilgiri Tahr and Lion-tailed Macaque. The reserve harbours an endemic tree *Gluta travancorica* locally known as "Chenkurinji" in Shendurney valley. The presence of other wild animals like elephants, mongoose, tiger, leopard, bear, sambar, nilgiri langur, malabar giant squirrel, gaur, king cobra, etc. 233 species of insects are recorded from the Agasthyamala Biosphere Reserve which includes 53 butterflies, 90 moths, 22 beetles, 20 bugs, 17 bees and wasps, 6 dragon flies, 26 unidentified flies and 2 grasshoppers etc. signifies its true wilderness. The diversity of cultivated plants covering cereals and millets of very dry land crop to paddy, pepper, plantain and spice crops of humid tracts are grown here. In addition, 600 medicinal plants and more than 100 economically important species occur in this area. The reserve is also a natural house for indigenous population known as 'Kani tribals' who lives and practice their customs over centuries. Their traditional knowledge on medicinal plants is well acknowledged by developing a immunoenhancer drug by TBGRI from local medicinal plant 'Arogyapacha' (*Trichopus zeylanicus* sub. sp. *travancoricus*)

The varied habitats of the BR houses a sizable number of flora, fauna and microbes including large number of endemic and RET species having special relevance to conservation. The following species, listed as possibly extinct, viz., *Ardisia blatteri, Calliandra cynometroides, Cissampelopsis ansteadii, Cordia octandra, Garcinia imberti, Madhuca bourdillonii, Palaquium bourdillonii, Pavetta praeterita, Sageraea grandiflora, Syzygium bourdillonii* are present in this reserve and collected for the first time after their first discovery. The endemic and little known species such as *Aganope agastyamalayana, Canthium agastyamalayanum, Hedyotis kottangathattii, Hedyotis peyyarrensis, Hedyotis ramarowii var. Kannikattica, Hedyotis tirunelveliensis, Impatiens tirunelvelica, Ixora tirunelvelica, Memecylon gopalanii, Memecylon manickamii, Memecylon mundanthuraianum, Memecylon tirunelvelicum, Polyalthia tirunelveliensis, Sonerila vaniyangalpodavana, Teucrium ramaswamii, Xanthophyllum manickamii, Andrographis rava, Andrographis, Asystasia travancorica, Barleria nitida, Barleria pilosa, Blepharis lawsonii, Dianthera wallichi, Diotacanthus albiflorus, Diotacanthus grandis, Justicia salsoloides, Lepidagathis pungens, Lepidagathis* sp., *Stenosiphonium parviflorum, Stenosiphonium wightii, Aerva wightii, Gluta travancorica, Holigarna arnottiana, Holigarna beddomei,* etc., are also reported from this BR.

The important faunal elements which need protection are nilgiri langur, liontailed macaque and brown palm civet among the 43 mammals endemic to Western Ghats. There are three reptiles (*Calotes elliotti, Ristella beddomii* and

Brachiophidium rhodogaster), nine amphibians (*Gegenophis ramaswami, Indirana beddomii, I. leithii, Rana semipalmatus, R. temporalis, Philuatus leucorhinus, Micrixalum fuseus, Nyctibatrachus major, Rhacophorus malabaricus*) and three fishes (*Bataiso travancorica, Parambassis thomassi, Batasio travancoria*) considered endemic to the reserve. They are not only endemic but also come under various threat categories of conservation.

New species like Ceylon frogmouth, forest eagle owl, brown wood owl, short-toed eagle, yellow checked tit, etc., are also reported from this Biosphere. The travancore laughing thrust is another valuable member of the birds in this reserve. Southern bird wing, malabar rose, malabar tree nymph, blue oak leaf, red helen, buddha and blue banded peacock, spotted puffin, southern duffer, blue pansy, malabar raven and map butterfly are rare and endemic butterflies of this reserve. The above mentioned flora and faunal species are of conservational importance and by harbouring them the BR is contributing significantly to the global biodiversity pool.

14.6. Progression of Conservation and Management

As the reserve is spread over states of Kerala and Tamil Nadu and accommodates wildlife sanctuaries and tiger reserves, both the states promulgated suitable orders for protecting this areas from time to time. Mundanthurai sanctuary was formed in 1962 (G.O. Ms. No. 2556) by Food and Agriculture Department, dated: 02.08.1962 under the wild birds and animal protection act 1912 primarily for the conservation of Tiger. Kalakad sanctuary was notified in G. O. Ms. No. 183 by Forest and fisheries department dated: 06.03.1976 to conserve lion tailed macaque. Kanyakumari sanctuary including Veerapulai and Klamalai RF was notified vide G. O. Ms. No. 156, by Environment and Forest department, dated: 16.07.2002. Neyyar Wild Sanctuary was constituted as per notification no G. O. (MS) 781/58/ad dated: 06.08.1958 and the boundaries were subsequently modified vide G. O. Ms. No. 2305/f2/71/AD dated: 18.03.1971 by adding Neyyar reservoir area as part of the wildlife sanctuary. Peppara Wildlife Sanctuary was constituted during the year 1983 vide G. O. (P) No. 379/83/AD dated: 21.12.1983 by the department of Forests and Wildlife. Among others, the following acts at present ensure the protection of the reserve.

- Wildlife Protection Act, 1972
- Forest Conservation Act, 1980 with effect from 26.10.1980
- Kerala Forest Act, 1961
- Kerala Private Forest (vesting and Assignment) Act, 1971
- Tamil Nadu Forest Act, 1882.

The Management of the Biosphere Reserve is more comprehensive and dynamic system and requires long term management perspective values which should encompass a participatory role for all concerns, targeting on a strong enforcement, development, public awareness, education and training, etc. Therefore, concrete efforts are being initiated to integrate the disparate ventures on biodiversity conservation, natural resource management and community development. Projects are being implemented to impart training to the tribals for the NWFPs harvest, fire management, soil conservation, cultivation practices, medicinal plant collection etc. The Eco-development activities initiated by State forest departments brought about a wholesome change in the livelihood pattern of the villagers bordering the biosphere reserve. Eco-development may be defined as “the process of bringing about better protection and management of the protected areas in participation with the forest fringe dwellers”. The process involves participatory planning and implementation of activities which reduce forest dependency and at the same time provide more productive livelihoods. The democratic functioning of participatory structures ensures empowerment and economic upliftment particularly of tribal populations. It essentially aims to reduce dependency of the forest fringe dwellers like cattle grazing, encroachment, illicit timber and non-timber forest produce collection, poaching etc. by providing them sustainable alternative livelihood. This is made possible by micro financing linked with micro enterprises and by promoting self help groups through revolving fund at village level set up initially by a seed grant. The basic philosophy involves ecological development of the forest through the economic development of the forest fringe dwellers by adopting a strategy of micro credit. The system is working very well in this biosphere reserve with active involvement of forest and other line Govt. departments

In view of long term maintenance of landscapes, ecosystem components and sustainable utilization of its resources, a set of research and monitoring programmes have been executed by R & D institutions, University departments, colleges etc, with the financial support from state and central government organizations. The research programmes includes climatology and edaphology, mapping and monitoring of vegetation and land use, survey of flora, fauna, microorganisms etc, ethnobiology, medicinal plants, wildlife corridors, ecology and phytogeographical affinities of floral elements, habitat monitoring, restoration of RET species, meteorological and hydrological monitoring, impacts of human interference etc. The results obtained from these studies are incorporated in the working plans of the Biosphere Reserve.

Considering long term maintenance of landscapes, ecosystem components and sustainable utilization of its resources, a set of research and monitoring programmes have been executed in the reserve which includes climatology, mapping and monitoring of vegetation and land use, survey of flora, fauna, microorganisms, etc., floral elements, habitat monitoring, restoration of RET species, meteorological and hydrological monitoring, impacts of human interference, etc.

14.7. Issues and Concerns

The reserve is located in close proximity to many towns and villages and therefore facing heavy population pressure on the resources and which affect the ecosystem functioning to some extent. The issues are mostly of socio – economic nature due to conflict of interest of various stakeholders. The reserve is being subjected to cater the need of developmental projects like hydro electric schemes, extension of agriculture, road and townships, gracing, encroachment, collection of NWFPs etc. However, the impacts are now contained to the barest minimum by the authorities with the help of local participation. The State level steering committees for Biosphere reserve have been constituted for co-ordination between various government departments, organizations, etc. District co-ordination committees have also been setup for local co-ordination. Facilities are being created for undertaking research programmes funded by National and International organizations on conservation, eco-restoration and related areas.

14.7.1. Improving livelihood options to inhabitants

The core zone is a protected zone where human interference is kept bearest minimum. The area coming under the core zone consists of Pandimottai, Alwarkurichi, Umayar, Aruliyar, Kariyar, Kannikatty, Narathar, Dharbhakulam etc. All forms of biotic interference are strictly regulated except scientific studies contributing to better management and enhancement of the quality of biodiversity. The vegetation of buffer zone mainly consists of southern secondary moist mixed deciduous forests and west coast semi-evergreen forests. Since the pressure of human population within the reserve pose severe conservation problem, the efforts are directed towards their effective rehabilitation. The west coast semi-evergreen forests of this area are in a stage of degradation so that effective measures are being taken to rehabilitate these areas through afforestation with the help of scientific organizations and local people.

14.7.2. Tourism

Tourism contributes significantly for improving the quality of life of indigenous and local communities by way of generation of substantial income. Ecotourism activities are at present helping in the development and protection of sanctuaries and the reserve forests by educating the public through eco-education, nature campus, interpretation centre etc. Through the ecotourism the tribals' knowledge on medicinal plants and other resources are increasingly getting acknowledged. However, piling of plastics pose major environmental problem. Measures are being taken to minimize the use, periodic lifting, processing and recycling of wastes. Other impacts are vandalism, causing forest fire, soil erosion, disturbance to the wild animals, etc. Boating and many other tourism facilities in the reservoir are, however, badly affecting fishes and birds.

14. 8. Perspective Plan

It is now well recognized that Biosphere Reserves are amongst internationally accepted areas with well co-

In the reserve, all forms of biotic interferences are strictly regulated except scientific studies contributing to better management and enhancement of the quality of biodiversity.

ordinated functions to ensure environmental, economic and social sustainability at national, regional and global levels. The concept promotes harmonious integration of people and nature for sustainable development through participatory approach, knowledge sharing, human well-being improvement and respect for cultural and social values. In short, the biosphere reserves serve as learning sites for sustainable development. At present, the reserve is protected based on the prescriptions in the management plan prepared by both the states in their respective areas. However, for realizing the significant role played by the BRs in promoting the ecosystem services, it is felt necessary to have a five year perspective plan to serve protection to production function of landscape and ecosystems which encompass the reserve. For preparing the perspective plan,

Ecotourism activities are at present helping in the development and protection of sanctuaries and the reserve forests by educating the public through eco-education, nature camps, interpretation centre, etc.

the Madrid action plan adopted by UNESCO during February 2008, gave guidelines with 4 major action areas, 31 targets and 65 actions. These guidelines need to be appropriately followed in preparation of perspective plan to face the new challenges in an ever changing world to achieve the larger objectives of sustainable development in the 21st Century. Both Research and Development priorities of the reserve and surroundings need to be kept in mind while preparing such a plan.

14.9. Success stories

Among others the BR is well placed by implementing the following measures through Vanasamrakshna Samithi and Eco development committees with local people.

- Protection against grazing, illicit collection of timber, firewood, poaching, smuggling, fire, etc.
- Habitat improvement and restoration of degraded forests with local flora.
- Eco-development activities in the villages adjoining the biosphere reserve to effectively reduce human pressure on the protected area.
- Regulation of pilgrimage to Agasthyamala during holy season.
- Collection of NWFPs by the tribals through Eco-development committees.
- Regulated ecotourism activities at Shedurney, Peppara and Neyyar Wildlife Sanctuaries and effective disposal of plastic wastes by manual collection.
- Research activities on biotic and abiotic components for scientific management.

AG Pandurangan
Co-ordinator, BR. Programme
Tropical Botanic Garden and Research Institute
Palode, Thiruvananthapuram -695 562 (INDIA)
Phone: + 91-472 2869226, 2869246
Fax: + 91-472 2869646

RK Rai
Ministry of Environment and Forests, CGO Complex
Lodi Road, New Delhi 110 003 (INDIA)

15
Achanakmar - Amarkantak Biosphere Reserve - Central Highlands, India

15.1. Introduction

The Achanakmar-Amarkantak Biosphere Reserve was notified by Government of India on 30 March 2005 as the 14th Biosphere Reserve in India. The reserve spreads from Maikal hill ranges to the junction of Vindhyan and Satpura hill ranges forming a triangular shape in Chhattisgarh and Madhya Pradesh states of Indian Union.

Designation Date	:	30 March 2005
Total Area	:	3,835.51 km^2
Core Area	:	551.55 km^2
Buffer Area	:	1,955.87 km^2
Transition Area	:	1,328.09 km^2
Extent	:	21°15' and 22°58 N 81°25' and 82°5' E

15. 2. Area Description

This BR lies between the parallels of latitude 21°15' to 22°58' North and longitude 81°25' and 82° 5' East. It falls

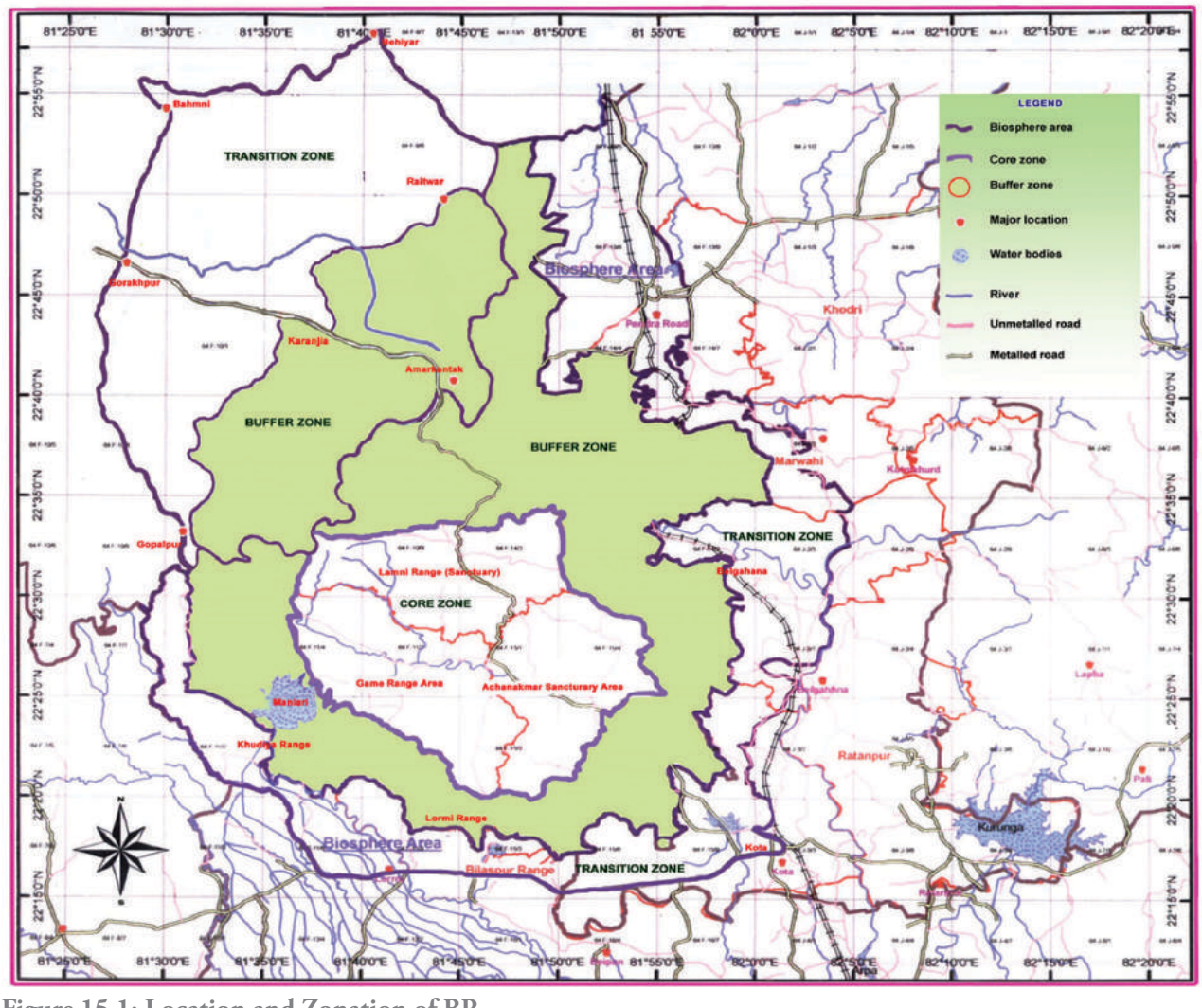


Figure 15.1: Location and Zonation of BR



in Malayan realm, Tropical Dry or Deciduous Forest Biome and Deccan Peninsula bio-geographic zone of the country. Its total geographical area is 3835.51 km^2. The core zone, which falls in Bilaspur district of Chhattisgarh state, is dense forest with terrains of hills and valleys and spread over an area of 551.55 km^2. Being a Wildlife Sanctuary it is protected to conserve its richness of flora and fauna. Of the total buffer and transition area, 2058.98 km^2 falls in Bilaspur district of Chhattisgarh state and 1224.94 km^2 in Dindori and Anuppur districts of Madhya Pradesh state (Figure 15.1). The topography varies from plain rice fields of Bilaspur and Anuppur districts and wheat fields of Dindori district to the hills of Maikal range of Satpura. The BR is well connected by road from Bilaspur and Raipur of Chhattisgarh and Anuppur and Shahdol of Madhya Pradesh.

The drainage system of the reserve consists of three major rivers originating from the buffer zone, viz. the Narmada River flowing towards West of its origin; the Johilla and the Sone rivers flowing towards North of the BR. A water check dam viz. Khudia dam situated in the Maniari River towards south-west of the reserve. Many streams and seasonal rivers fulfil the needs of inhabitants and wildlife. The area has many seasonal streams and rivers which help to restore the sustainability of various flora and fauna existing in different zones.

15. 3. Background Information

15.3.1. Land use history

The current core area of Achanakmar-Amarkantak BR was declared as a Reserve Forest in 1878 by notification No. 5037 dated 7th Dec. 1878 under Section 34 of the Indian Forest Act VII. Later on, it was given under the Zamindari system to Pendra Zamindar (Landowner). In 1912, Government of India advised the Zamindar to introduce the fire protection measures and removal of climbers and regularisation of Nistar, but he failed to follow the instructions. The area was cut and burnt and system of shifting cultivation, locally known as 'podu' or 'bewar', was practised by the baiga and other tribal inhabitants especially on the steep slopes of Maikal range. Under this practice, the sal forests were cleared and cultivated for 2-3 years by tribal and then abandoned following shifting to another area. This practice had long lasting effect on vegetation cover or composition giving rise to mixed species with poor regeneration. Later on, a working scheme was introduced by Government in the area to preserve the forest cover and improve its depletion. The practice was then restricted to a limited area.

In 1928, Mr. C.M. Wilfer prepared a working plan of Pendra Zamindari. In the initial years Pendra Zamindar followed some of the prescriptions and a large number of irregular felling of tree were done through contractors led to heavy irregular over exploitation. This tradition of felling was continued up to 1951. To check the deterioration, Government decided to take over the management of these forests by abolition of proprietary rights in the state, and transferring them to the forest department vide notification no. 28 of CR/299 XII dated 07-05-51. After abolishing the proprietary rights, the Government of Madhya Pradesh declared it as Protected Forest under adhoc notification No. 233-X and 9-X-59 dated 9-3-1957 and 10-7-1958 respectively. Minor alteration of afforestation and deforestation occurred in later years. The forests of the reserve were notified under section 241 of the Madhya Pradesh Land Revenue code 1959 vide Govt. of M.P. notification no. 7102/6006/VII dated 27-12-63 and no. 7/06/7-C/2 dated 03-09-64. These were the special significance for the protection and control of the Government forests in the tract. The area was surveyed some times during 1955 to 1963. Considering sufficient number of wildlife, the M.P. Government under the provision of section 66(4) of the wildlife protection Act 1972 declared the area as Achanakmar Game Sanctuary vide notification no. 2649-966-10-2-75 dated 28th June 1975. Subsequently, the Government of M.P. declared the present core area of the BR as reserve forest under Indian Forest Act Sec 34 vide notification no. 5037 dated 07/12/1978. After enforcement of Wildlife Protection Act, all the forestry works including collection of NTFPs were stopped by Government. However, to improve the degraded compartments a few teak plantations were done between the years 1952 to 1978.

15.3.2. Inhabitants

Nearly 7,617 traditional primitive tribal inhabitants, as per the population census of the year 2001, are settled in 22 villages of the core zone. The buffer and transition zones

Among tribes, residing in BR, notable are Baiga, Gond, Kol, Kanwar, Pradhan and Panka. The baigas are primitive Dravidian tribe. They are the most ancient, remarkable and delightful oldest tribe of India. They migrated from eastern Satpura hills and settled in Bilaspur district of the reserve. They use to avoid tilling and ploughing due to their rituals and beliefs. Presently, the baigas are dominant in population and ranked on the top among the other tribal communities in the BR. They are settled in maximum numbers at Mahamai followed by Chhaparwa, Jalda, Lamni, Rajak and Surhi. They get fuel, fodder, edible roots and tubers from forest besides cultivating some seasonal agricultural crops in small areas. Mahamai village has two hamlets namely Babutola and Ghameri where 13 and 45 families are living from last 10 to 15 years. Baiga is an endogamous group. The population of baiga is increasing due to the high birth rate and immigration from other parts of the state. Now, some of them have come forward and changed their primitive lifestyle. Gonds also have their origin from Dravid culture. Gond of core area is known by Pathare Gond and Singraulia Gond based on their place of migration. Their economy is largely dependent on agricultural labour. Kols migrated to Madhya Pradesh and Chattishgarh from Singhbhum district of Jharkhand province. In the present boundaries of the BR, they are settled at Achanakmar, Bindawal, Bamhani, Chhaparwa, Jakadbandha and Lamni. Kanwar refers to their origin to Mahabharata times. They constitute two types of family, i.e. single and joint family. Majority of them, live as single family. Oraons are also Dravidians tribe migrated from Chotta Nagpur. Some of them have come from Sarguja district and settled in BR in early eighties. They are mobile/ traveller community with a tradition of ready acceptance of innovations. Oraons are now settled in Surhi, Jakadbandha, Daganiya, Mahamai (core zone) and Jamunahi, Ghameri and Babutola (transition zone). Besides this, traders have also

of BR comprises of 399 villages and sub urban areas with a population of 4,40,404 persons. Major residential areas or settlements namely Kota, Khondri, Dindori, Amarkantak, Pendra road, Karanjiya, Gorakhpur, Lormi, Akhrar, Rajendragram and some revenue and forest villages like Jagatpur, Kabir, Rajki, Boirha and Sarasdol exist in buffer and transition zones. All together, there are 27 communities living in different zones of the BR. These include Baiga, Gond, Dhanwar, Kol, Kanwar, oraon, Chamar, Sais (Sarthi), Basore, Lonia, Muslim, Sindhi, Brahmin, Rajput, Goswami, Baraith, Kalar, kumhar, Kewat, Nai, Ahir (Raut), Panika, Sondhiya, Lohar, Maratha, Sonar and Baniya, etc.

migrated from nearby areas. They are now settled in some sub urban localities like Kota, Gorakhpur, Amarkantak.

15.3.3. Cultural heritage

The sub urban township Amarkantak, situated in the buffer zone of the BR, is of great cultural and religious significance for Hindus, Jains and Sikhs. It is the origin place of the holy Narmada, the Sone and the Johilla rivers. It is said that Adi Sankaracharya, who was born in 788 AD, consecrated on the bank of the river Narmada at Amarkantak. He laid foundation of Pataleshwar Mahadev at the origin of river Narmada. This place was later named as Surajkund. Kalchuri Maharaja Karna Dev (1042-1072 AD) constructed temple at Surajkund. An open pool has been constructed at the origin of the Narmada river, which is known as Narmadakund. A number of temples such as Narmada temple, Shiva temple, Shri Shuryanarayan temple, Durga temple, etc., surround the Narmadakund. The ancient temples of Kalchuri period, Machhendranath and Pataleshwar are excellent examples of architecture. It is said that Gods, Gandharvas, Asuras (demons), saints and sages achieved their spiritual powers at Amarkantak. Kapil Muni, Bhrigu Rishi and Markandeya Rishi are believed to had their ashrams here. Devotees from different states, throughout the year, visit these temples and ashrams.

15.3.4. Landscape features that attract visitors

Amarkantak plateau, Lamni and Achanakmar forest ranges, many permanent and seasonal waterfalls like Durgadhara, Shambhudhara, Kapildhara, Mendri Sarai fall and water reservoirs like Sinhwal-sagar lake provide aesthetic value to the area and have scenic spots. The cool, calm, dense sal forest with a variety of wild fauna, also attract the tourists. A number of tourists visit the core and buffer zones of BR for enjoying its wilderness and wildlife. The trend of number of tourists visiting Achanakmar and Lamni has continuously increased in the recent years. Students from nearby universities, researchers from various research organisations

The forest types found in the BR are: Northern Indian Tropical Moist Deciduous Forests, Northern Indian Moist Deciduous Forests and Northern Tropical Dry Deciduous Forests and their subtypes.

of the country often come for various studies related to floral and faunal taxonomy, ecology, animal behaviour, etc.

15.4. Special Features

The reserve area forms a part of the Satpura and Vindhyachal mountain series with valleys in between. It separates the planes of northern India and the Indian peninsula. The vegetation or forest types and subtypes met in the reserve are: Northern Indian Tropical Moist Deciduous Forests, subtype Northern Indian Moist Deciduous Forests consisting of Moist Peninsular sal forest-moist high level sal forest, moist low level sal forest, moist valley sal forest and Northern Indian Moist Deciduous Forests sub-type Moist Mixed Deciduous Forests Northern Tropical Dry Deciduous Forests subtypes Dry Peninsular sal Forests and Northern Dry Mixed Deciduous Forests. The present BR encompasses a variety of ecosystem like sal forest, mixed forest, degraded

forest and agro-forestry ecosystems. The various floral and faunal species have evolved due to geographical barriers, likewise various micro and macro ecosystems have evolved or undergoing evolution, following hydrological and mineral cycling, climate change, etc. There are many other important aspects, where serious research efforts can unfold the global importance of the area in the interest of mankind.

The tribal communities living in most of the villages near water sources of the BR have small families. They are partially dependant on forest for food, and fully dependant for fodder and fuel, besides farming in small forest land. They work as labourers and often engaged by the reserve managers for various habitat improvement activities. They also move in forest to collect honey, lac, silk cocoon, mushroom, rhizomes of Dioscorea, flowers of mahua (*Madhuca indica*), fruits of chironji (*Buchnania lanzan*), custard apple, mango, aonla (*Emblica officinalis*), imli (*Tamarindus indicus*), etc., in a sustainable manner for their day to day use and marketing of the surplus in the weekly tribal market for cash income. The inhabitants of thickly populated villages have constituted forest protection committees, eco- development committees and village panchayats, which help them in their socio-economic development.

The inhabitants are, however, allowed to collect NTFPs for their domestic needs besides being cultivating some crops around their settlement area. Similar benefits are provided to the inhabitants of buffer and transition zones of the BR. They are allowed to collect NTFPs on sustainable manner and sell their collected material to Chhattisgarh MFP Co-operative Federation Ltd and M.P. State MFP Federation Ltd. Meetings and workshops are often arranged to discuss on the research priorities of the reserve and inhabitants residing therein. In general, following priorities have been identified:

- Identification of factors that lead to habitat and environmental degradation and their ecological rehabilitation.
- Taxonomical identification of various species of flora, their population status, type of threats to them and their qualitative assessment.
- Sustainable use of natural resources, in-situ and ex-situ conservation of rare, endemic and threatened species to prevent them from extinction.
- Identification of appropriate technology for conservation and evaluation of environmental efficiency and steps for protection of fragile and vulnerable ecosystem.
- Basic needs of the rural population in BR are the improved agricultural and horticultural practices including improved varieties, fodder, etc., education and training to improve socio-economic status of inhabitants. Water conservation techniques by encouraging construction of small stop dams in buffer zone, harvesting and utilization of rainwater, etc.
- Exploration of alternative means of livelihood and income generation by motivating tribal on latest techniques of silk, lac, honey extraction, eco-tourism, etc.

15.5. Biodiversity Values

15.5.1. Flora and Fauna

The reserve is very rich in biodiversity components and comprises of 1498 species of identified flora, 327 species of identified fauna and many more un-described floral and faunal taxa. Plant species like the lichen *Caloplaca amarkantakana* (Fam: Teloschistaceae), fern *Isoetes bilaspurensis* (Fam. Isoetaceae) and an angiosperm *Bothrichloa grahamii* (Fam: Poaceae) are endemic to this region. Thirty five threatened species of flora and 55 threatened species of fauna belonging to various groups have been identified and assigned different threat categories regionally as well as globally following IUCN criteria.

The pteridophyte, like, *Ceratopteris thalictroides* (syn. *Acrostichum thalictroides*), *Cheilanthes rufa* (syn. *Aleuritopteris rufa*), *Dryoathyrium boryanum* (syn. *Aspidium boryanum*, *Lastrea boryana, Phegopteris kingie*), *Marginaria macrocarpa, Microsorium membranaceum* (syn. *Polypodium membranaceum, Pleopeltis membranaceum*), *Polystichum auriculatum* (syn. *P. harpohyllum*), *Pteris quadriaurita* have been reported since 1970. Species of ferns like *Adiantum capillus veneris* and *Lygodium flexuosum* are endangered. Among angiosperms, *Rauvolfia serpentina* is critically endangered whereas *Clerodendrum serratum, Acorus calamus*, and *Eulophia herbacea* are endangered locally as well as at regional level. Remaining 22 species are vulnerable. Among fauna, there are 2 critically endangered species, viz. *Philautus sanctisilvaticus* (Amphibia: Hylidae),

Recorded bio-diversity of the reserve

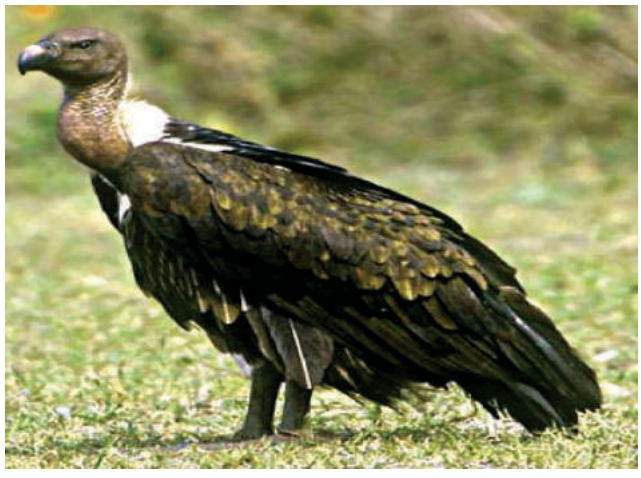
Flora

Angiosperms	-	1111
Gymnosperms	-	16
Pteridophytes	-	40
Bryophytes	-	16
Lichens	-	130
Fungi	-	178
Algae	-	7

Fauna

Mammals	-	27
Birds	-	142
Lizards & Snakes	-	15
Amphibians	-	10
Pisces	-	16
Beetles & Cricket	-	27
Butterflies & Moth	-	85
Centipedes	-	5

Gyps bengalensis (Aves: Accipitridae) and 2 endangered fauna, viz. *Notopterus chitala* (Pisces: Notopteridae), *Panthera tigris* (Mammalia: Felidae). Besides, 51 low risk to vulnerable species as per IUCN categorization have been reported. The reserve is a known habitat for animals like tiger, bison, bear, spotted deer, barking deer, wild cat, fox, wild dog, sambhar, four horned antelope, mouse deer, etc. It has rugged terrain as well as grasslands giving shelter to wildlife in all seasons. Rich dense forests dominated by sal and its associates give way to high precipitation further enhancing and promoting moist habitat and supported plant diversity. Besides this, there are 518 floral species of food and medicinal values. Seven of them are pteridophytes whereas remaining 511 species are flowering plants. Investigations on sustainable harvesting of many species was done during



past and studies on some of them are in progress.

15.6. Issues and Concerns

15.6.1. Higher dependency of inhabitants on BR

Almost all the families living in villages have cattle, which are fully dependant on the reserve for grazing. The villages are also dependant on BR for firewood and NTFPs. About 8233 tonnes of 47 items of NTFPs with a total value of more than 2.70 crores are collected by local tribals from Amarkantak plateau. The income realized through the sale of NTFPs is reported from Rs. 28,234 to Rs. 28,325 thousand per annum.

15.6.2. Man animal conflicts

The conflict making animals in Achanakmar- Amarkantak are the snakes, small mammals like wild boar, large carnivores like leopard, tiger, sloth bear, etc. Marwahi Forest Division of the BR is well known for human-sloth bear conflict. The maximum incidences due to mauling are reported to be caused by sloth bear followed by jackals, leopards, hyena, wild boar and bison. The reason is probably due to degradation of forest areas, fragmented and interspersed agricultural fields. Restoration of sloth bear habitat in degraded areas may help to check the conflict between sloth bear, leopards, etc. and human inhabitants in the BR.

15.6.3. Fire protection

Frequent fire is a major problem in some areas where inhabitants burn the ground debris in March-April to facilitate collection of Mahua flowers and getting better quality of tendu leaves. It destroys the regenerating saplings and season's seedlings besides wiping out the ground flora. Forest Protection Committees have been constituted in fire prone areas to prevent the ground flora. Some efforts are to be done to prevent fire in the BR.

15.6.4. Illegal poaching and harvesting

In spite of strict vigilance, illegal poaching activities in the BR are not uncommon. Similarly, illegal felling and harvesting of NTFP is also reported. The forest protection committees have been constituted by BR managers in villages to prevent the illegal activities. They are also strictly vigilant and check gates are operating at the approachable roads.

15.7. Perspective 5 year Plan

The effective Management is a way that ensures community participation in conservation and utilization of the resources in a sustainable manner as well as evolves new means to secure economic well-beings of community. The Ist perspective 5 year plan of the BR was prepared during the year 2005 soon after its notification as the 14th Biosphere Reserve of the country. Various developmental activities for 5 years (2005-06 to 2009-10) were planned and discussed in State Level Steering Committee. The plan for Rs. 797.92 lac was approved and submitted to Government of India, Ministry of Environment & Forests, New Delhi, which sanctioned a sum of Rs. 126.82 lac to initiate the work as per the plan. The activities of the plan are as follows:

15.7.1. Conservation

- Habitat Improvement by Soil & moisture conservation through construction of check dams, retaining wall landscape zone, Grass meadow development & plantation, Rehabilitation of degraded bamboo forests.
- *In-situ* and *ex-situ* conservation of plant species
- Monitoring of Biodiversity change in selected areas.
- Conservation of indigenous species of fruit plants and Minor Forest Produce.

15.7.2. Eco-development and livelihood security

- Sanitation by construction of toilets in semi-urban centres, Development of infra-structure like Patrolling camps, forest roads, etc.
- Eco-development of revenue areas by digging wells, etc., Promotion of fuel wood/ fodder species and intensive planting in Private Community lands.

- Promotion of non-conventional energy by providing LPG connection in school and semi-urban areas and distribution of solar lamps.
- Promotion of activities for increasing crop production and manure by construction of Irrigation check dams, field channels, promotion of biogas and vermicompost.
- Promotion of mushroom cultivation, lac cultivation pruning, supply of Tussar reeling Charkha, collection of honey, collection and processing of Mahul leaves, promotion of biodiesel plants.

15.7.3. Capacity building and awareness generation

- Conservation of ancient places and Natural Heritage sites, Religious tourism and management of solid waste.
- Awareness campaign by development of Interpretation Centre, Nature trails and Trekking routes and promotion of tourist facilities.
- Establishment of Herbarium & interpretation of local flora.
- Training-cum-workshop for implementing agencies.
- Organization of nature camp for school children.
- Organizing of Jaiv Mandal Yatra.
- Installation of publicity sign boards, publication, purchase of books, video film, posters, brochures, etc.
- Skill Development.

15.7.4. Management studies

- Short term feasibility studies like Environment Management Plan for BR and its surrounding areas using GIs technique, Ensuring fodder availability at 4 selected localities, and study of Change in socio-economic status based on census from 1991 to 2001.

15.7.5. Implementation strategy

On the basis of approved annual action plan, the priority activities are decided every year in the meetings of State Level Steering Committee. Accordingly, the fund is allocated by Government of India, Ministry of Environment & Forests for infra structure development, habitat improvement, village development, socio-economic upliftment, development of communication, ecotourism, *in-situ* and *ex-situ* conservation of plant species, promotion of non-conventional energy, promotion of activities for increasing crop production, manure production and, social welfare activities, etc., to State Government, who releases the fund to the BR management for implementing the various activities. Besides this, other agencies like Sericulture and Khadi Gramodyog department (Government of India) is also providing trainings to the inhabitants of transition zone of BR and supports them financially and technologically in wild silk production. Universities, Research Organisations and Non-Government Organisations are also financed by the Government of India as well as by the State Governments for taxonomical identification of various flora and fauna, and to increase the socio-economic status of inhabitants by maintaining their symbiotic and sustainable livelihood. The Tribal Welfare department also takes care of inhabitants by way of contributing for their education and health.

15.8. Benefits, Constraints and Opportunities

The topography, soil and climate of the reserve favour luxuriant growth of the flora. Protection provided to the flora and fauna helpes in preserving the gene pool of various endemic and rare species of the region. The average annual rainfall of the BR varies from 1322 mm to 1624 mm. There are many seasonal monsoon dependent and permanent streams, rivers like the Narmada, the Johilla and the Sone. But, the watershed management schemes are poorly developed. Only two check dams viz. Khudia dam on Maniary river and Sinhwal sagar lake are available to cater to the needs of various fauna of the BR during the dry season. Therefore, a few more stop dams need to be constructed to retain the water in at least core and buffer zones, so that, the movement of the wild animals could be restricted up to the core zone and the conflict between wild animals and man are minimised. Frequent movement of heavy vehicles during day hours as well as human settlements disturb the wild animals. Discouraging movement of heavy vehicles and new settlements in core zone can improve the present situation. Efforts to motivate inhabitants of two villages to shift from core zone to transition zone will have the fruitful results. There are many opportunities to develop the ecotourism in the BR. Tourist huts and rest houses at Lamni, Chhaparwa and Achanakmar are available for stay and early morning visits to witness the wildlife and site seeing. Development of herbarium, interpretation centre at Achanakmar may attract more visitors to the Achanakmar- Amarakantak BR.

15. 9. Success Stories

15.9.1. Successful initiatives for sustainable NTFP collection

- Earlier nearby traders of medicinal plants and other NTFPs used to purchase the raw material from the local poor tribal people at very nominal rates and to earn more, the tribal would over-exploit the raw material from the forest. Towards addressing this issue,

the State Forest Department of Chhattisgarh and Madhya Pradesh constituted Minor Forest Produce Co-operative Federations, which started helping the inhabitants technically in collection and then arranging the market for the harvested raw material. As a result currently various forest produces such as, Lac, honey, mahul leaves and many species of medicinal plants are collected by the inhabitants in sustainable manner from different ranges of the BR.

- In some ranges of the BR, forest protection committees or Van Surakshya Samiti have been constituted by the villagers. The members of these committees rear the silkworm on naturally occurring small bushes and trees of *Terminalia arjuna* and *T. tomentosa.* The cocoons developed from these worms are sold to Seed Multiplication and Training Centre, Central Silk Board, Bilaspur or even to local traders. The yield is taken in July- August and October – November and the income earned is Rs. 15375 to 46059 per year during 2005-06 and 23006-07. The silkworm cocoon production has helped in reducing the migration of villagers to nearby towns in search of jobs. It has also checked felling and lopping of trees in the areas where the silkworm breeds naturally on its hosts.

15.9.2. Systematic documentation and dissemination of information on BR

- Systematic documentation of flora, fauna and their dissemination to users, including BR managers, scientists and academicians have helped them in further identification of priority areas for further study and management intervention.

15.9.3. Successful protection of core area

- Various conservation and development activities in the buffer and transition zones have provided sufficient natural resources, which have helped in minimising the people's pressure on the core area.

KC Joshi
Nodal Person, Lead Institute to
Achanakmar- Amarkantak BR

Ruby Sharma
Tropical Forest research Institute
Mandla Road, Jabalpur- 482021 (M.P.), India
Phone : + 91-761-2840634
Fax : + 91-761-4044002, 2840484
eMail : kcjoshi21@rediffmail.com

16
Kachchh Biosphere Reserve - Kachchh Desert, India

16.1. Introduction

The Kachchh Biosphere Reserve (KBR), the fifteenth Biosphere Reserve designated by Government of India, represents unique combination of saline deserts, namely , Great Rann of Kachchh (GRK) and Little Rann of Kachchh (LRK) and seasonal wetlands. Wild Ass Sanctuary (4,954 km²) in LRK and Kachchh Desert Sanctuary (7,560 km²) in GRK constitute major portion of the reserve. It has been included in India's Biosphere Reserves network since January 2008 in recognition of uniqueness of the vast area.

16. 2. Area Description

Kachchh Biosphere Reserve (22°55' N - 23°55' N Latitudes and 69°05' E - 71°50' E Longitudes) is located in the western part of Gujarat state. Its entire area (12,454 km²) is spread over Patan, Surendranagar and Rajkot districts of Saurashtra region, Banaskantha of North Gujarat region and Kachchh district of Kachchh region. The boundary of the KBR consists of 343 villages, of which 188 are in Kachchh, 81 in Patan, 29 in Surendanagar, 14 in Rajkot, and 31 in Banaskantha. These villages are located within 1km distance from the periphery of the reserve.

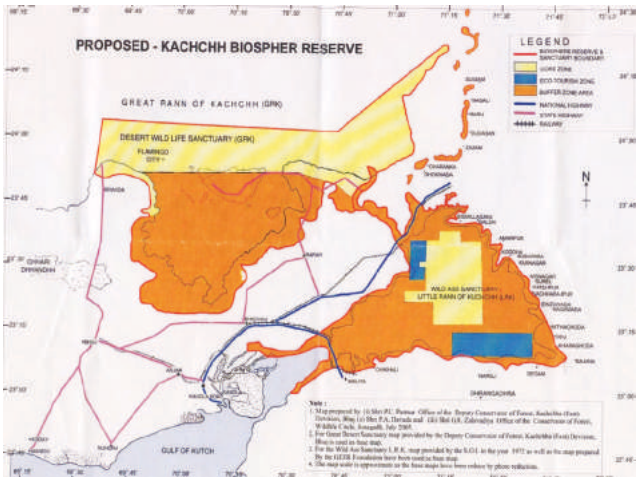


Figure 16.1: Kachchh Biosphere Reserve (Source: Kachchh Biosphere Reserve-A Management Plan for Protection, Conservation, Research & Development, GFD, 2005)

Designation Date	:	29 January 2008
Total Area	:	12,454 km²
Core Area	:	4,455 km²
Buffer Area	:	7,999 km²
Transition Area	:	Fringe area of the width of 5 km (proposed)
Extent	:	22°55' and 23°55' N 69°05' and 71°50' E

16.2.1. Zonation details

The core zone having an area of 4,455 km², which includes two Protected Areas [Kachchh Desert Wildlife Sanctuary (KDS) in GRK and the Wild Ass Sanctuary (WAS) in LRK] represents richness of species with many rarities of both flora and fauna.

The famous Flamingo City- the only area of the country where flamingos breed in enormous congregation during years with favourable breeding conditions- is located in the core zone of the reserve

The core zone includes the uppermost portion of GRK and mid-portion of LRK. The core zone is not only endowed with diverse flora and fauna peculiar to the saline desert-cum-wetland ecosystems, but also possesses some rarities of species and ecological peculiarities. The famous 'Flamingo City'-is located in the core zone. It is the only area in the country where flamingos congregrate in enoromus number to breed during the years with favourable breeding conditions.The core zone is also significant considering the presence of some islands that are locally called "Bets". These are elevated areas of land of various sizes that remain above water when the Rann gets flooded with water. As such, 98% of core area is under mud-flat and remaining 2% forms 'bets'.

The buffer zone is vast (7,999km²) and mainly covers area of Great Rann south to Desert Wildlife Sanctuary in GRK and

area of Little Rann surrounding the Wild Ass Sanctuary in Little Rann. It also includes the "neck portion" that connects LRK and GRK.

The transition zone of KBR is yet to be finalised. Five km wide belt around fringes of Ranns is proposed as transition zone.

16.2.2. Biogeographic characteristics

The Reserve is located in the Kachchh Desert biogeographic province (3A) of the Indian Desert Bio-geographic zone.

The biogeographic characteristics of reserve are represented by the biogeography of two Ranns. The Great Rann owes its origin to the transgression of the sea waters of the Arabian Sea entering through the Kori Creek. The gradual regression of the sea level is clearly shown by the presence of marine calcareous grit and oyster bed as also the swash marks and water line at the height of several meters from the present water level at the Pachchham *Bet* within the Great Rann. Great Rann can be divided in three zones, viz. *Bet* Zone, the Linear Trench Zone and the Great Barren Zone. From wetland point of view, these zones can be categorised as the Northern Freshwater Zone, Tidal-cum-Freshwater Zone and the Eastern Freshwater Zone respectively. The North Fresh Water Zone represents an old mouth of a river. The zone, which lies to the north of the line joining the Kuar Bet and Bela Bet, is above tidal range. The Tidal-cum fresh water zone is a depression extending from Kori creek eastwards up to the Kuar bet. Tidal waters of the Arabian Sea, through the Kori creek inundate it. The Eastern Fresh Water zone is the easternmost portion of the Rann, which is free from the sea water inundation. Inundation takes place by monsoonal water that directly flows as well as which had been discharged by the Luni river and other streams flowing into the Rann from the mainland in the south.

The Little Rann owes its origin to the transgression of the sea waters of the Arabian Sea entering through the Gulf of Kachchh. The NW-SE, NE-SW and E-W trending faults mark the triangular shaped Little Rann and appear to be responsible for its present configuration. The upliftment of the land along these geological faults during the late quarternary period coupled with the withdrawal of the sea has led to the formation of this landmass and detached from the Gulf of Kachchh. The Little Rann is wet on the Saurashtra side and dry and rocky on the north or vagad side. It is similar to Great Rann as far as physiography, eco-climate, vegetation and overall edaphic condition. However, the silts of to the material derived from the local sources of Gujarat unlike the silts of the Great Rann which are the deposits of the Indus river.

16.3. Background Information

In the reserve, thousands of square kilometres of the mud-flats of the Rann are almost at the sea-level (i.e., 4-15 m above mean sea level). Thus, overall altitudinal range for the vast mud-flats in the reserve is very narrow. However, to some extent, altitudinal variation is contributed by *bets*. In fact, one of the islands, namely Pachchham, has a hill called Kala Dungar that is the highest peak of Kachchh (458 m above mean sea level). The prevailing representativeness (richness), naturalness (nativity) and uniqueness (endemism) of biodiversity elements in the reserve highlight its conservation value. Rich wildlife, diversity of flora and fauna, traditional life style of people, excavated Harappan city of the Bronze age (3000 BC) at Dholavira on Khadir Island and fossils make the reserve important from the view-point of eco-development. It may be important to note here that Great Rann of Kachchh portion of KBR is a treasure trove of petrified wood fossils and ammonite fossils of Jurassic period and Tertiary period respectively. At some places like Kuar bet dinosaur fossils also were available.

Vast area of mud-flat of the Rann is almost at sea-level.

Altitudinal variation is contributed by islands that dot the vast mud flat area. Highest Peak of Pachchham Island in Great Rann is 458 m above sea level.

Total area of KBR is 12,454 km^2 It is located in Indian Deserts biogeographic zone.

The entire site of the Rann was located originally in the tectonic depression. Since early tertiary, the Rann was a shallow inland sea. In the Mesozoic period, the Great and Little Ranns were part of the Arabian Sea.

The Great Rann has been tectonically unstable since its historical time. Tectonism was very effective as late as 1819 when a major earthquake finally destroyed the Indus river connection with the Kori creek. This earthquake in 1819 gave rise to the 'Allah Bund'- a linear mound-like formation that is 5-10 m high and 50 km long, The Allah Bund brought about many significant changes in the land forms. Thus, it caused blocking of the flow of the ancient Nara river (a tributary of the Indus), which in turn, resulted in the ruin of Lakhpat and Sindri ports. Formation of Allah Bund also brought changes in inundation and silting patterns of the Rann. Moreover, Allah Bund has also possibly played a role in diverting the flow of the river Indus. It may be noted the eastern branch of the Indus emptied itself into the Rann before the earthquake in 1819 that resulted into the formation of Allah Bund. According to the local tradition, a well-tilled plain, irrigated by a branch of the Indus, once covered the western part of the Rann, but human activities assisted by an earthquake diverted the water. The Rann, in fact, was also at the receiving end of the River Sutlej which after receiving waters from the river Yamuna and passing through Punjab and Rajasthan ended in the Rann. Moreover, the Rann was also a main outlet of Rajasthan rivers before the advent of arid conditions that occurred in the area 1000 years ago.

16.3.1. Landscape features and land-use history

The well-known bets in Great Rann of Kachchh are Khadir, Pachchham, Bela, Tragadi, Sol, Kakida, and Sansla. In Little Rann of Kachchh there are seventy four islands and some well-known ones are Jhilandhar, Wasraj Solanki, Andheriwan, Khijaliya, Pung, Dhutarimata, Nanda, Shedwa, Mardak, Lambadar, Dongi, Keshmara, Handi, Ratadiya, Bhangwara, Saheblana, Nada, Haraniya, Kakariya,Selaisuchi, Gajetia, Selaisuchi, etc. Due to the 'Allah Bund', a linear mound-like formation that is 5-10 m high and 50 km long, the Great Rann is considerably higher in centre than along the edges. In fact, the hydrology and evolution process of the Great Rann had been considerably influenced by formation of the Allah Bund. The bund has formed an E-W barrier, which truncated the flow of the ancient Nara river into the Arabian Sea through the Kori creek.

The core zone of the reserve is legally protected as two sanctuaries (Kachchh Desert Sanctuary in the Great Rann and Wild Ass Sanctuary in the Little Rann). Majority of the KBR is under mud-flat; while some portion is covered by bets. The inhabitants depend on natural resources available from the Rann ecosystems for food, fuel, fodder and ethno-biological purposes.

16.3.2. Reserve inhabitants

Reserve is a large entity with major portion of it being uninhabited. However, significant population largely consisting of inhabit fringes of the reserve weaker sections

of the society. About 12% tribal population of Kachchh is found in Rapar and Bhachau tehsils, part of which forms the KBR. KBR is a large area with major portions of it being uninhabited. However, some of the portions. The well-known tribal groups of the area are *Koli, Bhil* and *Paradhi* whereas *Charan* and *Meghwal* represent Scheduled castes. Majority of tribal still lead their traditional life style and they depend on the village surroundings for their biomass needs.

Livestock rearing is one of the major occupations in the whole region that includes KBR. Maldharis and Rabaris are the nomadic communities that maintain large herd of cattle. Other than milk based economy, livestock breeding and livestock trade through traditional means still remain the major source of income for the people of Pachchham-a major bet of the Great Rann and in Banni-a grassland adjacent to the Great Rann of Kachchh. These two regions alone account for over 90,000 livestock animals. The members of a community called 'Rabari' that keep moving as nomadic pastoralists throughout a year with their sheep and goats mainly inhabit the region around Great and Little Ranns of Kachchh.

Other than livestock rearing, rainfed agriculture is the traditional mainstay of the local communities. Large islands like Khadir and Pachchham islands have substantial area under rainfed cultivation. Large number of farmers use traditional knowledge for carrying out agriculture practices. They usually grow indigenous crop varieties of *jowar, bajra* (*pearl millet*), green gram (*mung*), moth, sesame (*til*) and gavari (*guar*).

Traditional handicraft activities, such as embroiderying (using cloths, mirrors, leather) and colouring of cloths through traditional '*Bandhej*' (tie and die) technique are quite alive. Few artisans from this region have acclaimed national and international recognition owing to their noteworthy handicraft work.

In the Little Rann of Kachchh, there are traditional fishermen that are known as '*Pagadiyas*'. They fish on small scale in and around creek areas using traditional gears. The Little Rann portion of the KBR support brackish water fisheries; especially the prawn fisheries. Brackish water comes into existence due to saline tidal waters from the Surajbari creek goes in the mud-flat and mixes with rainwater or water due to rains/rainwater run-off or local streams. More than 8000 small fishermen are dependent on this activity and they harvest abuout 3000 MT of prawns annually. Eleven species of prawns have been recorded and *Metapenaeus kutchensis* (endemic to Kachchh) and *M.affinis* are the main species among them.

The Little Rann produces 31% of the State's salt. The traditional salt workers are known as 'Agariyas'. There are about 50,000 '*Agariyas*', who are enganged in salt production work in Little Rann (Wild Ass Sanctuary). A large number of '*Agariyas*' are illiterate and they have fairly large families (average 6.5 persons per family). The net income of '*Agariya*' family is Rs. 15,000 to Rs. 20,000 per season.

16.3.3. State of knowledge

The Reserve is relatively well explored for avi fauna, mammalian and reptilian fauna. Knowledge regarding flora also exists to certain extent. However, other important areas

such as macro-invertebrates fauna, socioeconomics, ethno-biology and geophysical features have not been explored adequately. Knowledge regarding ecology of various floral and faunal species also needs to be expanded.

Following gap areas have been identified for priority attention for undertaking R&D activities:

- **Flora & Fauna:** (i) Floral diversity and plant ecology (ii) animal ecology (iii) Status assessment of threatened taxa;(iv) ethnobiological values; (v) Inventory and assessment of lower groups (pteridophytes, bryophyts, algae,fungi, lichens, macro-invertebrates etc.). (vi) Palaeontological studies
- **Socio-ecological:** (i) Human dependence and consequent impact on resources; (ii) Valuation of ecosystem goods and services; (iii) Change detection (spatio/temporal); (iv) Eco-tourism potential assessment; (v) Best practices – societal adaptation to changing scenarios.
- **Geo-physical:** (i) Seismic studies (ii) Hydrological systems; (iii) Weather monitoring and climate change evidences.
- **Development & Management:** (i) Optimal use of scientific evidences in management strategies; (ii) Man animal conflicts and their resolutions; (iii) Needs assessment, public awareness, and negotiations; (iv) Alternative livelihood options and income generation; (v) Protection and communication network.

16.4. Global and National Significance

The core zones (Kachchh Desrt Sanctuary and Wild Ass Sanctuary) of the reserve represent unique landscapes with outstanding naturalness value. In the words of Lieut. Burnes (in his Memoires 1828-1829) - 'the Rann is a space without a counterpart on the globe'. High concentration of Indian wild ass (*Equus heminous khur*), breeding congregation of Lesser flamingos (*Phoenicopterus minor*) at 'Flamingo City' and occurance of Mac Queen's Bustard (*Chlamydotis* sp.) in was portion of KBR have long been recognized globally. The Rann area is also nationally significant from the view point of likely existence of species like caracal (*Felis caracal*), greater hoopoe lark (*Alaemon alaudipes*), several threatened raptors and water birds. Above all, as the Rann (especially the Great Rann) is on the migration path of wintering migratory birds, it has great significance as an area to study bird migration flying over Central Asian Flyway. All birds journeying on this sector of the route must cross the wide expanse of the Great Rann that separates Sind from Kutch. The portion of the Rann islands

High concentration of Indian wild ass in Wild Ass Sanctuary portion of the RKBR and huge breeding congregation of flamingos at 'Flamingo City' in the Kachchh Desert Sanctuary portion of the KBR have long been recognized globally.

The area is also nationally significant from the view point of likely existence of species like caracal, Mac Queen's bustard

where the edge of the featureless desert meets the stony range of hills namely, Kala Dungar (Pachchham island), Bhanjda Bet (Khadir), Chhaparia dungar (Khadir) that runs in a more or less continuous chain along the north-eastern border of Kutch is considered best to observe swarms of migratory birds. In words of Late Dr. Salim Ali , : "For observations on the movements of migrating birds, to and from peninsular India, this venue is perhaps unique. Indeed, I cannot think, and certainly do not know, of a better."

16.5. Biodiversity Values

The entire area derives its importance due to presence of various rare and endangered species of Schedule-I & II of the Wildlife (Protection) Act, 1972. Some examples of threatened fauna are long-eared hedgehog (*Hemiechinus auritus*), Indian gazelle (*Gazella gazelle*), desert cat (*Felis libyca*), caracal (*Felis caracal*), Indian wolf (*Canis lupus*), Indian ratel (*Mellivora capensis*) and desert fox (*Vulpes vulpes pusilla*). Among the terrestrial birds of KBR, the MacQueen's Bustard (*Chlamydotis macqueeni*) and Pallid Harrier (*Circus macrourus*) are near threatened species whereas White-rumped Vulture (*Gyps bengalensis*) and Long-billed Vulture (*Gyps indicus*) are critically endangered. Several waterbirds like Painted Stork, Black-headed Ibis, Dalmatian Pelican and Lesser Flamingo belong to one or the other categories of IUCN Red List of threatened species. Among the reptiles, threatened species include banded gecko (*Crytopodion kachhensis*), desert monitor (*Varanus griseus*), spiny-tailed lizard (*Uromastrix hardwickii*) and black cobra (*Naja oxiana*).

The Great Rann portion of reserve is very important to study the migration of birds flying over Central Asia-India flyway.

As the mudflats of the Rann remain under water for part of the year and exist as dry exposed land for rest of the year,

the reserve is endowed with both, aquatic and terrestrial biota. Further, as it receives both freshwater and tidal waters during the year, organisms adapted to both, inland and coastal waters occur here.

The Kachchh Desert Sanctuary is internationally famous for the largest and the oldest known nesting colony of the Greater Flamingo (*Phoenicopterus roseus rubber*) in the Indian subcontinent. The nesting ground, well known as "Flamingo city" formed on the island 'Andabet' is situated on the vast featureless expanse of the Great Rann between Pachchham and Khadir islands, some 12 km N-E of the former. The nesting takes place during the SW monsoon, principally between July and October, when the area gets covered with shallow stretch of water partly from the outflow of the Luni river and partly from the sea. The nests cover several square of the Rann in this area. However, depending on rainfall and inundation conditions, nesting has also occurred as late as March- April. In 1998, the C.F., Bhuj along with the staff of the Forest Dept. had visited the breeding colony during March.

Apart from its significance for the flamingo breeding, the Great Rann portion of the reserve is known to have supported breeding of Great White Pelican in 1960 and Pied Avocet in 1944. The MacQueen's Bustard (*Chlamydotis* sp.), a migratory bustard for the Indian subcontinent is seen on some of the *Bets* during winter.

The Great Rann portion of KBR is also important from the viewpoint of the conservation of Indian Wild Ass (*Equus hemionus khur*). Though the eastwardly located Little Rann is the stronghold of the wild ass and internationally well known for it, limited value of the Great Rann (including KDS) as habitat of the ass should not be overlooked. Wild ass has been reported from Khadir, Tragdi, Vangara (Bangara), Bela and Jakhotra *bets*. The KDS portion of the KBR is also the home of wolf, hyena, foxes and lesser cats, hare s (including desert hare -*Lepus nigricollis kutchensis*).

Little Rann is an abode of a variety of other mammals, birds, reptiles, amphibians, -fish and micro/macro invertebrates and plants. A total 33 species/sub-species of wild mammals have been reported from the Little Rann that include 5 species of ungulates, 14 species of carnivores, 1 species of lagomorphs, 6 species of rodents and chiropternas, 1 species of pholidota, 3 species of insectivores and 1 species of primates. Wild Ass Sanctuary in the Little Rann is internationally famous for the endangered Asiatic wild ass (*Equus hemionus khur*).In 1990, 1999 and 2004, the wild ass population as per wildlife censuses organized by Gujarat Forest Department had been 2072, 2,839 and 3,863, respectively. Southern fringe of the Wild Ass Sanctuary had higher population density and encounter rate of wild ass, probably due to the fact that this fringe remains resource rich all the year round due to ground cover and crop. Bets like Pung, Mardak, Keshmaa, Nanda, Jhiladiya, Dhut, Jhilander and Wasraj are very important for various life requisites in general and breeding in particular. Apart from wild ass 130-150 chinkaras (Indian gazelle), 19 black bucks 303 blue bulls (nilgai) had been recorded during an ecological study conducted by GEER Foundation in 1998-99. During the wildlife censuses conducted by Forest Department 735 wild/feral pigs, 327 jackals, 180 Indian foxes, 2 desert foxes, 41 jungle cats, 2 desert cats, 41 hyenas, 5 pale hedge hogs, several mongooses and rodents were recorded.

Wild Ass Sanctuary in the Little Rann is internationally famous for the endangered Indian wild ass (*Equus hemionus khur*).

The Little Rann also provides an important feeding, breeding and roosting habitats for a large number of diverse avifauna due to its strategic location on bird migration route and its connection with the dynamic Gulf of Kachchh. The Little Rann regularly supports breeding of Lesser Flamingos. One of the major breeding records of Lesser Flamingo in the KBR has been one of August 1998 when 70,000-75,000 flamingos nested near Wasraj Solanki and Jhiladhar bets. About 97 species of water birds and 81 species of terrestrial birds had been recorded during an ecological study conducted by GEER Foundation. Among herpetiles, 29 species of reptiles and 4 species of amphibians have been recorded. Apart from the above mentioned vertebrate fauna, 25 species of zooplanktons, 1 species of annelid, 4 species of crustaceans, 24 species of insects, 12 species of molluscans and 27 species of spiders have also been reported.

As far as vegetation is concerned, the reserve is characterised by highly salt tolerant halophytes and xerophytes. The halophytes like *Suaeda* and *Atriplex*, grasses like *Aeluropus lagopoides, Sporobolus helvolus* and *Halopyrum mucronatum* and some xerophytes like *Capparis, Salvadora*, *Tamarix* and *Euphorbia nivula* thrive successfully. Besides, *Prosopis chilensis* is predominent on the *Bets* and fringes of the Rann. Some other main plants of the Rann are *Acacia* sp., *Zyziphus numularia* and *Streculia urens,* etc.

Many *bets* of the Great Rann partly or fully represent vegetated pockets, either covered with herbs, grasses or trees etc. and in turn provide food and/or cover to several terrestrial flora and fauna. Islands are certainly the hot-spot areas of the biodiversity in the reserve. They are like oases

- Kachchh Desert Wildlife Sanctuary was decleared in 1986
- Wild Ass Sactuary was declared in 1973
- Kachchh Biosphere reserve was declared in 2008
- Wild Ass Sanctuary and Falmingo city are declared as IBA

in the Rann. Khadir and Pachchham *bets* in the Great Rann portion of the KBR support more than 250 species of plants. *Comiphora wightii, Citulus colocynthis, Ephedra foliate, Helichrysum cutchicum, Heliotropium rarifolium, Dactyliandra welwitschi* and *Sida tiagi* are the rare and threatened plant species that exist on these *bets*. Besides, the mudflat near the edges of the bets provides food and habitat to the waterfowl. Similarly, the fringes of the Rann with scrub cover, herbaceous cover and cultivated fields are existent, also provide food and/or cover to the wildlife in the Great Rann of Kuchchh.

It may be noted that Khadir bet in the Great Rann is the largest true island. It consists of a high rising ridge extending east to west and providing a very impressive precipitous feature viewed from the north, towering as it does over the Great Rann. Southward, the escarpments slope gradually and is covered with climax desert flora. The introduced *Prosopis juliflora*, which has overrun Pachchham, Bela , the Banni and almost the entire borderland of the two Ranns, has not yet pervaded Khadir for the reason that it is still covered with its original flora. To the north-west and west of Khadir, including the wide belt of the Rann between Khadir and Pachchham, is a vast tract of the Rann, slightly lower than the continuous salt pans. Here the water accumulates and stands with the process of evaporation turns gradually more saline.

The *bets* in the Little Rann are rather small and being stopover places of cattle moving between Kutch and Saurashtra, are subjected to anthropogenic pressures. They are extremely important concomitants of the Little Rann, where they provide refuge to the wild ass and other desert fauna.

About 253 species of flowering plants have been reported from the Little Rann. Of these, 18 have been the tree species, 23 shrub species, 18 climbers/twiners, 157 herbs and 37 grasses. The dominant families representing more than 10 species are Fabaceae, Asteraceae, Cyperaceae and Poaceae. One hundred and seven species of algae have also been recorded from the wetlands in this area.

16.6. Progression of Conservation and Management

The area enjoys a long conservation and management history. It can be said to have started about 112 years back when the then king of Kachchh, Maharao Shri Khengarji discovered a huge breeding colony of the flamingos at what is currently well-known as 'Flamngo City' ('Hanj bet')'in the Great Rann portion of KBR. He first reported the fact to Capt. C. D. Lester in 1893. After that the colony was visited by several individuals with ornithological interest, including Dr. Salim Ali, Mr. Himmatsinhji and officers of the Forest Dept (e.g. C.F., Bhuj, Kachchh) . Late Dr. Salim Ali, the ornithologist of international repute from India, not only recorded massive nesting colony of flamingos at the same place in 1945, but also carried out an authentic enumeration of nests and young ones. As per his counting, there were 131 nests in every 100 sq. m spread over 1 lakh sq. m area. Forest Department has been contributing to the conservation of wildlife in the KBR by conducting wildlife censuses at regular intervals and by implementing legal protection in the form of Wild Ass Sanctuary and Kachchh Desert Sanctuary. The population of wild ass had undergone massive decline due to the outbreak of a disease kown as 'Surra' (caused by *Trypanosoma evansi* and transmitted by flies) in 1958 and 1960, and also due to 'South African Horse Sickness' in 1961. However, owing to the management and protection measures taken by the Forest Department in WAS, the population of wild ass has recovered and steadily increased from 2,072 in 1990 to 3,800-3,900 in 2005. As such the management responsibility of both these sanctuaries and Kachchh Biosphere Reserve is with the state forest department. Forest Department also conducts nature education camps for imparting nature education to young generation. Interpretation centers have been developed by Forest Department. As ecotorism complex has been developed by Forest Department at Dholavira on Khadir Island where the Bronze City of 3000 BC has been excavated.

16.7. Issues and Concerns

In-spite of the above successful initiatives, the reserve has several issues. Some of these listed below, deserving immediate attention so as to make the reserve a true success model:

- Demarcation of Transition zone is pending
- Inadequate water storage capacity due to less number of ponds and vantalavs and silted existing water bodies
- Scares water availability to wildlife during summers
- Poor fodder availability and deteriorated grasslands

- Invasion of *Prosopis juliflora* on fringes and on bets (Islands)
- Excessive grazing by livestock on various bets in the KBR
- Insufficient eco-development activities
- Inadequate research based data on various aspects of KBR (that may include ecological, bio-physical, climatological, socio-economic, geological, hydrological, paleontological, etc).

Towards effectively addressing the above-mentioned issues and considering the fast changing global thinking on the issues of sustainable management of reserves resources following can assume priority:

(a) Effective implementation of Management Plan of the reserve (2005)

(b) Improving monitoring and networking of the reserve through use of modern tools such as RS and GIS

(c) Development of reserve specific training capsules for diverse groups of stakeholders considering their needs and relevance

(d) Development of user-friendly information portal

(e) Establish baseline information on value of ecosystem services of KBR

(f) Developing alternate modals/strategies for sustainable use and management of BR resources under changing climate and economic scenarios

(g) Strengthen participation of communities and private sector in reserve management

8. Conclusion

Kachchh Biosphere Reserve in the Ranns of Kachchh, Gujarat sets a case having potential of getting included in the World Network of Biosphere Reserves (WNBR) under UNESCO's MAB programme. However, in comparison to several other BRs of the country, it is relatively recently established (i.e., 2008) and, therefore, there is considerable scope to fill up the information gaps. Towards addressing the issue of information gap and considering unique ecological, biological, geological, archaeological, paleontological and socio-cultural values of the reserve there exists a need of promoting intensive research and research based management.

Ketan Tatu, Bharat Pathak, RL Meena and **CN Pandey**
GEER Foundation (Lead Institute- Kachchh Biosphere Reserve)
Indroda Nature Park, Gandhinagar 382007, Gujarat (INDIA)
Phone : +91-79-23221385
Email : dir_geer@gujarat.gov.in

Photo Credits: Sunil Panchal (GEER Foundation Photo Bank)

17
Cold Desert Biosphere Reserve – Trans Himalaya, India

17.1. Introduction

The Cold Desert Biosphere Reserve (CDBR), the sixteenth Biosphere Reserve designated by the Government of India, represents various bio-physical features and unique values of Trans Himalayan Cold Desert ecosystem. The reserve is mostly dominated by the herbaceous and scrub vegetation. A very few small patches of trees, planted near the settlements, are also found. In the naural habitats a few patches of *Hippophae salicifolia* and a some individuals of *Juniperus polycarpos* are also present in the valley. The representativeness and uniqueness of the bio-physical and scio-cultural systems in the area has resulted its designation as the Cold Desert Biosphere Reserve.

17.2. Area Description

The Cold Desert Biosphere Reserve (327°59'to 31°44' N Latitudes and 77°21' to 78°34' E Longitudes) is located in the northern part of the Himachal Pradesh state. It covers the whole Spiti Forest Division and a few parts of Lahaul Forest Division (i.e., Baralacha Pass, Bharatpur and Sarchu areas).

Designation Date	:	28 August 2009
Total Area	:	7,770 km²
Core Area	:	2,665 km²
Buffer Area	:	3,977 km²
Transition Area	:	1,128 km²
Extent	:	32°59'to 31°44' N 77°21' to 78°34' E

17.2.1. Zonation Detalis

CDBR comprises of core, buffer and transition zones (Figure 17.1). The core zone covers approximately 2665 km² area and includes the areas of Pin Valley National Park, and Kibber and Chandratal Wildlife Sanctuaries. Buffer zone covers 3977 km² area and includes areas surrounding the core zones. The Tranisition zone covers an area of approximately 1128 km² and includes the inhabited areas mainly along the Spiti River and extends upto Sumdo.

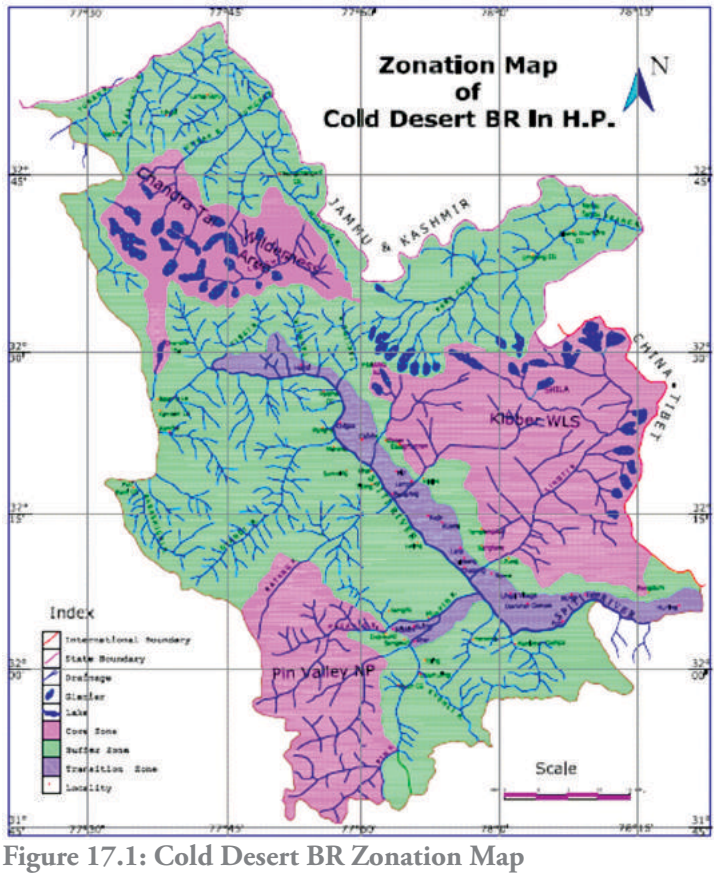


Figure 17.1: Cold Desert BR Zonation Map

17.2.2. Biogeographic characteristics

The CDBR falls in the Trans Himalayan Biogeographic Zone, and mostly represents Tibetan plateau province (1 B) in the State of Himachal Pradesh in India. The altitude ranges between 3300-6,600m asl. The unique topography, severe climate and poor soils represent a typical Cold Desert Ecosystem. The representative arid cold climate, natural and unique biodiversity elements clearly differentiate this biogeographic province from other provinces in the country.

17.2.3. Landscape features and land-use history

The core zones (i.e., Pin Valley National Park, Kibber Wildlife Sanactuary and Chandratal Wildlife Sanctuary) of the reserve represent the completely

protected sites. Buffer and transition are manipulation zones where eco-development activities and eco-tourism are encouraged. In general, the landscpe comprises of glaciers, shrubberries, thatches, plantation sites, settlement areas, agricultural land, wetlands and waste lands. The inhabitants in the reserve are largely dependent on wild resources for their sustenance. The major occupations include agriculture, horticulture and sheep rearing. The mules are used mostly for the transport.

Geologically the area is unique and consists of a complete sequence of geological formations dating from the Pre-Cambrian to the Cretaceous period with short breaks in Carboniferous and Jurassic periods. The formations consist of Schistose and Calcareous groups. The Schistose comprises of biolite-schists, schistose phyllites, phyllites, slates, paragneissic bands, quartzites and quartz-mica schists. The calcareous group comprises of white and grayish black crystalline limestones, flagy and slaty limestones, calcareous phyllites, calcareous gneiss, carboneous schists and dark grey phyllites interbedded with lime stones.

Spiti which forms the major parts of the reserve, is locally pronounced as 'Piti' and known as 'middle country', has its sub divisional headquarters at Kaza. The river Spiti originates at the base of the Kunzam range and flows eastward to join the Sutlej at Khab in Kinnaur. With practical isolation for centuries, Spiti has an intensely introvertive culture centred around its several monasteries- Dhankar, Kye, Tabo, Mud, Gungri, Lidang, Hikim, Sagnam, Mane Gogma and Giu, etc. The majority of the people in this area are Buddhists, followers of the Geluk-pa sect. The repetition of the mantra "Om mani padme hum" (literally, 'Behold, the jewel is in the lotus'), is constant; it is believed to bring good fortune and wash away all sins. For all the seeming bleakness, Spiti possesses a haunting beauty.

Spiti, is also known as the "fossil park of the world". Three villages, Kibber, Kaza and Kye fall on the route faovourite among those looking for fossils. These villages are situated at heights between 4200m and 4600m a. msl. Langza is famous for fossils of maritime life. These fossils are found on either side of Kang-yur and Paapen-yu nullahs near the village.

17.2.4. Reserve inhabitants, demographic trends and dependence

The CDBR is inhabited by over 113 villages (81- permanent and 32 - temporary settlements). The inhabitants mainly belong to the Indo-Mongoloid Group. As per 2001 census, total population of the Spiti valley is 10,679 (5,874 male and 4,805 female). The population density is about 2 people per square kilometer. Sex ratio is 818 women per 1000 men. Of the total population of the Spiti valley, over 77.8% fall in the category of Schedule Tribe and 5.6% as Scheduled Caste. while literacy rate in the valley is nearly 80%, for females it is <35%.

The inhabitants are largely dependent on agriculture and wild resources. Among the horticultural species, apple (*Malus pumilus*) is promoted, and among the agricultural crops, pea (*Pisum sativum*), potato (*Solanum tuberosum*), Droh, Gandam (*Triticum aestivum*), Neh, Jau (*Hordeum*

himalayense) are the prominent species. Among the wild edibles, Chherma (*Hippophae rhamnoides* sub. sp. *turkestania*) is a prominent species. About 118 species of the Medicinal and Aromatic Plants are known from the valley. The inhabitants are largely dependent on medicinal plants for their livelihoods. Various activities such as cultivation of medicinal plants, afforestation, ecotourism, land stabilization, etc., are promoted in manipulation zones of the reserve by the State and Central Government Organizations.

17.2.5. State of knowledge

Among Indian Biosphere Reserves, the CDBR is relatively a recent designation (2009). In general, some parts of the Spiti valley have been explored for the floral and faunal inventories, ethnobotany, population demography, cultural diversity, tourism potential and trends, etc. But, much focused studies in the notified area of CDBR are lacking. The available information is fragmentary.

Considering gaps in information and in view of features of the reserve, habitat and community wise assessment and mapping of the biodiversity including the lower groups of plants (i.e., pteridophytes, bryophytes, algae, fungi and lichens), assessment of plant animal relationships; threat categorization of biodiversity and population assessment of threatened species, diversity and extraction trends of economically important biological resources, valuation of ecosystem goods and services, monitoring and detection of spatio temporal changes, assessment of ecotourism potential, development of best packages of practices including snow harvesting for the socio-economic development of tribal community, glacier retreat and impacts on downstream ecology, assessment of the potential of hydro-electric projects and their impact on environment, monitoring of weather and climate change, optimal use of scientific knowledge in management strategies, man animal conflicts and their resolutions, education and awareness for the tribal communities about the conservation of natural resources, alternative livelihood options for sustenance, and establishment of an effective network of tribal communities, and other stakeholders, assume priority for systematic studies so as to strengthen the management of CDBR.

17.3. Regional, National and Global Significance

The representative, unique and socio-economically important biodiversity, unique landscapes, culture and religious places in the reserve attract scores of naturalists, trekkers, conservationists, tourists, researchers and academicians from India and abroad. Spiti valley which forms the major part of the CDBR is also called “Little Tibet” due to similarity

in landscapes, biodiversity, and climate. The villages in the valley attract various stakeholder groups due to unique life style and culture of the indigenous communities. The main Spiti valley is split into eastern and western valleys, which are connected with Ladakh & Tibet on eastern side & Kinnaur and Kullu on western side through high passes. The valley is very well known for the Monasteries. The Kye Monastery (4116m), located 12 km north of Kaza above Kye village is the oldest and biggest monastery of the valley and serves the western population of Spiti. It houses beautiful scriptures and paintings of Budha and many Lamas get religious training here.

The Thang Yug Gompa is located 13km above Kaza and works for western part of central Spiti. It generally has a Lama from Tibet. There is a long plateau above this Gompa which leads to Shilla peak.

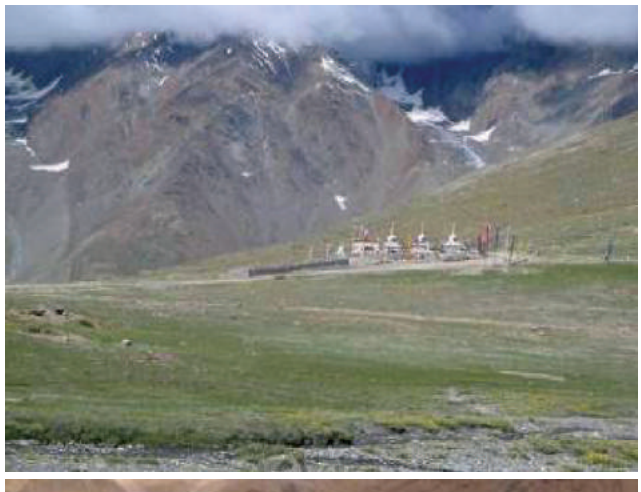
The Kungri Gompa is situated in the Pin valley about 10 km from Attargo and serves the population of Pin valley. The Dhankar Monastery is situated about 25 km east of Kaza and serves eastern part of central Spiti. Dhankar is a big village and erstwhile capital of Spiti Kingdom. On the top of a hill, there is a fort which used to be the prison in older times. The Monastery has about 100 Lamas and Budhist scriptures in Bhoti language. The Statue of "Vairochana" (Dhayan Budha) consisting of 4 complete figures seated back to back is the principal figure. The Tabo Monastery, serving the population of eastern side, belongs to the tenth century and located 50 km from Kaza. It is a famous Gompa next to Tholing Gompa in Tibet. It has about 60 Lamas and a large collection of scriptures, wall paintings, etc. The Murals of this Gompa have a great similarity to that of the Ajanta paintings. Kyil Khor or Mystic Mandala temple is placed on the backside of the main complex. It is home to some beautiful faded mandalas (frescos). Dromton Lhakhang and Maitreya Chapel are the two famous chapels to the north of the temple complex.

Chandratal Lake in Spiti Valley also known as Moon Lake is one of the most beautiful and spectacular lakes in Indian subcontinent. Set on a large meadow between lower ridge and main Kunzum range it offers excellent views of Mulkila mountain range and Samudra Tapu Glacier. The colour of water keeps changing through out the day from reddish to orange to blue to emerald green as day passes.

Kunzum Pass (4590 m) a gateway to Spiti from Kullu and Lahaul is famous for the temple of Goddess Durga and the panoramic view of Bara-Sigri Glacier (second longest glacier in the world) and other mountain peaks and Chandra, Bhaga and Spiti valleys.

Losar village (4080 m), situated near the confluence of Losar and Peeno streams, is worth visiting. Yak and horse riding are other charms to add to its beauty and unique experience.

Kaza (3800 m), a Sub Divisional Headquarter of Spiti valley, is situated on the left bank of Spiti River. Once it was the Headquarter of Nono, the Chief of Spiti. It has all modern facilities and is connected by road with Manali and Shimla except in the winter months.



Kibber (4205 m), one of the highest villages in the world is locally known as Khyipur, and surrounded by mountains. The Gette village (4270 m), the highest in the world is located at a short distance from Kaza. Kibber Wildlife Sanctuary offers a great view of the region's peaks namely Chau Chau Khanamo and Chau Chau Khang Nilda.

Baralacha Pass (4892 m) is located in Keylong –Leh road. It is famous for the Suraj Tal and view of the high snow peaks and glaciers. Bharatpur and Sarchu are the camping sites for the tourists. Both the places are located in Keylong –Leh road and attract both domestic and foreign tourists.

The protected areas namely Chandra Tal and Kibber Wildlife Sanctuaries and Pin Valley National Parks are very well known for the representative, natural and unique biodiversity of the Cold Desert. Among the floral elements, medicinal and aromatic plants are very well known, offer major livelihood options for tribal communities. Among the faunal elements, Woolly Hare, Tibetan Gazzle, Snow Leopard, Himalayan Black Bear, Himalayan Brown Bear, Snow Leopard, Fox, Wolf, Ibex, Himalayan Marmot, Indian Porcupine, Himalayan Blue Sheep, Red Billed Chough, Chukar Patridge, Snow Patridge, Blue Rock Pigeon, Snow Pigeon, Himalayan Snowcock, Lammergeier, Himalayan Griffon, Golden Eagle, Rosefinches, etc. occur in the area. Presence of these unique biodiversity elements has raised status of CDBR very high at regional, national and global levels.

The traditional agriculture and traditional medicine systems are also unique in the buffer and transition zones of the CDBR. Agriculture forms one of the most important parts of the socio-economic life of the tribal community. Agriculture is limited to one crop a year and is solely dependent on the winter snow melt. Traditional crops largely grown are barley and pea. These are well-suited to the region's peculiar geo-climatic conditions since they require minimum irrigation, and are fairly drought resistant and hardy. Moreover, they are well known for their high nutritional content and capability for increasing soil-fertility. Irrigation is totally dependent on the water obtained from melting of glaciers. The water is transported over long distances through small channels, locally known as kuhls.

The Amchi Medical Practice is also known as Sowa Rigpa, which means "Science of Healing" in available in classical Tibetan as well as in regional Himalayan and Central Asian languages and dialects. The Amchi System of Medicine is a spiritual practice, a science, and an art that dates back thousands of years. Aspects of this medicine system were transmitted from India to Tibet between 7th and 12th centuries, during the first and second dissemination of Buddhism. This

system combines the profound work of Sangye Menla, the Medicine of Buddha, with indigenous Tibetan traditions such as Bön, and was shaped into Sowa Rigpa as it is known today. The medicine may consist of a single herb or many. For example, a medicine called Agar 35 (*Agar Sonya*) contains 35 different kinds of herbs.

17.5. Biodiversity Values

Of the 985 plant species recorded from the Lahaul and Spiti districts, more than 500 species are recorded from the notified area of the Cold Desert Biosphere Reserve. Families Asteraceae, Poaceae, Brassicaceae, Fabaceae, Rosaceae, Scrophulariaceae, Ranunculaceae, Apiaceae, Polygonaceae and Cyperaceae are dominant in the area. The dominance of the dicots is relatively very high compared to the monocots. The cold desert comprises of alpine mesophytes, oasitic and desert vegetation. The most conspicuous character of the vegetation is the cushion like habit of plants which protects these plants from cold dry wind. The adaptational features of the species are perennial habit, dwarf size, long and massive root stock, internode suppression, higher pubescence and reflectance and spinescent, succulent habit, etc. The notable species of the CDBR are *Thylacospermum rupifragum, Acantholimon lycopodiodes, Myricaria elegans, Echinops cornigerus, Capsella bursa pastoris, Lindelofia anchusoides, Tanacetum tibeticum, Nepeta floccosa, Arnebia guttata, Potentilla nivea, Euphorbia tibetica, Lancea tibetica, Iris ensata, Carum carvi, Lepidium apetalum, Potentilla anserine,Peganum harmala, Stachys tibetica, Silene gonosperma, Draba glomerata, Carex nivalis, Oxyris digyna, Polygonum islandicum, Sedum ewersii, Saxifraga sibirica, Waldheimia tomentosa,W. nivea, Dianthus anatolicus, Oxytropis lapponica, Potentilla multifida, Nepeta tibetica, Polygonum sibiricum, Sedum tibeticum, Arabis tibetica, Braya thomsonii, Cordyalis crassifolia, Aconitum violaecum, Anemone rupicola, Arabis tibetica, Arnebia euchroma, Astragalus webbiana, Delphinium brunonianum, Dracocephalum heterophyllum, Lagotis kunawurensis, Picrorhiza kurrooa, Swertia petiolata, Thalictrum alpinum, Pseudomertensia echioides, Rheum tibeticum,Caltha palustris,Podophyllum hexandrum, Carex* spp., *Acantholimon lycopodioides, Cicer microphyllum, Rumex nepalensis, Achillea millifolium, Anemone rivularis, Brachyactis roylei, Cirsium wallichii, Heracleum candicans, Thymus linearis,Origanum vulgare, Pedicularis* spp., *Potentilla* spp., *Primula* spp., *Ranunculus* spp., *Saxifraga* spp., *Bromus* spp., *Euphrasia* spp., *Gentiana* spp., *Elymus nutanus, Pennisetum lanatum, Phleum alpinum, Poa alpina, P. tibetica*, etc. The notable shrubs are *Juniperus indica, J. communis, Hippophae rhamnoides* sub. sp. *turkestania, H. tibetana, Myricaria germanica, Caragana versicolor, Rosa webbiana, Lonicera* spp.*, Ephedra gerardiana*, etc.

About 118 species of the medicinal and aromatic plants have been reported from the Spiti valley of CDBR. The notable medicinal and ethnobotanically important plants are *Arnebia euchroma, Dracocephalum heterophyllum, Picrorhiza kurrooa, Artemisia maritima, Bergenia stracheyi, Delphinium cashmerianum, Ephedra gerardiana, Ferula jaeschkeana, Gentiana kurroo, Heracleum candicans, Hippophae rhamnoides,* sub. sp. *turkestania, H. salicifolia, H. tibetana, Hyoscyamus niger, Juniperus indica,*

Jurinella macrocephala, Lancea tibetica, Physochlaina praealta, Podophyllum hexandrum, Rheum australe, R. moorcroftianum, R. webbianum, Saussurea bracteata, S. costus, S. obvallata, Thymus linearis,Waldheimia glabra, W. tomentosa, Meconopsis aculeata, Nardostachys grandiflora, etc.

Faunal diversity: Cold Desert region is the home of highly adaptive threatened fauna. Among the mammalian fauna the Siberian Ibex (*Capra ibex sibirica*); Himalayan Blue Sheep (*Pseudois nayaur*), Snow Leopard (*Uncia uncia*), Tibetan Wolf (*Canis lupus chanko*), Wild Dog (*Cuon alpinus laniger*), Red Fox (*Vulpus vulpus*), Himalayan Weasel (*Mustella sibirica*), Marten (*Martes foina intermedia*), Himalayan Hill Otter (*Lutra lutra monticola*), Hare (*Lepus oiostolus*), Himalayan Marmot (*Marmota bobac*), Tibetan Wild Ass (*Equus hemionus kiang*), Wooly Flying Squirrel (*Eupetaurus cinereus*), Himalayan Black Bear (*Selenarctos thibetanus*), Himalayan Brown Bear (*Ursus arctos*), Indian Wolf (*Canis lupus*), Picca (*Ochotana* spp.), etc. are peculiar species of the reserve.

The CDBR also represents unique Avi- fauna. The notable among these are the Lammergeyer (*Gypaetus barbatus*), Himalayan Griffon (*Gyps himalayensis*), Golden Eagle (*Aquia chryaetos*), Chukar Partridge (*Alectronics chukor*), Himalayan Snow Cock (*Tetraogallus himalayensis*), Great Rosefinches (*Corpodacus* spp.), Goldfinch (*Cardulis* sp.), Red Billed Chough (*Pijrrhocrax grackles*), Snow Patridge (*Lerwa lerwa*), Blue Rock Pigeon (*Columba livia*), Snow Pigeon, Brahminy Myna, Black Redstart, Jungle Crow, Yellow Headed Wagtail, Brahminy Duck, Guldenstadt'Redstart, etc. Apart from the unique mammalian and avi fauna, a variety of faunal elements belonging to other classes are also represented in the reserve.

17.6. Progression of Conservation and Management

The conservation history of the CDBR area started with the establishment of Pin Valley National Park (1987), under the Wildlife Protection Act (WPA)-1972, covering geographical area of 675 km^2 between altitudes of 3300-6600m. This was followed by the establishment (1992) and notification (Section 26 of Wildlife Protection Act, 1972; Notification No. FFE-B-F(6)-29/99, dated- 01.11.1999) of the Kibber Wildlife Sanctuary in a geographical area of 1400 km^2 ranging between 4,000-5,600m, and Chandratal Wilderness Area of in 2007. The Chandratal Area has also been declared as Ramsar Site for the conservation of wetland biodiversity in 2008. More recently, on 28th August, 2009 (File No. 9/9/2005-CS/BR) the entire area of the Spiti valley and parts of the Lahaul valley i.e., areas surrounding Baralacha Pass, Bharatpur and Sarchu with a total geographical area of 7770 km^2 has been designated as Cold Desert Biosphere Reserve.

17.7. Issues and Concerns

In-spite of the best efforts made by the State and Central Governments for conservation of this area, there are many issues which need to be addressed so as to ensure conservation of entire reserve. Among others, some of the important issues are listed below.

- Promotion of Eco-Development activities in the buffer and transition zones and promotion and strengthening of local enterprises including crafts, products from wild edibles, and cultivation of commercially viable high value medicinal plants
- Rehabilitation of marginal and waste lands
- Lack of appropriate Ecotourism- Policy and infrastructure; improved protection and communication system
- Inadequate and non-timely compensation for wild animal victims
- Poor infrastructure for management and implementing long term studies
- Protection of rights of the tribal communities of the reserve



- Lack of appropriate marketing facility for the medicinal plants and wild edible products
- Lack of proper technique (s) for the snow water harvesting including irrigation
- Lack of studies on glacial environment, climate change and environmental impact analysis of the tourism
- Poor use of modern tools/technologies (i.e., IT) for information generation, dissemination and management of reserve
- Inadequate capacity building mechanisms for BR personnel and researchers
- Inadequate information on and recognition the ecosystem services emanating from the reserve
- Increased vulnerability of resources and inhabitants under changing climate
- Poor existance of alternate options to ensure sustainable use and management of resources under changing climate and economic scenarios

In view of the above, it seems that there is an urgent need to develop a management plan which addresses the short term and long term issues for the effective management of the CDBR and sustainable development of its inhabitants.

17.8. Perspective 5 year Plan – major components

The area designated as CDBR is being managed by the Forest Department under existing systems of the working plans/ management plans. However, considering the overarching concept of Biosphere Reserve, CDBR would require new initiatives and long term planning. In view of this, following action points can be suggested for consideration in the five year action plan.

- Assessment, monitoring, mapping, valuation and conservation prioritization of biodiversity elements
- Evaluation of ecosystem goods and services generated by the reserve
- Promotion of Eco-Development activities in the buffer and transition zones including ecotourism
- Cultivation of medicinal and aromatic plants
- Development of indigenous products from wild edibles and their marketing
- Promotion of indigenous craft and marketing of products
- Introduction of suitable agricultural and horticultural species for restoration of marginal lands
- Development of adequate snow harvesting technique (s)
- Conducting Environmental Impact Assessment of the tourism

Photo credits: Wildlife Institute of India photo bank

- Assessment and monitoring of retreat of the glaciers and impact study of climate change on the natural resources
- Development of infrastructural facilities for management and conducting long term studies
- Education and awareness programmes for the tribal communities and staff of the CDBR and ensuring participation of inhabitants in the management of CDBR
- Development of effective network among the State and Central Government R&D organizations, Line Departments, Biosphere Reserve Managers, NGOs, Local Institutions and inhabitants

9. Conclusion

The reserve is a unique representation of Cold Desert ecosystem in the Trans Himalaya. The unique topography, soil, climate, biodiversity and most importantly the socio-cultural systems contribute for increasing its national/global significance. The changing environmental conditions and socio-cultural value systems makes the reserve a priority candidate for indepth investigation in the coming years. As CDBR has come in existence very recently, therefore, it provides an opportunity for developing appropriate plan of action and management which addresses issues of conservation and development on timely manner through participatory mechanisms.

Sher S Samant, FNASc, FSE
Nodal Person for NDBR & CDBR
Scientist In-charge Himachal Unit & Theme Head, Biodiversity Conservation and Management
G.B. Pant Institute of Himalayan Environment & Development
Himachal Unit, Mohal-Kullu- 175 126, Himachal Pradesh, India
Phone : +91-1902- 225329
Fax: : +91-1902-226347
eMail : samantss2@rediffmail.com;samant62@yahoo.com

Lok Man S Palni, FNASc, FNAAS
Director, G.B. Pant Institute of Himalayan Environment & Development
Kosi-Katarmal, Almora 263 643, Uttarakhand (INDIA)
Phone : +91-5962- 241015; 241041
Fax: : +91-5962-241150
eMail : lmspalni@rediffmail.com; psdir@gbpihed.nic.in

Sanjeeva Pandey, IFS
Chief Conservator of Forests (Protected Areas)
Talland, Shimla, Himachal Pradesh, India
Phone : +91-177- 2623540 (O)
Fax: : +91-177-26224193
eMail :pandey.sanjeeva@gmail.com

18

Seshachalam Biosphere Reserve - Deccan South, India

18.1. Introduction

The Seshachalam Biosphere Reserve (SLBR), designated recently in 2011, is located in Seshachalam Hill-ranges of Eastern Ghats in Southern Andhra Pradesh. The reserve intends to enhance the efforts of conserve *in situ* all form of life, along with its support system, so that it could serve as a referral sysytem for monitoring and evaluating changes in natural ecosystems of representative biogeographic unit.

Designation Date	:	20 Sept., 2011
Total Area	:	4,755.997 km^2
Core Area	:	750.589 km^2
Buffer Area	:	1,865.156 km^2
Transition Area	:	within 5 kms radius of outer boundary of buffer (Approx 2,140 km^2)
Extent	:	13°38′ and 13°55′ N and 79°07′ 79°24′ E

18.2. Area Description

The Seshachalam Hill ranges of the eastern ghats lie between 13°38" and 13°55" N latitudes and 79°07" and 79°24" E longitudes and spread over two districts viz., Chittoor and Kadappa of Southern Andhra Pradesh. The Zonation map of Seshachalam Biosphere Reserve is given (Figure 18.1).

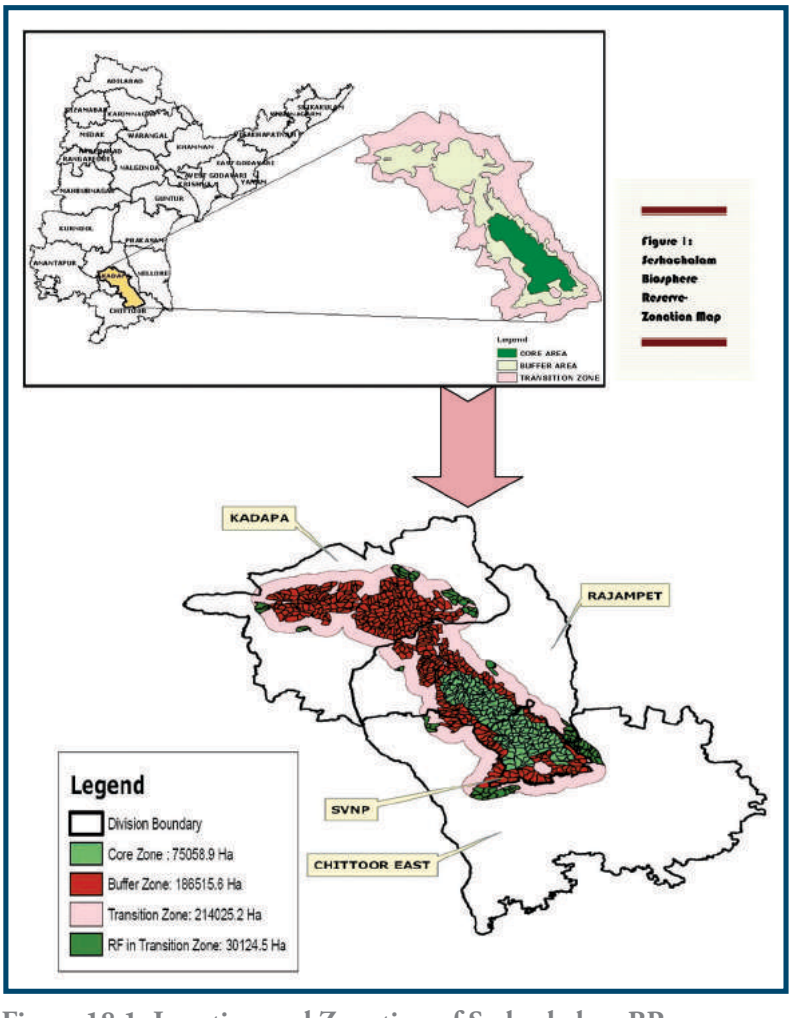


Figure 18.1: Location and Zonation of Seshachalam BR

18.2.1. Zonation Details

The total geographical area of Seshachalam Biosphere Reserve is 4,755.997 km^2 which spreads over 638 forest compartments. In order to undertake activities relating to biodiversity conservation and development of sustainable management aspects, the area is demarcated into 3 inter-related zones: (i) natural or core zone (ii) manipulation or buffer zone (iii) transition or restoration zone.

(i) The Core Zone

The central part of the reserve covering an area of 750.589 km^2 has been designated as core zone, which is completely free of human habitations and remains absolutely undisturbed. The core zone provides a suitable habitat for numerous plant and animal species, including higher order predators, and serves as centers of endemism, wild relatives of economic species, and also

represents an important genetic reservoir. The core zone, thereofre, forms a place of exceptional scientific interest. Strict nature reserves and wilderness areas of the reserve have been included as core area. Thus the Sri Venkateswara National Park forms a part of core zone. In addition, areas contiguous to the National Park and with high conservative value are included in the core zone. The core zone spreads over 183 forest compartments.

(ii) Buffer Zone

The buffer zone of reserve covers an area of 1,865.156 km^2, which includes 240.87 km^2 of Sri Venkateswara Wildlife Sanctuary. The buffer zone spreads over 455 forest compartments. The outer boundary of the core zone forms the inner boundary of the buffer. The outer boundary of the forest compartments forms the outer boundary of the buffer.

(iii)The Transition Zone

The transition zone of Seshachalam BR covers an area falling within 5 kms radius from the outer boundary of buffer zone and spreads over 41 forest beats. The outer boundary of these forest beats form the outer boundary of the transition zone and that of Seshachalam Biosphere Reserve. The temple complex of Tirumala spreading over 27.21 km^2 is also included in the transition zone.

18.2.2. Bio-geographic Characteristics

Biogeographically the Seshachalam Biosphere Reserve comes under: Malayan Realm, Tropical dry deciduous forests biome. Reseve falls under biogeographic zone Deccan Peninsula and province 6E- Deccan South of India

18.3. Background Information

18.3.1. Topography and Geology

The Seshachalam hill ranges are bounded by the Rayalaseema uplands in the west and northwest and the Nandyal Valley (formed by the Kunderu River) in the northeast. The Seshachalam Hills extend over 8,000 km^2, and their general trend is east-southeast. The Hills vary in elevation from 400 to 1,370 meters with an average altitude of 700m. The general configuration of the area is hilly undulating terrain and at places having deep gorges around plateaus. The hills have steep slopes both in the North and South. It comprises of seven peaks representing the seven hoods of Adisesha, thus attaining the name Seshachalam. The seven peaks are Seshadri, Neeladri, Garudadri, Anjanadri, Vrishbhadri, Narayanadri and Venkatadri. The Tirumala Hill is the abode of Lord Venkateswara, popularly known as Tirupati Balaji temple, the Second richest in India.

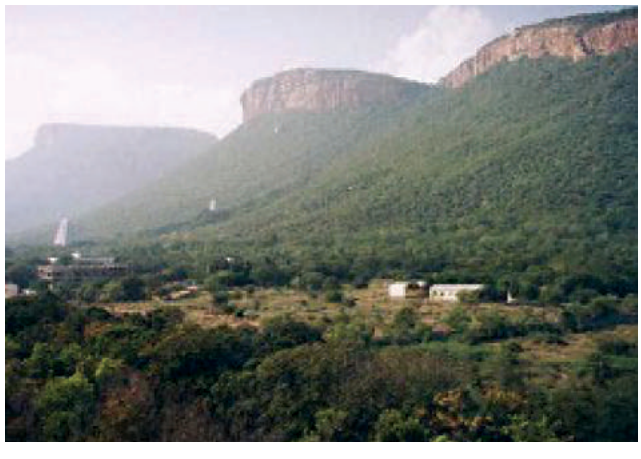
The area exhibits variety of geological rock and soil formations of Precambrian period (i.e., earlier than about 540 million years ago), and contains sandstone and shale inter-bedded with limestone and highly dissected with longitudinal valleys. The soils are sandy loam on the archean igneous rocks consisting of granite. The picturesque ranges are also known for beautiful waterfalls like Talakona, Gundalakona and Gunjana. About 365 such waterfalls are known to local people. Many micro-climatic habitats are formed on the rock formations at various altitudes.

18.3.2. Climate

The area has typical monsoonal climate with three distinct seasons summer, rainy and winter. The variation in climate occurs from place to place. The low lands are uncomfortably hot in summer with less rain fall. The mean maximum temperature ranges from 26° to 46°C and minimum from 9.7° to 25° C depending upon the season.

18.3.3. Land use pattern

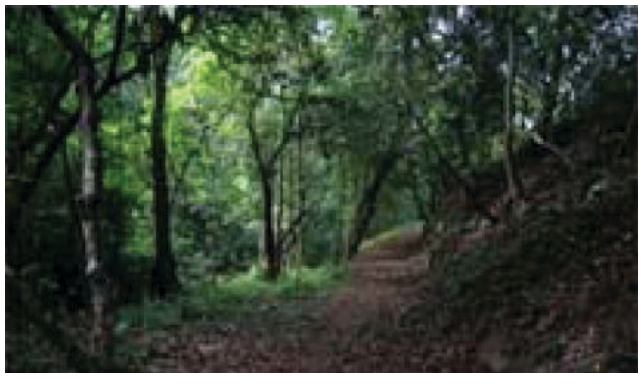
Of the total geographic area of the Seshachalam Biosphere Reserve, over 62 % comes under forest land (notified as reserve forest under Indian Forest Act,1927) and falls under the administrative control of Forest Department. Rest of the area is under agriculture, horticulture, water bodies, wasteland, and built up land. Thus the area is large enough to be effective as conservation unit. The area has 33 revenue mandals and 345 revenue villages comprising of 1340 habitations. The area is largely an agricultural rural setting with preponderance of forests. Agriculture is the mainstay of the population. Most of the villages are situated on the fringes of forests and people are dependent on these forests. Out of a total population of around 21,33,313, the scheduled castes (SC) and scheduled tribes (ST) population account for 10.26% and 2.5%, respectively. The average family holding is only 3-4 ha. The cattle and goats are reared in large numbers in the area. Working in the forest area is the supplementary source of income for the villages lying



in the close vicinity of the reserve. The village houses are generally constructed with mud and wooden poles.

18.4. Global and National Significance

The indigenous communities of the reserve are attached to the area due to its religious and socio-cultural significance. The ancient and sacred temple of Sri Venkateswara is located on the seventh peak, Venkatachala (Venkata Hill) of the Tirupati Hill, and lies on the southern banks of Sri Swami Pushkarini that is known popularly today as Tirupati Balaji Temple. The main temple complex of temple houses awe-inspiring idol of the Lord of the Seven Hills and is worshipped by millions



of devotees from all over the world. The devotees flock the temple in large numbers and make offerings in large quantity making it one of the the richest temple in India. The temple has a long history and has acquired significance in Indian religious lore, hence the entire area enjoys sacredstatus, especially from Hindus.

> **Being associated with Bliss-giving God Shiva and Vishnu – the entire area enjoys sacred status, especially for Hindus.**

18.5. Biodiversity values

18.5.1. Forest vegetation

The Seshachalam hill ranges are endowed with rich variety of forests. Following Champion and Seth's classification, the forests of reserve are grouped into Red sanders bearing forest (5A/C2), Southern dry mixed deciduous forest (5A/C30), Dry Deciduous scrub (5D/S1), Hardwicia Forest (5D/E4), Dry Savananah Forest (5D/S2). Legally, the entire forest area is notified as reserve forest under Indian Forest Act,1927. As per the remote sensing data (2006), of the total forest cover, the closed forest constitutes 9.6% and open forest 54%, scrub forests constitute 4.2%, while forest blank is 1.3%,in Chittoor. Similarly in Kadapa district, forest cover comprise, dense (7.5%), open (45%), Scrub (37%) and Blanks (9.8%).

18.5.2. Flora

The reserve is a home for nearly 1756 species of flowering plants belonging to 879 genera and 176 families. Diversity of floristic elements under differents groups is as below:

Taxa	Families	Genera	Species
Polypetalae	84	313	626
Gamaopetalae	32	288	556
Monochlamydeae	27	93	209
Monocotyledons	33	185	365
Total	176	879	1756

(i) Rare plants

Important rare plants in the reserve include; *Dillenia indica, Alphonsea sclerocarpa, Polyalthia korintii, Maerua oblogifolia, Niebuhria apetala, Casearia ellipitca, Shorea robusta, Hibiscus platanifolius, Kydia calycina, Melhonia incana, Aspidopterys indica, Pamburus missionis, Aglaia elaeagnoidea, Melia dubia, Soymida febrifuga, Ximenia americana, Loseneriella obtusifolia, Thraulococcus erectus, Alysicarpus longifolius, Crotolaria globosa, C.lumulata, C.quinquefolia, Eleiotis monophylla, Indigofera karnatakana, Ormocarpum cochinchinense, Pycnospora lutescens, Uraria picta, Cassia surattensis, Acacia eburna, Neptunia oleracea, Drosera indica, Memecylon lushingtonii, Corallocarpus epigaeus* and *Corbichonia decumbens. Hamiltonia suaveolens, Hydyotis avatifolia, Knoxia wightiana, Adenostemma lavenia, elephantopus scaber, Gynura lycopersicifolia, G. nitida, sigesbeckia orientalis, Wahlenbergia erecta, Lobelia alsinoides, Embelia villosa, Chionanthus ramiflora, Olea polygama, Schrebera swietenoides, Salvadora persica, tylophora fasciculate, Cordia gharaf, Evolvulus nummularius, Ipomoea wightii, Solanum trilobatum, Striga gesnerioides, Utricularia striatula, Radermachera xylocarpa, Stereospermum colais var, colais, Lepidagathis hamiltoniana, Rostelluaria simplex, Priva cordifolia, Svensonia hyderobadensis, Vitex peduncularis, Colebrookia oppositifolia, Leucas lanata, L.wightiana, Plectranthus coesta* and *Pogostemon paniculatus*.

(ii) Endangered plants

Endangered Plants of the reserve mainly include: *Homalium zeylanicum, Butea monosperma, Rhynchosia heynei, Tephrosia* sp.

(iii) Critically endangered plants

Rauvolfia serpentine and *Litsea glutinosa* are the critically endangered species in the Biosphere Reserve area.

(iv) Vulnerable plants

Hildegardia populifolia, Sterculia urens, Aegle marmelas, Rubia cordifolia, Gymnema sylvestre, Oroxylum indicum, Euphorbia fusiformis, Phyllanthus indofischeri, Stemona tuberosa and *Gloriosa superba* are considered vulnerable plants.

(v) Near threatened plants

Under this category species like *Shorea robusta, Celastrus paniculatus, Pueraria tuberose, Holostemma adakodien* and *Costus speciosus.* have been reported in the reserve.

(vi) Endemic plants

Out of the total seed bearing plants enumerated in the area, eleven species viz., *Shorea tumbaggaia* (Dipterocarpaceae), *Boswellia ovalifoliolata* (Burseraceae), *Indigofera barberi, Pterocarpus santalinus, Rhynchosisa beddomei* and *Sophora interrupta* (Fabaceae), *Terminalia pallida* (Combretaceae), *Syzygium alternifolium* (Myrtaceae), *Pimpinella tirupatiensis* (Apiaceae), *Leucas indica* var, *nagalapuramiana* (Lamiaceae) and one gymnosperm *Cycas beddomei* (Cycadaceae) represented endemic to the reserve.

18.5.3 Fauna

The faunal composition represents the Deccan Peninsular zone of bio-geographic classification of India. The great diversity of geo-morphology and vegetation give rise to multitude of habitats that support rich wildlife.

The wildlife belonging to schedule I, II, III & IV occur in the area. The forests of the reserve harbor certain highly endangered wildlife species, like Slender Loris, Indian Giant squirrel, Mouse deer, Golden Gecko, etc. Tigers, leopard, Elephants, sloth bear, Indian wolf, wild boar, chinkara, Four-horned antelope, chital and sambar, Ibex, Pig, Bonnet Monkey, Mongoose, Wild Dogs Black Buck, Bison, Jackal, Fox, Civet Cat, Jungle Cat, Lizards are some of other animals commonly found roaming in this area. More than 150 species of birds are reported from this area. Pangolins, Pythons, Pea fowls, Jungle Fowl, Partridges, Quail, Crested Serpent Eagle, Ashy Crowned Finch Lark, Indian Roller, Kingfishers, and White Bellied Woodpecker, etc., are common. It is estimated that 137 species of birds are found in Seshachalam Forests. Yellow throated Bulbul, an endangered bird species, is found to exist in Forests of Seshachalam Biosphere Reserve.

18.6. Issues and Concerns

The main threat to the ecosystem in the reserve is felling and smuggling of red sanders which is endemic to the area. Grazing of cattle and forest fires are common in the forests. Poaching of wild animals is another major threat to the ecology of the area.

> The multitude of habitats and ecological niches of Biosphere Reserve supports rich wildlife within the reserve.

18.6.1. Protection measures

- To prevent poaching of wild animals special Anti-poaching Range has been created with its Head Quarters at Tirupathi.
- In order to protect the forests from Red Sanders

smuggling the following measures are being taken:

(i) Regular patrolling of the vulnerable forest areas and vulnerable routes of smuggling by special parties and registering cases.

(ii) Identifying the habitual smugglers involved in Red Sanders wood smuggling and registering cases against them under P.D. Act.

(iii) All Red Sanders wood cases are being prosecuted. In cases of involvement of vehicles the vehicles involved are confiscated to State.

(iv) The issues related to forest produce, particularly that of Red Sanders wood smuggling are periodically reviewed by District Forest Protection Committee headed by the District Collector and also at the State Level Forest Protection Committee headed by the Chief Secretary of the State.

(v) The field staff has been provided with wireless net work, wireless hand sets and cell phones to improve communication facilities for tracking smuggling of red sanders.

(vi) In order to improve the forest protection, the local communities have been involved through the institution of Vana Samrakshna Samiti (VSS),. In all the cases involving forest produce detected by the department with the help of the VSS, 50% of the compounding fee realized or 50% of the value of the produce involved in the offence is being shared with the VSS.

(vii) The road network has been strengthened in the recent past to facilitate quick movement of forest staff in the deep vulnerable areas.

(viii) For the stay of staff at vantage points low cost sheds have been constructed under User Charges. Such camping sites facilitate better halting facilities for the staff while in forests. Sometimes such sheds are designed to have watchtowers to observe movement of fellers in the forest areas. About 15 such watch-towers / sheds have been constructed.

(ix) For patrolling in the RS bearing forest areas, Mobile Parties have been formed These parties comprising of Tribal Helpers headed by a Forest subordinate move in the forest areas to ensure protection. Tribal youth from VSS and EDCs are being engaged to overcome shortage of staff.

(x) Secret Service Fund is being provided to the frontline staff together information through informers.

In addition to the above during 2008-09 the following new initiatives were taken:

- Base camps with 4 to 6 tribal watchers have been established in interior forests of vulnerable areas to prevent felling of Red Sanders trees. At present base camps are operating at 29 places (Tirupati WLM Division – 9, Rajampet WL Division – 10, & Kadapa Division – 10).
- Strike Force parties have been constituted at 11 places for patrolling in vulnerable areas around the forests of Seshachalam Biosphere Reserve. In addition to these 11 Mobile parties are functioning @ one each range in this area.
- Action has been initiated to strengthen existing 18 check posts of Red Sanders bearing areas by placing ex-serviceman / Tribal watchers. Simultaneously new check posts are being put in place in order to check illicit transport of red sanders. In addition to the above check posts have been established at 14 places.
- Unused buildings / quarters of the Department have been repaired and forest stations are set up in these buildings. These forest stations are providing camping place for field functionaries, strike force and Tribal Watchers; information collection on smuggling and investigation of offences. During the current year 14 Forest Stations are functioning around the forests of Seshachalam Bio-sphere Reserve.
- Various publicity measures such as wall writings, publicity boards, publicity vans with AV materials etc., have been launched in forest fringe villages.
- Two dog squads with head quarters at Tirupati and Kadapa are functioning from March, 2009 to assist the field staff in detection of concealed Red Sanders both in storage and transit.

18.7. Administrative and Management System

The Seshachalam BR forest area extends over four forest divisions viz., Chittoor (East) Wild life division, Wildlife Management Division, Tirupathi in Chittoor district and wildlife division, Rajampet, and wildlife division, Kadapa in Kadapa district. These four divisions are organized into two wildlife management circles with their administrative headquarters at Kurnool and Tirupati managed by two Conservator/Chief Conservator rank officers. The forest divisions are headed by a Divisional Forest Officer, assisted by an assistant conservator of forests. The forest area is divided into 12 ranges, 91 forest beats and 640 forest compartments for administrative and management purposes. Sri Venkateswara Wildlife Sanctuary is delineated comprising 525.97 km^2 in Rajampet forest division of Kadapa and Chittoor (East) forest division of Chittoor districts out of a total reserve forest area of 2981.79 km^2. It has been notified as wildlife sanctuary under section 26 A of the wildlife (Protection) Act 1972 in the year 1998. The core area of Sri Venkateswara

Wildlife sanctuary is Sri Venkateswara National park and spreads over 353.63 km^2. The National park was notified under section 35 of Wildlife (Protection) Act 1972 by the Government of Andhra Pradesh in the year 1998.

The Seshachalam BR area is presently organized into two forest circles viz., Kurnool and Tirupati Wildlife Management Circles. The CF, WLM Circle, Tirupati has been designated as Field Director, Seshachalam BR for effective management and administration.

Following committees have been constituted for overall coordination and management of Seshachalam BR.

18.7.1. State level steering committee (SLSC)

At State level, a committee under the chairmanship of the Chief Secretary of the state with representatives from various line Departments of the State government steers through the coordination for BR. The committee also includes eminent Scientists, representatives of Lead Institute and Govt. of India. The committee oversees the programme implementation.

18.7.2. Field level co-ordination committee (FLCC)

At field level, a co-ordination committee under the chairmanship of Chief Conservator/ Conservator of Forests having jurisdiction over the area is constituted. The Committee co-ordinates the activities of various Departments.

18.8. Conclusion

Seshachalam Biosphere Reserve, with its unique values and representative features, has potential of becoming a model Biosphere Reserve to fulfill various functions of a reserve. While representing a classical case for absolute conservation of core zone, the participatory eco-development activities in buffer zone are supposed to increas co-operation between reserve inhabitants and management. However, the sensitivity of reserve resources for various anthropogenic pressures deserve attention of various stakeholder groups. Further, the reserve being a recent creation, there are opportunities to design researches, developmental activities and management at par with contemporary happenings at international level.

In-spite of of the above successful initiatives, the reserve has several issues, some of these listed below, deserving immediate attention so as to make the reserve a true success model:

(a) Development of a Perspective Plan (5 year) for effective management of BR
(b) Improving monitoring and networking of BR through use of modern tools
(c) Development of specific training capsules for diverse groups of stakeholders considering their needs and relevance with BR specific issues
(d) Development of user-friendly information portal for Seshachalam BR
(e) Establish baseline information on value of ecosystem services emanating from the BR
(f) Developing alternate modals/strategies for sustainable use and management of BR resources under changing climate and economic scenarios
(g) Strengthen participation of communities and private sector in reserve management

G Sudhakar, IFS
Director (Development) Environmental Protection Training and Research Institute (EPTRI)
91/4, Gachibowli, Hyderabad, 500 032
phone: +91-40-23180100
Fax: +91-40-23180135
eMail: drsudhakar@eptri.com

Other Contacts:
Conservator of Forests, Wildlife Management, Tirupati,
Phone: +91-877-2231887
Divisional Forest Officer, Wildlife Management,
Sri.Venkateshwara National Park, Tirupati
Phone:+91-877-2280980
e-Mail : cfwlm_apfd_tpt@ap.gov.in

19
Panna Biosphere Reserve - Central Highlands, India

19.1. Introduction

Designated as eighteenth Biosphere Reserve, Panna is the most recently notified Biosphere Reserve by the Ministry of Environment and Forests, Govt of India on August 25, 2011. Interestingly, it forms 3rd Biosphere Reserve in the State of Madhya Pradesh. This reserve represents a unique ecosystem within the narrow belt of table top mountains of 'Vindhyan Hill Ranges' and part of 'Bundelkhand' region. Besides including the traditional agro-ecosystems, the reserve truly represents dry deciduous forest ecosystem of central India.

Designation Date	:	25 August 2011
Total Area	:	2,998.98 km^2
Core Area	:	792.53 km^2
Buffer Area	:	987.20 km^2
Transition Area	:	1219.25 km^2
Extent	:	24°21′ and 24°59′ N 79°38′ and 80°29′ E

19.2. Area Description

The area of Panna BR (24° 21' 8" to 24° 59' 3" N latitudes and 79° 38' 6" to 80° 29' 15" E longitudes), administratively falls under Panna and Chhatarpur districts in the state of Madhya Pradesh (Figure 19.1).Of the total area of Panna BR (2998.98 km^2), 64.16% falls in Panna district and the remaining 35.84% in Chhatarpur. The reserve includes 3 Protected Areas (i.e., Panna National Park, Gangau and Ken-Gharial sanctuaries).

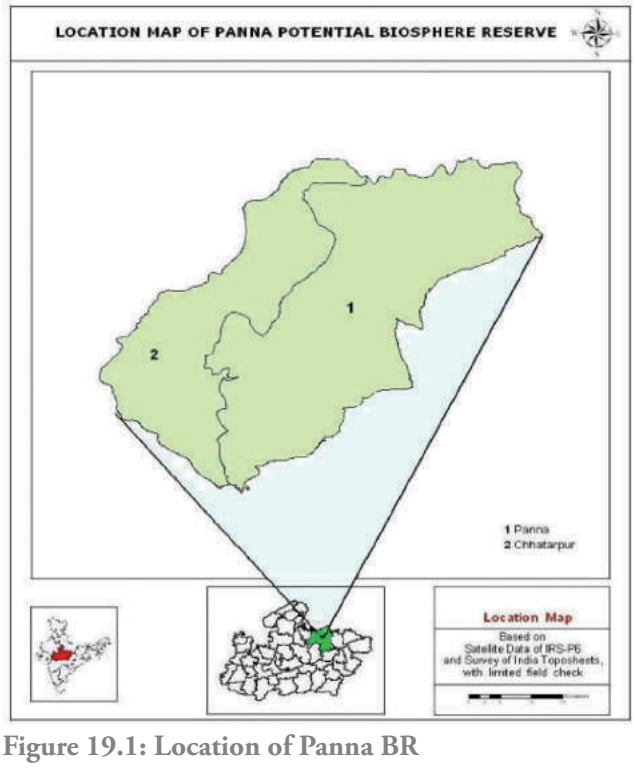


Figure 19.1: Location of Panna BR

Panna BR is well connected by all weather roads from Satna (75 km) and Chhatarpur (70 km). The Khajuraho airport (32 km from Panna and Chhatarpur) is located on north-west boundary of the reserve. The National Highway No-75 passes through the BR.

19.2.1. Zonation

Meeting the zonation requirement under UNESCO guideline for BRs, the Panna BR consists of three well delineated zones – core (792.53 km^2, 26.43%), buffer (987.20 km^2, 32.92%) and transition zones (1219.25 km^2, 40.66%) (Figure 19.2).

The core zone includes entire area of Panna NP and parts I, III and IV of Gangau sanctuary. Besides this, an area of 190.74 km^2 consisting of Reserve (RF) and Protected forests (PF) of North Panna Forest Division have also been included in this zone (Figure 19.3). There are 6 villages within this zone, of which 04 are within Panna NP and remaining 02 within RF & PF. The core zone area is dominated by forests (92.05%), with considerably large proportion under dense forest cover (61.43%). Thus the overall quality of the forest in core zone is said to be excellent. Agriculture is confined to only 4.91% of core area.

The buffer zone consists of Ken - Gharial Sanctuary and part II of Gangau Sanctuary along with considerable RF and PF areas. Of the total, forest area covers 59.55% of buffer zone, with dense forests accounting for 22.34%. The degraded and open forests respectively constitute 17.71% and 15.41%. The agricultural area in buffer zone is 34.38%. The outermost transition zone includes relatively less forest

area (32.11%) wherein both dense and open types of forest are nearly 11% each. Large chunk of transition zone is under agricultural area (61.05%).

19.2.2. Biogeographic characteristics

The reserve falls under Bio-geographic Zone Deccan Peninsula and covers the Bio-geographic Province of Central highlands (6 A). However, it lies nearer to confluence of Deccan Peninsula- Central Highlands (6 A), Upper Gangetic Plains (7 A) and Semi-Arid Gujrat Rajputana (4B) thereby making it very unique in having representative elements of all three provinces. From agro-climatic zone point of view, the reserve represents Bundelkhand and Kymore plateau of Satpura hill ranges.

19.2.2. Geology, topography and Climate

With an altitudinal variation between 135 to 651m above mean sea level (msl), most of the BR area is undulating that represents hills of varied dimensions. The typical bench topography of the core zone with three plateaus on the right bank and two distinct, almost completely hilly portions, on the left bank of Ken river have given rise to large numbers of gorges, cliffs, overhangs, etc. The Ken River is one of the sixteen perennial rivers of MP and is truly the lifeline of the reserve. Majority of the area is covered by lateritic soil. Heavier black cotton soil is restricted to some depressions, and in vicinity of water bodies. Besides this, loamy soil is also found in the area.

The climate is mostly semi arid to dry sub-humid, with 7 months in a year remaining hot and dry. The average annual rainfall is about 1100 mm that varies between 757 to 1885 mm at Panna and between 493 to 1449 mm at Chhatarpur. The Archean system, Bijawar group, Vindhyan system, Semri system, Kaimur system, Deccan traps, and Alluvium types of rock systems have been defined for the reserve area.

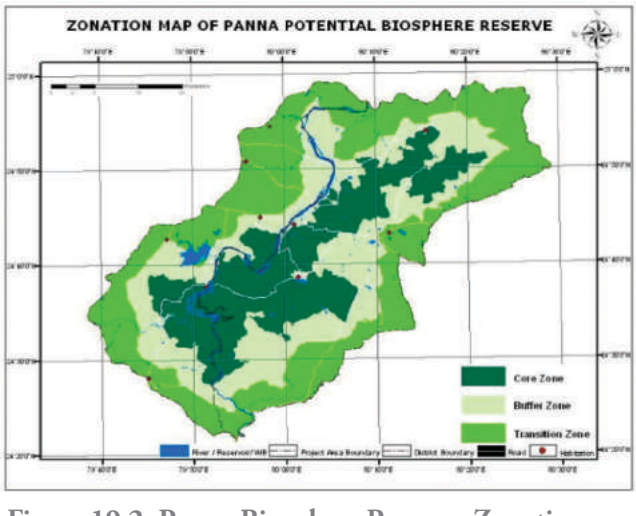


Figure 19.2: Panna Biosphere Reserve- Zonation

19.2.3. Landuse

As per the analysis of satellite imagery data of October 2006 and January 2007, maximum of the reserve is represented by forests (56.98%) followed by agriculture (37.43%), water bodies (3.02%), waste land (2.22%) and built up land (0.35%). Out of the total forests, 48.95% is covered with dense forests (Figure 19.3). Therefore, overall quality of forests in the reserve is referred to be as very good.

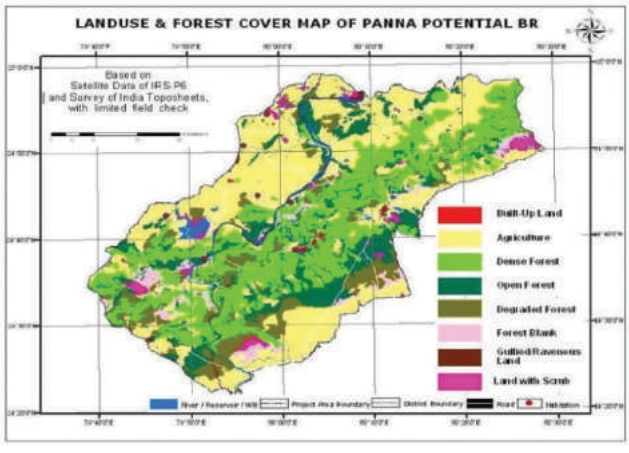


Figure 19.3: Landuse in Panna BR

19.3. Biodiversity Attributes

19.3.1 Floral diversity

Panna BR includes ecologically rich forest pockets, with dominance of dry deciduous forests. However, based on vegetation composition, it may be further divided into six forest types viz., southern dry deciduous teak forest, northern dry deciduous mixed forest, dry deciduous scrub forest, salai forest, dry bamboo forest and kardhai forest. The seasonal vegetation of the reserve has been categorized into rainy, winter and summer. The aquatic and marshy vegetation in the reserve are in the form of free floating or attached forms with floating plant parts.

The area has rich biodiversity, as it provides an ideal habitat for excellent growth and proliferation of large number of species. Based on available information, a total of 1255 species of lower and higher plants have been reported from the area, of which 982 species belong to angiosperm.

One of the most significant ecological aspect of the area is that it almost makes the northern most boundary of natural distribution of teak (*Tectona grandis*) and the eastern limits of Kardhai (*Anogeissus pendula*) forests. The entire area comprises of extremely diverse vegetation, ranging from sprawling grassland through mixed, pure stands of teak, Khair (*Acacia catechu*) and Kardhai.

A total of 69 angiospermic species in the reserve are observed to be rare. Amongst these, 3 species (viz., *Eriocaulon parviflorum, Oropetium roxburghianum*, and *Themeda laxa*) have been reported as endemic to India. Some of the rare plant species, for example, Nirmali (*Strychnos potatorum*), Safed-Musli (*Chlorophytum tuberosum*), Kalihari (*Gloriosa superba*), Bach (*Acorus calamus*), are also of high medicinal value.

In general, the area is rich in medicinal plants (108 species). Notable among these are: Giloy (*Tinospora cordifolia*), Gokharu (*Tribulous terrestris*), Bel (*Aegle marmelos*), Bija (*Pterocarpus marsupium*), Arjun (*Terminalia arjun*), Mandukparni (*Centella asiatica*), Chitrak (*Plumbego zeylanica*), Harra (*Terminalia chebula*), Mahua (*Maduca indica*), Gudmar (*Gymnema sylvestre*), Ashwagandha (*Withania somnifera*), Patthar chatta (*Didymocarpus pignae*), Adusa (*Adathoda vasica*), Kalmegh (*Andrographis paniculata*), Katsaraiya (*Barleria prionitis*), Nirgundi (*Vitex negundo*), Kali musli (*Curculigo orchiodes*), Guarpatha (*Aloe vera*), Satawari (*Asparagus racemosus*), Baheda (*Terminalia bellirica*), etc. In addition, a wide variety of secondary products e.g., Kattha, Gum and Resins are also obtained from the reserve forests. Among others, wild variety of Aonla (*Emblica officinalis*) growing in natural forests of BR is considered highly valuable as compared to cultivated one.

19.3.2 Faunal diversity

As many as 34 mammalian species have been reported in the Panna BR. The reserve habitats suit well to at least to 2 species of lesser cats [i.e., Siyah Gosh (*Felis caracal*) and Jungle cat (*Felis chaus*)]. Black buck (*Antilope cervicapra*), an endangered species, resides in the southern part of the BR.

Tiger, a flag ship species, is considered almost wiped out from the area. More recently, December 2010, two tigresses along with one male tiger have been reintroduced from the nearby Tiger Reserves considering issue of local extinction of tigers in the Panna tiger reserve. In the subsequent year tigresses gave birth to 7 cubs. Out of these, 5 cubs are still animate, retaining their existence in the new habitat. Thereafter one more tigress was reintroduced in 2011. This successive case of tiger reintroduction has resulted in increasing the number of tiger population to 9 in the BR area. Even with this early success, the survival and regeneration of this species would remain an extreme challenge for management authorities in this area.

The area is also rich in avian fauna. A total of 281 species of birds are reported in the area. The Ken river attracts number of avian species both pretty and good songsters. The Panna National Park can boast up the highest density of paradise flycatchers 'the State Bird of Madhya Pradesh'. Presently, there are several species of vulture which are on the brink of extinction. But still 7 of the 8 Indian vulture species are found in favourable habitats of BR. Out of which, long billed vulture and white-backed vulture are listed 'Critically Endangered' by IUCN in 2000.

The Ken River, which flows through the entire area from south to north, is the abode of long knouted Crocodile (Gharial) and Marsh Crocodile (Maggarmachha) and other aquatic fauna. The Crocodile (*Crocodilus palustris*) and long snouted Crocodile (*Gavialus gangeticus*) both co-exist in river Ken. This is rare occurrence as both species are generally found separately. The Gharial is listed as a critically endangered species by IUCN.

The Crocodile and long snouted Crocodile both co-exist in river Ken. This is rare occurrence as both species are generally found separately.

Two species of amphibian fauna have been reported from the area. The Ken River is full of fresh water fishes and crabs, forming a perfect aquatic natural ecosystem. As many as 14 species of fishes have been reported in the BR area. Mahseer, a threatened fish species, is also found in river Ken.

19.3.3. Domesticated animals

The domestic cattle found in the area include buffalo, cow, goats, etc. A native breed of cattle 'Kenkatha' breds in territories of Panna, Charkhari, Bijawar and Ajaigarh. Recent studies of cattle species revealed that the unrestricted interbreeding of Kenkatha with non–descript animals has resulted in degeneration of this native breed. Therefore, this issue requires immediate attention towards the conservation and improvement of this breed.

Faunal Diversity of Panna Biosphere Reserve

S. No	Group	Family	Genera	Species
1	Mammals	20	32	34
2	Avian	50	78	281
3	Reptiles	11	12	14
4	Amphibian	2	2	03
5	Fishes	8	12	14
6	Butterflies	3	23	25
	Grand Total	**94**	**159**	**371**

19.4. Conservation Value

Panna BR has a rich natural heritage with long history and tradition of wildlife conservation. The area is rich in wild animals- both by variety and by numbers. The area has been included in list of Tiger Reserves of India. As it links the eastern and western population of wild animals through the NE-SW running Vindhyan ranges, Panna Tiger Reserve is one of the most important PA in the north-central highlands of India. The area has great potential to provide an ideal habitat and breeding ground for several wild animals.

19.5. Socio-cultural Attributes

19.5.1. Settlements and demography

The geographical area of Panna BR is distributed in 2 districts covering 6 blocks, each district covering parts of 3 blocks. A total of 303 villages and 3 urban agglomerations (i.e., Panna, Khajuraho and Ajaigarh) are located within the reserve. While core zone has 6 villages and no urban agglomeration, a total of 159 villages and urban agglomerations are there in buffer zone and 141 villages located in transition zone. 80.35% of the total houses are located in rural areas. The number of households is 30.99 km^{-2}, and household density/ village is 256.14.

The total population of BR, as per 2001 census, is 4,26,498. The population density is 168.65 km^{-2} which varies between 139.33 km^{-2} (rural) and 1062.63 km^{-2} (urban). The population density in core zone is minimum (34.60 km^{-2}) followed by buffer (102.40 km^{-2}) and maximum (250.00 km^{-2}) in transition zone. A sizeable proportion of the population includes scheduled tribes (13.14%) and scheduled castes (16.50%). The literacy rate is 47.06 % (29.84 % male and 17.22 % female). The rural literacy rate is 42.76% while the urban literacy rate is 64.26%.

Of the total, workers involved in various economic activities constitute 37.62%. In rural area, the participation of workers is less (39.96%) as compared to urban area (60.03%). Zonewise analysis indicates that the participation of worker is maximum (52.27%) in core zone followed by buffer zone (40.86%) and minimum in transition zone (36.05%).

The BR area contains many villages, which are having their own tradition and culture. The reserve is inhabited by tribes like Gond (Rajgond, Nandgond and Saurgond) and Khairuas and Yadavas (Dauvas). The economy of the people residing in Panna BR is mostly based on agriculture, cattle rearing, milk yield, etc.

19.5.2 Archeological and tourist places

Panna is an archaeologist's delight. Its archaeological importance would defy the limitations of expression through language. From pre-history to the present, a continuous unbroken chain is found. The area has Mesolithic rock/cave paintings at Vrihaspati Kunda and Barachh, of the prehistoric man as well as the best sculptural and architectural imprints of the Gupta period. A great defensive fort at Ajaigarh and the ruins of another fort at Rajgarh stand testimony to the historicity and grandeur of Panna's past. Vrihaspati Kunda and Barachh are archaeological treasures, invaluable chronicles in the history of man and present an eloquent testimony of Panna being a heritage of great civilizations.






Among others, the area also covers Khajuraho, a UNESCO World Heritage Site, once the original capital of the Chandela Rajputs, a Hindu dynasty that ruled this part of India from the 10th to the 12th centuries. The Khajuraho temples were built over a span of a hundred years, from 950 to 1050. Khajuraho, famous for its unique chains of temples of Chandela Raj, located in the transition zone of Panna BR area, provides ample scope for tourism. It attracts million of tourists every year from all over the country. Panna has transformed a royal past into a vibrant, lively present.

The scenic splendor of the Panna BR area is unmatched especially in the monsoons. The entire forest area become lust green with many beautiful waterfalls. The river Ken meanders and winds its way through the heart of the reserve. Alternating valleys and plateaus, grassy Maidans, steep gorges and escarpments, down which the waterfalls cascade in glittering streams during the monsoon, present a breath-taking variety of views. While Caimasan fall is the tallest, the Pandav falls is serenity herself, the Gehrighat where the river Ken enters the gorge after a short flat stretch, is a scene which may not have a match elsewhere. Two

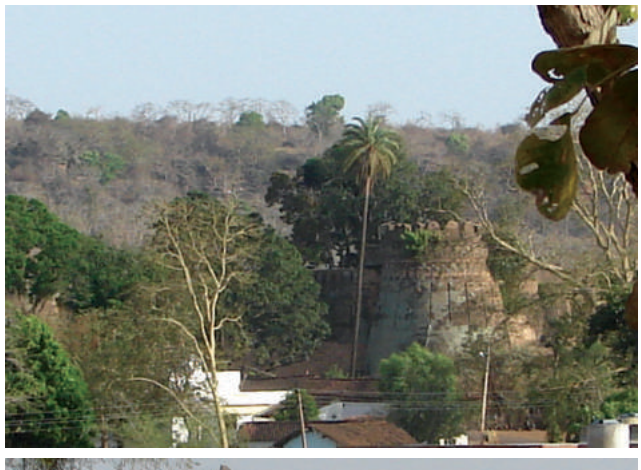
Khajuraho, famous for its unique chain of temples of Chandela Raj, located in the transition zone of Panna BR area, provides ample scope for tourism.

sanctuaries, i.e., Gangau and Ken-Gharial, are famous for rare wildlife and avifauna. Wildlife watchers will be rewarded by fascinating glimpses of the animal and bird kingdom in the Panna National Park, which is the natural habitat of a wide variety of birds and wild species. Ken - Gharial sanctuary along the river Ken near the spectacular Raneh falls is an added attraction for the tourists. Thus these sites provide an ideal place for eco-tourism. A trekking route from Raneh fall to Chhapara and Ajaigarh via Piparaghat has been identified for the tourists. This trekking route is full of nature's treasure.

19.6. Issues and Concerns

Within BR area, a major developmental project "Diamond mining" at Majhgawan near the Part II of the Gangau Sanctuary was carried out through National Mineral Development Corporation (NMDC). The mining activities at this area were stopped earlier. However, efforts are being made for restarting it again. Also, there is a proposal of establishing a railway line connecting Khajuraho to Satna, about 9 km of which would pass through part-I of Gangau sanctuary. Thus about 18.00 km of the Gangau sanctuary area will be isolated from the main Tiger Reserve area. However, two alternative routes have also been suggested to Railway Ministry. The final decision of Government of India is awaited.

There is also a proposal for constructing a dam in the Panna National Park area under Ken -Betwa link project. This is



proposed to be constructed at Daudhan village, 2.5 km upstream of the existing Gangau weir. As a result of this an area of 87.34 km^2 will come under submergence, of which 57.21 km^2 falls in Panna National Park. The landuse analysis indicates 49.09% of potential submerged zone is covered by forests followed by agriculture (28.69%), water bodies (16.92%) and waste land (5.29%). The zone wise analysis indicates that 65.50% area would come under core zone. Due to submergence north - west part of the Panna NP area will be isolated, resulting in adverse impact on the wild life and plant biodiversity as well. A total of 10 villages are fully coming under submergence and about 900 families having a total population of about 8550 will be displaced.

19.7. Management Aspects

Presently, Madhya Pradesh Housing and Environment Department is responsible for implementation of Management Action Plan (MAP) of BRs. Earlier, the State Government has appointed Environmental Planning & Coordination Organization (EPCO), Bhopal as Nodal Agency for preparation and implementation of Management Action Plan for other two BRs in the state (Pachmarhi and Achanakmar-Amarkantak - MP part). On similar lines, the same agency can also be appointed as nodal agency for implementation of Management Action Plan of this BR. The Ministry of Environment and Forests, GoI has already designated EPCO as Lead institution for Panna BR.

For management of Panna BR a federal structure has been proposed. The projects would be identified and prepared as per guideline issued by the Ministry of Environment and Forests, GoI for management and conservation of BRs and implemented by respective field level Govt. Deptt/ Organization, NGOs working in these areas.

For management of BR two committees have been proposed to be constituted. The State Level Steering Committee (SLSC) has been proposed to be constituted under the Chairmanship of Chief Secretary. This committee would be represented by Secretaries/ senior officials of the line department at state level. Similarly at district level, District Level Field Coordination Committee (DLFCC) has been proposed to be constituted under the chairmanship of respective District Collectors. The line and field Department/ Organisations/ NGOs/ experts would be member of the committee.

19.8. Long term Management Plan

Detailed prospective management plan embodying the management proposal for each eco sub-system will have to be prepared for continuity of management and time bound

implementation. This would include financial estimations, organizational and managerial responsibilities and budgeting on annual basis. Such practice is well entrenched in the forestry sector where forest management plans are prepared for 15 year periods and followed in the field. Presently management plans in most of the Biosphere Reserves are prepared on annual basis. Hence, there is a need to develop a long term strategy for preparing 5 years perspective plan for Panna BR that incorporates various plans already prepared by different departments/ organizations working in the area. Also, this keeps the concept of Biosphere Reserve as central so as to serve as guideline for preparing annual management plan of the reserve. This would help in prioritization of activities in the reserve. Among others, the perspective plan for Panna BR should consider the following:

19.8.1. Resettlement & rehabilitation

Indiscriminate destruction of wildlife habitat due to shrinkage in the forest and over hunting of wild animals in the past has posed a great threat to wildlife. Further, permanent human settlements, along with their livestock, in any protected area results in regular and frequent threat to wildlife. Thus, the resettlement of human habitations along with their livestock to a convenient place would form one of the most important operation in the reserve. The core zone of Panna Biosphere Reserve has been inhabited by man since long. There were 16 inhabited and abandoned villages in Panna Tiger Reserve area. Up to 2008-09, a total of 12 villages have already been rehabilitated out of Panna National Park. Thus only 4 villages have to be rehabilitated from Panna National Park. The rehabilitation process for these villages is under consideration. Also, 02 villages located in PF/RF of core zone would require appropriate intervention for resettlement.

19.8.2. Extension, education & training

As the Biosphere Reserve programme aims at providing a better quality of life to its inhabitants by way of assimilating their own traditional methods and lifestyles to the extent possible in the light of today's knowledge. Towards this end a strong extension thrust will be required. Therefore, the actions proposed for BR will first have to be explained and got appreciated by the people and thereafter put in practice. Extension and public relations would, therefore, be most important activity in future. Extension programme should

be carried out by all concerned. Success of the Biosphere programme will depend on awareness at different levels. The reserve local population will be covered in the extension programme but the custodians of the Biosphere Reserve, the managers and the planners, also need to be educated about the aims and objects of the programme. The reserve needs to be developed as a permanent place for environmental education, demonstrating the value and benefits of conservation areas and ecologically sound resource utilization practices for human survival and improving quality of life. The programmes need to be extended to university students, school children and nature groups/ NGOs, etc.

19.8.3. Research and monitoring

An ideal Biosphere Reserve provides the basic requirements of research, viz. sustained fellowship, field residential facilities, laboratory and equipment with support personnel, and have co-operative agreement with Government and non-Government organisations, universities, individual researchers and in-service research personnel of various disciplines and departments. The Panna BR, being a new creation, would definitely require adequate research focus from various national and international organizations. The researches need to be conducted in diverse disciplines. The perspective plan for the reserve, therefore, should provide ample scope to promote scientific research that will subsequently help in effective management of the reserve.

RP Singh
Coordinator & Officer-in-charge BR

Ajit K Sharma
Researcher

Faizan Rasheed
Project Manager
Environmental Planning & Coordination Organization (EPCO)
Paryavaran Parishar E-5, Arera Colony
Bhopal-462016

Phone: +91-755-2460104 (Direct)
EPBX: 2466970, 2464318, 2465686
Fax: +91-755-2460104, 2462136
eMail: rpsingh@epco.in, rps-br@rediffmail.com

Inventorisation and Monitoring of Biosphere Reserves in India Using Remote Sensing & GIS Technology

Inventorisation and Monitoring of Biosphere Reserves in India Using Remote Sensing & GIS Technology

The Project

Biosphere Reserve programme in the country emphasizes India's commitment for the implementation of Man and Biosphere (MAB) programme towards achieving the long term conservation and sustainable development goals enshrined within the concept of Biosphere Reserves (BRs). An urgent need has been felt to develop a coordinated programme to strengthen research on critical issues and to formulate a 'Perspective Plan' for intensive management of BRs in the country. In this context, with the funding support of National Natural Resource Management System (NNRMS) programme of the Ministry of Environment & Forests, Govt of India, the G.B. Pant Institute of Himalayan Environment & Development, along with partner institutions, has supported a country wide project to:

1. Create Natural Resources and social database using latest Remote Sensing (RS) images of existing BRs in India with a focus on Landuse Land Cover maps.
2. Study temporal changes in the land use dynamics (at 5 year interval starting from 1990 or from the date of notification) as result of BR management.
3. Make recommendations for effective management of BRs for redefining the zones/boundaries.
4. Develop and test RS/GIS based approaches for assessment and valuation of ecosystem services in a selected BR of the Himalayan region.

The National Natural Resources Management System (NNRMS) programmme of the Ministry of Environment & Forests, Govt. of India, supports the national requirements of natural resource management and developmental needs by generating a proper and systematic inventory of natural resources. Over the past twenty years the NNRMS programme has steered generation of spatial information using remote sensing data from various IRS missions.

Fact File

Focal Area:
Natural Resource Management

Funding Agency:
Ministry of Environment & Forests (Government of India), New Delhi

Lead Organization:
G.B. Pant Institute of Himalayan Environment & Development, Kosi-Katarmal, Almora

Partner Organizations:
National Remote Sensing Center, Hyderabad

Forest Survey of India, Dehradun

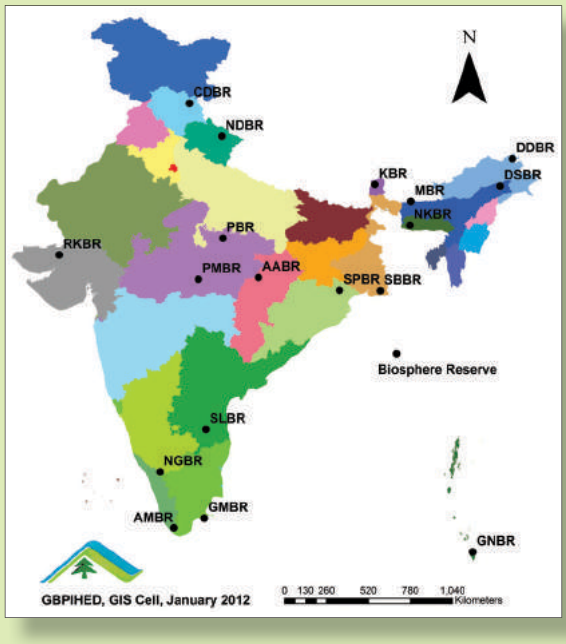
M.S. Swaminathan Research Foundation, Chennai

Expected Project Outcomes

1. Formulation of comprehensive Management Plan w.r.t. each BR
2. Decision support system through GIS based Resource Mapping
3. Ecological simulation of natural resources for prediction and scenario development
4. Monitoring indicators for effectiveness /impacts of various Schemes/Programmes

Following the UNESCO's guidelines and criteria, the Indian National Man and Biosphere (MAB) Committee identifies and recommends potential sites for designation as Biosphere Reserves.

As on January 2012, eighteen Biosphere reserves have been designated in the country.





Biosphere Reserves Of India (As on January 2012)

Himalaya and North-Eastern Region

1. Nanda Devi Biosphere Reserve (NDBR):

Location- Uttarakhand state. Date of Notification – 18 January, 1988. Total area – 6,407 km². World Heritage Site by UNESCO. Biogeographic Province - West Himalayan highland - 2B. Core zone– Nanda Devi National Park (NP) and Valley of Flower NP. Altitudinal range: ~1800m to 7816m. Important Fauna - Snow leopard, Common leopard, Himalayan black bear, Bharal, Musk dear, Himalayan Thar, Goral.

2. Nokrek Biosphere Reserve (NKBR):

Location- Meghalaya state. Date of Notification – 1 September, 1988. Total area – 820 km². Biogeographic Province – North East India-Meghalaya hills - 9B. Core zone - Nokrek NP. Altitudinal range: ~ 55m to 1412m. Important Fauna – Tiger, Leopard (Clouded & Common), Golden cat, Leopard cat, Stumped tailed macaque, Assamese macaque, Slow loris, Golden langur, Caped monkey, Hollock-gibbon.

3. Manas Biosphere Reserve (MBR):

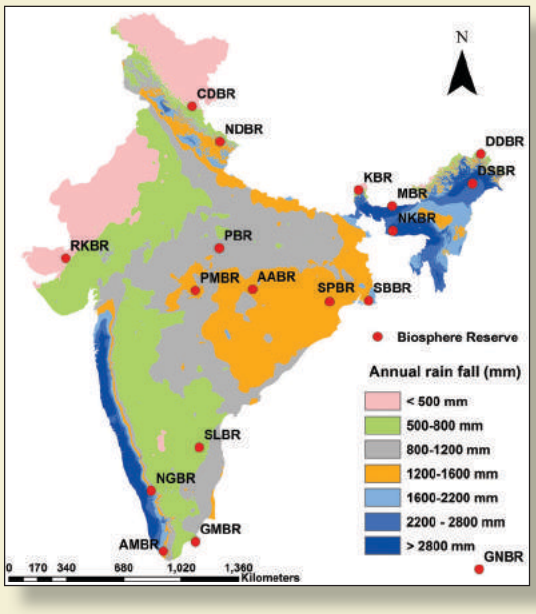
Location- Assam state. Date of Notification – 14 March, 1989. Total area – 2,837 km². Biogeographic Province - Brahmaputra valley - 9A. Core zone - Manas NP. Altitudinal range: ~ 61m to 110m. Important Fauna –Tiger, Leopard (Clouded & Common), Indian one horned rhino, Elephant, Hollock-gibbon, Golden Langur, and Pigmy-hog.

4. Dibru-Saikhowa Biosphere Reserve (DSBR):

Location- Assam state. Date of Notification – 28 July, 1997. Total area – 765 km². Biogeographic Province – Brahmaputra valley - 9A. Core zone - Dibru-Saikhowa Wildlife Sanctuary (WLS). Altitudinal range: ~ 110m to 126m. Important Fauna – Tiger, Elephant, Hollock-gibbon, Gangatic dolphin, Feral horses.

5. Dehang-Dibang Biosphere Reserve (DDBR):

Location- Arunachal Pradesh state. Date of Notification – 02 September, 1998. Total area - 5,111 km². Biogeographic Province – East Himalaya - 2D. Core zone - Mouling NP and Dibang WLS. Altitudinal range: ~ 500 m to 5000 m. Important Fauna - Snow leopard, Common leopard, Mechuka giant flying squirrel, Red panda, Asian golden cat, Marbled cat, Red Goral, Takin, Gaur.



6. Khangchendzonga Biosphere Reserve (KBR):

Location- Sikkim state. Date of Notification – 7 February, 2000 & re-notification 24 May, 2010. Total area – 2,931 km². Biogeographic Province – Central Himalayan highland -2C and Sikkim Trans-Himalaya – 1C. Core zone - Khangchendzonga NP. Altitudinal range: ~1,220m to 8,586m. Important Fauna - Snow leopard, Leopard (Clouded & Common), Tibetan wolf, Himalayan black bear, Musk dear, Himalayan Thar, Goral, Blue sheep.

7. Cold Desert Biosphere Reserve (CDBR):

Location- Himachal Pradesh state. Date of Notification - 28 August, 2009. Total area - 7,770 km². Biogeographic Province – Trans Himalaya-Tibetan Plateau -1A. Core zone - Pin Valley NP, Chandra Tal WLS and Kibber WLS . Altitudinal range: ~3300m to 6600m. Important Fauna - Snow leopard, Himalayan brown bear, Musk dear, Himalayan Thar, Himalayan Ibex.

Marine and Islands

8. Gulf of Mannar Biosphere Reserve (GMBR):

Location - Pamban island's southern coastline includes Rameswaram and Kanyakumari to mainland cost. Date of Notification - 18 February, 1989. Total area -10,500 km². Biogeographic Province – East Coasts - 8B. Core zone -Biosphere Reserve cluster. Altitudinal range: Sea level. Important Fauna- Sponges, Corals, Sea fans, Polychaetes, Prawns, Crabs, Lobsters, Cephalopods, Echinoderms.

9. Great Nicobar Biosphere Reserve (GNBR):

Location - Andaman and Nicobar. Date of Notification - 6 January, 1989. Total area - 885 km². Biogeographic Province Island -10B. Core zone– Campbell Bay NP and Galathea NP. Altitudinal range: ~ 642m. Important Fauna – Crabeating Macaque, Nicobar tree shrew, Dugong, Salt water crocodile, Marine turtle and Reticulated Python.

Desert & Western Ghats

10. Rann of Kachchh Biosphere Reserve (RKBR):

Location – Gujarat state. Date of notification – 29 January, 2008. Total area – 12,454 km². Biogeographic Province – Desert Kachchh - 3B. Core zone - Kutch Desert WLS and Wild Ass WLS. Altitudinal range: ~ 5m to 15 m. Important Fauna – Wild Ass, Striped hyena, Indian gazelle, Jackal, Desert fox, Desert cat, Caracal, Wolf.

11. Nilgiri Biosphere Reserve (NGBR):

Location – States of Kerala, Tamil Nadu and Karnataka. Date of Notification – 1 August, 1986. Total area – 5,520 km² (Core Area =1240 km² which is distributed in Kerala 264.5 km², Tamil Nadu 274 km², and Karnataka 701.5 km²). Biogeographic Province - Western Ghats - 5B. Core zone - Sileny Valley NP, Bandipur NP, Mudumalai NP, Nagarahole NP, Mukkuruthi NP. Altitudinal range: ~ 300 m to 2,635m. Important Fauna – Tiger, Common leopard, Wild dog, Elephant, Gaur, Sambar, Chital, Four-horned antelope, Nilgri Thar, Lion tailed macaque, Nilgri langur.

12. Agasthyamala Biosphere Reserve (AMBR):

Location – States of Tamil Nadu and Kerala. Date of notification – 12 November, 2000. Total area – 3,500 km². Biogeographic Province - Western Ghats - 5B. Core zone- Neyyar WLS and Shendurney WLS. Altitudinal range: ~ 100m to 1800 m.. Important Fauna – Tiger, Common leopard, Elephant, Gaur, Flying squirrels.

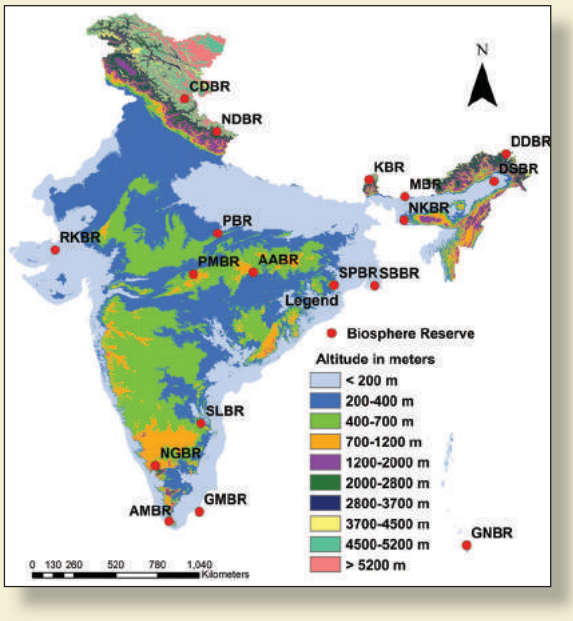
Central India & Gange's Delta

13. Pachmarhi Biosphere Reserve (PMBR):

Location – Madhya Pradesh state. Date of notification – 3 March, 1999. Total area – 4,981 km². Biogeographic Province - Deccan Peninsula Central Highlands - 6A. Core zone - Satpura NP. Altitudinal range: ~ 320m to 1,352m. Important Fauna – Tiger, Gaur, Common leopard, Indian giant squirrels and Flying squirrels.

14. Achanakmar-Amarkantak Biosphere Reserve (AABR):

Location – Chhattisgarh & Madhya Pradesh state. Date of notification – 30 March, 2005. Total area – 3,835 km². Biogeographic Province – Deccan Peninsula, Central highlands- 6A. Core zone - Achanakmar WLS . Altitudinal range: ~ 280m to 1,102m. Important Fauna – Tiger, Common leopard, Gaur, Chital, Sambar, Wild boar, Flying squirrels.



15. Panna Biosphere Reserve (PBR):

Location – Madhya Pradesh state. Date of notification – 25 August, 2011. Total area – 3,000 km². Biogeographic Province – Deccan Peninsula Central Highlands - 6A. Core zone - Panna NP, and Gangau WLS. Altitudinal range: ~ 200m to 550mlImportant Fauna – Re-introduced tiger, Common leopard, Sloth bear, Striped Hyena, Caracal, Jungle cat, Chital, Sambar, Wild boar.

16. Sunderban Biosphere Reserve (SBBR):

Location - West Bengal state. Date of notification -29 March, 1989. Total area – 9,630 km². Biogeographic Province East Coasts - 8B. Core zone - Sunderbans NP. Altitudinal range: ~ 6m to 9m. Important Fauna – Tiger, Common leopard, Salt water crocodile, Chital, Fishing cat, Leopard cat, Gangatic dolphin.

Eastern Coast & Ghats

17. Similipal Biosphere Reserve (SPBR):

Location –Orissa state. Date of notification - 21 June, 1994. Total area – 5,569 km². Biogeographic Province – Deccan Peninsula, Chotta Nagpur - 6B. Core zone - Similipal NP. Altitudinal range: ~ 600m to 1500m. Important Fauna – Tiger, Common leopard, Elephant, Bison, Wild boar, Sambar, Chital, Barking dear, Mouse dear.

18. Seshachalam Biosphere Reserve (SCBR):

Location- Andhra Pradesh state. Date of Notification – 20 September, 2010. Total area – 4,756 km². Biogeographic Province – Eastern Ghats, 6E. Core zone - Sri Venkateshwara NP. Altitudinal range: ~ 400 to 1370 m. Important Fauna – Slender loris, Indian giant squirrel, Mouse deer, Golden gecko.

Project Partners

G.B. Pant Institute of Himalayan Environment & Development (GBPIHED), Kosi-Katarmal, Almora
An autonomous institute of Ministry of Environment & Forests, Govt. of India, established in 1988.

The Institute is focal agency to: advance scientific knowledge, evolve integrated management strategies, demonstrate their efficacy for conservation of natural resources, and ensure environmentally sound development in the entire Indian Himalayan Region.

Among others, GBPIHED is designated lead institution for the following BRs - Nanda Devi, Cold Desert, Manas, Khangchendzonga, Dibru-Saikhowa, and Dehang-Debang. In present case, besides coordination, GBPIHED is executing project activities in these BRs.

National Remote Sensing Center (NRSC), Balanagar, Hyderabad
Indian Space Research Organization

NRSC is premier institution of ISRO with mandate of providing Earth Observation data from space and aerial platforms to users, develop technologies for the management of natural resources, and management and capacity building.

NRSC is responsible for executing project activities in Nilgri, Rann of Kutch, Agasthymalai, and Simlipal BRs.

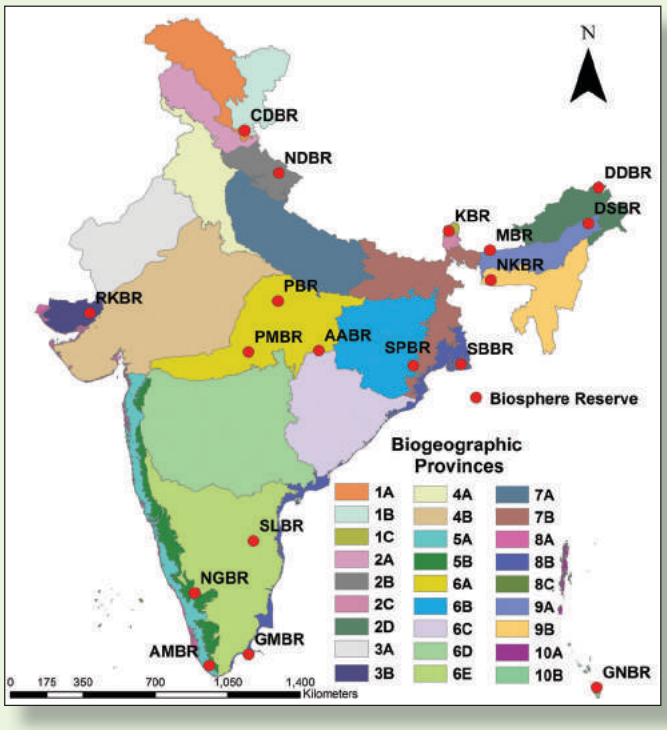
Forest Survey of India (FSI), Kaulagarh Road, Dehradun
Ministry of Environment & Forests, Government of India

FSI has principal mandate to conduct survey and assessment of forest resources in the country. In this project, FSI is developing database for Achanakmar-Amarkantak, Pachmari and Nokrek BRs.

MS Swaminathan Research Foundation (MSSRF), Taramani, Chennai
A Non-profit Research Organization

Involved in developing and following a pro-nature, pro-poor, pro-women and pro-sustainable on-farm and non-farm livelihoods through appropriate ecotechnology and knowledge empowerment.

MSSRF is responsible for undertaking project activities in Great Nicobar, Gulf of Mannar, and Sunderbans BRs.



Contact Persons:

GBPIHED

Dr LMS Palni, Director, psdir@gbpihed.nic.in
Dr RS Rawal, ranbeerrawal4@gmail.com
Dr Subrat Sharma, subrats@rediffmail.com

FSI

Mr ML Srivastava, Joint Director, mukundsifs@gmail.com
Ms Richa Dwivedi, richa_ifs@rediffmail.com

MSSRF

Dr V Selvam, Programme Director, vselvam45@hotmail.com
Dr R. Nagarajan, nagarajan@mssrf.res.in

NRSC

Dr CS Jha, Head, Forestry & Ecology, chandra.s.jha@gmail.com
Dr Sudhakar Reddy Chintala, drsudhakarreddy@gmail.com

Acknowledgements

NNRMS Division of MoEF for support and funding. PCCFs & BR Managers for support and inputs. Lead BR Centre GBPIHED for inputs.

Text Credits - Dr Randeep Singh, Ms R Dwivedi, Dr S Sharma,Dr RS Rawal
Photo Credits – Dr Randeep Singh, Dr Subrat Sharma, Dr GCS Negi, Dr GS Bhardwaj, Dr Rajiv Kalsi, Mr Aditya Singh
Sources: Biogeographic map- Wildlife Institute of India, Dehradun.
Climate & Elevation Data - http://www.worldclim.org

G.B. Pant Institute of Himalayan Environment & Development

G.B. Pant Institute of Himalayan Environment & Development
(An Autonomous Institute of Ministry of Environment and Forests
Government of India)
Kosi-Katarmal, Almora 263 643, India
+91-5962-241015 (T), 241014 (F)
E-mail - psdir@gbpihed.nic.in
www.gbpihed.gov.in

ABOUT THE EDITORS

Dr. Lok Man S Palni [Masters in Botany - University of Gorakhpur, Doctoral Degree (Ph. D) - University of Wales, UK] is Elected Fellow of the National Academy of Sciences, India and the National Academy of Agricultural Sciences, India. Having served various organizations in different capacities, Dr. Palni is currently Director, G.B. Pant Institute of Himalayan Environment & Development. He has published over 285 articles in Journals of National & International repute and several review articles, book chapters, as well as edited/ authored books. [*Contact: lmspalni@rediffmail.com; Ph:+91-5962-241015*]

Dr. Ranbeer S Rawal [Masters & Doctoral Degree in Botany -Kumaun University Nainital] is with the G.B. Pant Institute of Himalayan Environment & Development since 1993. While associated with various R&D projects under Biodiversity Conservation and Management theme, Dr. Rawal is Nodal Scientist for Lead Centre of Himalayan Biosphere Reserves in the Institute. He has over 75 scientific papers to his credit in peer reviewed journals and is among authors/editors of 4 books. [*Contact: ranbeerrawal4@gmail.com; Ph:+91-5962-241041*]

Dr. Rama K Rai [Masters & Doctoral Degree in Zoology – Banaras Hindu University, Varanasi] initially served the Zoological Survey of India and from 1982 he is working with the Union Ministry of Environment & Forests. While in the Ministry, Dr. Rai was instrumental in developing guidelines for effective implementation of Schemes on Biosphere Reserves and Botanical Gardens, and at his initiative a number of Indian Biosphere Reserves were brought on the World Network of UNESCO. [*Contact: ramak.rai@nic.in; Ph:+91-11-24367669*]

Dr. S. Venkata Reddy [Masters & Doctoral Degree in Zoology] was initially associated with Central Sericulture Research & Training Institute, Mysore. He is with the Ministry of Environment & Forests, GOI, from 1989. Currently he holds the position of Director (Scientific) and, among others, looks after the programme for designation of new Biosphere Reserves in the country and inclusion in World Network of Biosphere Reserves. [*Contact: sv.reddy@nic.in; Ph:+91-11-24366764*]

जहाँ है हरियाली
वहाँ है खुशहाली ।

The Ministry of Environment & Forests (MoEF)

The Ministry of Environment & Forests (MoEF) is the nodal agency in the administrative structure of the Central Government for the planning, promotion, co-ordination and overseeing the implementation of India's environmental and forestry policies and programmes.

The primary concerns of the Ministry are implementation of policies and programmes relating to conservation of the country's natural resources including its lakes and rivers, its biodiversity, forests and wildlife, ensuring the welfare of animals, and the prevention and abatement of pollution. While implementing these policies and programmes, the Ministry is guided by the principle of sustainable development and enhancement of human well-being. The broad objectives of the Ministry are: (i) Conservation and survey of flora, fauna, forests and wildlife; (ii) Prevention and control of pollution; (iii) Afforestation and regeneration of degraded areas; (iv) Protection of the environment; and (v) Ensuring the welfare of animals. [details http://envfor.nic.in].

G.B.Pant Institute of Himalayan Environment & Development

G.B. Pant Institute of Himalayan Environment and Development (GBPIHED) was established in 1988-89, during the birth centenary year of Bharat Ratna Pt. Govind Ballabh Pant, as an autonomous Institute of the Ministry of Environment and Forests (MoEF), Govt. of India. The Institute has been identified as a focal agency to advance scientific knowledge, to evolve integrated management strategies, demonstrate their efficacy for conservation of natural resources, and to ensure environmentally sound management in the entire Indian Himalayan Region (IHR). The Institute has headquarters at Kosi-Katarmal, Almora (Uttarakhand) and four regional units, namely, Himachal Unit at Mohal (Kullu, HP), Garhwal Unit at Srinagar (Garhwal, Uttarakhand), Sikkim Unit at Pangthang (Sikkim) and North East Unit at Itanagar (Arunachal Pradesh). [details http://gbpihed.gov.in].