Chandrakasan Sivaperuman Dhriti Banerjee Basudev Tripathy Kailash Chandra *Editors* 

Faunal Ecology and Conservation of the Great Nicobar Biosphere Reserve



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# Faunal Ecology and Conservation of the Great Nicobar Biosphere Reserve



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## Foreword



I am delighted to write the foreword for the book titled *Faunal Ecology and Conservation of the Great Nicobar Biosphere Reserve*. The Andaman and Nicobar Islands are known for their rich biodiversity resources. There are 836 islands, islets and rocks, which can be distinguished geographically into two groups, i.e. Andamans and Nicobars. The Andaman Islands are the extension of the submerged Arakan Yoma Mountain range of Myanmar and the Nicobars are the continuation of the Mentawai Islands to the south and southeast of Sumatra. The *Ten Degree Channel* isolates Andaman Islands from Nicobar Islands.

The Great Nicobar Biosphere Reserve is one of the 18 Biosphere Reserves in India recognizing its importance in high degree endemism and diverse flora and fauna. The Great Nicobar Biosphere Reserve is included in the UNESCO-MAB Network of Man and Biosphere Reserve (MAB) during May 2013. It represents the tropical rain forests in Andaman and Nicobar Islands of the biogeographic region. This reserve is known for its unique biodiversity and houses rich genetic germplasm resources. The important faunal elements of the Reserve include the Nicobar Tree Shrew, Nicobar Wild Boar, Long-tailed Macaque, Nicobar Civet, Nicobar Pigeon, Nicobar Megapode, Great Nicobar Serpent Eagle, Leatherback Sea Turtle and Reticulated Python.

This book exemplifies 32 research chapters covering both terrestrial and marine ecosystems of the Great Nicobar Biosphere Reserve. This is a welcome step on the conservation of faunal communities in the tropical forest ecosystem especially in the

Biosphere Reserves. I congratulate the editors *Drs. Chandrakasan Sivaperuman*, *Dhriti Banerjee, Basudev Tripathy and Kailash Chandra* for their earnest effort to bring this volume with a treasure of knowledge to the public domain.

It is my hope and expectation that this book will provide an effective tool on the faunal diversity of the Great Nicobar Biosphere Reserve and reference resource for materials for students, researchers, academic institutions and managers.

(Shri. Bhupender Yadav)

Environment, Forest and Climate Change, and Labour and Employment, Government of India New Delhi, India Date: 05.06.2022 Bhupender Yadav

## Preface

India is very rich in resources due to its diversified habitat and climatic conditions and reported 7.5% of the total animal species of the world. Biosphere reserves are areas of terrestrial and coastal or marine ecosystems or its amalgamation. Biosphere reserves are sites established by countries and recognized under UNESCO's "Man and Biosphere" (MAB) programme to promote sustainable development based on local community efforts and thorough science. The concept of "Biosphere Reserves" was initiated by the United National Educational Scientific and Cultural Organizations (UNESCO) in the year 1970 in order to facilitate the resolution of increasing conflict between people and the Protected Area under its Man and Biosphere Programme (MAB). The Government of India has designated 18 Biosphere Reserve until 2020, of which 11 are part of the World Network of Biosphere Reserves. The total area of Biosphere Reserves is 86,480.58 km<sup>2</sup>, which is 2.54% of India's total geographical area. The first biosphere reserve of the world was established in 1979. According to UNESCO, as of July 2021, there are 714 biosphere reserves across 129 countries in the world which also include 21 trans-boundary sites.

Andaman and Nicobar Islands are the mountain chains of 836 islands, islets and rocky outcrops located between the Bay of Bengal and Andaman Sea of the Indian Ocean at a length of 800 km with a coastline of 962 km. Andaman and Nicobar group of islands are separated by 150 km wide Ten Degree Channel. The total landmass of these Islands is 8249 km<sup>2</sup>. The Great Nicobar Biosphere Reserve is one of the 18 Biosphere Reserves created under the Man and Biosphere Programme of the Ministry of Environment, Forest and Climate Change, Government of India. The total area of the Great Nicobar Island is 1044 km<sup>2</sup>. It is a tropical and sub-tropical moist broadleaf forest biome and located in the Indo-Malayan bio-geographic zone. The Great Nicobar Biosphere Reserve is included in the UNESCO-MAB Network during May 2013. The Great Nicobar Biosphere Reserve represents the tropical rain forests and is rich in species composition. The Great Nicobar houses 650 species of angiosperms, ferns and gymnosperms. The fauna consists of over 2050 species of animals. The important faunal elements of the Biosphere Reserve include the Nicobar Tree Shrew, Nicobar Wild Boar, Long-tailed Macaque, Nicobar Civet, Nicobar Pigeon, Nicobar Megapode, Great Nicobar Serpent Eagle, Leatherback Turtle and Reticulated Python. This biosphere reserve is also the habitat of two tribes of Indo-Mongoloid stock, namely the Nicobarese and Shompen.

This is an outcome of the expedition conducted in the Great Nicobar Biosphere Reserve and also our previous research works carried out in this region. The target audience for this volume comprises research scholars, students and wildlife managers. We sincerely hope that the results of this book will be widely accessible to readers of all backgrounds. We would like to express our sincere gratitude to all the authors who have contributed chapters to this book; also we thank everyone who has supported directly and indirectly to this book.

Port Blair, India Kolkata, India Pune, Maharashtra, India Kolkata, India Chandrakasan Sivaperuman Dhriti Banerjee Basudev Tripathy Kailash Chandra

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We, the authors, take this opportunity to express our profound gratitude to the officials of the Ministry of Environment, Forest and Climate Change, Government of India, for providing the necessary facilities and encouragement for preparing this editorial volume. Our sincere thanks go to the officials of the Department of Environment and Forests, Andaman & Nicobar Islands, for their logistic support and cooperation during the field survey in Great Nicobar Islands. The author (CS) would like to extend his sincere thanks to the Deputy Commissioner, Nicobar District; Assistant Commissioner, Campbell Bay, Great Nicobar Island, for their support and cooperation; The Inspector General, Indian Coast Guard, Andaman and Nicobar Region, for their logistic support to cover the various locations in Great Nicobar Island. The author (CS) acknowledges the assistance of Ms. R. Kayal Vizhi, Research Scholar, the Ministerial, Administrative & Technical Staffs, Andaman & Nicobar Regional Centre, Zoological Survey of India, Port Blair, for support at different levels. This work would not have been possible without the kind support and help of our colleagues, family members and people who have willingly helped us in different ways for completion of this pictorial guide. We would like to extend our sincere thanks to all of them.

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## About the Editors

**Chandrakasan Sivaperuman** is currently working as Scientist-E and Officer-in-Charge at the Zoological Survey of India, Port Blair. He has been extensively involved in field surveys in different ecosystem of the country, i.e. Kole wetlands of Kerala, Southern Western Ghats, Eastern Ghats, Great Indian Desert, Andaman and Nicobar Islands. He has published more than 300 research papers in national and international journals and newsletters. He also authored/edited more than 35 books published by reputed national and international publishers. He has participated in the 36th Indian Scientific Expedition to Antarctica during 2016–2017 and carried out studies on the species abundance and distribution of birds and mammals in Antarctica.

**Dhriti Banerjee** is a first woman director in 100 years of Zoological Survey of India history. She has an illustrious career as a scientist, conducted research in taxonomy, zoogeography, morphology and molecular systematics. She has received several national and international grants for her master's and doctoral studies. She travelled extensively across the country, studying fauna diversity in tiger reserves, wildlife sanctuaries, nature reserves and ecosystems. In addition, she is involved in a long-term study on biodiversity in the Himalayas and examines the possible effects of climate change on the fauna of the Himalayas.

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**Kailash Chandra** is a Director (Retd.), Zoological Survey of India. He has more than 35 years' experience in the field of biodiversity conservation. He has worked in various ecosystems of our country, *i.e.* High Altitude, Islands, and Central India in various faunal groups especially on Coleopterans. He has contributed through various kind of publications, especially more than 40 books, 400 research papers

in various journals, chapter in books and popular articles. He has guided more than 15 Ph.D. students. He has visited various Natural History Museums in different parts of the world. He also participated in the 21st Indian Antarctica Scientific Expedition during 2001–2002. He has conducted many national and international seminars, besides chairing many and delivering keynote addresses.

Part I

**Terrestrial Ecosystem** 



1

## **Great Nicobar Biosphere Reserve: An Overview**

Chandrakasan Sivaperuman and Dhriti Banerjee

#### Abstract

India is one of the 17 megadiverse countries in the world, and there are four biodiversity hotspots found in India. These are Indo-Burma, Himalaya, Western Ghats-Sri Lanka, and Sundaland. From a biological diversity point of view, India is very rich in resources due to its diversified habitat and climatic conditions. India also supports 7.5% of the total animal species of the world. In this chapter, an effort has been made to compile and provide a detailed account of the overview of the Great Nicobar Biosphere Reserve.

#### Keywords

Andaman · Biodiversity · Biosphere · Great Nicobar · Conservation

### Introduction

Biosphere reserves are sites established by countries and recognized under UNESCO's "*Man and the Biosphere*" (MAB) programme to promote sustainable development based on local community efforts and thorough science. As places that seek to reconcile the conservation of biological and cultural diversity with economic and social development through partnerships between people and nature, they are ideal to test and demonstrate innovative approaches to sustainable development from local to international scales. It aims to achieve three interconnected functions,

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namely, conservation, development, and logistic support. Each biosphere reserve is required to have the three connected zones, i.e., *transition, buffer*, and *core zones* (UNESCO 2017; Saricam and Erdem 2012).

The concept of "biosphere reserves" was initiated by the United Nations Educational, Scientific and Cultural Organizations (UNESCO) in the year 1970 in order to facilitate the resolution of increasing conflict between people and the protected area under its Man and Biosphere Programme (MAB). The MAB, launched in the year 1970 by UNESCO, is a broad-based ecological programme aimed at developing within the natural and social sciences a basis for the rational use and conservation of the resources of the biosphere and for the improvement of the relationship between man and the environment, to predict the consequences of today's actions on tomorrow's world, and thereby to increase man's ability to manage efficiently the natural resources of the biosphere. The approach emphasizes the importance of the structure and functioning of ecological systems and their mode of reaction when exposed to human intervention, including the impact of man on the environment and vice-versa. The MAB is primarily a programme of research and training and seeks scientific information to find a solution to concrete practical problems of management and conservation.

It is aimed to bring at least one representative site in the country within each biogeographic province under the network of biosphere reserve and ensure their long-term protection and conservation by involving various stakeholders. Biosphere reserves are designated to deal with one of the most important questions reconciling the conservation of biodiversity, the quest for economic and social development and maintenance of associated cultural values. Conservation of landscapes, ecosystems, species, and genetic variations promotes economic development, which is culturally, socially, and ecologically sustainable, and provides logistic support for research, monitoring, education, and exchange of information related to local, national, and global issues, which are important aspects of biosphere reserves (Rai 2002; Sharma et al. 2002).

#### Definition

The biosphere reserves are areas of terrestrial and coastal/marine ecosystems. They are multipurpose protected areas where both flora and fauna are protected and are *Science for Sustainability support sites*, promoting research in ecological conservation and environmental preservation. UNESCO's "Man and Biosphere Programme", is an intergovernmental scientific programme, which aims to establish a scientific basis for the improvement of relationships between people and their environments. It was launched by UNESCO in 1971. Under the programme, UNESCO has established the World Network of Biosphere Reserves (WNBR). Biosphere reserves are nominated by national governments. If selected by UNESCO, they are included in the WNBR. There are 714 biosphere reserves in 129 countries, including 21 transboundary sites (as of January 2021; https://en.unesco.org). The WNBR of the MAB Programme promotes North–South and South–South collaboration and

represents a unique tool for international cooperation through sharing knowledge, exchanging experiences, building capacity, and promoting best practices (www. unesco.org).

#### **Criteria for Designation of Biosphere Reserve**

- A site that must contain an effectively protected and minimally disturbed core area of the value of nature conservation.
- The core area should be typical of a biogeographical unit and large enough to sustain viable populations representing all trophic levels in the ecosystem.
- The management authority to ensure the involvement/cooperation of local communities to bring a variety of knowledge and experiences to link biodiversity conservation and socio-economic development while managing and containing conflicts.
- Areas with potential for preservation of traditional tribal or rural modes of living for harmonious use of the environment.

#### **Characteristics of Biosphere Reserve**

The characteristic features of biosphere reserves are:

- Each biosphere reserves are protected areas of land or coastal environments wherein people are an integral component of the system. Together, they constitute a worldwide network linked by international understanding for the exchange of scientific information.
- The network of biosphere reserves includes significant examples of biomes throughout the world.
- Each Biosphere Reserve includes one or more of the following categories:
  - Biosphere reserves are representative examples of natural biomes.
  - Biosphere reserves conserve unique communities of biodiversity or areas with unusual natural features of exceptional interest. It is recognized that these representative areas may also contain unique features of landscapes, ecosystems, and genetic variations, *e.g.*, one population of a globally rare species; their representativeness and uniqueness may both be characteristics of an area.
  - Biosphere reserves have examples of harmonious landscapes resulting from traditional patterns of land use.
  - Biosphere reserves have examples of modified or degraded ecosystems that are capable of being restored to more natural conditions.
  - Biosphere reserves generally have a non-manipulative core area, in combination with areas in which baseline measurements, experimental and manipulative research, education, and training are carried out. Where these areas are not contiguous, they can be associated with a cluster.

#### **Functions of Biosphere Reserves**

#### Conservation

- To ensure the conservation of landscapes, ecosystems, species and genetic variations;
- To encourage traditional resource use systems;
- To understand the patterns and processes of the functioning of ecosystems;
- To monitor the natural and human-caused changes on spatial and temporal scales

#### Development

- To promote, at the local level, economic development, which is culturally, socially, and ecologically sustainable.
- To develop strategies leading to the improvement and management of natural resources.

#### **Logistics Support**

- To provide support for research, monitoring, education, and information exchange related to local, national, and global issues of conservation and development
- Sharing of knowledge generated by research through site-specific training and education
- The development of community spirit in the management of natural resources.

#### The Lima Action Plan for UNESCO's Man and the Biosphere (MAB) Programme and Its World Network of Biosphere Reserves (2016–2025)

#### Vision and Mission of the MAB Programme

The vision is a world where people are conscious of their common future and interaction with our planet and act collectively and responsibly to build thriving societies in harmony within the biosphere. The MAB Programme and its World Network of Biosphere Reserves (WNBR) serve this vision within and outside of biosphere reserves (UNESCO 2017).

The mission for the period 2015–2025 is to:

- Develop and strengthen models for sustainable development in the WNBR;
- Communicate the experiences and lessons learned, facilitating the global diffusion and application of these models;
- Support the evaluation and high-quality management, strategies and policies for sustainable development and planning, as well as accountable and resilient institutions;
- Help member states and stakeholders to urgently meet the Sustainable Development Goals through their experiences from the WNBR, particularly through

exploring and testing policies, technologies, and innovations for the sustainable management of biodiversity and natural resources and mitigation and adaptation to climate change.

#### Strategic Objectives

MAB's strategic objectives for 2015–2025 derive directly from the three functions of biosphere reserves identified in the Statutory Framework for the WNBR and the key global challenge of climate change, identified in the Madrid Action Plan for Biosphere Reserves. These strategic objectives are to:

- 1. Conserve biodiversity, restore and enhance ecosystem services, and foster the sustainable use of natural resources.
- 2. Contribute to building sustainable, healthy, and equitable societies, economies, and thriving human settlements in harmony with the biosphere.
- Facilitate biodiversity and sustainability science, education for sustainable development (ESD), and capacity building.
- 4. Support mitigation and adaptation to climate change and other aspects of global environmental change.

**Strategic Objective 1** Conserve biodiversity, restore and enhance ecosystem services, and foster the sustainable use of natural resources

The conservation and sustainable use of biodiversity is a critically important challenge. Biodiversity provides insurance and supports human well-being through a range of ecosystem services. Loss of biodiversity results in reductions in ecosystem services, creating direct threats to human well-being, and is an important indicator of an unbalanced system where vital components are affected. Habitat loss and fragmentation due to human development and unsustainable consumption and production patterns are among the major causes of diminishing biodiversity globally. The current unprecedented scale of exploitation of our natural resources calls for their improved governance and stewardship.

- 1. Member states actively support their biosphere reserves as models for sustainable development by contributing to the implementation of global conventions and other multilateral environmental agreements and the achievement of relevant SDGs.
- 2. Alliances at local, national, and regional levels are established to support biosphere reserves in carrying out their biodiversity conservation function and provide benefits to local people, thus contributing to the achievement of the 2011-2020 Strategic Plan for Biological Diversity and its Aichi Biodiversity Targets.
- 3. Effective, equitable, and participatory planning for sustainable development in biosphere reserves specifically considers the rights, needs, and capacities of

young people, as well as women and indigenous and local communities and their ownership, access to, and sustainable use of natural resources in and around biosphere reserves.

- 4. States, local government, international organizations, and the private sector support biosphere reserves through the effective use of the ecosystem approach, to ensure the continued delivery of ecosystem services both within biosphere reserves and to the wider communities that rely on their provision for their health and well-being.
- 5. The role of the MAB Programme in research and experimentation towards models and solutions for sustainable development, including their global diffusion, is strengthened.

**Strategic Objective 2** Contribute to building sustainable, healthy, and equitable societies, economies, and thriving human settlements in harmony with the biosphere.

A burgeoning world population increasingly concentrated in rapidly expanding urban areas of all sizes, notably in coastal regions, has resulted in the overexploitation and unsustainable use of limited natural resources, accelerating pollution and environmental degradation, with significant impacts on human well-being. Healthy, equitable societies and economies, and thriving human settlements, are essential elements of the quest for long-term sustainability and social development. Achieving this objective requires in-depth knowledge of natural and cultural heritage, socioeconomic realities, and innovative approaches to increasing resilience. Through its WNBR, MAB is uniquely well placed to support the transition to thriving economies and sustainable societies, not only in individual member states, but also through transboundary biosphere reserves. These provide opportunities for cooperation and understanding, as enabling environments that foster the harmonious coexistence of people and of people and nature, and promote a culture of peace with regard to the use of, and benefits from, shared natural resources.

- 1. Biosphere reserves act as, and are recognized and supported by, all levels of government as models for promoting sustainable development and advancing the implementation of the Sustainable Development Goals (SDGs) relating to equitable and healthy societies and settlements.
- 2. Biosphere reserves act as models for exploring, establishing, and demonstrating sustainable economic systems that positively affect the conservation of biodiversity and its sustainable use.
- 3. Biosphere reserves act as models to explore, establish and demonstrate innovative approaches that foster the resilience of communities and opportunities for youth, through livelihood diversification, green businesses, and social enterprise, including responsible tourism and quality economies.
- 4. Functional mechanisms are established to ensure that those who facilitate the provision of ecosystem services from biosphere reserves are equitably compensated and supported by those who utilize and benefit from these ecosystem services, often in distant urban areas.

- 5. Biosphere reserves contribute directly to the health and well-being of those who live in them and those who are related to them.
- 6. Transboundary biosphere reserves are reinforced through multi-scale dialogue and capacity building specific to transboundary issues.

**Strategic Objective 3** Facilitate biodiversity and sustainability science, education for sustainable development (ESD), and capacity building

Sustainability science is an integrated, problem-solving approach that draws on the full range of scientific, traditional, and indigenous knowledge in a transdisciplinary way to identify, understand, and address present and future economic, environmental, ethical, and societal challenges related to sustainable development. At a biosphere reserve level, this requires collaboration between all the different stakeholders, including scientists, policymakers, members of local communities, and the private sector. ESD promotes the inclusion of key sustainable development issues in teaching and learning to motivate and empower learners to change their behaviour through acquiring new skills, competencies, and values and to take action for sustainable development. Biosphere reserves, particularly through their coordinators, managers, and scientists, have key roles to play in operationalizing and mainstreaming sustainability science and ESD at local and regional levels, in order to build scientific knowledge, identify best practices, and strengthen the interface between science, policy, and education and training for sustainable development.

- 1. MAB and its WNBR are fully engaged with international, regional, national, and subnational research initiatives and programmes that contribute to the post-2015 development agenda and the SDGs.
- 2. The establishment of an international network of scientists working in biosphere reserves and with their managers/coordinators and other stakeholders.
- 3. Each biosphere reserve has an active research programme, based on the principles of sustainability science, which provides the basis of participatory decision-making and management in the biosphere reserve.
- 4. Traditional knowledge is used as a "knowledge input" for managing biosphere reserves while recognizing the importance of both empowering indigenous and local communities as guardians of unique knowledge, and maintaining cultural identity.
- 5. Training and capacity-building activities in biosphere reserves and at national, regional, and global levels address the interlinked issues of conservation and sustainable use of biodiversity, mitigation and adaptation to climate change, and the socio-economic and cultural well-being of human communities.
- 6. ESD activities take place in all biosphere reserves, including all partners of civil society. Biosphere reserves also serve as ESD hubs from which the models are disseminated.
- 7. Increased partnerships between biosphere reserves and UNESCO Education Sector programmes, such as the Global Action Programme (GAP) on ESD, the

UNESCO Associated Schools Project Network (ASPnet), and the UNITWIN/ UNESCO Chairs Programme, and other relevant education and capacity-building bodies of the United Nations.

**Strategic Objective 4** Support mitigation and adaptation to climate change and other aspects of global environmental change

Climate change continues to be of paramount concern for the future of humankind. It is now extremely likely that human activities have been the dominant cause of the observed warming since the mid-twentieth century. According to the fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC), warming of the climate system is unequivocal; many of the observed changes since the 1950s have been unprecedented over decades to millennia. The specific values of and opportunities for biosphere reserves in relation to climate change were recognized in the Madrid Action Plan for Biosphere Reserves (2008-2013) and the Dresden Declaration on Biosphere Reserves and Climate Change (2011). These aim to place a greater focus on the capacities of the MAB Programme and its biosphere reserves for mitigating and adapting to the impacts of climate change, and for integrating their contributions effectively into national and international climate strategies and policies. This requires simultaneously addressing the complex interactions between climate change and other aspects of global environmental change, such as loss of biodiversity, urbanization, desertification, degradation of land and water resources, and stratospheric ozone depletion.

- 1. The WNBR functions as a global network of regions to promote learning and pilot innovative actions to monitor, adapt to, and mitigate the effects of climate change and other types of global environmental change.
- 2. Member states actively support their biosphere reserves as models in implementing the United Nations Framework Convention on Climate Change (UNFCCC), the United Nations Convention to Combat Desertification (UNCCD), the Convention on Biological Diversity (CBD), and the Global Framework for Climate Services (GFCS).
- 3. Member states and other decision-makers recognize and promote biosphere reserves as priority sites in developing and implementing strategies on climate change mitigation and adaptation, in particular through: (1) energy efficiency and the development and adoption of renewable and clean energy, including energy saving through responsible consumption; and (2) approaches related to carbon sequestration and REDD+ (Reducing Emissions from Deforestation and Forest Degradation).
- 4. Member states actively promote the transfer of approaches developed in biosphere reserves to other countries and regions.

#### **Biosphere Reserves in India**

The Man and Biosphere (MAB) Programme initiated by UNESCO in 1972 is a broad-based ecological programme aimed at the improvement of the relationship between man and the environment to predict the consequences of today's actions on tomorrow's world and thereby to increase man's ability to manage the natural resources of the biosphere efficiently. The approach emphasizes research and training and seeks scientific information to find solutions to problems in management and conservation. The concept of biosphere reserves, especially its zonation, into core area(s) (dedicated to conservation), buffer area(s) (sustainable use), and transition area(s) (equitable sharing of benefits), was later broadly adopted under the Convention on Biological Diversity (CBD) process, which entered into force on December 29, 1993. The CBD has two principal objectives, namely, conservation and sustainable use of biological diversity and fair and equitable sharing of benefits arising from its utilization. The Articles 6(20) of the CBD call for in situ and ex situ conservation, incentives for conservation and sustainable use, research and training, awareness and education, impact assessment, regulating access to genetic resources, access and transfer of technology, and provisions of financial resources. While dealing with these issues, CBD emphasizes nationally determined priorities and capacity and needs full and effective participation of local communities.

Biosphere reserves are special entities for both people and nature and they are living examples of how human beings and nature can co-exist while respecting each other's needs. These reserves contain genetic elements evolved over millions of years that hold the key to future adaptations and survival. The high degree of diversity and endemism and the associated traditional farming systems and knowledge held by the people in these reserves are the product of centuries of human innovation and experimentation. These sites have global importance, having tremendous potential for future economic development, especially as a result of emerging new trends in biotechnology.

The Indian National Man and Biosphere (MAB) Committee was first constituted in 1972 as a follow up of UNESCO's Man and Biosphere (MAB) programme initiated in the 1970s. The MAB programme is coordinated, serviced and funded by the Ministry of Environment, Forest and Climate Change, Government of India, New Delhi. The Committee supervises the activities under the programme and encourages interdisciplinary research, demonstration, and training. In the year 1979, a subgroup of the Indian MAB Committee identified 14 sites in India for being designated as Biosphere Reserve based on which subsequent advice of the committee, the Government of India has designated 18 Biosphere Reserve until 2020 (Table 1.1) of which, 11 are part of the World Network of Biosphere Reserves. The total area of biosphere reserves is 86,480.58 km<sup>2</sup>, which is 2.54% of India's total geographical area. These sites were identified on the basis of their unique biodiversity, naturalness, and effectiveness as conservation units. These reserves contain genetic elements evolved over millions of years that hold the key to future adaptations and survival of living organisms. The high degree of diversity and

1.	Name of the biosphere reserve	Nilgiri*
	Year of establishment	01.08.1986
	States	Tamil Nadu, Karnataka, Kerala
	Coverage	Part of Wayanad, Nagarhole, Bandipur and Mudumalai, Nilambur, Silent Valley and Siruvani hills in Tamil Nadu, Kerala and Karnataka
	Biogeographic zone	5B: Western Ghats (Mountains)
	Total area	5520 km <sup>2</sup>
		Core: 1240 km <sup>2</sup>
		Buffer: 4280 km <sup>2</sup>
		Transition: 705 km <sup>2</sup>
	Forest type	Evergreen forests, semi-evergreen forests, moist deciduous forests, dry deciduous forests, scrub forests, montane shola/ grasslands
	Important fauna	Tiger, Indian elephant, gaur, lion-tail macaque, Nilgiri tahr, bison, Nilgiri marten, Nilgiri langur, Giant squirrel
	Coordinates	Lat. 11° 36' and 12° 0' N; Long. 76° 0' and 77° 15' E
	Biogeographic characteristics	The Nilgiri Biosphere Reserve comes under the Malabar Rain Forest Realm No. 4, Province No. 1, and Biome No. 1 of Udvardy's Biogeographical provinces of the world.
	Biodiversity values	The NBR supports more than 3500 species of flowering plants, of which 1500 are endemic, 1030 species of fauna, which includes, 550 species of birds, 30 species of reptiles and amphibians, 300 species of butterflies.
	Global and national significance	Nilgiri Biosphere Reserve encompasses a number of protected/ reserve forests, which house a spectrum of ecosystems and habitats. This reserve contributes significantly to maintaining the global biodiversity value of Western Ghats Biodiversity Hot Spot. Apart from preserving biological and cultural diversity, the Nilgiri Biosphere Reserve also provides ecological sustainability to the entire region.
2.	Name of the biosphere reserve	Gulf of Mannar*
	Year of establishment	18.02.1989
	States	Tamil Nadu
	Coverage	India part of Gulf of Mannar extending from Rameswaram Island in the North to Kanyakumari in the South of Tamil Nadu
	Biogeographic zone	8 B: Coast (East Coast)
	Total area	10,500 km <sup>2</sup>
		Core: 21 islands
		Buffer: $20 \times 160$ km aquatic area
		Transition: 705 km <sup>2</sup>
	Forest type	Tropical dry, broad-leafed forest, seaweed communities, sea grass communities, coral reefs, salt marshes, and mangrove forests

 Table 1.1
 Details of biosphere reserve in India

3.

-	Important fauna	Dugong or sea cow
	Coordinates	Lat. 8° 47' and 9° 15' N; Long. 78° 12' and 79° 14' E
	Biogeographic characteristics	The Gulf of Mannar Biosphere Reserve is characterized by four specialized ecosystems, namely, coral reefs, mangroves, sea grass, and islands.
	Biodiversity values	The GMBR supports 79 species of crustaceans, 108 species of sponges, 260 species of molluscs, 100 species of echinoderms, and 120 species of corals.
	Global and national significance	The Gulf of Mannar Biosphere Reserve has exuberant growth of mangroves on their shoreline and offers an excellent ground for turtle nesting. The sea bottom of the inshore islands is carpeted with sea grass beds, which not only serve as feeding grounds for endangered sea cows ( <i>Dugong dugon</i> ). The fringing and patchy coral reefs that surround the islands are the most complex and delicate ecosystems which are often referred to as " <i>underwater tropical rain forests</i> " and are treasure house of marine ornamental. This unique marine ecosystem forms one of the richest biodiversity areas in the Indian subcontinent.
	Name of the biosphere reserve	Sunderbans*
	Year of establishment	29.03.1989
	States	West Bengal
	Coverage	Part of the delta of Ganges and Brahmaputra river system in West Bengal
	Biogeographic zone	8B: Coasts (East Coasts)
	Area (km <sup>2</sup> )	9630 km <sup>2</sup>
		Core: 1692 km <sup>2</sup>
		Buffer: 2233 km <sup>2</sup>
		Transition: 5705 km <sup>2</sup>
	Forest type	Tidal swamp forests, saline water-type mixed forests, brackish water-type mixed forests, palm swamp type
	Important fauna	Bengal tiger, Bengal monitor lizard, Salvator lizard, saltwater crocodile
	Coordinates	Lat. 20° 30' and 22°15' N; Long. 88° 05' and 89°10' E
-	Biogeographic characteristics	The reserve falls within the Indo-Malayan Realm, province No.4.3.1 (Bengalian Rain Forests) and Tropical Humid Forests Biome. According to the recent classification of India, it falls in biogeographic zone 8B: Coast and represents East Coast province
	Biodiversity values	The SBR supports 964 species of flowering plants, including 81 species of mangroves, 24 species of medicinal plants, and 150 species of algae. Among the fauna, 163 species of birds, 40 species of mammals, 56 species of reptiles, 165 species of fishes, 15 species of prawns, 67 species of crabs, and 23 species of molluscs
	Global and national significance	The Sundarbans constitute 63% of total Indian mangroves, and the entire eastern Indian fishery depends on the input from the Sunderbans. The Sunderban is the largest contiguous mangrove

		patch (along with Bangladesh) on the globe. It is the only mangrove tiger-land on the globe. The reserve was included in the World Heritage list in 1989. Sunderban saves Kolkata and its suburbs from the rage of annual high gales from the sea
4.	Name of the	Nanda Devi*
	biosphere reserve	
	Year of	18.01.1988
	States	
	Coverage	Part of Chamoli, Pithoragarh and Almora districts in Uttarakhand
	Biogeographic zone	2B: Himalaya (West Himalaya)
	Total area	6407.03 km <sup>2</sup>
		Core: 712.12 km <sup>2</sup>
		Buffer: 5148.57 km <sup>2</sup>
		Transition: 546.34 km <sup>2</sup>
	Forest type	Mixed temperate and subalpine
	Important fauna	Himalayan snow leopard
	Coordinates	Lat. 30°05' and 31°02' N; Long. 79°12' and 80°19' E
	Biogeographic characteristics	The NDBR is falls in the west Himalayan biogeographic province of zone Himalaya. However, some areas in the northern extremes represent Trans Himalayan Cold Desert characteristics
	Biodiversity values	The NDBR includes 137 species of pteridophytes, 146 species of bryophytes, 77 species of lichens, and 128 species of fungi. Among the faunal group, 29 species of mammals, 243 species of birds, 229 species of insects, 14 species of molluscs, 8 species of amphibians
	Global and national significance	Nanda Devi and Valley of Flowers National Parks are represented in the unique landscape. The Valley of Flowers National Park is one of the most picturesque hanging alpine valleys in the West Himalaya. It is India's first national park exclusively designated for the conservation of Himalayan flora
5.	Name of the	Nokrek*
	biosphere reserve	01.00.1000
	establishment	01.09.1988
	States	Meghalaya
	Coverage	Part of East, West and South Garo Hill districts in Meghalaya
	Biogeographic zone	9B: North East (Hills)
	Total area	820 km <sup>2</sup>
		Core: 47.48 km <sup>2</sup>
		Buffer: 227.92 km <sup>2</sup>
		Transition: 544.60 km <sup>2</sup>
	Forest type	Evergreen forests, semi-evergreen forests, deciduous forests,
	JT -	bamboo, grasslands, and riverine forests
	Important fauna	Red panda, stump-tailed macaque, pigtailed macaque, giant- flying squirrel
	Coordinates	Lat. 90°13' to 90°35' E; Long. 25°20' to 25°29' N

	Biogeographic characteristics	The Nokrek Biosphere Reserve falls in Burma's monsoon forests biogeographic unit and represents biogeographic province 9B of the Meghalaya Hills
	Biodiversity values	This reserve is blessed with rich floral diversity, including 804 species of angiosperms. The 15 species of <i>Ficus</i> are the most diverse species in the reserve
	Global and national significance	Nokrek is the only biosphere reserve in Meghalaya, comprising parts of East, West, and South Garo Hill districts. It is one of the most important reserves in India from a conservation point of view because of its diverse fauna and flora. This area is home to many rare, endangered, and endemic faunal species. The Hoolock gibbon is the only apes in India and is conserved as an endangered species. Occurrence of genetic diversity of <i>Citrus</i> spp. specially the <i>Citrus indica</i> Tanaka population and also other related cultivars like <i>C. latipes</i> Tanaka., <i>C. reticulate</i> Blanco., <i>C. aurantifolia</i> Swingle, <i>C. grandis</i> Osbeck., <i>C. jambhiri</i> Lushington and <i>C. limon</i> Burm is significantly important
6.	Name of the biosphere reserve	Pachmarhi*
	Year of establishment	03.03.1999
	States	Madhya Pradesh
	Coverage	Part of Betul, Hoshangabad and Chhindwara districts in Madhya Pradesh
	Biogeographic zone	6A: Deccan Peninsula (Central Highlands)
	Total area	4991.72 km <sup>2</sup>
		Core: 1555.23 km <sup>2</sup>
		Buffer: 1785.58 km <sup>2</sup>
		Transition: 1640.91 km <sup>2</sup>
	Forest type	Moist deciduous, dry deciduous, central Indian subtropical hill forest
	Important fauna	Giant squirrel, flying squirrel
	Coordinates	Lat. 22°11′ and 22°50′ N; Long. 77°47′ and 78°52′ E
	Biogeographic characteristics	This region falls in the northern part of biogeographic zone (6) and biogeographic province (6A), viz., Deccan Peninsula— Central Highlands. The entire area falls within the Satpura hill ranges, which is one of the major geographical features of central India
	Biodiversity values	This reserve supports rich biodiversity. About 1399 species of flora have been reported, of which 1190 species are of angiosperms, 7 species of gymnosperms, 97 species of bryophytes, 75 species of pteridophytes, and 30 species of thallophytes. 925 species of fauna were reported, of these 255 species are birds, 63 species mammals, 71 species fishes, 18 species reptiles, 8 species amphibians, and 410 species of invertebrates
	Global and national significance	Pachmarhi BR is often recognized as the "genetic express highway" linking two biodiversity hotspots of the country, viz., the Eastern Himalaya and the Western Ghats

7.	Name of the biosphere reserve	Similipal*
	Year of establishment	21.06.1994
	States	Odisha
	Coverage	Part of Mayurbhanj district in Orissa
	Biogeographic zone	6B: Deccan Peninsula (Chotta Nagpur)
	Total area	5569 km <sup>2</sup>
		Core: 1194.75 km <sup>2</sup>
		Buffer: 1335.86 km <sup>2</sup>
		Transition: 3038.39 km <sup>2</sup>
	Forest type	Northern tropical semi-evergreen forests, northern tropical moist deciduous forests, dry deciduous hill forests, high-level sal forest, grassland and savannah
	Important fauna	Gaur, royal Bengal tiger, wild elephant, ruddy mongoose
	Coordinates	Lat. 20°17' and 22°34' N; Long. 88°40' and 87°10' E
	Biogeographic characteristics	The Similipal Biosphere Reserve falls in the Chotta Nagpur province of zone Deccan Peninsula
	Biodiversity values	This biosphere reserve accounts for rich flora and fauna, which makes the region a hotspot of biodiversity and very interesting for ecological studies. 1076 species of flowering plants have been reported, of these 60 species are pteriodophytes and 23 species are bryophytes. Among the fauna, 304 species of birds, 55 species of mammals, and 62 species of reptiles were identified
	Global and national significance	Among mammals, Similipal BR is known for its population of the rare melanistic tigers and good sex ratio of the Asian elephants. 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. Wild native cultivars like <i>Oryza officinalis</i> and <i>Oryza granulata</i> are important genetic sources for crop improvement
8.	Name of the biosphere reserve	Achanakmar-Amarkantak*
	Year of establishment	30.03.2005
	States	Madhya Pradesh and Chhattisgarh
	Coverage	Part of Anuppur and Dindori districts of Madhya Pradesh and Bilaspur district of Chhattisgarh
	Biogeographic zone	6A: Deccan Peninsula (Central Highlands)
	Total area	3835.51 km <sup>2</sup>
		Core: 551.55 km <sup>2</sup>
		Buffer: 1955.87 km <sup>2</sup>
		Transition: 1328.09 km <sup>2</sup>
	Forest type	Northern Indian tropical moist deciduous forests, Northern Indian moist deciduous forests, and Northern tropical dry deciduous forests and their subtypes
	Important fauna	Tiger, leopard, gaur, chital, backbuck, giant squirrels

	Coordinates	Lat. 21°15' and 22°58 N; Long. 81°25' and 82°5' E
	Biogeographic	The Similipal Biosphere Reserve falls in the Chotta Nagpur
	characteristics	province of zone Deccan Peninsula
	Biodiversity values	This biosphere reserve is rich in biodiversity resources; 1498
		species of flora and 327 species of fauna have been identified.
		Among the flora, 1111 species of angiosperms, 16 species of
		gymnosperms, 40 species of pteridophytes, 16 species of
		7 species of algae Among the fauna 27 species of mammals
		142 species of hirds 15 species of rentiles 10 species of
		amphibians, 16 species of fishes, 27 species of beetles, 85 species
		of butterflies and moths, 5 species of centipedes
	Global and national	This biosphere reserve supports 35 species of threatened species
	significance	of flora and 55 species of fauna
9.	Name of the	Great Nicobar*
	biosphere reserve	
	Year of	06.01.1989
	establishment	
	States	Andaman and Nicobar Islands
	Coverage	Southernmost Island of Andaman and Nicobar Islands
	Biogeographic zone	10B: Nicobar Islands
	Total area	1038.70 km <sup>2</sup>
		Core: 5362.3 km <sup>2</sup>
		Buffer: 3487.7 km <sup>2</sup>
		Transition: 153.70 km <sup>2</sup>
	Forest type	Tropical evergreen, moist deciduous forests, littoral forests,
	Turner de mé Comme	Infand forests.
	Important fauna	Nicobar megapode, long-tailed macaque, leatherback turtle, Great Nicobar serpent eagle, saltwater crocodile
	Coordinates	Lat. 7° and 7°20' N, Long. 93°37' and 93°46' E (Zone I); Lat.
		6°46′ and 7°′ N, Long. 93°37′ and 93°56′ E (Zone II)
	Biogeographic	The biosphere reserve falls within the Indo-Malayan
	characteristics	(9B) biogeographical region. The biosphere reserve is located in
		the Great Nicobar Island of the Union Territory of Andaman and Nicobar Islands
	Biodiversity values	This biosphere reserve is rich in biodiversity resources
	blourversity values	648 species of flora belong to 422 genera under 142 families.
		besides 2050 species of animals. The vertebrate fauna includes
		22 species of mammals, 106 species of birds, 32 species of
		reptiles, 8 species of amphibians and 314 species of fishes.
		Invertebrates are represented by more than 400 species of insects,
		including 73 species of butterflies and 155 species of moths, and a
		large number of other invertebrate species that await discovery.
		the Nicobar treeshrey. Nicobar wild boar long-tailed macaque
		Nicobar civet. Nicobar pigeon. Nicobar megapode. Great Nicobar
		serpent eagle, leatherback turtle, and reticulated python