



Chapter  
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## Climate change and its enormous impacts on global biodiversity

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### Abstract

Biodiversity is being destroyed by human at a rate unprecedented in history. Since the industrial revolution, human activities have increasingly destroyed and degraded forests, grasslands, wetlands and other important ecosystems, threatening human well-being. About 75% of the earth's ice-free land surface has already been significantly altered, most of the oceans are polluted and more than 85% of the area of wetlands has been lost, the report showed. Average global temperature has increased by 0.74°C in last 100 years, rainfall patterns have changed and the frequency of events also increased. Change in climate has consequences on the biophysical environment such as changes seasons, glacial retreat, decrease in Arctic sea ice extent and a rise in sea level. These changes have impact on biodiversity, in term of phenology, distribution and populations, and ecosystem level in terms of distribution, composition and function. This chapter reviews the information about the importance of biodiversity, threats to biodiversity, climate change and its impact on biodiversity and international approaches towards mitigating the effect of climate change.

### Keywords

Biodiversity, Climate change, Global temperature, Impacts, IPCC

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## Introduction

India possesses a distinct identity, not only because of its geography, history and culture, but also because of the great diversity of its natural ecosystems. The panorama of Indian biological diversity is much wider, as it comes under the twelve mega biodiverse (Hot-spot) centers of the world. It contains a great wealth of biological diversity in its forests, its wetlands and in its marine areas which are distributed all over the country. This richness is shown in absolute numbers of species and the proportion they represent of the world total (Williams, 2008). Climate change has become the most crucial environmental concern of the decade. Much attention is rightly focused on reducing carbon emissions and greenhouse gases from industrial, energy and transport sector through reduction in fuel consumption and use of renewable/green energy. However, as countries are looking for mitigation and adaptation processes, protection of natural habitats is a key factor of climate change strategies. Strengthened support for protected areas and more sustainable resource management can contribute to strategies as well as for protection of the biological resources and ecosystem. Climate change is developing as one of the greatest threats to biodiversity, increasing pressures on genetic resources, species and populations. Biodiversity conservation and sustainable development are the possible ways to curtail the impact of climate change (CBD, 2009).

## Convention on Biological Diversity (CBD)

The impacts of climate change on biodiversity are of major concern to the Convention on Biological Diversity (CBD). The Convention also recognizes that there are significant opportunities for mitigating climate change and adapting to it, while enhancing the conservation of biodiversity. In an effort to draw attention to the mounting threats and opportunities, the CBD is calling on the nations of the world to celebrate the International Day for Biological Diversity on 22 May 2007 under the theme “climate change and biodiversity” (Book *et al.*, 2008).

## Biodiversity

Biodiversity is a form of variation in life in different habitats of a certain ecological areas. It is a variation within and between species in particular habitats. It is the variation among living organisms from different sources including terrestrial, marine and desert ecosystems, and the ecological complexes of which they are a part. There are some subdivisions of the biodiversity like genetic diversity, species diversity and ecosystem diversity. Biodiversity is a remarkable association of the species of specific species and their associations.

### Important values of the biodiversity

*Source of food:* It is a better sources of food to the living beings needed for generation and regulation of

the life.

**Source of medicine:** It is a rich diversity of the plants in nature. Out of them many includes medicinal properties and are used as a sources of medicine to the peoples due to their effectiveness and low prize.

**Ecological balance:** In nature there is a specific and remarkable role of the each species. Each ones function is particular in nature. The roles of microorganisms are also significant with the role of plants and animals in varied directions.

**Support to the species diversity:** In nature each one species are interconnected in many ways of their life and are surrounded by the environment which affecting directly or indirectly to their life system.

**Environmental conservation:** It participating role in conservation of various components of the environment.

**Control on soil erosion:** Plants performing role in control on soil erosion in di jferent zones.

**Industrial values:** It is a better sources of raw materials to the industry for formation of clothes, paper, Wax, Rubber and wool.

**Recreational value and ecotourism:** It provide recreation and also important for development of ecotourism.

**Water resource protection:** Biodiversity also maintain the quality and quantity of water in certain ecological areas. It manage against the effect of flood and drought

**Pollution control:** It is playing a significant role in pollution control in nature. By purifying the environmental components it is playing important role in pollution control.

**Regulation of climates:** Forests maintains the rainfall that supports the regulation of hydrological cycle in nature important for life of each species.

**Educational values:** It provides not only better facility to study on certain species and their life pattern but also support the scientific observation of the species in nature.

**Biogeochemical cycles:** Biodiversity regulates the biogeochemical cycles in particular ecosystem needed for better growth and development of the varied species.

**Economic benefits:** Biodiversity plays role in economic growth of the peoples as the nature with rich biodiversity is a better sources of valuable products such as food, medicine, fish and many more useful things to human beings.

**Ethical values:** Biodiversity focus on the human relationship with the other bio species in nature. So, due to ethical value the species are protected by the human beings.

**Providing better chances to the species:** The basic life requirements of the each species are presence of food, protection and better chances of reproduction.

**Productive value:** It is a better sources for productions of animal as well as plant products important for preparation of various beneficial products using it.

**Existence values:** It also support the life to live in nature and playing a great role in existence of the diversity of the species of the plants and animals both in certain ecological areas (Patel, 2015).

### **Composition of biodiversity**

**Ecological diversity:** Biome- Bioregion- Landscapes- Ecosystems- Habitats- Population (Heywood,

1995).

**Organismal diversity:** Kingdom-Phyla-Families-Genera-Species- Sub species- Population.

**Genetic diversity:** Populations-Individuals-Chromosomes- Genes - Nucleotides.

### Levels of biodiversity

- **Genetic diversity:** Genetic variability within a species
- **Species diversity:** Species variability within a community
- **Ecosystem diversity:** Organization of species in an area into distinctive plant and animal communities.

**Genetic diversity:** Every individual in a species differs widely from other individuals in its genetic makeup due to large number of combinations possible in the genes. This genetic variability is essential for healthy breeding population of a species.

**Species diversity:** Every natural and man-made ecosystem is made up of a variety of animal and plant species. Some ecosystems such as tropical rainforests are very rich in the number of species as compared to other ecosystems such as the desert ecosystem. At present the scientists have been able to identify 1.8 million species on the Earth.

**Ecosystem diversity:** There are a large variety of different ecosystems on the Earth. Distinctive ecosystems include natural landscapes like forests, grasslands, deserts, mountains and aquatic ecosystems like rivers, lakes and seas. Each of these also has man modified areas such as farmlands, grazing lands and urban lands. Any ecosystem that is over used or misused loses its productivity and gets degraded.

## Biodiversity in India

Ministry of Environment, Forest and Climate Change reported (MoEFCC) that India is a mega diverse country contributing 7 to 8% of all recorded species, including 45000 plants species and 91000 animals species in the world, while India have only 2.4% of the world's land area. It is situated at the tri junction of the Afrotropical, Indo-Malayan and Palearctic realms, all of which support rich biodiversity. Being one of the 17 identified mega diverse countries; India has 10 biogeographic zones and is home to the mammalian species (8.58%), avian species (13.66%), fishes (11.72%), amphibians (4.66%), reptiles (7.91%), and plants (11.80%). Himalaya, Indo Burma, the Western Ghats-Sri Lanka and Sundaland are four out of 34 globally identified biodiversity hotspots are representing India. India's global ranking is 10<sup>th</sup> in 633 birds (69 species), 5<sup>th</sup> in reptiles (156 species) and seventh in amphibians (110 species). Total 811 cultivated plants and 902 of their wild relatives have been documented. Farm animals includes broad spectrum of 34 cattle, 12 buffaloes, 21 goat, 39 sheep and 15 chicken as native breeds.

The area of Indian forests have covered over 692,027 km<sup>2</sup>, cover 21.05% of the topographical area of the India, whereas forest cover has either remained static or has reduced in most of the developing countries. India has added around three million hectares of forest and tree cover over the last decade.

The total tree cover in India is estimated to be 9.08 million hectares, accounting for about 3% of the total topographical area of the India (MoEFCC, 2014).

## Threats to biodiversity

- The key threats confronting India's biodiversity
- Habitat loss
- Fragmentation and degradation
- Unsustainable use and overexploitation
- Pollution
- Invasive alien species
- Climate change and desertification

The Living Planet Report is based on data from the Living Planet Index produced by the Zoological Society of London. The index is statistically created from journal studies, online databases and government reports for 20,000 populations of 4,200 species of mammal, bird, reptile, amphibian and fish, or approximately 6% of the world's vertebrate species (Figure 1). Indian biodiversity faces a variety of direct and indirect effects and challenges. National Forest Commission reported that the amount of these effects and challenges is very high, with as many as a third of all endemic species facing the threat of extinction (NFC, 2006). The demands of a growing human population for food, medicine, fiber, fodder, shelter and fuel, along with the need for economic development are putting and exponentially growing pressure on biodiversity and ecosystems across the country. Land use change, especially the expansion and intensification of agriculture, is creating pressure on habitats in some regions of the country through loss and fragmentation of forests, grasslands, scrublands, wetlands and other habitats. Agricultural escalation leading to loss of habitat heterogeneity, effects of agrochemicals on wild species, pollution and eutrophication due to agricultural runoff also threaten both species and the habitats (Soni and Farid Ansari, 2017).

### Climate change

Climate refers to the general weather conditions of a place over many years. Climate change is a significant variation of average weather conditions i.e. conditions becoming warmer, wetter, or drier over several decades or more. It's that longer-term trend that differentiates climate change from natural weather variability. While "climate change" and "global warming" are often used interchangeably, global warming is the recent rise in the global average temperature near the earth's surface.

**Effects on biodiversity:** Climate change has been emphasized as serious threats to biodiversity which are likely to be adversative for biodiversity. Variation in precipitation and temperature are two important aspects of climate variability that are likely to have a direct and significant effect on India's biodiversity (Table 1 and Figures 1, 2 and 3).

Table 1. Climate change and potential impacts on biodiversity.

Climate change	Potential impacts on biodiversity
Increased ambient temperature	Species and population range shifts and/or changes in phenology leading to alteration or loss of biotic interactions
Changes in annual and seasonal precipitation	Changes in community composition
Increased frequency of extreme events	Mortality resulting from flooding after storms or drought events; damage or mortality resulting from deep freezes or heat waves
Changes to hydrologic regimes	Reduced stream flow affecting population persistence and community composition
Ocean acidification	Change in water chemistry affecting calcification rates of marine organisms
Sea level rise	Habitat loss and fragmentation affecting population persistence
Increases in ocean stratification	Reduced productivity of pelagic ecosystems
Changes in coastal upwelling	Changes in productivity of coastal ecosystems and fisheries

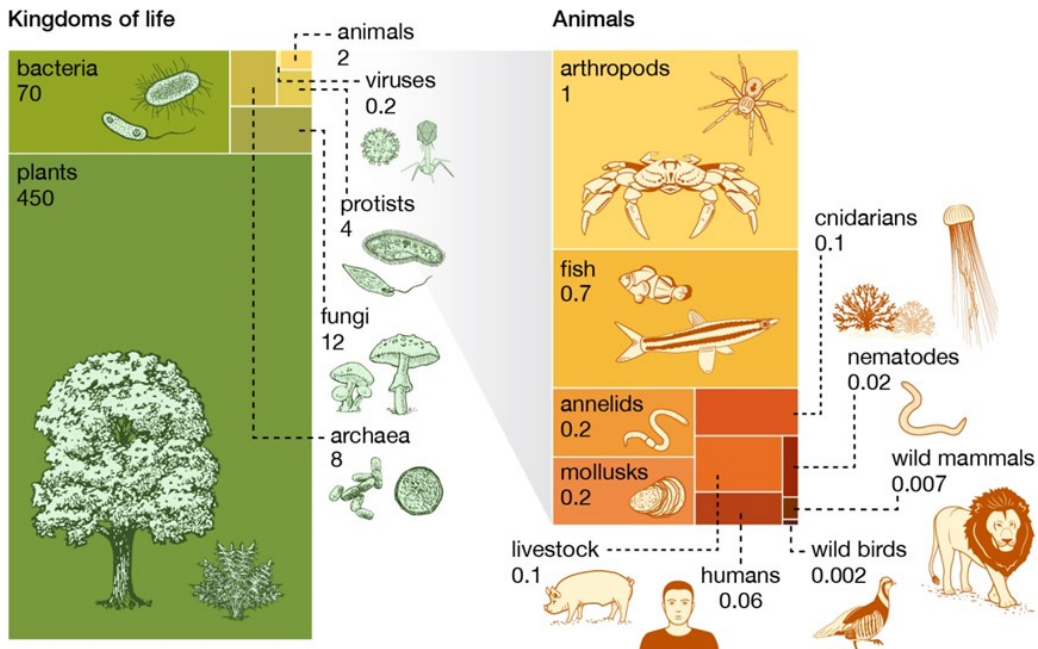


Figure 1. Relative biomass on Earth. The planet's biomass is classified by kingdom of life and other major groupings, and the size of each group's relative footprint is displayed using gigatons of carbon as the common measure (Source: <https://www.britannica.com/science/living-things>).



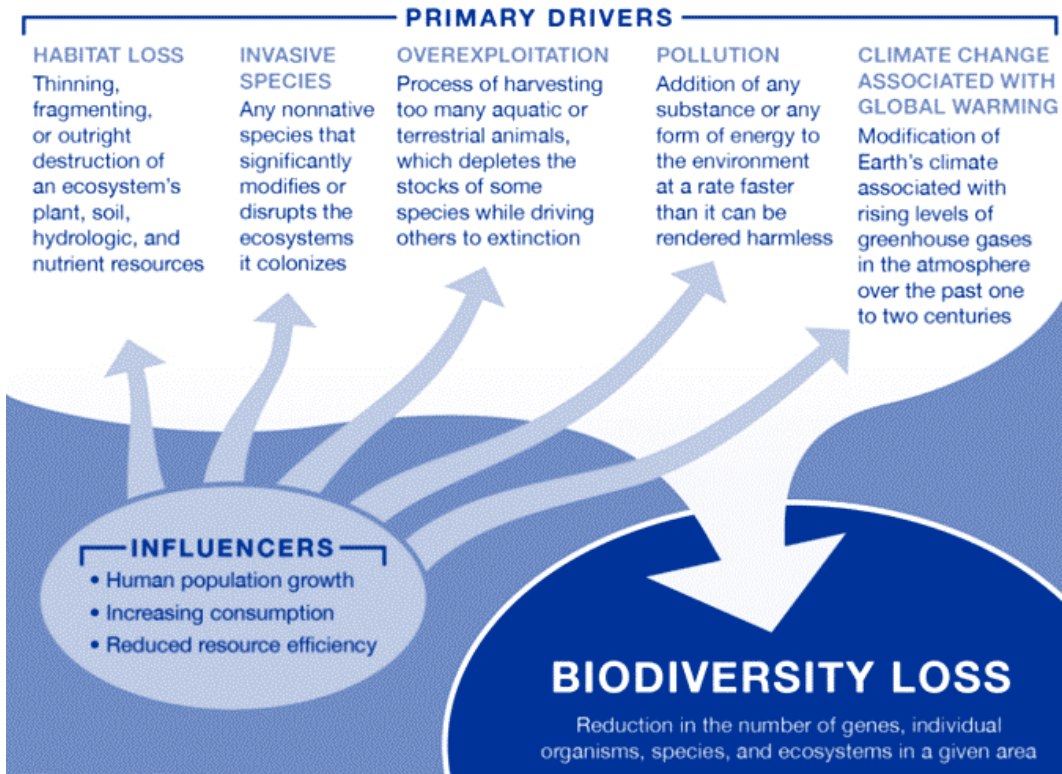


Figure 2. Threats to biodiversity (Living Planet report, 2020).

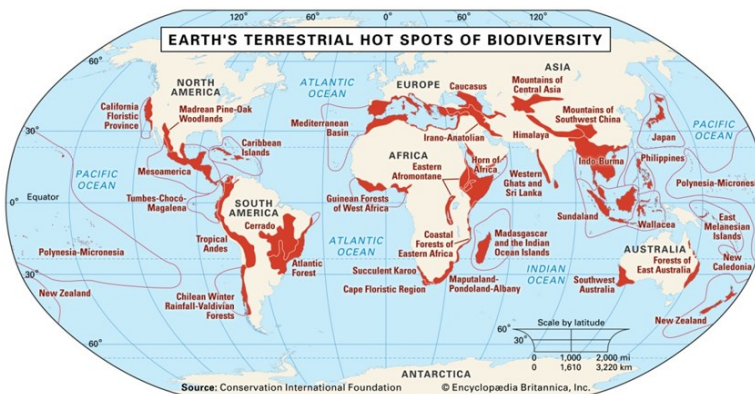


Figure 3. Terrestrial Hot Spots of Biodiversity (Source: <https://kids.britannica.com/students/assembly/view/107194>)

**Natural resources**

Each 1°C rise in temperature will lead to shifting the zone of occurrence of several specialist species by 160 meter vertically and 160 km horizontally. Although the specific impact of climate change on India's natural resources area wise is yet to be studied (Thuiller, 2007). Sukumar (1995) reported that endemic mammals like the Nilgiri Thar face an increased risk of extinction.

**CO<sub>2</sub> levels and temperatures**

Impact of climate change on biodiversity are expected to increase in magnitude and prevalence as CO<sub>2</sub> levels and temperatures continue to rise and in extreme conditions, i.e., heat and storms, increase in frequency and intensity (IPCC, 2007). IPCC has predicted that the resilience of many ecosystems will be threatened by a unique combination of climate change, associated disturbances such as drought, flooding, wildfire and other global change drivers such as land use change, pollution, fragmentation of natural systems, and overexploitation of resources (CBD, 2009).

**Environmental changes**

When it comes to land biodiversity, global warming is the biggest enemy of the polar regions. Fauna like polar bears, penguins, puffins, and other Arctic creatures will face a constant threat of losing their habitat through the diminishment of ice caps. As the ice melts, it increases the sea level, which will affect and perhaps destroy ecosystems on coastlines.

**Wetlands and fresh water ecosystems**

Climate change accelerate the damage to wetlands and fresh water ecosystems, such as lakes, marshes and rivers. Increasing temperature will cause water quality to deteriorate and have negative impacts on aquatic organisms, with the possibility of some species becoming extinct (Campbell, 2009).

**Biodiversity vulnerability to climate change**

The vulnerability of biodiversity to is dependent on the character, magnitude, rate of changes experienced by a species or system (exposure), the degree to which they are, or are likely to be, affected by or responsive to those changes (sensitivity), and the ability to accommodate with impacts with minimal disruption (Williams *et al.*, 2008; Glick *et al.*, 2011). The biodiversity is impacted by a range of anthropogenic stressors including land use change, non-native invasive species, exploitation, pollution and disease. In many cases, other stressors are currently or are expected to be the primary drivers of biodiversity loss (Flather *et al.*, 1997, Wilcove *et al.*, 1998). Overall, it is anticipated that the impacts of climate change will become increasingly prevalent and dominant in the coming decades and interact synergistically with existing stressors to affect biodiversity's vulnerability (Brook *et al.*, 2008; Barnosky *et al.*, 2011; Mantyka *et al.*, 2012). Therefore an urgent priority is to carry out a comprehensive inventory and catalogue the status of biological diversity in the country before they are lost forever. This will enable the formulation of effective biodiversity management plans and also the ability to determine if



biodiversity changes are due to environmental degradation driven by other factors or due to climate change.

## Impact of climate change on insect pest population

Increased temperatures will also increase the pest population, and water stressed plants at times may result in increased insect populations and pest outbreaks. This will affect the crop yield and availability of food grains and threaten food security. The climatic change impacts on pests populations may include: changes in diversity and abundance of insect pests, changes in geographical distribution of insect pests, increased overwintering insects, rapid population growth and generations, changes in synchrony between pests and their host plants, introduction of alternative host plants, changes in host plant resistance, changes in insect biotypes, changes in tritrophic interactions, impact on extinction of species, changes in activity and relative abundance of natural enemies, increased risk of invasive pest species, reduced efficacy of crop protection technologies and increased problems of insect transmitted diseases. These changes will have major implications for crop protection and food security, particularly in the developing countries, where the need to increase and sustain food production is most urgent. Long-term monitoring of population levels and insect behaviour, particularly in identifiably sensitive regions, may provide some of the first indications of a biological response to climate change. The impact of climate change will vary across regions, crops and species. A large number of models and protocols have been designed to measure the effects of climate change for different species and in different disciplines. There is a need for interdisciplinary cooperation to measure the effects of climate change on the environment and food security. It will be important to keep ahead of undesirable pest adaptations, and consider global warming and climate change for planning research and development efforts for integrated pest management (IPM) in the future (Sharma, 2010).

## International approach on climate change

**United Nations climate change conference:** In November, 2015 United Nations Climate Change Conference, COP 21 was held in Paris, France. First time in the conference, it was concluded to meet their objective i.e. a global agreement on reduction of climate change in the Paris, which was adopted with acclamation by nearly all states.

**Intergovernmental panel on climate change (IPCC):** The intergovernmental panel on climate change is a dedicated body jointly established by the World Meteorological Organisation and the United Nations Environmental Programme (UNEP) has been assigned to prepare comprehensive document on scientific assessments of various aspects of climate change.

**The United nations' framework convention on climate change (UNFCCC):** The UNFCCC came in existence on 21 March 1994. The Rio Convention was adopted by UNFCCC at the Rio Earth Summit in 1992. The prime goal of the convention was to make stable the concentrations of greenhouse gas at a

level that would prevent dangerous man made interference with the climate system.

**The Kyoto protocol:** A commitment by the parties for setting the internationally binding on emission reduction targets was made under the Kyoto Protocol which was linked to the United Nations Framework Convention on Climate Change and it was adopted in Kyoto, Japan, in December 1997 and come into force in February 2005.

**The Bali road map:** At 13th conference of the parties (3rd meeting) the Bali Road Map was adopted in December 2007 in Bali. This Map includes the Bali Action Plan, which plans the course for a new negotiating process designed to handle climate change.

**National environment policy:** An essential element of India's response to climate change has been out-lined in National Environment Policy (2006). These, interalia, include observance to principle of common but differentiated responsibility and respective capabilities of different countries, identification of key liabilities of India to climate change, in particular impacts on forests, coastal zones, agriculture, water resource and health, assessment of the need for adaptation to climate change and inspiration to the industry to join in the CDM (Clean Development Mechanism) (Soni and Farid Ansari, 2017).

## Solutions to biodiversity loss

Dealing with biodiversity loss is tied directly to the conservation challenges posed by the underlying drivers. Conservation biologists note that these problems could be solved using a mix of public policy and economic solutions assisted by continued monitoring and education. Governments, nongovernmental organizations, and the scientific community must work together to create incentives to conserve natural habitats and protect the species within them from unnecessary harvesting, while disincentivizing behaviour that contributes to habitat loss and degradation. Sustainable development (economic planning that seeks to foster growth while preserving environmental quality) must be considered when creating new farmland and human living spaces. Laws that prevent poaching and the indiscriminate trade in wildlife must be improved and enforced. Shipping materials at ports must be inspected for stowaway organisms.

Developing and implementing solutions for each of these causes of biodiversity loss will relieve the pressure on species and ecosystems in their own way, but conservation biologists agree that the most effective way to prevent continued biodiversity loss is to protect the remaining species from overhunting and overfishing and to keep their habitats and the ecosystems they rely on intact and secure from species invasions and land use conversion. Efforts that monitor the status of individual species, such as the Red List of Threatened Species from the International Union for Conservation of Nature and Natural Resources (IUCN) and the United States Endangered Species list remain critical tools that help decision makers prioritize conservation efforts. In addition, a number of areas rich in unique species that could serve as priorities for habitat protection have been identified. Such "hot spots" are regions of high endemism, meaning that the species found there are not found anywhere else

on Earth. Ecological hot spots tend to occur in tropical environments where species richness and biodiversity are much higher than in ecosystems closer to the poles.

Concerted actions by the world's governments are critical in protecting biodiversity. Numerous national governments have conserved portions of their territories under the Convention on Biological Diversity (CBD). A list of 20 biodiversity goals, called the Aichi Biodiversity Targets, was unveiled at the CBD meeting held in Nagoya, Japan, in October 2010. The purpose of the list was to make issues of biodiversity mainstream in both economic markets and society at large and to increase biodiversity protection by 2020. Since 2010, 164 countries have developed plans to reach those targets. One of the more prominent targets on the list sought to protect 17 percent of terrestrial and inland waters or more and at least 10 percent of coastal and marine areas. By January 2019 some 7.5 percent of the world's oceans (which included 17.3 percent of the marine environment in national waters) had been protected by various national governments in addition to 14.9 percent of land areas.

## Conclusion

Promoting the appropriate and effective coordination among biodiversity and climate change programs in India by incorporating the eco-friendly environmental policy, bringing the biodiversity and climate change into national plans and programs. Developing policy, guidelines for biodiversity, climate change and reduce the vulnerability of local communities to climate change impacts and enhance the flexibility of local communities to the impacts of climate change. Public participation is necessary to integrate ecosystem conservation and rural development, because it is necessary to know the needs for they depend on a particular ecosystem. Identify the key sectors of the country vulnerable to climate change, in particular impacts on water resources, agriculture, health, coastal areas and forests. Promote research to develop methodologies for tracing changes and evaluating impacts of climate change on glaciers, river flows and biodiversity.

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