Effect of Global Warming on Biodiversity in India

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Introduction

It is now well established that the world is heating up. The average temperature of the Earth's surface increased by an estimated 0.6°C in the 20th century, and according to the most recent projections of the Intergovernmental Panel on Climate Change, could rise 1.4 to 5.8°C above the 1990 average by 2100. Much of this predicted increase is attributed by scientists to increasing concentrations of greenhouse gases such as carbon dioxide (CO_2) in the atmosphere.

The effects of such a temperature increase might include:

- more frequent extreme high maximum temperatures and less frequent extreme low minimum temperatures;
- a decrease in snow cover: satellite observations suggest that the area of the planet covered by snow has already declined by 10 per cent since the 1960s;
- rising sea levels ;
- an increase in the variability of climate, with changes in both the frequency and severity of extreme weather events and
- alterations to the distribution of certain infectious diseases.

According to India's National Action Plan on Climate Change (IPCC), multi-model averages show that the temperature increases during 2090-2099 relative to 1980-1999 may range from 1.1 to 6.4°C and sea level rise from 0.18 to 0.59 meters. These could lead to impacts on freshwater availability, oceanic acidification, food production, flooding of coastal areas and increased burden of vector borne and water borne diseases associated with extreme weather events.

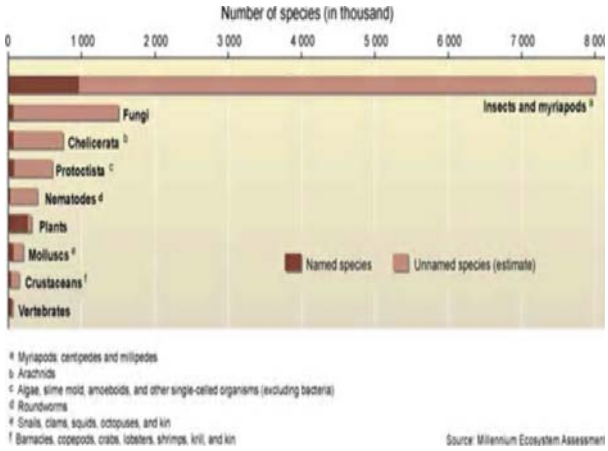
At the national level, increase of ~0.4°C has been observed in surface air temperatures over the past century. A warming trend has been observed along the west coast, in central India, the interior peninsula, and north-eastern India. However, cooling trends have been observed in north-west India and parts of south India. A trend of increasing monsoon seasonal rainfall has been found along the west coast, northern Andhra Pradesh, and north-western India (+10% to +12% of the normal over the last 100 years) while a trend of decreasing monsoon seasonal rainfall has been observed over eastern Madhya Pradesh, north-eastern India, and some parts of Gujarat and Kerala (-6% to -8% of the normal over the last 100 years). There has been an overall increasing trend in severe storm incidence along the coast at the rate of 0.011 events per year. While the states of West Bengal and Gujarat have reported increasing trends, a decline has been observed in Orissa. The available monitoring data on Himalayan glaciers indicates that while recession of some glaciers has occurred in some Himalayan regions in recent years, the trend is not consistent across the entire mountain chain. It is accordingly, too early to establish long-term trends, or their causation, in respect of which there are several hypotheses.

Now we should expect annual mean surface temperature rise by the end of century, ranging from 3 to 5°C under A2 scenario and 2.5 to 4°C under B2 scenario of IPCC, with warming more pronounced in the northern parts of India, from simulations by Indian Institute of Tropical Meteorology (IITM), Pune. Some simulations by IITM, Pune, have indicated that summer monsoon intensity may increase beginning from 2040 and by 10% by 2100 under A2 scenario of IPCC.

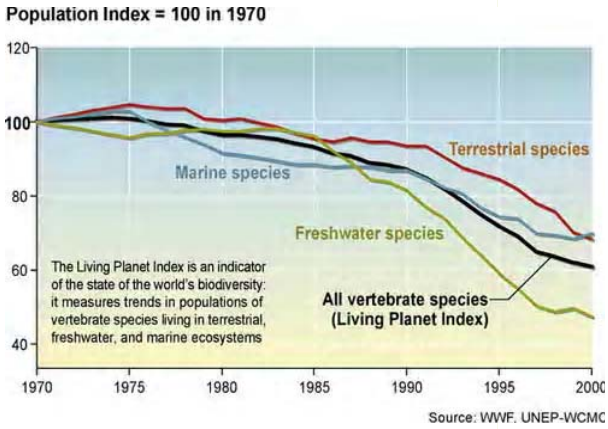
Biodiversity: what is it, where is it, and why is it important?

Biodiversity reflects the number, variety and variability of living organisms. It includes diversity within species, between species, and among ecosystems. The concept also covers how this diversity changes from one location to another and over time. Indicators such as the number of species in a given area can help in monitoring certain aspects of biodiversity.

The following chart gives an idea of the biodiversity.



There has been a decline in Biodiversity in recent years. The Living Planet Index, compiled by the WWF, provides an indication of the declines in the overall abundance of wild species.



Global warming is having impact on Biodiversity in various ways. Some impacts are discussed here:-

Global warming effects on biodiversity and animals

In its most recent assessment, the IPCC re-iterates that 20-30% of species assessed so far are likely to be at increased risk of extinction if increases in global average warming exceed 1.5-2.5°C (relative to 1980-1999) and as global average temperature increase exceeds about 3.5°C, model projections suggest significant extinctions (40-70% of species assessed) around the globe. Global warming does not only make vegetation "gasp for air" but also leads to animal habitat loss. This is an especially big problem for sensitive species.

The loss of these habitats leads to extinction of the amphibians dependent on these forests for their survival. Many species may be seriously affected by the spread of viruses and bacteria which normally thrive in warmer conditions. This, among many other things, may push these animals even closer to the brink of extinction.

It is not only the habitat loss and spread of diseases that may cause animal extinction. It is also the availability of food and water for animals that will

likely be made more scarce as a result of global warming. Thus are just some examples of animals affected. The water level has risen considerably resulting in frequent floods, eroding of riverbanks and mingling of freshwater and seawater sources thus leading to the extinction of several marine species. The shift in climatic conditions has an adverse effect on sea levels, availability of food, amount of rainfall, the composition of an ecosystem and temperature levels. In fact, early instances of life extinction have been attributed to climate change.

In the past, many species have managed to thwart the risk of extinction by migrating to greener pastures. But given the current scenario, it is extremely difficult to tackle the consequences of global warming, since human beings have made it all the more difficult by splitting up, transforming and at times obliterating the existing habitats and thereby leaving no scope for migration.

As far as different species are concerned, the effect of global warming is clearly visible with some of them shifting their habitats. Moreover, it is also becoming more difficult to preserve huge land tracts, which is affecting the chances of preserving biodiversity of a particular region. It is believed that if the situation is not taken stock of immediately, then around 2050 species will disappear from the surface of the Earth as a result of global warming.

Global warming has already threatened the existence of the alpine meadows located in the Rocky Mountains. Mangroves and tropical montane are also exposed to the threat of extinction in future owing to global warming. The melting of polar ice has already taken a toll on the population of penguins and polar bears. Global warming has also threatened the existence of coral reefs.

The list of animals at risk of climate change will, of course, be longer and longer as the planet gets hotter and hotter.

Global warming effects on various seasonal processes of plants and animals

Many seasonal processes are also affected by global warming. We are starting to witness:

- Earlier leaf production by trees.
- Earlier greening of vegetation.
- Changed timing of egg-laying and hatching.
- Changes in migration patterns of birds, fish and other animals.

Reductions and re-distributions in populations of algae and plankton; this threatens the existence of fish and other animals that rely on algae and plankton for food.

Impacts on forests and wild Life

Based on future climate projections of Regional Climate Model of the Hadley Centre (HadRM3) using A2 and B2 scenarios and the BIOME4 vegetation response model, it is predicted that 77% and 68% of the forest areas in the country are likely to experience shift in forest types, respectively under the two scenarios, by the end of the century, with consequent changes in forests produce. Correspondingly, the associated biodiversity is likely to be adversely impacted. India's NATCOM I projects an increase in the area under xeric scrublands and xeric woodlands in central India at the cost of dry savannah in these regions.

A mean Sea Level Rise (SLR) of 15-38 cm is projected along India's coast by the mid 21st century and of 46-59 cm by 2100. India's NATCOM I assessed the vulnerability of coastal districts based on physical exposure to SLR, social exposure based on population affected, and economic impacts. In addition, a projected increase in the intensity of tropical cyclones poses a threat to the heavily populated coastal zones in the country.

What will it mean for India's plants and animals?

Climate change could have dramatic effects on a wide range of India's plants and animals.

Shifts in climatic envelopes

To estimate the effect of climate change on species, scientists use what they call a climatic envelope (sometimes also referred to as a bioclimatic envelope), which is the range of temperatures, rainfall and other climate-related parameters in which a species currently exists.

As the climate warms, the geographic location of climatic envelopes will shift significantly, possibly even to the extent that species can no longer survive in their current locations. Such species will need to follow their climatic envelopes by migrating to cooler and moister environments, usually uphill or northwards in the northern hemisphere. There is some evidence that plants and animals are already responding to warmer temperatures. The tree line (above which there are no trees) may move up in altitude in coming years.

In many cases, however, such migration might not be possible because of unsuitable soils and other unfavourable environmental parameters, geographical or human-made barriers and competition from species already in an area.

As human activities, particularly agriculture but also settlement and industrial development, have expanded over the last few centuries, natural vegetation- such as forests, grasslands and heathlands- have been cleared in large patches. Once-extensive plant communities have been reduced in size and broken into smaller patches. This habitat reduction and fragmentation poses a problem because it limits the ability of many species to migrate to favourable conditions. Species on mountain-tops, islands and peninsulas will have a similar problem.

In general, those species with restricted climatic envelopes, small populations and limited ability to migrate are most likely to suffer in the face of rapid climate change. A number of species will be affected physiologically by global warming. There is evidence that some species are physiologically vulnerable to temperature spikes.

Coral bleaching

Warmer sea surface temperatures are blamed for an increase in a phenomenon called coral bleaching, which a whitening of coral is caused when the coral expels a single-celled, symbiotic alga called zooxanthellae. This alga usually lives within the tissues of the corals and, among other things, gives them its spectacular range of colours. Zooxanthellae are expelled when the coral is under stress from environmental factors such as abnormally high water temperatures or pollution. Since the zooxanthellae help coral in nutrient production, their loss can affect coral growth and make coral more vulnerable to disease. Major bleaching events took place on the Great Barrier Reef in 1998 and 2002, causing a significant die-off of corals in some locations.

Increases in extreme events

Predicted changes in the intensity, frequency and extent of disturbances such as fire, cyclone, drought and flood will place existing vegetation under stress and favour species able to rapidly colonise denuded areas. In many cases this will mean the spread of 'weed' species and major changes in the distribution and abundance of many indigenous species.

Rises in concentrations of carbon dioxide

The basic ingredients of photosynthesis are carbon dioxide and water. Increased carbon dioxide in the atmosphere causes increased growth rates in many plant species. This is good news for farmers, but only if this carbon dioxide 'fertilisation' effect is matched by adequate soil moisture and other nutrients. Leaf-eating animals may not be so lucky: increased concentrations of carbon dioxide could diminish the nutritional value of foliage. Rising levels of atmospheric carbon dioxide could also decrease the calcification rates of corals, meaning

that reefs damaged by bleaching or other agents would recover more slowly.

Sea-level rise

In most climate-change models, sea levels are predicted to rise by 9 to 88 centimetres by 2100, due to the thermal expansion of the oceans and the melting of polar ice-caps. coupled with the effects of storm surges, which are expected to be of a greater magnitude in a warmer world. Coastal ecosystems, such as mangrove forests and low-lying freshwater wetlands in could be severely affected.

The first victims

The early victims of all these factors will be the endangered species. The following list describes the list of endangered species in India including all animals and birds which occur in India and are rated as Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) in the 2004 International Union for Conservation of Nature and Natural Resources (IUCN) and Wildlife Institute of India(WII)..

Critically Endangered

- Jenkin's Shrew (*Crocidura jenkensii*). (Endemic to India.)
- Ganges Shark(*Glyphis gangeticus*)(Endemic to India.)
- Himalayan Wolf (*Canis himalayensis*) (Endemic to India and Nepal.)
- Indian Vulture (*Gyps indicus*)
- Malabar Large-spotted Civet (*Viverra civettina*).
- Namdapha Flying Squirrel (*Biswamayopterus biswasi*). (Endemic to India.)
- Pygmy Frog (*Sus salvanius*).
- Salim Ali's Fruit Bat (*Latidens salimalii*). (Endemic to India.)
- Wroughton's Free-tailed Bat (*Otomops wroughtoni*). (Endemic to India.)
- Jerdon's Courser (*Crows bitorquatus*). (Endemic to India.)

Endangered

- Andaman Shrew (*Crocidura andamanensis*). (Endemic to India)
- Andaman Spiny Shrew (*Crocidura hispida*). (Endemic to India)
- Asian Arowana (*Scleropages formosus*)
- Asiatic Black Bear (*Selenarctos thibetanus*)
- Asiatic Lion (*Panthera leo persica*)
- Asiatic Wild Dog/ Dhole (*Cuon alpinus*)
- Banteng (*Bos javanicus*)
- Blue Whale (*Balaenoptera musculus*)
- Capped Leaf Monkey (*Trachypithecus pileatus*)
- Chiru (Tibetan Antelope) (*Pantholops hodgsonii*)
- Wild Cat (*Felis silvestris ornata*)
- Fin Whale (*Balaenoptera physalus*)
- Ganges River Dolphin (*Platanista gangetica*)
- Golden Leaf Monkey (*Trachypithecus geei*)
- Great Indian Rhinoceros (*Rhinoceros unicornis*)
- Hispid Hare (*Caprolagus hispidus*)
- Hoolock Gibbon (*Bunipithecus hoolock*) (Previously Hylobates hoolock).
- Indian Elephant or Asian Elephant (*Elephas maximus*)
- Indus River Dolphin (*Platanista minor*).
- Kashmir Stag/ Hangul (*Cervus elaphus hanglu*)
- Kondana Soft-furred Rat (*Millardia kondana*). (Endemic to India).
- Lion-tailed Macaque (*Macaca silenus*). (Endemic to India).
- Loggerhead Sea Turtle (*Caretta caretta*).
- Malabar Civet (*Viverra civettina*)
- Markhor (*Capra falconeri*).
- Marsh Mongoose (*Herpestes palustris*). (Endemic to India.) (Previously considered to be a subspecies of *Herpestes javanicus*).
- Narcondam Hornbill (*Rhyticeros narcondami*)

- Nicobar Shrew (*Crocidura nicobarica*). (Endemic to India).
- Nicobar Tree Shrew (*Tupaia nicobarica*). (Endemic to India).
- Nilgiri Leaf Monkey (*Presbytis johni*)
- Nilgiri Tahr (*Hemitragus hylocrius*). (Endemic to India).
- Olive Ridley Turtle. (Endemic to Orissa, Andhra Pradesh, India)
- Particolored Flying Squirrel (*Hylopetes alboniger*).
- Peter's Tube-nosed Bat (*Murina grisea*). (Endemic to India).
- Pygmy Hog (*Sus salvanius*)
- Red Panda (Lesser Panda) (*Ailurus fulgens*).
- Royal Bengal Tiger (*Panthera tigris tigris*).
- Sei Whale (*Balaenoptera borealis*).
- Servant Mouse (*Mus famulus*). (Endemic to India).
- Snow Leopard (*Uncia uncia*).
- Wild Water Buffalo (*Bubalus bubalis*). (Previously Bubalus arnee).
- Woolly Flying Squirrel (*Eupetaurus cinereus*).

Vulnerable

"Endangered Mammal List". Wildlife Institute of India (WII).

- Andaman Horseshoe Bat (*Rhinolophus cognatus*). (Endemic to India.)
- Andaman Rat (*Rattus stoicus*). (Endemic to India.)
- Argali (*Ovis ammon*).
- Himalayan W-toothed Shrew (*Crocidura attenuate*)
- Sri Lankan Highland Shrew (*Suncus montanus*).
- Asiatic Black Bear (*Ursus thibetanus*).
- Asiatic Golden Cat (*Catopuma temminckii*).
- Assamese Macaque (*Macaca assamensis*).
- Back-striped Weasel (*Mustela strigidorsa*).
- Barasingha (*Cervus duvauceli*).
- Bare-bellied Hedgehog (*Hemiechinus nudiventris*). (Endemic to India.)
- Blackbuck (*Antilope cervicapra*).
- Brow-antlered Deer (*Cervus eldi eldi*)
- Brown Bear (*Ursus arctos*)
- Brown fish owl (*Ketupa zeylonensis*). (Endemic to India.)
- Brown Palm Civet (*Paradoxurus jerdoni*)
- Central Kashmir Vole (*Alticola montosa*). (Endemic to India.)
- Clouded Leopard (*Neofelis nebulosa*).
- Day's Shrew (*Suncus dayi*). (Endemic to India.)
- Dhole (*Cuon alpines*).
- Dugong (*Dugong dugon*).
- Eld's Deer (*Cervus eldi*).
- Elvira Rat (*Cremnomys Elvira*). (Endemic to India.)
- European Otter(also known as Eurasian Otter) (*Lutra lutra*)
- Fishing Cat (*Prionailurus viverrinus*).
- Four-horned Antelope (*Tetracerus quadricornis*).
- Ganges River Dolphin (*Platanista gangetica*)
- Gaur (*Bos gaurus*).
- Golden Jackal (*Canis aureus*)
- Goral (*Nemorhaedus goral*)
- Himalayan Musk Deer (*Moschus chrysogaster*)
- Himalayan Shrew (*Soriculus nigrescens*)
- Himalayan Tahr (*Hemitragus jemlahicus*).
- Humpback Whale (*Megaptera novaeangliae*).
- Indian Fox (*Vulpes bengalensis*)
- Indian Giant Squirrel (*Ratufa indica*). (Endemic to India.)
- Indian Wolf (*Canis lupus indica*)
- Irrawaddy Squirrel (*Callosciurus pygerythrus*).
- Jerdon's Palm Civet (*Paradoxurus jerdoni*). (Endemic to India.)

- Kashmir Cave Bat (*Myotis longipes*).
- Kerala Rat (*Rattus ranjiniae*). (Endemic to India.)
- Khajuria's Leaf-nosed Bat (*Hipposideros durgadasi*). (Endemic to India.)
- Kolar Leaf-nosed Bat (*Hipposideros hypophyllus*). (Endemic to India.)
- Lesser Horseshoe Bat (*Rhinolophus hipposideros*).
- Lesser Panda (*Ailurus fulgens*)
- Mainland Serow (*Capricornis sumatraensis*).
- Malayan Porcupine (*Hystrix brachyuran*).
- Mandelli's Mouse-eared Bat (*Myotis sicarius*).
- Marbled Cat (*Pardofelis marmorata*).
- Mouflon (or Urial) (*Ovis orientalis*).
- Nicobar Flying Fox (*Pteropus faunulus*). (Endemic to India.)
- Nilgiri Leaf Monkey (*Trachypithecus johnii*). (Endemic to India.)
- Nilgiri Marten (*Martes gwatkinsii*). (Endemic to India.)
- Nonsense Rat (*Rattus burrus*). (Endemic to India.)
- Asiatic Wild Ass (*Equus hemionus*).
- Pale Grey Shrew (*Crocidura pergrisea*). (Endemic to India.)
- Palm Rat (*Rattus palmarum*). (Endemic to India.)
- Red Goral (*Naemorhedus baileyi*).
- Rock Eagle-owl (*Bubo bengalensis*). (Endemic to India.)
- Rusty-spotted Cat (*Prionailurus rubiginosus*).
- Sikkim Rat (*Rattus sikkimensis*).
- Sloth Bear (*Melursus ursinus*).
- Slow Loris (*Loris tardigradus*).
- Smooth-coated Otter (*Lutrogale perspicillata*). (Previously *Lutra perspicillata.*)
- Sperm Whale (*Physeter macrocephalus*).
- Sri Lankan Giant Squirrel (*Ratufa macroura*).
- Stumptail Macaque (*Macaca arctoides*).
- Takin (*Budorcas taxicolor*).
- Wild Goat (*Capra aegagrus*).
- Wild Yak (*Bos grunniens*).
- Tiger

Threatened

- Indian Wild Ass (*Equus hemionus khur*)
- Leopard (*Panthera pardus*)
- Red Fox (*Vulpes vulpes montana*)
- Kashmir Stag (*Praygnaa*)

What would rapid species extinction mean for India?

Global warming is predicted to take place faster in the next century than at any time for at least the last 10,000 years. Coupled with other factors, such as continued land-clearing, this could mean the extinction of species at a rate even greater than when the dinosaurs disappeared about 65 million years ago. Some species not under immediate threat of extinction might nonetheless suffer decreases in population size, diminishing intra-species' genetic diversity (and therefore face increased vulnerability).

Does it really matter if many species go extinct? The world would certainly be a less interesting place with less biodiversity, but would it affect us?

A diversity of species increases the ability of ecosystems to do things like hold soils together, maintain soil fertility, deliver clean water to streams and rivers, cycle nutrients, pollinate plants (including crops), and buffer against pests and diseases– these are sometimes called 'ecosystem functions' or 'ecosystem services'. A loss of species could reduce this ability, particularly if environmental conditions are changing rapidly at the same time. It is therefore possible that as the climate changes and as species are eliminated from an area we will see a change in some ecosystem functions; this could mean more land degradation, changes in agricultural productivity and a reduction in the quality of water delivered to human populations.

Adapting to change

Scientists agree that human-induced global warming is happening, and that the world will continue to warm for some time even if greenhouse gas emissions are somehow curbed. Some species, particularly insects, might be able to adapt to changing conditions or evolve in response to global warming. But for many, especially those that are already rare and have limited climatic envelopes, global warming could pose an insurmountable challenge.

The plan, which was developed in consultation with scientists, conservationists and national, state and local governments, contains seven objectives, along with actions that should be taken to achieve the objectives. At this early stage of development many of these actions are aimed at improving our understanding of the impacts of global warming on biodiversity, while others are general or strategic in nature.

Some of the impacts of global warming may be sudden, but in many cases societies will have some years to adapt their management of biodiversity as conditions change. Increasing our understanding of the effects of climate change on biodiversity, and developing practical ways of mitigating such effects, are critical to limit the damage. Even so, the dangers are great for humans as well as our native plants and animals.

National Mission for sustaining the Himalayan ecosystem

The Himalayan ecosystem is vital to the ecological security of the Indian landmass through providing forest cover, feeding perennial rivers that are the source of drinking water, irrigation, and hydropower, conserving biodiversity, providing a rich base for high value agriculture, and spectacular landscapes for sustainable tourism. At the same time, climate change may adversely impact the Himalayan ecosystem through increased temperature, altered precipitation patterns, and episodes of drought.

Concern has also been expressed that the Himalayan glaciers, in common with other entities in the global cryosphere, may lose significant ice-mass, and thereby endanger river flows, especially in the lean season, when the North Indian rivers are largely fed by melting snow and ice. Studies by several scientific institutions in India have been inconclusive on the extent of change in glacier mass, and whether climate change is a significant causative factor.

It is accordingly necessary to continue and enhance monitoring of the Himalayan ecosystem, in particular the state of its glaciers, and the impacts of change in glacial mass on river flows. Since several other countries in the South Asian region share the Himalayan ecosystem, appropriate forms of scientific collaboration and exchange of information may be considered with them to enhance understanding of ecosystem changes and their effects.

It is also necessary, with a view to enhancing conservation of Himalayan ecosystems, to empower local communities, in particular through the Panchayats, to assume greater responsibility for management of ecological resources.

The National Environment Policy, 2006, interalia provides the following relevant measures for conservation of mountain ecosystems:

- Adopt appropriate land-use planning and watershed management practices for sustainable development of mountain ecosystems.
- Adopt "best practice" norms for infrastructure construction in mountain regions to avoid or minimize damage to sensitive ecosystems and despoiling of landscapes.
- Encourage cultivation of traditional varieties of crops and horticulture by promotion of organic farming enabling farmers to realize a price premium.
- Promote sustainable tourism through adoption

of "best practice" norms for tourism facilities and access to ecological resources, and multistake-holder partnerships to enable local communities to gain better livelihoods, while leveraging financial, technical, and managerial capacities of investors.

- Take measures to regulate tourist inflows into mountain regions to ensure that these remain within the carrying capacity of the mountain ecology.
- Consider particular unique mountain scapes as entities with "Incomparable Values", in developing strategies for their protection.

National Mission for a Green India

Forests are repositories of genetic diversity and supply a wide range of ecosystem services thus helping maintain ecological balance. Forests meet nearly 40% of the energy needs of the country overall, and over 80% of those in rural areas, and are the backbone of forest-based communities in terms of livelihood and sustenance. Forests sequester billions of tons of carbon dioxide in the form of biomass and soil carbon. The proposed national programme will focus on two objectives, namely increasing the forest cover and density as a whole of the country and conserving biodiversity.

Increase In forest cover and density

The report of the Working Group on Forests for the 11th Five-Year Plan puts the annual rate of planting during 2001/02 to 2005/06 at 1.6 million hectares and proposes to increase it to 3.3 million hectares during the 11th Plan. The final target is to bring one-third of the geographic area of India under forest cover.

The Greening India Programme has already been announced. Under the programme, 6 million hectares of degraded forest land would be afforested with the participation of Joint Forest Management Committees (JFMCs), with funds to the extent of Rs 6000 crores provided from the accumulated additional funds for compensatory afforestation under a decision of the Supreme Court in respect of forest lands diverted to non-forest use.

The elements of this Programme may include the following:

- Training on silvicultural practices for fast-growing and climate- hardy tree species.
- Reducing fragmentation of forests by provision of corridors for species migration, both fauna and flora.
- Enhancing public and private investments for raising plantations for enhancing the cover and the density of forests.
- Revitalizing and upscaling community-based initiatives such as Joint Forest Management (JFM) and Van Panchayat Committees for forest management.
- Implementation of the Greening India Plan.
- Formulation of forest fire management strategies.

Conserving biodiversity

Conservation of wildlife and biodiversity in natural heritage sites including sacred groves, protected areas and other biodiversity 'hotspots' is crucial for maintaining the resilience of ecosystems. Specific actions in this programme will include:

- *In-situ* and *ex-situ* conservation of genetic resources, especially of threatened flora and fauna.
- Creation of biodiversity registers (at national, district, and local levels) for documenting genetic diversity and the associated traditional knowledge.
- Effective implementation of the Protected Area System under the Wildlife Conservation Act.
- Effective implementation of the National Biodiversity Conservation Act, 2001.