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Climate change and biodiversity: inter-linkages, impact, mitigation and adaptation

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INTRODUCTION

Climate change and biodiversity have been major dominant issues since the latter part of the twentieth century at the international level. The rich variety of life on earth has always had to deal with a changing climate. A major influence on evolutionary changes that had produced plant and animal species of today is the result of adaptation that different life forms showed to climate change. This is a usual pattern that the survival of ecosystems and their function are perfectly compatible with the variation in the climate.

But according to the Millennium Ecosystem Assessment, climate change has become a major threat to biological diversity and is projected to become an increasingly important driver of change in the coming decades. There are several reasons why plants and animals of today cannot adapt to the current climate change. The main reason being the rapid change in temperature and rainfall pattern that the planet has never experienced in the past centuries. This is why the issue has become one of serious concerns.

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CLIMATE CHANGE

Climate is the average weather events for a long-term period of time and, thus, climate change represents a change in these weather patterns. As mentioned in the United Nations Framework on Convention of Climate Change (UNFCCC) article 1, cimate change may be defined as the "*change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is, in addition to natural climate variability observed over comparable time periods*." So climate change deals with increase in relative temperature over the earth surface, change in the pattern of precipitation and evaporation, raising global mean sea level, melting of ice in the polar region, decrease in total availability of water in the basin and extreme climatic events.

BIODIVERSITY

The term biodiversity may be commonly understood as the variety of life forms on earth that gives an expression of ecosystems, goods and services that sustain human lives. Some indigenous and rural communities are particularly dependent on many goods and services for their livelihood. In connection to climate change, the United Nations Convention on Biological Diversity (UNCBD) has defined it as "variability among living organisms from all sources includ-

ing, *inter alia*, terrestrial, marine and other aquatic ecosystems and ecological complexes of which they are part that includes diversity within species, between species and of ecosystems."

INTERNATIONAL AGREEMENTS

It began with the First World Conference on the Changing Atmosphere in October 1988 at Toronto, where scientists and politicians concluded that "humanity is conducting an unintended, uncontrolled, globally pervasive experiment whose ultimate consequences could be second to a global nuclear war." The conference recommended, the so called 'Toronto target', reduction of carbon dioxide emissions by 20% by the year 2005. In the same year Intergovernmental Panel on Climate Change (IPCC) published its First Assessment Report, which highlighted the increase in accumulation of human-made greenhouse gases in the atmosphere. In 1992, Rio Earth Summit documented two international conventions, viz. United Nation Convention on Biological Diversity (UNCBD) and United Nation Framework Convention on Climate Change (UNFCCC). The UNCBD, informally known as the Biodiversity Convention came out with an internationally binding treaty with three main goals: a) conservation of biological diversity, b) sustainable use of its components and c) fair and equitable sharing of benefits arising from genetic resources. The Convention was opened for signature at the Earth Summit on 5 June 1992 and entered into force on 29 December 1993. UNFCCC also framed a treaty with these objectives: a) To stabilize greenhouse gas (GHG) concentrations and b) To prevent dangerous anthropogenic interference with the climate system. This treaty was enforced in 21st March 1994.

In December, 1997 (COP3) Kyoto Protocol was signed, which bound industrialized countries to reduce greenhouse gas emission by an average of 5.2% below 1990 levels for the period 2008 -2012. Since most of the nations gave economic development as an urgent priority, responses to threats like climate change and impact on biological diversity proved to be difficult which in turn led to alternatives in order to achieve different international agreements. In December, 2007 (COP 13/MOP3) Bali Action Plan was agreed to replace the Kyoto Protocol with four major objectives like enhanced national/international action on mitigation, enhanced action on adaptation, enhanced action on technology development and transfer to support action on mitigation and adaptation and enhanced action on the provision of financial resources and investment to support the above actions.

The United Nations proclaimed May 22 as the International Day for Biological Diversity (IDB) to increase understanding and awareness of biodiversity issues. Since the UN General Assembly of 2007 which is the International Polar Year coincided with the International Day of Biological Diversity, "Climate change and Biological Diversity" was chosen as the theme for International Day of Biological Diversity in the year 2007. The United Nations General Assembly declared 2010 as the International Year of Biodiversity in its resolution number 61/203.

INTER-LINKAGES BETWEEN CLIMATE CHANGE AND BIODIVERSITY

The links between climate change and biodiversity run both ways. Biodiversity is threatened by climate change but proper management of biodiversity can reduce the impacts of climate change. The inter-linkages between biodiversity and climate change have been recognized within the UNFCCC and CBD as well as other international fora. Article 2 of the UNFCCC recognizes the importance of limiting climate change to a level that would allow ecosystems to adapt naturally to climate change. The CBD also has adopted a number of decisions on biodiversity and climate change, and in 2001 formed an Ad Hoc Technical Expert Group (AHTEG) on Biodiversity and Climate Change, to consider the possible negative impacts of climate change

related activities on biodiversity, identify the role of biodiversity in climate change mitigation and identify opportunities for achieving climate change and biodiversity co-benefits.

Conserving natural terrestrial, freshwater and marine ecosystems and restoring degraded ecosystems (including their genetic and species diversity) is essential for the overall goals of the UNFCCC because ecosystems play a key role in the global carbon cycle and in adapting to climate change, while also providing a wide range of ecosystem services that are essential for human well-being and the achievement of the Millennium Development Goals. About 2,500 Gt C is stored in terrestrial ecosystems, an additional ~ 38,000 Gt C is stored in the oceans (37,000 Gt in deep oceans, i.e., layers that will only feed back to atmospheric processes over very long time scales and ~ 1,000 Gt in the upper layer of oceans2) compared to approximately 750 Gt C in the atmosphere. On average ~160 Gt C cycle naturally between the biosphere (in both ocean and terrestrial ecosystems) and atmosphere.

Thus, small changes in ocean and terrestrial sources and sinks can have large implications for atmospheric CO_2 levels. Human-induced climate change caused by the accumulation of anthropogenic emissions in the atmosphere (primarily from fossil fuels and land use changes) could shift the net natural carbon cycle towards annual net emissions from terrestrial sinks, and weaken ocean sinks, thus further accelerating climate change. Ecosystems provide a wide range of provisioning (e.g. food and fibre), regulating (e.g. climate change and floods), cultural (e.g. recreational and aesthetic) and supporting (e.g. soil formation) services, critical to human well-being including human health, livelihoods, nutritious food, security and social cohesion. While ecosystems are generally more carbon dense and biologically more diverse in their natural state, the degradation of many ecosystems is significantly reducing their carbon storage and sequestration capacity, leading to increases in emissions of greenhouse gases and loss of biodiversity at the genetic, species and ecosystem level; climate change is a rapidly increasing stress on ecosystems and can exacerbate the effects of other stresses, including from habitat fragmentation, loss and conversion, over -exploitation, invasive alien species, and pollution.

IMPACT OF CLIMATE CHANGE ON BIODIVERSITY

Climate change has already produced significant and measurable impacts on almost all ecosystems, taxa

and ecological processes, including changes in species distribution, timing of biological behaviours, assemblage composition, ecological interactions and community dynamics. Species have evolved over millions of years to adapt to specific climatic conditions as well as to variations in climate, but the current increase in temperature and differing weather patterns has occurred over an extremely short period of time which evolutionary processes are not able to match. Therefore, many species of plants and animals are not able to adapt to changing temperature and weather. Some of the main impacts are noted below:

1. Changes in distribution

At the simplest level, changing patterns of climate will alter the natural distribution limits for species or communities. In the absence of barriers it may be possible for species or communities to migrate in response to changing conditions. Vegetation zones may move towards higher latitudes or higher altitudes following shifts in average temperatures. Montane species and endemic species have been identified as being particularly vulnerable because of narrow geographic and climatic ranges, limited dispersal opportunities, and the degree of other pressures.

2. Increased extinction rate

Range contraction and fragmentation of habitats have more severe effect upon species of limited dispersal abilities, slower life history

traits and range restricted species such as polar and alpine species and species restricted to riverine and freshwater habitats. Local extinction of species often occurs with a substantial delay following habitat loss or degradation.

3. Timing of life cycle (phenology)

Changes to the timing of natural events have been documented in many studies and may signal natural adaptation by individual species. Changes include advances in spring events and delays in autumn events, changes in the timing of leaf unfolding, flowering, and reproduction.

4. Interactions between species

Differential changes in timing lead to mismatches between the peak of resource demands by reproducing animals and the peak of resource availability. This causes population decline in many species, including increase in the herbivory rates by insects as a result of warmer temperatures, and may indicate limits to natural adaptation.

5. Invasive species

Global climate change creates conditions that may be suitable for some invasive species to become established in new areas. They become invasive and can affect native species by eating them, competing with them, hybridising with them, or introducing pathogens or parasites.

NEGATIVE IMPACTS OF CLIMATE CHANGE ON BIODIVERSITY THAT HAVE SIGNIFICANT ECONOMIC AND ECOLOGICAL COSTS

1. Provide the goods and services

These include provisioning services such as fisheries and timber production, where the response to climate change depends on population characteristics as well as local conditions and may include large production losses.

2. Changes the pattern of plant, animal and human diseases

Current research projects increases in economically important plant pathogens with warming. There has also been considerable recent concern over the role of climate change in the expansion of plant, animal and human disease vectors and/or increase the areas of exposure. For example, short-term local experiments have demonstrated the impacts of predicted global change on plant health including rice. Furthermore, studies of the impacts of climate change on the range of East Coast fever, a tick-borne cattle disease, shows increase in areas of potential occurrence. The increased inundation of coastal wetlands by tides may result in favourable conditions for saltwater mosquito breeding and associated increases in mosquito-borne diseases such as malaria and dengue fever.

3. Affects the ability of ecosystems to regulate water flows

The regulation of water quality and quantity is a key ecosystem service worldwide. Higher temperatures, changing insulation and cloud cover, and the degradation of ecosystem structure result in the occurrence of more and higher peak-flows on the one hand and in the mean time, impede the ability of ecosystems to regulate water flow. This has major consequences for both ecosystems and associated species assemblages and people in the scale of whole catchment areas. In addition, freshwater and wetlands, riverine and alluvial ecosystems and many forest types are affected by changes in the hydrological regime.

4. Disproportionate impact on the indigenous people and may increase human conflict

Many areas of the richest biodiversity and high demand for ecosystem services are in developing countries where billions of people directly rely on them to meet their basic needs.

Small island developing States and least developed countries are particularly vulnerable to biodiversity-related impacts of changes such as projected temperature and sea level rise, ocean current oscillation changes and extreme weather events. Further, most of the indigenous people are affected because their livelihood and cultural way of life is being determined by changes in the local ecosystem. It also affects the knowledge, innovations and practices of indigenous people and local communities and associated biodiversity-based livelihoods.

5. Agricultural and other use value

The wild relatives of crop plants – an important source of genetic diversity for crop improvement – are potentially threatened by climate change. Consideration should also be given to the loss of species of potential use but which are not currently well known for the goods and services that they provide. Such species may be well known to local people, but unknown to science. For example, a plant (called "*shungu panga*") that grows close to wetlands is used by indigenous communities in the Amazon for multiple cure purposes and this would disappear when wetlands are affected by climate change.

MITIGATION AND ADAPTATION

Mitigation is described as a human intervention to reduce greenhouse gas sources or enhance carbon sequestration, while adaptation to climate change refers to adjustments in natural or human systems in response to climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

The resilience of biodiversity to climate change can be enhanced by reducing non-climatic stresses in combination with conservation and management activities that maintain and restore biodiversity. Activities that promote mitigation of or adaptation to climate changes include:

1. Maintaining and restoring native ecosystems
2. Protecting and enhancing ecosystem services
3. Managing habitats for endangered species
4. Creating refuges and buffer zones
5. Establishing networks of terrestrial, freshwater and marine protected areas

CONCLUSION

Climate change and biodiversity are very much interrelated that no one can separate or ignore their significance and importance. It has to be recorded that they can make changes not only in the ecosystem but also have a prominent role in the survival of the now and then generation. This is the time that one could make concrete commitment to be aware and contribute even the least in the activities to promote mitigation and adaption to climate change and reduce the impact on biodiversity.

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