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CLIMATE CHANGE AND BIODIVERSITY MANAGEMENT: A REVIEW

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Review Article

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ABSTRACT

Biodiversity plays an important role in climate regulation. Anthropogenic activities have changed the global climate since last few decades. This climate change adversely affected the biological resources of the country. This review basically discuss the importance of biodiversity, the consequences faced by the plants, animals, humans and ecosystem owing to the climate change and also control measures or strategies should be taken for the conservation of biodiversity which can protect the earth from the consequence of climate change. Maintaining and restoring healthy ecosystem plays a key role in adapting to and mitigating climate change through biodiversity conservation, sustainable use and sustainable land management and yield multiple environmental, economic and social benefits.

Keywords: Biodiversity, Climate change, Conservation, Ecosystem, Management.

INTRODUCTION

The term Biodiversity is used by Rio de Janerio Convention to refer to all aspects of variability evident within the living world, including diversity within and between individuals, populations, species, communities, and ecosystems. In the simplest sense, biodiversity may be defined as the sum total of species richness, i.e. the number of species of plants, animals and microorganisms occurring in a given region, country, continent of the entire globe. Broadly speaking, the term biodiversity includes genetic diversity, species diversity, ecosystem diversity and habitat diversity.

Biodiversity is continually transferred by a changing climate. Conditions change across the face of the planet, sometimes slowly, sometimes in larger increments leading to rearrangements of biological associations. Now, a new type of climate brought about by human activities is being added to this natural variability, threatening to accelerate the loss of biodiversity already underway due to other human stressors.

Maintaining and restoring healthy ecosystems plays a key role in adapting to and mitigating climate change through biodiversity conservation, sustainable use and sustainable land management and yields multiple environmental, economic and social benefits.

The different possible effects of climate change that can operate at individual, population, species, community, ecosystem and biome scales, notably showing that species can respond to climate change challenges by shifting their climatic niche along three non-exclusive axes: time(e.g. phenology), space (e.g. range) and self (e.g. physiology). Climate change has led to phonological shifts in flowering plants and insect pollinators, causing mismatches between plant and pollinator populations that lead to the extensions of both the plant and the pollinator with expected consequences on the structure of plant-pollinator networks (Kiers *et al*, 2010). Climate change is able to decrease genetic diversity of populations due to directional selection and rapid migration, which could in turn affect ecosystem functioning and resilience (Botkin *et al*, 2007).

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In response to climate change some species may have indirect impact on the other species that depend on them. A study of 9650 interspecific systems, including pollinators and parasites, suggested that around 6300 species could disappear following the extinction of their associated species (Koh *et al*, 2004).A resent analysis of potential future biome distributions in tropical South America suggests that large portions of Amazonian rainforest could be replaced by tropical savannahs (Lepetz *et al* 2009).

Increased temperature and decreased rainfall lead to changes in the phenology, physiology and migration trends of some organisms like migratory fishes and birds. These changes causes might be dry out some lakes, especially in Africa (Campbell *et al*., 2009). Oceans are predicted to warm and become more acidic, resulting in degradation of tropical coral reefs which can lead to disturbance in habitat and patterns of survival of marine species. Wetlands and coastal ecosystems are at a huge risk due to increasing sea levels. Many communities have already become climate refugees to evade rising sea level (Anonymous, 2007).

In this globalization era and Intellectual Property Rights (IPR) regimes, there is an urgent need for proper and scientific quantification and documentation of our biodiversity. This traditional knowledge is helpful to maintaining the nation's natural resources, for growing its agricultural economy, for sustaining and improving the human health and its life style. Thus, to maintain the balance of ecosystem, interaction between the plants and animals, conservation and protection of our biodiversity, reforestation and agro-forestry practices are highly required. The ecological balance is necessary for widespread biodiversity (Verma 2017a), human survival (Verma 2018) and overall sustainable development (Verma, 2019). There is need of biodiversity conservation (Verma, 2015) and the biodiversity has different levels (Verma, 2016). The genetic diversity acts as a buffer for biodiversity (Verma, 2017b). The biodiversity loss has ecological impact (Kumar Ajay *et al*., 2017).

Impact of Climate change on Biodiversity

Only a small change in pattern of climate has severe impact on the biodiversity, altering the habitats of the species and presenting a threat for their survival, making them vulnerable to extinction. Millennium Ecosystem Assessment (MEA) predicts that a changing global climate change to be the principal threatens to the biological diversity and ecosystem (Anonymous, 2007). The distribution of species (biogeography) is largely determined by climate, as is the distribution of ecosystems and plant vegetation zones (biomes). Climate change may simply shift these distributions but, for a number of reasons, plants and animals may not be able to adjust, hence some species and ecosystems are likely to be eliminated by climate change. When a species becomes extinct, the species associated with it in an obligatory way also become extinct.

Due to increase in temperature several alpine plant species like *Berberisasiatica, Taraxacum officinale, Jasminum officinale* etc have shifted towards higher altitude (Alo and Wang, 2008). Teak dominated forests are predicted to replace the Sal trees in central India and also the conifers may be replaced by the deciduous types. According to Gates (1990) increase in 30C temperature may leads to the forest movement of 2.50 km / year which is ten times the rate of natural forest movement. According to FAO (2000), due to climatic changes about 9% of all known plant species are at verge of extension.

Anonymous (2009) reported that invasive species are a threat to native species being more tolerant to climatic variations. The major invasive alien plant species include *Lantana camara, Eupatorium odoratum, Eupatorium adenophorum, Parthenium hysterophorus, Ageratum conyzoides, Mikania micrantha, Prosopis juliflora* and *Cytisus scoparius*. Variation in temperature and precipitation patterns can result in more frequent droughts and droughts and floods making indigenous plants more vulnerable to pests and diseases (Tibbetts, 2007).

Slight change in climatic condition leads to the extinction of animal species. For example Climate change has resulted in extinction of animals like golden toad and Monteverde harlequin frog (McCarthy, *et al*, 2001); Polar bears are in danger due to reduction in Arctic ice cover; North Atlantic whale may become extinct, as planktons, its main food have shown decline due to climate change. Though the exact impact of climate change on India's natural resources is yet to be studied in detail, pioneering studies show that endemic mammals like the Nilgiri tahr face an increased risk of extinction (Sukumar *et al*., 1995). Further, there are indicative reports of certain species e.g., Black-and rufous flycatcher (*Ficedula nigrorufa*) shifting their lower limits of distribution to higher reaches, and sporadic dying of patches of Shola forests with the rise in ambient surface temperatures.

The sex ratio of sea turtle disturb because as a result of high temperature more female turtles are produced. Some threatened species (frogs, toads, amphibians, tigers and elephants) are vulnerable to the impacts of climate change like sea level changes and longer drier spells. Changes in ocean temperature and acidification may lead to loss of

95% of the living corals of Australia's Great Barrier Reef (Anonymous, 2007).

Climate change also alters the disease behavior in animals. The devastating amphibian disease chytrid fungus, likely exacerbated by warmer temperatures, has left many amphibian populations dwindling or extinct.

The climate change has a huge impact on biodiversity (Prakash and Srivastava, 2019). For example, more increase in temperature and increased carbondioxide are likely to be beneficial to many plants, resulting in an acceleration of biomass production. Milder winters might increase survival of many currently threatened species might in temperate regions. Increased precipitation may also benefit some plant communities and species depending on them. Moreover, several studies reported detrimental effects of climate change on biological invasions (Peterson et al., 2008). Although few studies report beneficial effects of global changes on biodiversity, they certainly exist and add to the difficulty of getting a clear overview of the effects of climate changes on the biodiversity of our planet.

Impact of Climate change on Ecosystem

Millennium Ecosystem Assessment (MEA) assessed the consequences of ecosystem change for human well-being from 2001 to 2005, the MEA involved more than 1360 experts to work worldwide and predicts that only a small change in climate has severe impact on the ecosystems. Their findings provide a state-of-the –art scientific appraisal of the services they provide, as well as the scientific basis for action to conserve and use them sustainably. The Millennium Ecosystem Assessment completed in 2005 found that overall people have made greater changes to ecosystems in the last half of the 20th century than at any time in human history.

Terrestrial ecosystem: Beyond 2050, terrestrial ecosystems, which play an important role as carbon sinks, may reach the upper limit of the absorptive capacity or even, decrease their net carbon uptake. It increases the global average temperature exceed 1.5-2.50C that adversely affected the food and water supply to species. Thus major changes in ecosystem structure & function, species' ecological interaction and geographic ranges decrease the 20-30% plant and animal species.

Marine and Coastal ecosystem: Climate change is leading to sea level rise, increased coastal erosion, flooding, higher storm surges, sea salinity ingress, increased sea-surface temperatures, ocean acidification and coral bleaching. Rising sea level presents extreme threat to marine ecosystems which can lead to disturbance in habitat and patterns of survival of marine species. Wetlands and coastal ecosystems are at a huge risk due to increasing sea levels. Many communities have already become climate refugees to evade rising sea level (Anonymous, 2007). The sea level rise recorded over the past 40 years is responsible for the loss of 28 percent of the mangrove ecosystem. Modelling suggests that up to 96 percent of suitable tiger habitat in the Sundarbans could be lost in the next 50–90 years (Loucks *et al*., 2010). Islands are also rich in biodiversity and have high economic importance. But at present due to climate change more than 23% island species are becoming endangered and hence economic loss in the tourism sector.

Himalayan ecosystem: Temperatures in the Himalayan ecosystem are increasing at a rate of 0.9 °C annually, which is considerably higher than the global average of 0.7 °C per decade. Due to this changes mosquito are seeing first time in Lhasa and Tibet cities, located 3490 meters above sea level. There are similar reports of flies at Mount Everest base camp in Nepal. The presence of these insects suggests the possible spread of vector borne diseases, such as malaria and dengue fever, to areas where cooler temperatures previously protected people from these threats (FAO, 2012).

Inland water ecosystem: It includes fresh water lotic and lentic ecosystem and comprising 0.8% of the earth's surface, but support 6% of the total species. They are rich source of food, income, employment and biodiversity. Changing climatic conditions like rainfall and temperature lead to changes in the phenology, physiology and migration trends of some organisms like migratory fishes and birds.

Forest ecosystem: One third of earth's surface is covered by forest and it is the home place of two third of all terrestrial species. They are also rich biodiversity hotspots. But half of the original forest has been cleared up till now. Green house effect has led to increase in growth of some forest, migration of tree species towards high altitude, increased attack of pest, invasive species and wild fires, hence modifying the composition of forest. According to FAO (2000), due to these changes many animals, primates and 9% of all known plant species are at verge of extension.

Biodiversity responses to climate change

Because of climate changes, species may produce several types of adaptive response mechanisms. The mechanisms are either due to micro-evolution (i.e. species can genetically adapt to new conditions through mutations or selection of existing genotypes) (Salamin *et. al.*, 2010) or plasticity, which provides a very short-term response within individuals lifetimes. It may involve intraspecific variation in morphological, physiological or behavioural traits that can occur on different time scales within population's spatial range (Chevin, *et al*., 2010). Empirical evidence suggests that plastic there is increasing contribution is often more important than genetic contribution, as observed in birds and marmots (Hoffiman and Sgro, 2011). On the other hand, there is increasing empirical evidence that evolution can be very rapid (Lavergne *et al*., 2010) and selection-driven phenotypic changes have enhanced the invasive potential (Phillips, 2009). Recent studies on evolutionary rescue also confirm that rapid evolution through mutation and selection could allow species to adapt rapidly against environmental changes.

The responses to climate changes by a species may be spatial or temporal or self axes. The first two axes corresponds are easily observable and well documented responses to global warming. One of the best-documented responses from both palaeontological records and recent observations is a spatial shift of species tracking suitable climatic conditions at the regional scale. Latitudinal and altitudinal range shifts have already been observed in more than 1000 species-especially those with high dispersal capacities like birds, insects and marine invertebrates (Parmesan, 2006), leading to a reduction in range size particularly in polar and mountain top species (Forero-Medina *et al*., 2010). However, individuals shift their distribution to stay in quasi equilibrium with the climatic conditions they are adapted to, but they may not be adapted to other abiotic factors such as photoperiod or novel biotic interactions (Visser, 2008). In these cases, micro-evolution may be needed for them to persist. The phonological changes i.e. changing in flowering, fruiting and seasonal migrations are most ubiquitous responses to against 20th century global warming. Parmesan (2006), reported that due to global warming, phonological events has become advanced by more than 10 days per decade in some species. These phonological changes can help species keep synchrony with cyclical abiotic factors. Yet, they can also be disruptive, by increasing asynchrony in predator-prey and insect-plant systems, which may lead to species extinction. Self correspond (physiological and behavioural changes) is less visible to and allow species to adapt the new climatic conditions in the same spatial and temporal frame.

Management of Biodiversity conservation

Responses of different species against climate change help the ecologists to provide scientific guidance for the development of conservation strategic. The study recording how climate affect species, biomes or ecosystems could assist in identifying the most appropriate conservation measures. For instance, species or ecosystem projected to be primarily affected by climate change may require adapted measures compared to species negatively affected by land use change that could persist through protecting of their remaining natural habitat. A widespread view is that an important strategy is to enhance landscape connectivity to enable species to move through a matrix of interconnected habitats to favour escapes from unsuitable climatic conditions. In this increasingly hot debate, case-by-case decisions have been advocated, based on the balance between threatened status of a species and threat of that species for the recipient ecosystem, as well as the socioeconomic context in which conservation is taking place (Dawson *et al*., 2011). In this record, preventive actions are foremost importance because it should be remembered that the proportion of species extension is a powerful function of the expected global warming hence minimizing global warming is an important step in the preservation of species from extension, with each tenth of degree avoided saving an increasing number of species. Thus it is a challenge for conservation planners to design reserve networks that protect biodiversity *in situ*.

The following important steps are proposed by various scientists all over the world to save existing biodiversity:

- Protection and improvement of various ecosystems like forest, grassland, swamps and waterbodies.
- Natural bamboo breaks/ bamboo forests are excellent habitat for several wild animals and therefore, need to be conserved.
- Prevention of unnecessary destruction of wildlife by educating human being concerning causes, results and remedial measures of wildlife depletion.
- Key biodiversity areas should be protected from cattle and anthropogenic activity.
- Intensive research should be carried out in key biodiversity areas to study the habitat, ecology and food requirement of wild animals and biotic pressures etc.
- Preparing wildlife data base and inventories. List of threatened species at the local has to be prepared and updated so that conservation efforts may be focused on these species in the given area.
- Increased support from state and central government agencies for the conservation of natural resources.
- Prevention of devastating forest fires.
- Regularly contact or monthly contact environmental awareness education and programme should be

conducted. It is very useful and major link between people and the Government.

- Biodiversity conservation awareness programme should be conducted at school level which will also gives fruitful effects in due course of time
- Conservation of biodiversity through a network of protected areas including National Parks, Sanctuaries, Biosphere Reserves, Marine reserves, gene Banks, Wetlands, coral Reefs, etc.
- The integrated approach is essential to solve the problem by public awareness and primary education of biodiversity importance, pollution and the effect of global warming on biodiversity.

CONCLUSION

Small change in climate has an impact on the biodiv ersity like change in their distribution pattern, migration of species, invasion of invasive species, change in the phonological behaviour like breeding period, migration time etc, increase in the forest fires and pest attacks (Rathore and Jasrai, 2013). The timing of species life cycle events is expected to be altered, species distributions will change radically, trophic networks will be affected and ecosystem functioning may be severely impaired, leading in the worst cases to countless species extensions.

Increasing our understanding of the affects of climate change on biodiversity, and developing ways of mitigating such effects, are critical to limit such damage. Over the past decades, some of this understanding has been effectively translated into mathematical models that can be used to forecast climate change impacts on species distributions, abundance and extensions. These models are characterized by their high diversity of understanding structures and assumptions, with predictions differing greatly depending on the models used and species studied. Most of these models indicate alarming consequences for biodiversity with worst-case scenarios leading to extension rates that would qualify as the sixth mass extension in the history of earth (Barnosky *et al*., 2011).

Thus there is a growing realization among decision-makers that biodiversity is not an optional bonus in human affairs, but the very foundation of our existence. Moreover, biodiversity conservation tailored to changing climatic conditions is not only necessary to help species and habitats to adapt to change, but such action is also likely to mitigate climate change (FAO, 2012). In terms of agriculture, there is a need for climate resilient farming systems. Climate literacy should be spread and a cadre of Community Climate Risk Managers should be formed in villages. The calamity of climate change should be converted into an opportunity for developing and spreading climate resilient farming techniques and systems (Swaminathan and Keshvan, 2012). It is also crucial to improve our understanding of the vulnerability of biodiversity to climate change, to develop other predictive approaches and to go beyond prediction. Even so biodiversity is a key resource in climate mitigation and adaptation strategies through the delivery of direct and indirect ecosystem services.

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