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IMPACT OF GLOBAL WARMING ON BIODIVERSITY

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ABSTRACT

Global climate change is the most severe environmental threat in the 21st century. Today climate change is a global challenge for humankind. Climate change is having significant effects and is a major threat not only for mankind, but also for life on earth as a whole. Climate change represents one of the most important threats to our planet's biodiversity. There is a two-way relationship between biodiversity and climate. Biodiversity is threatened by human-induced climate change and climate change is already forcing biodiversity to adopt either through shifting habitat or changing life cycles. Plants and animals are endangered due to global warming resulting from increasing concentration of carbon dioxide released into atmosphere through different human activities. Climate has played a critical role in fluctuations of biodiversity levels. There is some evidence that plants and animals are already responding to warmer temperatures. The basic objective of this paper is to analysis the present and future impact of climate change on biodiversity.

KEY WORDS: Global Warming, Climate change, Biodiversity

"We shall not finally defeat AIDS, tuberculosis, malaria, or any of the other infectious diseases that plague the developing world until we have also won the battle for safe drinking water, sanitation and basic healthcare."

: Kofi Annan, Former Secretary-General of the United Nations

INTRODUCTION

Plants and animals of extremely diverse and varied morphological characteristics and structural organization are encountered on the surface of the earth *(Bhattacharya, 2005)*. Natural resources offer the foundation for life on Earth. The basic social, ethical, cultural and economic significance of living and non-living natural resources have been identified in religion, art and literature from ancient history *(Sen, 2008)*. Natural resources are referred to the naturally occurring substances which are considered precious in their relatively unmodified condition. It serve as the base on which the process of development takes place, especially at its early stage (*Hussain, 2007)*. Changes in the condition of natural resources and their long-term, usually negative, impacts on society and economy have been pointed out clearly and alarmingly by several comprehensive studies, such as Millennium Ecosystem Assessment. The UN has declared 2005-15 as *'Water for Life'* period. This indicates the use of available water and find out the alternative measures for future *(Nair and Kumar, 2007)*. To sustain a healthy life and its purposeful activity, it is necessary to ensure basal metabolic rate and aerobic process (*Sharma, 2008).* The agricultural sector is one of the largest contributors to greenhouse gas emissions, second only to the energy sector. Conversely, climate change affects agriculture throughout the world *(Agriculture, Agro-biodiversity. and Climate Change, 2008)*. Climate change is an important factor in determining the past and future distributions of biodiversity *(Cheung et al., 2009).*

Every year 22nd May is observed as International day for Biological Diversity. The theme of this day in 2007 was "*Biodiversity and climate change*". Global climate change is the most severe environmental threat in the 21st century. It has been observed that *"Civilization itself is threatened by global warming"*. Climate change is a global challenge for humankind. It is having significance effects and is a major threat not only for mankind, but also for life on earth as a whole. It represents one of the most important threats to planets biodiversity. There is a two-way relationship between biodiversity and climate: biodiversity is threatened by human-induced climate change is already forcing biodiversity to adapt either through shifting habitat or changing life cycles..

The environment, as well as the human societies that exist within it, depend on fresh water and its associated resources *(Srivastava, 2006).* Around 1.75 million species have been named by taxonomists to date. Human health and well-being are directly dependent on biodiversity. Global biodiversity is changing at an unprecedented rate, the most important drivers of the change being land conservation, climate change, pollution, unsustainable harvesting of natural resources and the introduction of exotic species. It provides genetic resources for food and agriculture and therefore constitutes the biological basis for world

food security and support for human livelihoods *(Dahiya, 2006).*

WHAT IS BIODIVERSITY?

Biodiversity are vast array of species of plants, animals and microorganisms created by nature are the *'foundation of human life'* on earth *(Sharma et al., 2004)*. Biodiversity reflects the number, variety and variability of living organisms. It includes all organisms, from microscopic bacteria to plants and animals. Biodiversity is every where, both on land and in water. It includes diversity within and between individuals, populations, species, communities and ecosystems. It is defined in according with Article 2 of the Convention of Biological Diversity to mean the variability among living organisms from all sources including *inter alia*, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems *(Ranade, 2008)*. The biodiversity in soil includes all major groups of bacteria, fungi, algae and most of the animal phyla *(Joy, 2007).* There are many different kinds of definition that have been devised for biodiversity. One is genetic diversity, which can refer to the diversity of genes within a single species as well as between species. Another is taxonomic diversity, based of course on the different taxa contained within an ecosystem. The third is functional diversity, which recognizes the variety of roles that different organisms – including the separate life stages of individual species – play in the ecosystem *(Silvert, 2011)*. There are between 5- 30 million distinct species on Earth; most are microorganisms and only about 1.75 million have been formally described *(Integrated solutions for biodiversity, climate change and poverty, 2010)*. Rich and diverse forms of plant, animal and microbial life inhabit warm and humid regions in between the Tropic of Cancer and Capricon. Countries like Brazil, Columbia, Mexico, Peru, Ecuador, Indonesia, Malaysia, India, Zaire, Madagascar, and Australia that are located in this region are known as mega diversity countries *(Mandal & Ray, 2007)*. India belongs to pantropical region in Asia. Ecosystem diversity in India includes desert, forests, grasslands, and mangroves *(Chaudhuri, 2007).*

Biological diversity is most essential for survival of human being because it is delicately and intrinsically incorporated in the ecosystems. The values of biodiversity are both consumption as well non-consumptive. The consumptive use includes: food, medicine, tool for breeding and other domestic needs. The non-consumptive use value includes ecological processes and tourism. Importance of bio-resources can further be visualized by the fact that about 75% of the total items of export from India is directly or indirectly a bio-product *(Mishra & Prasad, 2004)*. There are more than 35,000 known species of spiders from 80 different families distributed all over the world and about 700 species from 44 different families are represented from India in widely varying climates and ecological niches *(Singh & Singh, 2004)*. Global warming is a consequence of enhancement of atmosphere greenhouse gases. Main greenhouse gases are: Carbon dioxide, Methane, Nitrogen oxide, water vapour and other volatile organic compounds. Global greenhouse gas emissions have continued to rise *(Ranade, 2009)*.

IMPORTANCE OF BIODIVERSITY

In order to highlight the significance of biodiversity conservation it is essential to estimate the worth of species concerned.

The estimation of biodiversity is very difficult: (i) due to the information and uncertainty and (ii) due to variation from location to location, ecosystem to ecosystem and country to country. Java and Asheem Srivastava (1998) have reported that the valuation of biodiversity is based on the premise that it is a biological resource meant to provide:

1. The material basis for human life.
2. For agricultural and other utilitarian needs.
3. Nutritionally significant edible plants and animal species.
4. Medicinal drugs for human and animal health care.
5. Coastal zone stabilization through mangrove ecosystems.
6. Support to fisheries through coral reefs, &
7. Place for religious practices-aesthetic value *(Maruthanayagram & Sharmila, 2004).*

GLOBAL WARMING AND BIODIVERSITY

Global warming has the potential to cause extinctions in a great majority of the world's especially valuable ecosystems. Losses of habitat types are predicted within the eco regions and, based on species–area relationships, can be expected to result in losses of biodiversity *(Malcom el all, 2002)*. Perhaps the most significant cause of the increased greenhouse effect and global warming is the 30% increase in atmospheric carbon dioxide since 1750. Present carbon dioxide concentrations years are due to the burning of fossil fuels for human consumption and transportation *(Solution to global climate change: photovoltaic technology plant, 2010)*. Both the Arctic and the Antarctic are expected to continue warming. More sea ice will disappear; in the Arctic, this will allow ships to move safely through wide expanses of ocean formerly blocked by ice *(How will global warming affect my world, 2003)*. It is widely accepted that global warming is happening, there is a growing demand for accurate forecasts of its effects, and much concern about its effects on biological diversity *(Botkin, 2007).* There is very little doubt today among the scientific community that anthropogenic, or human-induced, greenhouse gas pollution has contributed significantly to the global warming experienced since the beginning of the industrial era in the late 1800s. Over the past 100 years, the earth's surface has warmed by approximately 0.6°C. Scientists warn that if the current rate of greenhouse gas emissions continues, global air temperatures could rise between 1.5 to 4.5°C by the year 2100. The direct and more tangible consequences for human civilizations of such a temperature increase range from melting of glaciers and polar ice caps and the subsequent rising of sea levels and flooding of coastal areas, to increase in transmission of tropical diseases, to large-scale disruptions in global climatic patterns resulting in both unusual droughts and flooding world-wide *(Kannan & James, 2009).* The synergism of rapid temperature rise and other stresses, in particular habitat destruction, could easily disrupt the connectedness among species and lead to a reformulation of species communities, reflecting differential changes in species, and to numerous extirpations and possibly extinctions *(Root el al., 2003).* Climate change is projected to affect agricultural biodiversity through increased temperatures, changes in rainfall patterns, and extreme weather events, diminishing crop yields and declining food security. The conservation of crop and livestock genetic resources is important for maintaining options for further agricultural needs.

The impacts of climate change on biodiversity will vary from region to region. The most rapid changes in climate are expected in the far north and south and in mountainous regions. These also happen to be the regions where species are more likely to become trapped, with no alternative habitat to which they can migrate. Species with small fragmented populations, or populations restricted to small areas, are also especially vulnerable to any climatic shifts *(Integrated solutions for biodiversity, climate change and poverty, 2010).* Climate change is already forcing biodiversity to adapt either through shifting habitat, changing life cycles, or the development of new physical traits. Impacts already observed include:

1. Coral bleaching, caused by increased sea temperatures, is causing die-offs amongst coral reef communities from Australia to the Caribbean.
2. The Common Murre has advanced breeding by 24 days per decade over the past 50 years in response to higher temperatures.
3. The Baltimore oriole is shifting northward and may soon disappear entirely from the Baltimore area *(Climate change and biodiversity, 2007).*
4. Polar bear populations are coming under threat as food becomes harder to hunt.

Climate change is the term used to describe a gradual increase in the average temperature of the Earth's atmosphere and its oceans, a change that is believed to be changing the Earth's climate forever. Due to global warming the plants, animals and insect that live in the forest will be affected, both by changing habitat and in direct response to temperature increases and changes in precipitation, fire regimes and storm events. Insects and plants are becoming extinct because of habitat loss, overexploitation, pollution, overpopulation and the threat of global climatic changes. Insects comprise the largest group of organisms and are involved in various vital *'ecosystem services'* such as pollination, decomposition, herbivores and biological control as well as contributing directly to human based economies through silk and honey production. It is well known that India is one among the 12 mega biodiversity countries of the world and 80% of the insects are endemic in India *(Impact of Climate Change on Biodiversity of insects and Environment, 2010).* The value of agricultural crops, fisheries, fuel and fodder, medicinal and aromatics, textiles and leader, fibre crops and beverages could be a staggering, mind-boggling billion of dollars of international trade (*Ghosh, 2007).*

Coastal and marine ecosystems are among the most biologically and economically productive ecosystems in the world and the same is true for India where these ecosystems are both a source of livelihood as well as of a range of ecological services that are critical for the day to day well-being of millions of people particularly coastal communities. Despite their tremendous ecological and economic importance and the existence of a substantial policy and regulatory framework, India's coastal and marine ecosystems are under increasing threat. Numerous direct and indirect pressures arising from different types of economic development and associated activities are having adverse impacts on coastal and marine biodiversity across the country *(Identification of research gaps in coastal and marine biodiversity conservation in India, 2010).*

STRONG EVIDENCE OF EXTINCTIONS DUE TO GLOBAL WARMING

Over the past 100 years, the global average temperature has increased by approximately 0.68C and is projected to continue to rise at a rapid rate. Although species have responded to climatic changes throughout their evolutionary history, a primary concern for wild species and their ecosystems is this rapid rate of change. The synergism of rapid temperature rise and other stresses, in particular habitat destruction, could easily disrupt the connectedness among species and lead to a reformulation of species communities, reflecting differential changes in species, and to numerous extirpations and possibly extinctions (Root et all, 2003).

In the mountain forests of Central America, strikingly colored Harlequin frogs were the first charismatic conspicuous vertebrates to succumb to global warming. Sixty-seven percent of 110 endemic species have become extinct in just two decades. Several species of birds arrived earlier than they did in pre-warming times. Spring first-time migratory arrivals advanced an average of 1.3 to 4.4 days per decade; and subsequent breeding activities too hastened by an average of 1.9 to 4.8 days per decade over a time frame of 30-60 years. Early arrival in the spring of migratory birds has resulted in increased competition for optimal nest sites with early nesting resident species. Birds in Europe and the western Palearctic are laying eggs earlier. Peak dates of caterpillars have been shifted much earlier than the hatching of tit chicks, and this has led to food deprivation for the chicks thereby affecting reproductive success and population recruitment. The evidence has mounted from the plant kingdom as well. Flowering and leafing among several European plant species has occurred earlier in the year by an average of 1.4-3.1 days per decade in a study covering a time period of 30- 48 years *(Kannan & James, 2009)*. Arrival dates of short-distance migratory birds in North America seem to have been affected disproportionately by global warming *(Butler 2003)*. Dunn & Winkler (1999) reported that climate change has affected the breeding date of tree swallows throughout the continent. In Canada, warming trends have resulted in a northward expansion of the range of the red fox, and a subsequent retreat of the range of the Arctic fox *(Hoffman & Parsons 1997; Walther et al. 2002).*

With the melting of large areas of the Antarctic ice shelf, more liquid and warmer water is available for colonization, and several Antarctic plants and invertebrates have shown striking distributional changes *(Smith 2001)*. Macroscopic plants like mosses have especially been influenced by the change in climate. But perhaps the Antarctic phenomenon that has not only regional but also global effects is the drastic reduction in population of krill in the seas near that continent *(Loeb et al., 1997)*. Reduction in sea ice area near the Antarctic Peninsula has affected krill recruitment rates.

The history of global biodiversity is best seen in the marine animals since the ocean is where life started, and marine animals are the best represented in the fossil record *(Roy, 2007)*. In the marine domain, there is an apparent increase in species diversity of hard substratum epifauna from the Arctic to tropics. The Arctic is much younger and has low biodiversity and low endemism compared with the older Antarctic. The longer period of geographic isolation of the Antarctic is also important for biodiversity generation. Production processes also differ and whereas the Arctic is dominated by many commercial fish species the Antarctic

is characterized by invertebrates which support birds and mammals and only a small fishery. Probably the most well-known diversity pattern in the marine domain is that of coral genera and species, which show highest values in the Indonesian archipelago and falling values radiating westwards across the Pacific Ocean. Another pattern that has received much attention is that in soft sediments with increasing diversity from shallow areas to the deep sea. Temperature is probably the single most important physical variable structuring marine ecosystems. There is growing appreciation that the composition, abundance, and trophic efficiency of plankton communities are tightly linked to water temperature, beyond their direct physiological responses. It is this critical influence of temperature that makes marine systems acutely vulnerable to global warming (*Richardson, 2008).*

With the exception of ocean dumping and UV-B radiation there are probably few human activities posing major threats to oceanic diversity. However, long-transported materials enter the open ocean system and there are concerns about effects of organ chlorine compounds on plank tonic and benthic systems. Most of the threats to biodiversity are in the coastal zone and are a direct result of human population and demographic trends. The world population has more than doubled since World War II and is expected to increase from 5.5 billion in 1992 to 8.5 billion by 2025. More important however, are the demographic trends of increased population densities in coastal areas. It is estimated that 67% of the global population lives on the coast or within 60 km of the coast and the percentage is increasing.

In Sri Lanka reef cover is declining by 10% annually and in the Gulf of Thailand by 20% annually *(ASEAN, 1992)*. In the Philippines studies show that almost 70% of 735 studied reefs are seriously damaged and in Eastern Indonesia 80% of the reefs have been damaged by dynamite fishing. There is reason to believe that similar damage is occurring in East Africa and in the Caribbean. Recently the US State Department (1995) has launched an International Coral Reef Initiative which is endorsed by scientists, policy makers, donor organizations and national representatives. This concludes that `human activity is the primary agent of degradation' of reefs either from direct impacts or by inadequate planning and management of coastal land and upland activities. All these impacts are exacerbated by human population growth, increased pollution.

Mangrove forest destruction is occurring on an equally alarming rate. Indonesia has by far the largest areas of mangroves (21 011 km2) and 45% have been lost and the rates of loss are increasing rapidly. Data from the World Resources Institute show losses of between 40 and 70% in Africa, almost 70% in Asia, 85% in India and 87% in Thailand. While losses of coral reefs and mangrove habitats are probably the most significant in terms of losses of biodiversity it should not be forgotten that other critical coastal habitats are also disappearing. Wetland areas, estuaries and sea grass beds are known to be key nursery areas for coastal fisheries and yet are being destroyed rapidly without there being full ecological and economical appraisal of the consequences even in developed countries.

The GESAMP State of the Marine Environment Report *(GESAMP, 1990)* is still the most authoritative statement of the threats to marine life. In recent years there has been a recognition that heavy metals seldom pose a threat to marine biodiversity,

although there are local areas where high concentrations are still cause for concern, such as areas subjected to mining waste run-o€ and industrialized estuaries or fjords. Ciguatera, a disease affecting the nervous and cardio-vascular systems is caused by eating tropical fish that have bio-accumulated toxins from natural algae. There are greatly increasing stresses on coasts caused by tourism even in Antarctica and the Arctic. The most serious threats are those of habitat destruction. Mangroves are often removed, wetland areas filled in and estuaries reclaimed to make way for touristic complexes without there being any evaluation of the benefits of the intact systems. Once built the resort may lead to effects on adjacent habitats through sewage discharge and other threats and ultimately to the loss of habitats and their resources. Establishment of hotels on coral reefs is becoming popular and often leads to the destruction of the habitat that was the reason for the development in the first place *(Gray, 1997).*

The effect of climate change was the most important factor of freshwater fish loss under the scenarios, while anthropogenic water withdrawal contributed much less to species loss (an additional 0–5%). However, in regions where substantial irrigation has occurred in the past and is expected to increase, water consumption is particularly important for fish biodiversity decline *(Freshwater Biodiversity Threatened by Climate Change, 2006).* The obtained extinction rates were compared with the rates of habitat loss due to deforestation, which has been generally recognized as one of the most serious threats to biodiversity. Under the assumption that projected habitat changes were reached in 100 years, estimated rates of species extinctions associated with global warming in tropical hotspots in some cases exceeded those due to deforestation. These calculations rely on many assumptions but the results suggest that, under certain scenarios, global warming could be a more serious threat to biodiversity than deforestation *(Global Warming Threatens Planet's Biodiversity, 2006).*

Species most vulnerable to extinction will be those with small populations, slow rates of dispersal, restrictive elevation, climate requirements, and/or those whose habitat is limited or occurs in patches. Over the past 30 years, freshwater species have declined faster compared to terrestrial or marine species. Unfortunately, growing evidence indicate that this trend is likely to persist in the future. On one hand, freshwater ecosystems will probably further suffer from invasive species and land use changes. On the other hand, freshwater biota is likely to be impacted by the predicted reduction in water availability driven by increased water consumption for human uses and indirectly related to global climate change *(Freshwater Biodiversity Threatened by Climate Change, 2006)*. Global change is often perceived as human-induced modifications in climate. Indeed, human activities have undeniably altered the atmosphere, and probably the climate as well *(Watson et al. 1998).* Global warming is expected to increase evapotranspiration, causing soil moisture declines that may offset modest increases in continental precipitation and lead to greater aridity in water limited systems around the world *(Zavaleta, 2003).*

Migratory species face particular extinction risk, since they require multiple habitats in a particular seasonal order increasing the probability of climate change-induced disruption of their habitat requirements. Also at risk are endemics, species with narrow elevational ranges, and species with limited dispersal ability or long reproductive

cycles. Ecosystems most vulnerable include those that are sensitive to climate, highly exposed to climate change, geographically restricted, or dominated by long-lived species. Alpine ecosystems, prairie wetlands, remnant native grasslands, and permafrost-based and ice-edge ecosystems are identified as being particularly at risk. In summary, climate change is likely to induce the following:

1. Large-scale biome, ecosystem, and species shifts
2. A breakdown and re-sorting of current plant communities and ecosystems
3. A general expansion of species ranges northwards and upslope
4. Loss of ecosystems, including some wetland and alpine areas
5. Changes in habitat quality and availability
6. Increases in growing degree days
7. Changes in synchrony between species—for example, the timing of predator/prey or flower/ pollinator interaction
8. Differential range shifting—for example, when a pollinator insect experiences a range expansion but its host plant does not *(Gayton, 2008).*

CONCLUDING OBSERVATION

Biodiversity is important for human civilization. Global warming is a threat before the existing biodiversity of this earth. Over the past 100 years, the global average temperature has increased by approximately 0.68C and is projected to continue to rise at a rapid rate. The effect of climate change was the most important factor of freshwater fish loss under the scenarios, while anthropogenic water withdrawal contributed much less to species loss. With the melting of large areas of the Antarctic ice shelf, more liquid and warmer water is available for colonization, and several Antarctic plants and invertebrates have shown striking distributional changes Conserving habitats and ecosystems is the key to species conservation.

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