Loss of biodiversity in the face of global warming

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Introduction

Solar energy serves as the primary energy source for almost all the ecosystems of the world and drives primary production. Solar radiation is the heat source for the earth and fuels the optimum ecosystem functions. Incoming IR radiation is retained within the atmosphere by heat trapping gases such as carbon dioxide exerting the natural greenhouse effect (Rogers, 1990). Atmospheric carbon dioxide is essential for organic evolution and sustenance of all the biomes. Had it not being for carbon dioxide, the average global temperature would be -18ºC (Abrahamson, 1989). With technical revolution, several natural and synthetic gases such as carbon dioxide, methane, nitrogen oxides and halocarbons have accumulated in the atmosphere casing enhanced greenhouse effect increasing the global average temperature. Increased temperature causes significant atmospheric alterations leading to climate change (Cox *et al*., 2000). The major reason behind the global warming is increased combustion of fossil fuels for energy. Certain industries also emit greenhouse gases. Further, destruction of the carbon sinks such natural forests, adverse agricultural practices such as intensive monoculturing that damage the carbon and methane storage capacity of soil aggravate the situation (Chen *et al*., 2001). Intensification of global warming is reflected by the fact that the 10 warmest years of the 19th, 20th and 21st centuries being recorded within the last decade: 1998, 2005, 2003, 2002, 2004, 2006, 2007, 2001, 1997, 2008. During this period, global sea surface temperature has risen by 0.4-0.8ºC and it is predicted that this value will creep up to 1.4-5.8ºC at the turn of the 21st century if no proper measures are taken to limit the emissions of greenhouse gases (IPCC, 2008).

Impacts on natural vegetation

The wet tropical montane ecosystems and temperate ecosystems such as taigas, boreal forests and tundras are the most vulnerable to global warming and related impacts. The extent of these biomes is shrinking significantly with global warming such as, rainforests of north east Amazon that are being degraded. Generally, vegetation shifts poleward with warming climates but montane and polar habitats do not have a physical space to shift (Leemans and Eickhout, 2004). With warming climates, diversity rich habitats will get replaced by less diverse habitats, where rainforests will be converted to grasslands or deserts (Emanuel, 1985). Global warming imposes a physiological stress on vegetation that reduces net primary production and enhances the heterotrophic respiration ultimately leading to growth retardation and reduction in net ecosystem productivity (Saxe *et al*., 2000). Further with increased atmospheric temperature, natural vegetation is highly susceptible for pest and pathogenic infestations. This can be attributed to subjugation of plants' innate defenses against pathogens and increased environmental favorability for pests and pathogens. For example, under higher-than-average Mediterranean temperatures, the Oak fungus causes severe root rotting (Harvell *et al*., 2002). Further, during 1992-93, three successive unusually warm summers invoked the worst infestation of bark beetles devastating thousands of hectares of Australian and German forests.

High temperature allows thermophilic exotic flora to achieve a competitive advantage over native flora. Certain invasive plants demonstrate increased seed production and seed viability ensuring their propagation. For example, in Florida, introduced eucalyptus species have invaded the swamplands and formed dense monotypic stands hindering the growth of native vegetation.

Impacts on terrestrial fauna

Terrestrial fauna may feel multiple impacts upon global warming including changes in phenology, distribution and physiology, even extinctions. Temperature, rainfall and humidity may become unfavorable, rendering certain habitats hostile. Moreover, environmental severity reduces growth, impairs reproductive success, foraging abilities and immunity (Parmesan *et al*., 1999).

Amphibians, being specialized for narrow thermal regimes, are imperiled by global warming with reduced humidity and precipitation predisposing them for dehydration and reduction in egg and juvenile survival. Through habitat modification, global warming renders certain habitats unsuitable for amphibians, such as early drainage in ephemeral ponds and vegetation dieback. Similarly, in Africa, Silver dik-dik, Grey-cheeked Mangabey and Sahara Oryx are losing the majority of their habitats with global warming (Thuiller *et al*., 2006). Once preferred habitats shrink, wildlife experiences resource scarcity and range restrictions. Species with restricted distribution encounter grievous conditions with global warming (Dunbar, 1998). For example, lower altitudinal limit of the Gelada Baboon rises by 500m for every 2ºC rise in temperature shrinking its range towards the northern parts of the Ethiopian Plateau where their original distribution will be halved. Global warming can result decreased thickness of natural forests causing increased

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predation by invasive species. This was evident in the Easter Island where Pacific Rats voraciously fed on native birds (Hunt, 2007).

Migratory birds confront problems with global warming due to phenological disruptions, low food availability on migratory routes and destinations (Green and Pickering, 2002). Marked shifts in temperature are cues for migration. Success in migration depends on food availability and environmental conditions at the overwintering site. Upon arriving at destination or refuges, birds predate on invertebrates that emerge synchronizing birds' arrival, to replenish energy. The effect of global warming results an asynchrony between advent of birds and emergence of invertebrates, where the birds decimate with starvation. Further, sea level rise and inundation of coastal wetlands reduce availability of habitats of migratory birds (Austin and Rehfisch, 2004).

In face of global warming, volant species show poleward shifts in their ranges. For example; among 35 non-migratory European butterfly species, 63% have shifted their range to the north-pole by 35-240km during the 20th century (Parmesan *et al*., 1999). For biologically viable poleward shifts, the entire community needs to move simultaneously, which mostly does not happen. For instance, the critically endangered Kirtland Warbler of the USA nests in sandy soils of Michigan's Jack pine forests. With warming trends, they retreat into far north of Canada, where undrained soil disfavors nesting and young rearing (Arau jo *et al*., 2005).

Global warming alters climate oriented phenomena that govern ecosystem structure and function. For instance, in Australia, retarded pyric events decreased the extent of open forests and woodlands markedly reducing the faunal diversity (Asner *et al*., 1997). High temperature reduces occurrence of cloud-born mist which yields a unique environment for amphibians. Sex determination of herpetofauna is governed by temperature not by genes.

Hence, high temperature causes highly skewed sex ratios decreasing reproductive success (Lance et al., 2000). With global warming, parasitic infections become more virulent and spread faster. Most tropical pathogens prefer high temperature. In warm climates, distribution, pathogenesis and reproductive success of pathogens and their vectors get improved substantially (Bengis *et al*., 2003). Extreme heat imposes physiological stress which greatly weakens host's immunity increasing the host's vulnerability. Strongylid lungworms of Musk Oxen developed rapidly under slightly higher summer temperatures (Dobson *et al*., 2003).

Impacts on aquatic fauna including marine and coastal ecosystems

Most prominent threat over coastal ecosystems comes up with the rise of sea level, due to thermal expansion of sea water. Rising sea levels inundates and intrudes into coastal and brackish water habitats casing habitat loss for many species either as a direct result of floods or due to increased salinity (IPCC, 2008). Rising temperature causes rapid melting of oceanic iceburgs and ice sheets inhabited by polar fauna. Microbial primary producers grow on sea-ice. With rapid melting, microorganisms will disappear causing food shortage. Reduced sea-ice area has proven to shorten hunting duration for polar bears significantly reducing their weight. Further, reduced sea-ice cover has lead to population crashes in the Arctic fox marine carnivores (Lawrence and Soame, 2004). The main impact of global warming on inland wetlands is drying out and reduction of water levels with increased evaporation and water temperature being inhospitable, potentially exceeding physiological tolerance. Besides, high temperature could deplete the dissolved oxygen levels well below biologically favorable limits (Rehfisch *et al*., 2004).

Rising of sea surface temperature alters patterns of sea water circulation that governs nutrient distribution and physio-chemical properties of oceans. This will affect the distribution of marine species as in response to modifications of resource availability. For instance, in California, climate-ocean regime shift in 1976-77 resulted in reduced nutrient supply, decreasing productivity and causing reduction in sea bird abundance (IPCC, 2008).

Coral bleaching is another profound effect of global warming. Coral reefs require tropical sea temperature (18°C) and nutrient supply for wellbeing. Even a 1-2°C increment in the seawater temperature can destroy the algae and expulse it form corals, where reefs lose coloration and become white. Secondarily, hydrozoans of the colony may face nutrition deficiencies and become unable to maintain the calcium carbonate skeleton. Coral bleaching can be aggravated by pathogens that become highly virulent in warmer temperatures (Kumaraguru and Ramakritian, 2003).

With the recognition of the threats over biodiversity convoked by the global warming, it is essential take immediate actions to prevent this global catastrophe. Upon identification of increased emission of carbon dioxide as the major causative, it is important to reduce emissions and to preserve the natural mechanisms of carbon removal. This should include minimizing use of fossil fuels, seeking alternative eco-friendly energy sources and protection of wetlands and forests as natural carbon sinks. Saving the planet from global warming is a responsibility of all the nations.

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