

Chapter-45

Climate Change and Biodiversity Loss: Ecosystem Impacts and Conservation Challenges – A Case Study Review

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Abstract

The biggest danger to the biodiversity of our planet is climate change and it has a large impact on both ecosystems and the distribution of species. The aims of this literature review include examining the relationship between biodiversity and climate change, and giving an overview of the different ways climate change can influence biodiversity through four main mechanisms: increased temperature, altered precipitation patterns and extreme weather event, ocean acidification, and loss of habitat. We evaluate how climate change is impacting biodiversity using case studies that include coral reefs, forest ecosystems, and arctic ecosystems. We then discuss how these changes will affect conservation efforts and include ideas for potential ways to reduce the loss of biodiversity due to climate change.

Keywords: Climate change, Biodiversity loss, Species migration, Ocean acidification, Habitat degradation, Conservation.

Introduction

Biodiversity describes the variety of all life forms within ecosystems, and it contributes greatly to stabilizing the environment and providing all essential ecosystem services, and thus are essential for human life (food, clean water, air purification, and pollination). However, the contribution of climate change to biodiversity loss is becoming increasingly significant because it is altering the environmental conditions that determine biodiversity by disrupting the ecological processes that support biodiversity. Global temperature rise, altered precipitation patterns, habitat degradation, and ocean acidification have already impacted species survival and ecosystem function. Consequently, some species must adapt, migrate to new habitats, or face extinction; therefore, the relationship between climate change and biodiversity loss is complex and multifaceted (Millennium Ecosystem Assessment, 2005; Cardinale et al., 2012; IPBES, 2019). This review addresses climate change impact on biodiversity by examining the direct and indirect effects across various ecosystems; this will be achieved through a number of case studies that will demonstrate how climate change impacts on species, ecosystems and ecosystem services.

Climate Change and Its Impact on Biodiversity

1. Rising Temperatures and Shifting Habitats

The global temperature has risen around 1 °C since the start of industrialization, resulting in serious environmental repercussions globally. The increase in the temperature has caused some animals to migrate further north or to higher altitudes in search of cooler

temperatures. There has also been movement of some species (e.g., parasites) northward along with other organisms due to the increase in temperature in the Arctic region (Kafle et al., 2020). In addition, coral reefs are experiencing extensive bleaching events because the temperature of the oceans exceeds tolerable limits for these species (Hughes et al., 2017). As a result, there are changes in the make-up of fish species because some fish species are not able to adapt to the new habitat requirements of the changing environment and are therefore out-competed or replaced by more adaptable or invasive species.

2. Ocean Acidification and Marine Biodiversity

The increased levels of CO₂ in the atmosphere are absorbed by the Oceans, leading to Ocean Acidification, which adversely affects Marine Ecosystems, particularly Coral Reefs and Shellfish. By 2100, the ocean's pH will likely decrease by 0.3 to 0.4, which will have a dramatic impact on Coral Calcification, disrupting the Food Web (Doney et al., 2009). The Great Barrier Reef is one of the most diverse marine habitats in the world, and it is experiencing record amounts of Coral Bleaching due to the increased temperature and Ocean Acidification (Burke et al., 2010). When Corals are lost, then species that depend on these habitats, such as Fish and Invertebrates, are also removed from the marine environment, thus reducing Marine Biodiversity.

3. Habitat Destruction and Ecosystem Services

The impacts of climate change can be severe on habitats, especially by way of habitat loss through deforestation, desertification and flooding. Habitats (ecosystems) like forests that provide vital ecosystem services (i.e., carbon sequestration and support for biodiversity) are threatened by fires, pests, disease caused by climate change. In the Amazon Rainforest, for example, increased drought and subsequent deforestation are reducing the biodiversity of that region of the world (Nobre et al., 2016). Additionally, habitats (ecosystems) like wetlands and coastal areas are at risk of disappearing due to sea level rise (Nicholls et al., 2020). In turn, this loss of habitat will eliminate the species such habitats (ecosystems) support and will further reduce the ecosystem services those habitats provide to people (i.e., flood regulation and water filtering).

Case Studies of Climate Change Impacts on Biodiversity

1. The Great Barrier Reef: A Marine Ecosystem in Crisis

The Great Barrier Reef is Located on the eastern Australian coast and has been subjected to repeated coral bleaching events over the last several decades due to both an increase in sea surface temperatures and an increase in Ocean acidification. Hughes et al. (2017) evaluated the effects of these changes on the Great Barrier Reef and found that in the last 30 years the Coral Cover has decreased on average by 50% throughout the reef. The increase in the frequency and intensity of Coral Bleaching Events has also resulted in the loss of many Coral-Dwelling Fish and Invertebrate Species. The Great Barrier Reef is a case in point regarding how vulnerable marine Biodiversity is to rises in Temperature and Ocean Acidification.

2. Arctic Ecosystems and Melting Ice

The Arctic area is heating up almost twice as fast as the average around the world and thus accelerating the reduction of sea ice which is the habitat for all the species who live

there, such as polar bears, seals, and arctic foxes. The melting of the ice will force these species to find ways to adapt to their altered habitat or go extinct. According to the Arctic Council, by 2050, more than 30% of all the polar bears will no longer exist because of the loss of habitat and the subsequent change in food sources. Warming of the Arctic has caused the migration patterns of birds and mammals to be altered and has created an imbalance of the ecosystem.

3. Forests and Biodiversity Loss

Forests comprise a vital ecosystem as they host an enormous proportion of the Earth's biodiversity. Nevertheless, the temperature increases and drought conditions are causing an increase in pest and disease distribution among tree populations. In the Amazon rainforest, drought conditions have increased the occurrences of wildfires, causing the continued loss of forest cover (Nobre et al., 2016). This loss of forest biodiversity will have major impacts on the many species that depend on these forest ecosystems for their source of food and shelter.

Consequences of Biodiversity Loss Due to Climate Change

1. Disruption of Ecosystem Services

The depletion of biodiversity results in an ongoing degradation of critical ecosystem services needed for human health and sustainability. An example is demonstrated by how the loss of pollinators caused by climate change will threaten global food security (IPBES, 2019). Similarly, the degradation of coral reefs will result in a loss of coastal protection and increased vulnerability to storm surges and sea-level rise.

2. Economic Impact

Economic loss from biodiversity loss; this is particularly applicable to businesses that are resource based, such as fish stocks, tourism, and agricultural products. Reef degradation has impacted tourism dependent on coral reefs in the Caribbean (Burke et al., 2011), while changes in rainfall patterns and loss of pollinators will diminish agricultural productivity.

3. Health Impacts

Climate change and loss of biodiversity have the potential to negatively impact the health of humans by increasing the spread of vector-borne diseases. Many of these vector-borne diseases have increased geographic distribution and transmission potential due in part to changes in temperature and environment (Rocklöv & Dubrow, 2020).

Mitigation and Adaptation Strategies

1. Conservation of Ecosystems and Species

The protection of biodiversity is enhanced through the use of protected areas, which creates an environment for survival as well as providing resources for future generations. For example, MPAs protect coral reefs (below water) from human activities, and, at the land surface level, protected forests eliminate harmful practices to all living things. Both types of protection help to reduce pressures on coastal and inland ecosystems due to impacts of climate change.

2. Ecosystem Restoration

The restoration of ecosystems which have been degraded (e.g., reforestation, wetland restoration, and coral reef restoration) can improve the resilience of biodiversity to

climate change. An example of this is the restoration of mangroves, which offers protection against coastal erosion while providing habitat for marine species (Alongi, 2014).

3. Mitigating Climate Change

Global action has been taken to reduce greenhouse gas emissions, such as through international treaties such as the Paris Agreement, and are critical elements to help slow the rate of climate change. In addition, reducing deforestation and encouraging sustainable practices of land management can also help mitigate biodiversity loss.

Conclusion

Biodiversity faces serious and far-reaching effects from climate change, including loss of coral reefs, disappearance of Arctic habitats, deforestation and shifting species distributions as a result of this problem; this has significantly changed ecosystems everywhere on earth. By utilizing case studies contained within this paper as supporting evidence for the impact of climate change on various ecosystems, the need for prompt action in order to alleviate the negative impacts of climate change on biodiversity and other vital ecosystem services necessary for human life has been established. Thus, strong global cooperation/development of conservation strategies together with effective international attempts to mitigate climate change is necessary to protect biodiversity into the future.

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