CHAPTER 32

# Climate Change Impacts: Disruptions in Wildlife, Ecosystems and Fisheries

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## SUMMARY

Climate change refers to long-term patterns of change in global, regional and local climate averages. The characteristics of the Earth's climate are attributed to the combined effects of natural causes and human-induced forces. Human activities release greenhouse gases into the atmosphere, causing the observed ever-increasing world average temperature, accompanied by unprecedented occurrences of unusual, extreme weather. This will likely change worldwide ecosystems and hence present a risk for whole species of both flora and fauna to be extinct. In addition, climate change has seriously and negatively impacted the majority of the living world through the upsetting of their basic environmental conditions and their alteration of ecological processes. High temperatures trigger shifts in the phenology behavior and distribution of plant and animal species while trying to live and survive under the climatic change facilitated by rising temperatures. A good example is such shifts can stimulate mismatches within species interaction, e.g. predator-prey relationships or plant-pollinator dynamics, with serious effects on respective ecosystems.

## INTRODUCTION

Climate is the most complex system and our understanding of it is limited due to its spatial and temporal variability. Climate change can be defined as fluctuations and shifts in weather conditions across time and space at various scales and magnitudes that cause a change in climatic type, such as shifting from warm and moist to warm and dry climates and so on. The atmosphere is mostly turbulent and unstable due to elemental variations that cause spatiotemporal heterogeneity. The earth's climate is changing continuously and has changed significantly since 100 million years ago when dinosaurs roamed the planet and tropical plants thrived near the poles. Reports of increases in global average air and ocean temperatures, extensive melting of glaciers and ice sheets and rising global average sea levels suggest the world's climate is getting hotter. Global warming has become such a critical concern that countless summits and conferences have been convened across the globe and mitigation plans have yet to be fully implemented. Meanwhile, there is a conceptual contrast between 'climate change' and 'global warming'. Climate change can be caused by external forces and natural internal forces as well as by long term anthropogenic changes in atmospheric composition and land use. It may take the form of severe weather events or slow systemic changes that cause the environment to slowly deteriorate. Climate change is described as a long-lasting alteration in the mean and variability of the climate's attributes by IPCC's AR4 (Chakraborty et al., 2014).

Climate changes can be caused by a variety of external and internal factors, including extreme variations in the earth's orbit, solar variability, tectonic processes (primarily plate tectonics, which involves the movement of continents and ocean basins), volcanic activity, changes in the composition of the atmosphere. At the local, regional and global levels, these processes can involve energy exchanges between the atmosphere, hydrosphere, lithosphere and cryosphere. Human activities are also responsible for global warming. Global warming is the slow increase in air temperatures in the atmosphere and on the ground, along with the resulting modifications to the global radiation balance. It is primarily the result of human activity, though natural processes also contribute to global warming, and it affects climate on different scales. Although there has always been some degree of climate change throughout Earth's history, the fact that these changes are happening globally and are mostly the result of human evolution. The actual statement is that "the climate of the world has changed in the past, is changing now and there is every reason to expect that it will change in the future." Climochronology, or the history of paleoclimates, implies that the climate of the world has changed in the geologic past. Trends in climate change are going to increase. The Jurassic

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Period's abrupt and sudden shift to a cold environment caused the mass extinction of dinosaurs (Chakraborty et al., 2014).

## CAUSES

The two types of climate change are manmade (anthropogenic) and natural (Fig 1). The burning of fossil fuels, the cutting of forests and the raising of livestock are examples of anthropogenic or man-made processes causing climate change. Overall, 75% of greenhouse gas emissions are caused by the burning of fossil fuels which release greenhouse gases into the atmosphere, including carbon dioxide (CO2), which traps heat and contributes to global warming. The removal of forests reduces the capacity of the planet to absorb carbon dioxide from the atmosphere. Trees also aid in regulating the climate because they provide shade and produce oxygen. Methane (CH4) and nitrous oxide (N2O) are two strong greenhouse gases released by raising livestock and growing crops. Pollutants and greenhouse gases are released during manufacturing and other industrial processes which contribute to global warming (Díaz-Isaac et al., 2019).

When compared to factors caused by humans, the impact of volcanic eruptions on the climate is negligible and temporary. Fossil fuels, oil, gas and coal are the largest contributors to climate change accounting for over 75% of greenhouse gas emissions and nearly 90% of CO2 emissions. Although variations in the energy output of the sun can affect the climate of the earth, that are not the main reason for the warming that has been observed over the past century. The spreading of sunlight and consequently, the climate of the earth can be changed by slight modifications to the orbit of the earth. But the observed warming over the past century is not primarily due to these changes (Steffen et al., 2018).

## TEMPERATURE CHANGES AND WILDLIFE

The most frequent problems caused by climate change for both people and wildlife are cloudbursts, dry spells, rising sea levels, thawing permafrost and salinization. Climate change affects the structure, function, and services that nature provides to society, as well as individual species and their habitat (Díaz-Isaac et al., 2019). Although climate change usually stays confined, on rare occasions it can spread rapidly and disturb atmospheric circulation, food chains and nutrient flow in different parts of the world. A vital component of all

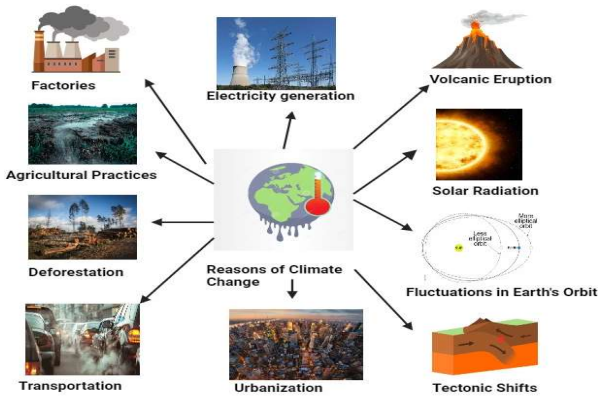


**Fig1.** Anthropogenic and natural causes of climate change

biological activity is solar energy. It encourages primary production and maintains the majority of biomass. It keeps the biological tolerance level of the earth intact (Lambert et al., 2014). It should be highlighted that while some species are not greatly affected by climate change, others are experiencing contrasting results. Phylogenetic niche conservatism and ecological productivity are the two key elements that contribute to tropical regions' rich biodiversity. Although these two aspects are critical, a growing corpus of theoretical and practical data indicates that kinetics is the most important element overall (Brown, 2014).

Natural ecosystems and wildlife have been impacted by climate change in several ways abrupt changes in the physical properties of the atmosphere, disasters and climatic events. The development of wildlife diseases and the invasion of exotic species affects climate change. Some species were unable to restore their habitats and phenological patterns in response to climate change, while others migrated to higher latitudes or altitudes. Within the same ecosystem, these phenomena differ amongst species and cause ecosystem components to break down. Therefore, one of the main causes of ecosystem degradation and biodiversity loss should be attributed to climate change (Kavanagh et al., 2019). Several human activities increase greenhouse gas emissions, which exacerbates the greenhouse effect and causes global warming (Fossi et al., 2018), This phenomenon causes dangerous climate change by increasing the temperature of the atmosphere and the sea surface. Over the past few decades, there has been an increase in sea surface temperature of 0.78°C ±0.18°C. The Inter-Governmental Panel on Climate Change projects that by the turn of the 21st century, the average sea surface temperature will have increased by 1.1°C to 6.4°C. Temperatures have risen 8 times faster in the last 20 years than in the previous 100 years and the rate of climate change is too rapid for most species and these species cannot adapt according to the environment and extinct. The ability of wildlife to adapt to climate change relies critically on the rate of change (Ramp et al., 2015).

### Climate change and the emergence of new diseases

Indicators of a changing climate include heat waves, droughts, heavy rainfall, floods or dry spells with little water, dust storms, tropical cyclones (typhoons or hurricanes), wildfires, melting snow, the disappearance of river deltas and coastal cities and changes to the environment such as deforestation, urbanization and habitat fragmentation (Handmer et al., 2012; Nava et al., 2017). It is commonly known that exposure to vector insects, environmental and ecosystem disturbance, climatic changes and the spread of infectious diseases are all correlated (Fig 2) and have an epidemiological relationship (Greer et al., 2008).

## TEMPERATURE CHANGE AND AQUATIC FAUNA

Climate change has had a substantial impact on marine ecosystems, causing changes in the ocean's temperature and chemical composition, primary productivity and the distribution and abundance of various species (Bryndum-Buchholz et al., 2019). Marine predators at higher trophic levels are likely to be impacted by changes in oceanic

conditions as well as changes in the distribution and number of prey population. For marine megafauna specific consequences of climate change are unknown. As "ecosystem engineers," cetaceans are vital to the nutrient cycle of the ocean and play a significant role in marine ecosystems. Furthermore, cetaceans are known to assist in managing prey populations (Casini et al., 2012) and provide feeding opportunities for marine birds (Dill et al., 2003).

There are already many other anthropogenic stresses like plastic, chemical and noise pollution, that severely affect large marine mammals (Nabi et al., 2018). These stresses may eventually cause several cetacean populations to collapse, which would have long-term effects on the services and functioning of marine ecosystems (Ballance, 2018). However, some research has been conducted on the consequences of climate change and so far, a variety of effects on cetaceans have been identified (Storrie et al., 2018). Impacts at the individual level include elevated bioaccumulation and increased mortality from algal blooms (Booth & Zeller, 2005).

## HABITAT LOSS AND FRAGMENTATION

Studies showed that climate change and habitat fragmentation are linked because there are many ways to show that habitat fragmentation is caused by climate change (Pörtner et al., 2019). Habitat loss and fragmentation occur due to alterations in the vegetation zones and water availability (caused by the rise in temperature). Habitat fragmentation results in the disturbance of the necessary migration routes and breeding grounds for aquatic organisms due to the isolation of the animals caused by such cases, resulting in much crisis in terms of genetic diversity (Rugh et al., 2001). Fragmented habitats also make aquatic ecosystems vulnerable to pollution and invasive species that threaten native species. Habitat fragmentation is brought about through climate change, where terrestrial animals are made to adapt or shift to regions more appropriate to them as their resources for food, water and shelter become limited (Jepson et al., 2016). Habitat fragmentation causes long-term reduced reproductive success, higher rates of predation and increased competition for resources. Moreover, habitat fragmentation can enhance the vulnerability of ecosystems to the impacts of climate change, thus further reducing the possibility for species adaptation to altered environmental conditions. In light of this, the synergism between habitat fragmentation and climate change seriously jeopardizes the conservation prospects of both aquatic and terrestrial species (Pinsky et al., 2020).

Habitat degradation and fragmentation seriously threaten fisheries and wildlife. It is reported that human-induced habitat loss, degradation and fragmentation were the greatest threats to biodiversity (Wang et al., 2020). The fragmented habitats limit species mobility through their actions and human land use. This limits those species' ability to alter their distribution in response to climate change. In freshwater systems, the two primary drivers, such as climate change and habitat fragmentation, may interact. Due to deforestation and other changes in climatic conditions, nearly 25% of the world's natural habitats could be destroyed. Habitat is being shrunk, altered, melted and at times completely disappeared around the globe due to climatic change (Schumann et al., 2013).

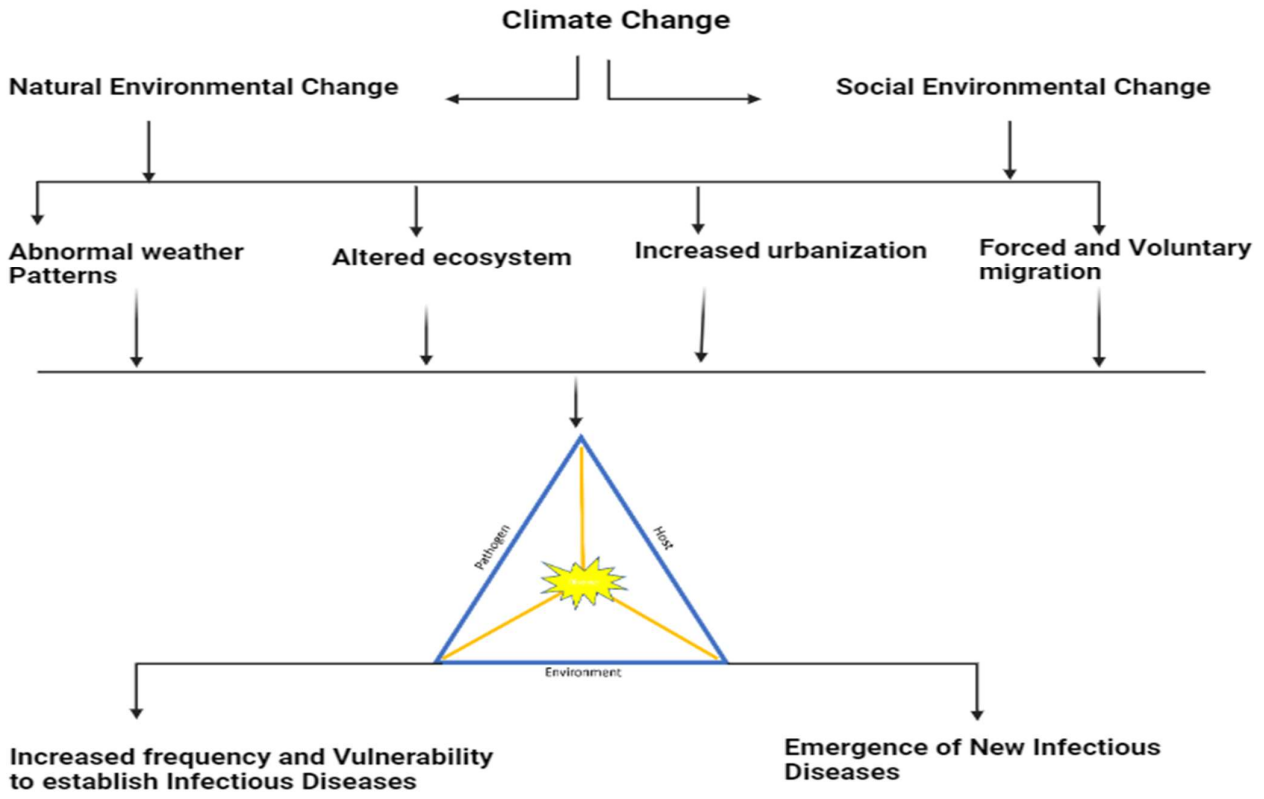


**Fig 2.** Layout of how climate change causes the emergence of new diseases

## SEA LEVEL RISE AND OCEAN ACIDIFICATION

Sea level rise is the average increase in the water level of the oceans. Over the last century, sea levels have risen (and continue to rise) because of global warming caused by human activities that have increased greenhouse gases in the atmosphere. Sea level rise threatens the animals that spend their entire lives on land. Several animal species are threatened species under the US Endangered Species Act and are at risk of losing critical habitat due to sea level rise (Derville et al., 2019).

By releasing CO2 into the atmosphere, humans are drastically changing the chemistry of the ocean which has bad impact on marine life. From 2 million years, the acidity of the ocean has increases by 25%. Due to changing ocean chemistry, marine animals and plants did not have enough time to migrate or adapt as they did before. Marine life faced two challenges as a result of acidification, decreased carbonate availability and increased acidity. Many marine species are predicted to suffer from ocean acidification (Albouy et al., 2020).

Ocean warming is one of the main factors influencing changes in species distribution and abundance in marine ecosystems. Climate change causes changes in the geographic range of many species, which are usually most noticeable near the northern or southern areas where warming or cooling is thought to push marine fishes to higher or lower latitudes. Such alterations have been documented in several studies conducted in the North Sea and other European regions (Roman et al., 2014).

### Effects on larvae

The life cycles of many marine fishes and invertebrates are intricate. They are born as larvae, grow and then use ocean currents to spread to far-off places. Because they are so tiny, larvae are especially sensitive to high acidity. The development of sea urchin and oyster larvae is disrupted when the levels of acidity increase. In a different scenario, fish larvae become incapable of identifying and avoiding predators. Larvae are vulnerable, which means that while organisms can reproduce, their offspring may not reach maturity stages (Doughty et al., 2016).

### Altered migration patterns

Many wild animal species migrate annually to breeding grounds in the Arctic or North Temperate regions. Examples of migratory taxa include mammals, insects and many bird species (Newton, 2023). However, little is known about how migration behavior evolved and modulated its ecological consequences (Gilg & Yoccoz, 2010). There must be many advantages accrued from breeding at higher latitudes that compensate or balance things out with the physiological costs and mortality risks associated with migration (Tulp & Schekkerman, 2008). There are several advantages which include seasonal food supplies, extended foraging days, low incidence of infections and parasites and less pressure from predators (McKinnon et al., 2010). Long-distance terrestrial animal populations have been under threat or becoming fewer in number and exceed their native competitors in several cases (Bairlein, 2016).

Global biodiversity has been changed by climate change and aquatic and terrestrial animal migrations have been dramatically altered. This rise in temperatures shifts the seasonal patterns and changes the timing of many species' migrations (Koleček et al., 2021). This warming changes the traditional migratory paths and feeding grounds for most aquatic animals, including fish and marine mammals. However, changes in ocean temperature can affect plankton distribution which is a critical food source for many marine species. Then that would go on to influence the fish patterns and other migratory cycles of predators (Rushing et al., 2020).

Similarly, land animals are equally affected by climatic variations such as changes in temperature and precipitation patterns affect food and water supplies on the migration routes of animals. For example, with changes in vegetation and insect abundance, many birds may view breeding and nesting sites as insecure. Moreover, climate change can lead to habitat destruction and fragmentation, making animal movement difficult and therefore, forcing them to find new migration routes or habitats to avoid extinction. Currently, climate change places a heavy strain on the delicate balance of ancient migration patterns for most aquatic and terrestrial species (Studds et al., 2017).

### Disruption of food chains

Climate change disrupts food chains in an ecosystem at all trophic levels. Severe events, changes in precipitation patterns and increases in temperature conditions are the changed circumstances under which the availability and distribution of resources are altered, hence unbalancing predator-prey relationships. For instance, warming oceans affect the distribution and abundance of plankton, the base of marine food chains, directly affecting fish, marine mammals and access to prey by seabirds. Temperature changes can alter the time insects emerge from hibernation and the time flowering plants are in bloom (Gilg et al., 2012)

These factors have an impact on the growth rate and reproductive and survival rates of organisms as they move up the food chain. For instance, an increase in prey population may trigger population expansion with further changes in ecosystem dynamics, general reductions in prey ultimately lead to starvation and population declines for predators. From a general perspective, disturbance to the food chain puts the resiliency or stability of ecosystems at risk and thus makes the conservation of biodiversity and ecosystem services quite challenging (Meltofte, 2007).

## IMPACT OF CLIMATE CHANGE ON FISHERIES

Climate change affects fisheries all over the globe in several ways. Climate change causes a fundamental alteration, gross in nature, on oceanic and freshwater systems, impacting fish populations and fishery management, consequently affecting communities that depend on them. First, changes in ocean temperatures influence the distribution and abundance of fish species. Many species are shifting north or into deeper

waters, driven by the warming temperatures that have shifted historical fishing grounds and made it harder for fleets to adapt (Alexiadou et al., 2019). This redistribution affects catch rates, species composition and the economic viability of fishing, particularly the small-scale fisheries with limited capability to follow fish into new distribution areas. Ocean acidification is also advanced through ocean chemistry changes primarily by increasing CO2 absorption. Because acidification inhibits the forming of calcium carbonate shells and skeletons, it can impact growth, survival and ability to reproduce fish larvae and shellfish such as oysters and mussels. This presents a severe risk to wild fisheries dependent on such species and related aquaculture operations (Stachowicz et al., 2007).

Fisheries were already under much pressure; now, with the changing climate, extreme weather events add to these problems. Storms, heat waves and hurricanes can all impact fishing vessels and fishing infrastructure that may be located along coastlines; therefore, such activities disrupt fishing operations and lead to a loss of livelihoods. Extreme weather can accelerate habitat destruction and loss of substantial fish breeding grounds using coastal erosion, coral bleaching and mangrove loss (Marsili et al., 2018). Changes in freshwater discharge and precipitation act to alter salinity in coastal water and estuaries, affecting the spawning and migrating behavior among species through transitional habitats. For instance, reduced freshwater inflows have a high percentage chance of intrusion that may affect the ability of any fish species, like salmon, to reproduce during their spawn when they need special conditions. Finally, climate change still impacts fisheries beyond the purely ecological aspects, addressing socio-economic points. Because fishing communities depend on fisheries for food security, livelihoods, and cultural identity, they are disproportionately vulnerable to the effects of climate change. This is especially true for communities located in developing nations and small island states. Fish-dependent communities may experience reduced income, food insecurity and high susceptibility to poverty as a result of declining fish stocks and altered fishing techniques (Panti et al., 2019).

## ANIMAL DEATHS AND EXTINCTIONS DUE TO CLIMATE CHANGE

Since climate change brings a different effect - direct and indirect - to animals, there is no way this number can be quantified. But we can compare the number of annual deaths of animals due to climate change this century with the number of animal deaths, which occurred in other centuries. A new study from researchers at the Weizmann Institute of Science explains that since the human population has increased, the biomass of wild animals has decreased by 85%. According to the World Wildlife Fund (WWF), the biomass of wild animals has reduced by 70% during the last 50 years. However, as a result of the tremendous system of animal agriculture, which produces and kills 83 billion animals per year, the total mass of animals is growing (Sebo, 2021).

Already began the Sixth Great Extinction. It is the first Great Extinction that only human beings brought. Any extinction occurring has been before 1500 C.E., influenced by human beings and other factors. Humans have been thought to be the cause of the extinction of 7.5-13% of species. Climate change will lead to the extinction of many more. Some 40,000 species are endangered on the IUCN Red List at likely risk of extinction from climate change. But it overlooks the high class of invertebrates-probably including the great majority of species on Earth—and it also makes too much of the birds and mammals (Cahill et al., 2013).

## MITIGATION AND ADAPTATION STRATEGIES

Global ecosystems, fisheries and wildlife are all at risk from climate change, which calls for extensive mitigation and adaptation plans to lessen the effects. These are strategies covering all the options that exist in reducing greenhouse gas emissions through the betterment of resilience and improvement in the techniques for sustainable management of ecosystems (Heide-Jørgensen & Laidre, 2004).

The principal means through which mitigation strategies attempt to reduce the factors causing climate change is by reducing greenhouse gas emissions. This will be achieved through using renewable energy sources, enhancing the economy in the use of energy and establishing laws regulating the emissions generated through industrial activities, land-use alterations and deforestation. Habitat restoration and conservation are fundamental in sequestrating CO2 and upholding biodiversity at the ecosystem and wildlife levels (Seyboth et al., 2016). It is a fact that the preservation and restoration of natural habitats—such as forests, wetlands and mangroves—supports wildlife, enables ecosystem functions like storing carbon and regulating water and mitigate climate change (Meyer-Gutbrod et al., 2015).

It may include the reduction of terrestrial ecosystems that are highly prone to climate-induced distresses such as fires, drought and extreme weather conditions. For example, by applying prescribed burns, land managers can reduce fuel loads and the potential for catastrophic wildfires (Derville et al., 2019). Some adaptation strategies in these areas might include managing fisheries to cope with changing fish distribution and shifting ocean conditions and restoration of coral reefs and mangroves, which could provide natural barriers against storms and sea level rise (Cartwright et al., 2019).

Such adaptation strategies of fisheries should be goal-driven toward increasing the resilience of fishing communities and fish stocks to the impacts induced by climate change. This may involve implementing ecosystem-based fisheries management strategies that consider the interactions and the general ecological setting of marine ecosystems (Loseto et al., 2015). Sustainable fishing methods, like catch limits, gear limitations and marine protected zones, can lessen overfishing and increase the ability of fish stocks to withstand the effects of climate change. Additionally, by making investments in disaster mitigation, climate-resilient infrastructure and alternative livelihoods, fishing communities can be shielded from the socioeconomic effects of climate change (Häussermann et al., 2017).

To effectively address the threats that climate change poses to ecosystems, fisheries and wildlife, integrated approaches that incorporate both mitigation and adaptation strategies are needed. Communities, stakeholders and governments must work together and coordinate on a local, national and worldwide scale (Bailleul et al., 2013). Through the implementation of proactive measures aimed at reducing emissions, safeguarding biodiversity, restoring natural habitats and promoting sustainable management practices, we can enhance the ability of wildlife, ecosystems, and fisheries to withstand the effects of climate change (Lefebvre et al., 2016).

## CONCLUSION

Global biodiversity would have sharply been threatened by climate change, given that the diverse taxa of species at risk are from temperature extremes, changes in precipitation patterns and extreme weather events. Ecosystems are subjected to these disturbances, which will lead to changes in species distribution, change the fragments of their habitat and will result in losing their habitat, many species went extinct, and more are in danger through this terrible effect of climate change. The reduction in variability may also have further ramifications on the services and resources delivered to man by the ecosystems. Changes in ocean conditions exert a significant impact on fisheries, especially fish stocks, fish productivity and the ways and means by which people live from them. Those barriers remain and the adverse impacts of climate will be guaranteed to be lessened using adaptive management techniques. Adoption of habitat restoration and sustainable resource management approaches, as well as techniques in fisheries that are associated with ecosystems, is more likely to raise the capacity of wildlife, ecosystems and fisheries to become more resilient to the negative effects of climate change. The effort being made would come from the government, stakeholders and the community to work together to find a solution to this problem. Only the functioning of collective working will make us ever optimistic toward the protection of the natural environment and assuredness toward the well-being of present and future generations.

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