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4. Climate Change Impacts on Forest and Its Management Options

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Abstract:

The productivity, biodiversity as well as ecosystem of forests are vulnerable to climate change. If it continues like this some of the valuable goods and services provided by forests may be compromised. Amongst the different weather parameters the temperature and rainfall are the main contributing factors of climate change that harms the whole ecosystem of forest. Forest fire, deforestation, increasing pollution level in air are other devastating affects to forests. The outbreak of disease, pests etc can also devastate the forests by defoliating, weakening, and killing the trees. As the insects can complete 4-5 life cycles within a short period of time with increase in temperature there may be severe infestation due to climate change. Forest fires can also release CO2 to the atmosphere that contributes towards climate change. Therefore, to protect the forests from these losses its management is essential to increase forest ecosystem services and reduce vulnerability to climate change.

Keywords:

Weather, Productivity, Ecosystem, Deforestations

4.1 Introduction:

Climate change is the long term conspicuous deviation from normal weather patterns in terms of temperature and rainfall. Now a day's the general people without any scientific knowledge can understand the reality of climate change by feeling the implications and changes in day to day life. Although natural causes like volcanic eruption, variation on solar cycle etc. are there manmade causes like burning of fossil fuel and coal, deforestation etc are the main drivers of climate change. Burning of fossil fuels causes combustion and increases the temperature of earth that leads to green house effect. Amongst the green house gases carbon di oxide is the highest contributor towards global warming. So the mitigation of CO2 seems to be to good approach to reduce carbon concentration in the atmosphere. The trees absorb carbon dioxide when they are grown and release greenhouse gases if they are cut down and are burned or left to rot. From this point of view, projects involving reforestation and intensive planting of new forests have been emerging all over the world as they are presented as simple measures to implement [1,2,3]. Lots of mega projects in Africa or India are being carried out to eradicate the increasing level of CO2 [4-8]. For example, the green wall that is erected in Africa, that is made of trees, to prevent the advance greenhouse gases another process or tool that contributes to CO2 removal from the atmosphere and to store for a certain period of time.

This storage occurs mainly in oceans, seas, soils, forest where organisms capture carbon and release oxygen into the atmosphere. The balance between CO2 captured by forest through photosynthesis is 14.1 PgCyr-1 and CO2 released through respiration and forest fire is 11.6 PgCyr-1 that represents a positive balance of capture and storage.[9]. Forests sequester large quantities of carbon; of the 450–650 Pg of carbon stored in vegetation (IPCC, 2013), over 360 Pg is in forest vegetation [10]. Globally, forest loss not only releases a large amount of carbon to the atmosphere, but it also significantly diminishes a major pathway for carbon removal long into the future [11]. Tropical forests, which hold the greatest amount of above ground biomass and have one of the fastest carbon sequestration rates per unit land area [12], face the greatest deforestation pressure (FAO, 2020).

4.2 Climate Change Impacts on Forest:

Climate change has profound implications for people and the natural world. In case of forests, the extreme weather events has a direct consequence to forest environments by increasing the occurrence of rural fires and changing environmental conditions that lead to the proliferation of exotic forest species that could present in an invasive behavior due to a faster adaptation to the new climatic parameters [13–16]. Plant growth is inhibited because of changes in weather patterns in terms of temperature, rainfall etc. Development of land, suppression of natural periodic forest fire and air pollution together has also impact on forests. If these are likely to continue in the decades ahead, some of the valuable goods and services provided by forests may be compromised. Climate change can also alter the frequency and intensity of forest disturbances such as insect outbreaks, invasive species, wildfires, and storms. Although in some cases, forests can recover from a disturbance but these acts can reduce forest productivity and change the distribution of tree species.

Along with the different weather parameters like temperature, precipitation, the carbon-di-oxide have effect on overall growth and development of forest species. Because of warming temperature some forest species have a tendency to shift their habitat but some species are at risk as they cannot adapt to a changed habitat as temperature passes the threshold level. On the other hand in Antarctica and Greenland, because of higher air temperatures huge ‘ice sheets’ on land are melting which run off into the oceans. The warming planet is also causing an expansion of sea water, increasing its volume. Both of these factors are driving an increase in global sea-levels and the global sea-level has risen by around 20 cm since the start of the 20th century. This has made storm surges – the rise in sea level that occurs during intense storms – more likely to exceed existing sea defences and cause flooding. As many densely-packed cities are in low-lying coastal regions around the world, this hazard can affect large numbers of people. This is particularly true in developing countries such as Bangladesh, but cities like Venice and Miami are also low lying and will be affected too. In the UK, rising sea levels have contributed to recent decisions to abandon areas of coastline, such as the village of Fairbourne on the Welsh coast.

Again, because of increase in temperature, the warmer air holds more water, making heavier downpours. This increased heavy rainfall may lead to increased flooding, damaging property and threatening lives. Again, because of change in precipitation pattern some areas will face drought and some areas will be flooded. Plants have a maximum limit of tolerating scarcity of water. It crosses that threshold level some plants in forest may die.

There is also a risk of forest fire because of drought situation. In UK, there is evidence that some specific weather events, such as the heavy rainfall in the winter of 2014/15, have been made more likely by climate change.[17] Similar impacts are occurring elsewhere in the world. The record amount of rain that fell on Houston during Hurricane Harvey in 2017 helped make it the second most costly hurricane to hit the USA since 1900. Climate change has made a damaging downpour like this around three times more likely.

If we study effect of CO2 on forest, increase in CO2 concentration have a positive effect if water and nutrient are not limiting factors, with good productivity in plants. Overall growth of the plants in forest ecosystem will be good with good fertility in non limiting condition of water and plants will have wider spreadibility. Along with these weather events, forests ecosystem can be disturbed by diseases and pests outbreak and forest fire etc. Although in some cases forest trees recovers but in most of the time productivity of forest decreases. The outbreak of insects often defoliate, weaken, and kill trees. In Colorado in 2007, pine beetles had damaged more than 650,000 acres of forest area and spruce beetles had damaged more than 3.7 million acres in southern Alaska and western Canada.[18] Some insects like hemlock woolly adelgid change its habitat to northern climate with the warming of climate as it is very sensitive to cold weather.[19] Moreover, due to lack of natural controls, such as predators or pathogens, as well as inadequate defenses in trees, can allow insects to spread. As the insects can complete 4-5 life cycles within a short period of time with increase in temperature there may be severe infestation due to climate change. The native vegetation may be replaced by invasive plant species as they are more tolerant to change in climatic condition.[18][20]

4.3 Deforestation and Climate Change:

Approximately 30% of the Earth's land mass is covered by forests [21]. Existance of these forests provide social, economic, ecological and aesthetic benefits to natural systems and people. Moreover, presence of forest acts a hub for biodiversity, it supplies food, have medicinal and economic value, help in hydrological cycle regulation, protect soil cover, and serve as aesthetic and recreational sites. In addition exchanges of water, carbon dioxide, energy and other chemical species with the atmosphere are because of influence of forest [22], [23].

But sometimes these forest trees are removed or cleared off for farm use or some other purposes. There has been a significant decrease in primary forest area by 300 million ha since 1990. Between 2000 and 2010, around 13 million hectares of forest were converted to other uses or naturally lost, compared to 16 million hectares per year during the earlier decade [22]. As a result atmosphere as well as soil is disturbed. In soil, flux of carbon is disturbed. It also results in soil degradation, carbon emission as a result of plant decomposition left on forest floor, albedo effect, and intensification of hydro-meteorological hazards. Another consequence of deforestation is increasing risk of landslides, slope destabilization, floods, increased surface runoff and soil erosion. After the Kashmir earthquake (2005) an increased risk of landslides and debris flow was encountered due to exploitation of forests. In 2010 Pakistan experienced the worst flood of its history. Scientists termed the unprecedented rate of monsoon rains as impacts of climate change in the region.

Moreover, wildfire causes huge loss to forests. In U.S wildfires consumed more than 8 million acres of forest in the year 2011 (an area roughly the size of Maryland), that causes 15 deaths and more than $1.9 billion damages. Rise in temperature and drought conditions during the early summer contributed towards this loss [24]. Climate change is projected to increase the extent, intensity, and frequency of wildfires in certain areas of the country. Warmer spring and summer temperatures, coupled with decreases in water availability, dry out woody materials in forests and increase the risk of wildfire. As fires releases CO2 to the atmosphere it contributes towards climate change.

4.4 Management of Forest in Changing Climate:

By realizing the impact of climate change the priority should be given on management options. In management aspects productivity as well as sustainability of resources should be given importance. Management of ecosystem is another concern where capturing of carbon and carbon sequestration is done. According to Seidl et al. [25]) sustainable forest management is prerequisite for management of sustainable forest. It is seen that forest species are damaged by invasive species that increases the load of forest ultimately leading to forest fire. Based on the scenario in which climate changes lead to an expected increase in temperature, maintaining the structure and functions of Mediterranean forests has become a challenge for forest managers. Vila-Cabrera et al. [26] showed that research is focused mainly on strategies to decrease risk and promote resistance in the short term, rather than on enhancing long-term resistance. On the other hand, as expected in economic activities, management strategies seek to obtain benefits in the short term and frequently have unintended consequences on other adaptation objectives and untargeted ecosystem components that are so important in Mediterranean-type climate regions.

There is an another attempt to reflect the environmental and social as well as economic benefits provided by forests which is called Sustainable forest management (SFM). As adopted by FAO, SFM is the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems [27]. It becomes widely accepted after the UN Conference on Environment and Development in 1992 (the ‘Earth Summit’ in Rio de Janeiro), which first saw international commitment to the concept of sustainable development more broadly.

More precise definitions of SFM inevitably vary from region to region, since the types of forests, the needs of the populations who live in and around them, and the social, economic, environmental and political contexts in which their protection and management are set also vary regionally. Although it is undoubtedly true that the concept of SFM may be appealed to more frequently than it is implemented in reality, it has had a major impact on policy-making and practices relevant to the world’s forests. Active forest management enhances carbon uptake, both because the rate of carbon uptake slows as forests mature, net primary productivity declines and natural mortality increases, and also because unmanaged forests increase the chance of massive carbon losses from disturbances such as fire, insects or disease infestations[28]. Harvesting mature trees and replanting should therefore increase the rate of carbon uptake, as well as generating timber for wood products.

4.5 Conclusion:

Climate change is a global issue with many implications. It has many consequences on forest and on other hand forests helps in mitigating the impact of climate change. It protects the biodiversity, act as a protective layer to the soil, and maintains atmospheric temperature too. But due to deforestation the natural atmosphere is disrupted leading to change in climate and we face devastations. Globally, forest loss releases a large amount of carbon to the atmosphere. So management of forest is a effective tool to cope up with the impact of climate change. Through management options productivity of forests as well as sustainability of resources can be maintained as well as ecosystem can also be restored.

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