IMPACT OF CLIMATE CHANGE ON BIODIVERSITY

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Abstract:

Climate change refers to the long-term changes in temperature and weather due to human activities. Increase in average global temperature and extreme and unpredictable weather are the most common manifestations of climate change. In recent years, it has acquired the importance of global emergency and affecting not only the wellbeing of humans but also the sustainability of other lifeforms. Enormous increase in the emission of greenhouse gases (CO_2, methane and nitrous oxide) in recent decades largely due to burning of coal and fossil fuels, and deforestation are the main drivers of climate change. Marked increase in the frequency and intensity of natural disasters, rise in sea level, decrease in crop productivity and loss of biodiversity are the main consequences of climate change. Obvious mitigation measures include significant reduction in the emission of greenhouse gases and increase in the forest cover of the landmass. Conference of Parties (COP 21), held in Paris in 2015 adapted, as a legally binding treaty, to limit global warming to well below 2 °C, preferably to 1.5 °C by 2100, compared to pre-industrial levels. However, under the present emission scenario, the world is heading for a 3–4 °C warming by the end of the century. This was discussed further in COP 26 held in Glasgow in

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Introduction:

Climate change refers to long-term changes in local, global or regional temperature and weather due to human activities. For 1000s of years, the relationship between lifeforms and the weather have been in a delicate balance conducive for the existence of all lifeforms on this Planet. After the industrial revolution (1850) this balance is gradually changing and the change has become apparent from the middle of the twentieth century. Now it has become a major threat to the wellbeing of

humans and the sustainability of biodiversity. An increase in average global temperature, and extreme and unpredictable weather are the most common manifestations of climate change. It has now acquired the importance of global emergency. According to the report of the latest Intergovernmental Panel for Climate Change (AR6 Climate Change 2021), human-induced climate change as is prevalent now is unprecedented at least in the last 2000 years and is intensifying in every region across the globe. In this review the drivers of climate change, its impact on human wellbeing and biodiversity, and mitigation measures being taken at global level are briefly discussed.

Drivers of climate change:

Emission of green-house gases:

Steady increase in the emission of greenhouse gases (GHGs) due to human activities has been the primary driver for climate change. The principal greenhouse gases are carbon dioxide (76%), methane (16%), and to a limited extent nitrous oxide (2%). Until recent decades, the temperature of the atmosphere was maintained within a reasonable range as some of the sunlight that hits the earth was reflected back into the space while the rest becomes heat that keeps the earth and the atmosphere warm enough for the sustenance of life forms. Accumulation of greenhouse gases combine with water vapour to form a transparent layer in the atmosphere that traps infrared radiation (net heat energy) emitted from the Earth's surface and reradiates it back to Earth's surface, thus contributing to the increasing temperature (greenhouse effect). Methane is 25 times and nitrous oxide 300 times more potent than CO_2 in trapping heat. Until 2019, the US, UK, European Union, Canada, Australia, Japan and Russia were the major CO_2 producers and were responsible for 61% of world's emissions. Now, China produces the maximum amount of CO_2 (27%) followed by USA (11%) and India (6.6%); on per capita basis, however, India stands ninth.

The emission of GHGs is largely due to the burning of fossil fuels (coal, oil and natural gas) for automobiles and industries which result in carbon emissions during their extraction as well as consumption. The amount of CO_2 in the atmosphere before the industrial revolution used to be around 280 ppm and now it has increased to 412 ppm (as of 2019). Increase in the atmospheric temperature also leads to an increase in the temperature of the ocean. The oceans play an important role in the global carbon cycle and remove about 25% of the carbon dioxide emitted by human activities. Further, some CO_2 dissolves in the ocean water releasing carbonic acid which increases the acidity of the sea water. Rising ocean temperatures and acidification not only reduce their capacity to act as carbon sinks but also affect ocean ecosystems and the populations that relay on them.

Increasing demand for meat and milk has led to a significant increase in the population of livestock and conversion of enormous amount of the land to pasture and farm land to raise livestock. Ruminant animals (largely cows, buffaloes and sheep) produce large amounts of methane when they digest food (through enteric fermentation by microbes), adding to the greenhouse gases in the atmosphere (Sejiyan et al. 2016). To produce 1 kg of meat it requires 7 kg of grain and between 5000 and 20,000 L of water whereas to produce 1 kg of wheat it requires between 500 and 4000 L of water (Pimentel and Pimentel 2003). Anaerobic fermentation of livestock manure also produces methane. According to Patrick Brown, our animal farming industry needs to be changed; using readily available plant ingredients, the nutritional value of any type of meat can be matched with about one twentieth of the cost (See Leeming 2021).

The main natural source of nitrous oxide released to the atmosphere (60%) comes from the activity of microbes on nitrogen-based organic material from uncultivated soil and waste water. The remaining nitrous oxide comes from human activities, particularly agriculture. Application of nitrogenous fertilizers to crop plants is a routine practice to increase the yield; many of the farmers tend to

apply more than the required amount. However, it results in nitrous oxide emissions from the soil through nitrification and denitrification processes by microbes. Both synthetic and organic fertilizers increase the amount of nitrogen available in the soil to microbial action leading to the release of nitrous oxide. Organic fertilizers, however, release nitrogen more slowly than synthetic ones so that most of it gets absorbed by the plants as they become available. Synthetic fertilizers release nitrogen rapidly which cannot be used by plants right away, thus making the excess nitrogen available to microbes to convert to nitrous oxide. Presently CO_2 concentration in the atmosphere is higher than at any time in at least 2 million years, and methane and nitrous oxide are higher than at any time in the last 800,000 years (AR6 Climate Change 2021).

Permafrost (permanently frozen soil), widespread in Arctic regions of Siberia, Canada, Greenland, Alaska, and Tibetan plateau contains large quantities of organic carbon in the top soil leftover from dead plants that could not be decomposed or rot away due to the cold. Global warming-induced thawing of permafrost facilitates decomposition of this material by microbes thus releasing additional amount of carbon dioxide and methane to the atmosphere.

Deforestation:

Limited deforestation in early part of human civilization was the result of subsistence farming; farmers used to cut down trees to grow crops for consumption of their families and local population. In preindustrial period also, there was a balance between the amount of CO_2 emitted through various processes and the amount absorbed by the plants. Forests are the main sinks of atmospheric CO_2. After the industrial revolution, the trend began to change; increasing proportion of deforestation is being driven by the demands of urbanization, industrial activities and large-scale agriculture. A new satellite map has indicated that field crops have been extended to one million additional km^2 of land over the last two decades and about half of this newly extended land has replaced forests and other ecosystems (Potapov et al. 2021).

In recent decades the demands on forest to grow plantation crops such as oil palm, coffee, tea and rubber, and for cattle ranching and mining have increased enormously thus reducing the forest cover. According to the World Wildlife Fund (WWF), over 43 million hectares of forest was lost between 2004 and 2017 out of 377 million hectares monitored around the world (Pacheco et al. 2021). Amazon Rain Forest is the largest tropical rain forest of the world and covers over 5 million km^2. It is undergoing extensive degradation and has reached its highest point in recent years. According to National Geographic, about 17% of Amazon rain forest has been destroyed over the past 50 years and is increasing in recent years; during the last 1 year it has lost over 10,000 km^2. In most of the countries the forest cover is less than 33%, considered necessary. For example, India's forest and tree cover is only about 24.56% of the geographical area (Indian State Forest Report 2019).

Impacts of climate change:

Increase in atmospheric temperature has serious consequences on biodiversity and ecosystems, and human wellbeing. The most important evidences of climate change is the long term data available on the CO_2 levels, global temperature and weather patterns. The impacts of climate change in the coming decades are based on published models on the basis of the analysis of the available data. Comparison of the performance of climate models published between 1970 and 2007 in projecting global mean surface temperature and associated changes with actual observations have shown that the models were consistent in predicting global warming in the years after publication (Hausfather et al. 2019). This correlation between predicted models and actual data indicates that the models are indeed reliable in accurately predicting the global warming and its impacts on weather pattern in the coming decades and their consequences on biodiversity and human welfare.

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Conclusions

Climate change has now become the fastest growing global threat to human welfare. The world has realized the responsibility of the present generation as it is considered to be the last generation capable of taking effective measures to reverse its impact. If it fails, human civilization is likely to be doomed beyond recovery. As emphasized by many organizations, the climate crisis is inherently unfair; poorer countries will suffer its consequences more than others. India is one amongst the nine countries identified to be seriously affected by climate change. According to a WHO analysis (2016) India could face more than 25% of all global climate-related deaths by 2050 due to decreasing food availability. China is expected to face the highest number of per capita food insecurity deaths. Bhutan, a small Himalayan kingdom with 60% forest cover, is the most net negative carbon emission country; its GHG emission is less than the amount removed from the atmosphere. Other countries should aim to emulate Bhutan as early as possible.

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