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# **Climate Change and the Need for Forest Conservation: Deforestation and Forest Fires as Leading Threats in India**

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## **Abstract**

*India is one of the countries that is hugely affected by climate change. It has one of the highest economic activity densities in the world, as well as a large number of poor people who depend on the natural resource base for survival, with a heavy dependence on rainfall. Climate change could drive more than 100 million people into severe poverty by 2030, according to the World Bank, by disrupting agriculture and fueling the spread of malaria and other diseases. India has challenged the UN's haste to declare climate change an international security issue, potentially granting the Security Council the authority to act on it, and has highlighted the approach's flaws. According to India, a "simple Council decision" to take over climate change compliance would jeopardise the Paris Agreement and multilateral attempts to find solutions. Climate change is a global security problem in the twenty-first century. In view of climate change affecting the biosphere, this paper will address two natural phenomena: deforestation, which is one of the oldest and most important contributors to climate change, and forest fires, which occur regularly each year as a result of climate instability. Further, this paper outlines the involvement of India along with other countries, analysing the features and the changes brought about by the environment and climate laws, policies, and agreements and lastly acknowledging the need for a prompt framework to initiate a stern action towards climate change and create an impact.*

**Keywords:** *Climate Change, Deforestation, Indian Forests, Conservation*

## **1.0 Introduction**

The objective of this research paper is to convey the importance of the need to address the increasing climate change issues in India with some major instances of deforestation as a leading contributor and forest fires as a leading consequence of the same in the last twenty years. The research methodology adopted for this research paper is the qualitative research method using secondary sources of data available like research papers, scholarly articles, news articles, reviews and educational videos relevant to the topic undertaken. A PESTELE analysis is also conducted at the end of the research paper to understand the implications of the measures to protect the Indian forests from deforestation and wildfires as a result of climate change.

Climate change, as we know, is no longer confined to being an environmental concern. In fact, it has emerged to be the greatest developmental challenge for the planet. With the climate going through a drastic change, it is imperative to conserve the environment more than ever and environmental-friendly sustainable solutions are the need of the hour. About 24.56% of the geographical area of the country is covered with large forests and trees; it is therefore imperative that these be protected and nurtured at all costs (*India State of Forest Report, 2019, n.d.*). As we go further into the paper, we discuss the relationship between climate change and forest ecosystems to understand the vulnerability of the situation.

To get a better understanding of how climate change is very actively contributing to deforestation and forest fires, we have taken up a few recent instances to emphasise the gravity of the situation, namely- the **Deforestation of Mollem National Park and Bhagwan Mahaveer Wildlife Sanctuary** and the **Uttarakhand Forest Fires**. Amidst the pandemic 2020, the National Board for Wildlife cleared more than 30 forest clearance proposals, out of which three projects were from Bhagwaan Mahaveer Wildlife Sanctuary and Mollem National Park, Goa for projects that include double-tracking of a railway line, expansion of a four-lane highway, and laying a 400kv transmission line will pass through the forest. On the other hand, we had the 2020 Uttarakhand forest fires that started in late May after several forest fires broke out in Srinagar of Pauri Garhwal district in Uttarakhand, India. The causes of this fire were said to be rising temperature, the low moisture level in the forest soil in addition to the hot winds that make their way to the north during this time of the year.

In light of these two major climate-affecting events, the research paper concludes with a detailed discussion on how even some of the renowned policies and protocols can be structured according to the analysis conducted based on the political, environmental, social, technological, economic, legal, and ethical aspects of deforestation and forest fires in climate India.

## **2.0 Climate Action and Life on Land**

There is no country that is not experiencing the drastic effects of climate change. Greenhouse gas emissions are more than 50 per cent higher than in 1990. Global warming is causing long-lasting changes to our climate system, which threatens irreversible consequences if we do not act (*United Nations Development Programme, n.d.*).

In the 1800s when the Industrial Revolution took place a lot of factories were set up, coal was actively burnt in these factories to generate energy and run the factories, automobile, machinery etc. although, theoretically we might say that the industrial revolution lasted from 1780 - 1840, the world as we see today, the capitalisation, modernisation, and industrialisation never really came to an end. The global population has also tripled in the last 70 years. Additionally, we are consuming more products from animals that release another significant pollutant, also one of the greenhouse gases, that is, methane. The concern at this point is not that the planet is getting warmer but that all of this phenomenon is happening way too fast for the planet to actually come to rest and cool down. “It’s actually the warmest temperature on Earth since the last ice age”, says Johan Rockström, Director Potsdam Institute for Climate Impact Research Human life depends on the earth as much as the ocean for our sustenance and livelihoods. Plant’s life provides 80 per cent of the human diet, and we rely on agriculture and important economic resources. Forests cover 30 per cent of the Earth’s surface, provide vital habitats for millions of species, and important sources for clean air and water, as well as being crucial for combining climate change. Every year, 13 million hectares of forests are lost, while the persistent degradation of drylands has led to the desertification of 3.6 billion hectares, disproportionately affecting poor communities (*Goal 15: Life on Land*, n.d.). While 15 per cent of the land is protected, biodiversity is still at risk. Nearly 7000 species of animals and plants have been illegally traded. Wildlife trafficking not only erodes biodiversity, but creates insecurity, fuels conflict, and feeds corruption.

Urgent action must be taken to reduce the loss of natural habitats and biodiversity which are part of our common heritage and support global food and water security, climate change mitigation and adaptation, and peace and security. The most recent report from International Union of Forest Research Organization (Seppälä et al. 2009) paints a rather gloomy picture of the future of the world forests in a changing climate; it suggests that in a warmer world, the current carbon regulating services of forests (as carbon sinks) may be entirely lost, as land ecosystems could turn into a net source of carbon dioxide later in the century. The impacts of climate change on forests in India are assessed based on the changes in the area under different forest types, shifts in the boundary of forest types and the Net Primary Productivity (NPP).

This assessment was based on (i) spatial distribution of current climatic variables, (ii) similar data for future climate projected by relatively high-resolution regional climate models for two different climate change scenarios, and (iii) vegetation types, NPP and carbon stocks. The NPP is projected to increase by 68.8% and 51.2% and soil organic carbon (SOC) by 37.5% and 30.2%.

## **2.1 Impact on NPP**

The NPP tends to increase over India by an average of 66.5% by 2085 and 49% by 2085. Notably, the increase is higher in the north-eastern part of India due to warmer and wetter climate (Chaturvedi et al., 2010).

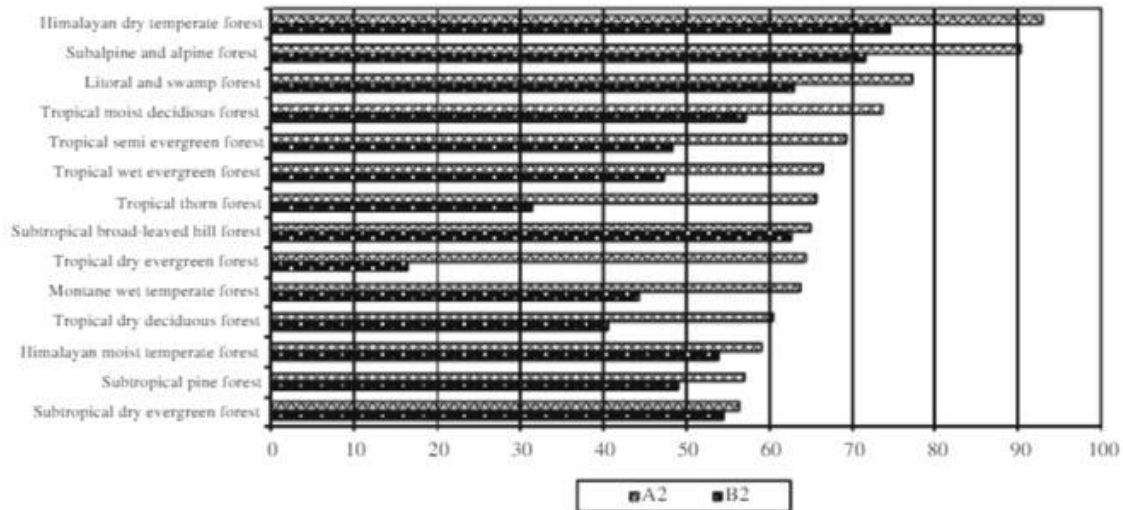
## **2.2 Impact on Soil Organic Carbon (SOC)**

A trend similar to NPP distribution can be observed for soil organic carbon which is to be expected as increased NPP is the primary driver of higher litter input to the soil. However, the quantum of increase compared to baseline, in this case, is lower: around 37% and 30%, for the A2 and B2 scenario respectively (averaged over the whole of India) Tropical moist deciduous forests and sub-alpine and alpine forests, are projected to have large (40–45%) increases in SOC. The increase in NPP results in augmented litter fall which contributes to higher SOC. In contrast, subtropical pine forests and Himalayan moist temperate forests have much smaller increases (20–30%) in SOC.

## **3.0 A Vulnerability Index for Indian Forests**

Forests in India are already subjected to multiple stresses including over-extraction, insect outbreaks, live-stock grazing, forest fires and other anthropogenic pressures. Climate change will be an additional stress. Disturbed and fragmented forests and monoculture forests are likely to be more vulnerable to climate change. Therefore, we develop a vulnerability index and assess the vulnerability of different forest types and regions. Based on the dynamic global vegetation modelling, we present a forest vulnerability index for India which is based on the observed datasets of forest density, forest biodiversity as well as the model predicted vegetation type shift estimates for forested grids.

The vulnerability index suggests that the upper Himalayas, northern and central parts of the Western Ghats and parts of central India are most vulnerable to projected impacts of climate change, while Northeastern forests are more resilient.



**Fig. 15** Percentage change in NPP by 2085 for A2 and B2 scenarios compared to baseline (according to Champion and Seth 1968 classification)

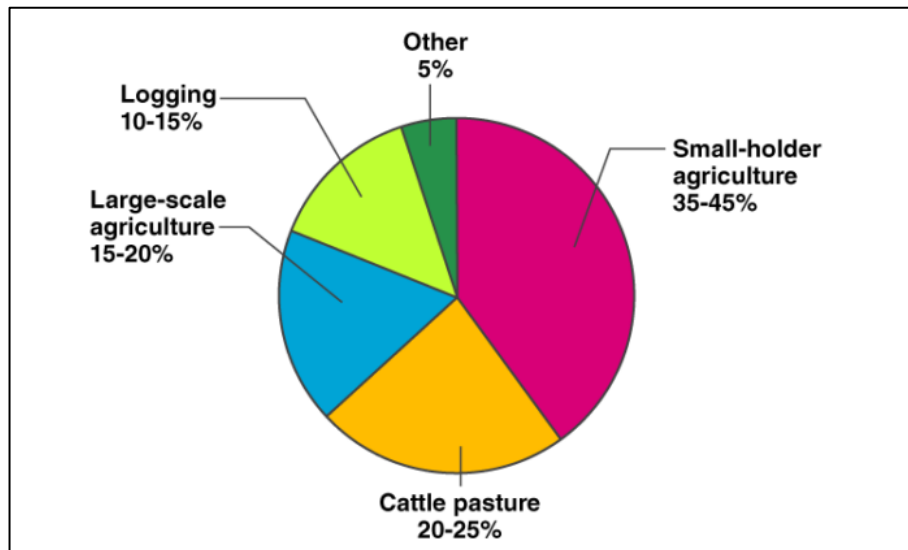
#### **4.0 Deforestation in India**

Deforestation, as we know, is the complete and prolonged removal of huge patches of trees and vegetation from the land either due to natural or human-driven causes. Deforestation, in turn, has a great impact on the wildlife, ecosystems, loss of biodiversity, weather patterns, and even the climate of a region. The results indicated that forests covered an area of 869,012 km<sup>2</sup> in 1930 which has decreased to 625,565 km<sup>2</sup> in 2013, a net loss of 243,447 km<sup>2</sup> (28 %) in eight decades. The highest annual average forest loss was found to be 4795 km<sup>2</sup> during 1930–1975, 1476 km<sup>2</sup> during 1975–1985, 767 km<sup>2</sup> during 1985–1995, 356 km<sup>2</sup> during 1995–2005 and 209 km<sup>2</sup> during 2005–2013. Between 1930 and 1975, forest experienced large-scale deforestation at a gross annual rate of 0.77 % which has declined to 0.29 % and 0.14 % for the 1975–1985 and 1985–1995 periods respectively. Quantification of the annual rate of gross deforestation for the recent period indicates 0.07 % during 1995–2005 and 0.05 % during 2005–2013. The lower rates of deforestation during recent periods support the effectiveness of conservation measures taken at the national level (Reddy et al., 2015).

#### **4.1 Causes of Deforestation**

The major deforestation has mostly occurred due to the conversion of forests to agriculture. The construction of reservoirs contributed to 4.1 % of forest loss. The tropical forests have experienced large scale deforestation followed by subtropical forests. The primary anthropogenic activities (human activities) that contribute to deforestation include Agriculture (ranging from small-scale and large scale farming), Logging (that includes cutting trees to be used as raw material), and mining and urban expansion (clearing of forest area for the construction of infrastructure).

According to the secretariat of the United Nations Framework Convention on Climate Change (UNFCCC), agriculture is the root cause of 80% of deforestation. Logging accounts for another 14% and the cutting of trees for use as wood fuel account for 5%. A pie-chart detailing the driving cause of the deforestation of tropical forests between the years 2000 and 2005 is provided below.



Slash-and-burn agriculture results in large-scale deforestation are the burning of a large area of forest land and the subsequent planting of crops in the same soil (which is now fertilised by the ashes of the burned trees).

#### **4.1.0 Secondary Factors**

Deforestation is also a result of overpopulation and population growth, as they increase the demand for a variety of resources such as food and infrastructure, such as the construction of homes and other facilities, agriculture, and the construction of highways, dams, and other infrastructure. Natural disasters such as volcanic eruptions, hurricanes, flooding, and other natural calamities, pests invading the forest environment, forest fires ignited by lightning, and other natural phenomena may also cause deforestation. However, natural causes play a minor role in the total deforestation of the Earth's land surface, it is worth noting that anthropogenic factors account for almost all of it.

#### **4.2 The case of Deforestation in Mollem, Goa**

The Western Ghats, which include Goa's largest protected area, date back 150 million years. When the Intergovernmental Panel on Climate Change (IPCC) performed a 1.5-degree impact assessment, the Western Ghats were found to be one of the most resilient habitats to climate change. Just 36 biodiversity hotspots exist on the earth, and the Western Ghats forests are one of them. Maintaining the dignity of the Western Ghats helps Goa to develop better climate change adaptation strategies. The sanctuary is also home to more than 70 mammal species, 235 bird species, 219 butterfly species, 44 fish species, 45 reptile species, 27 amphibian species, 80 odonate species, 75 ant species, 721 plant species, at least 43 fungi species and 18 lichen species. Most of the species found here are also endemic to the Western Ghats.

There are three infrastructure projects that threaten the forests in and around Mollem National Park and Bhagwan Mahaveer Wildlife Sanctuary. In the middle of the lock-down, the National Board for Wildlife cleared or discussed more than 30 forest clearance proposals. Of these, 3 projects from Bhagwan Mahaveer Wildlife Sanctuary/Mollem National Park, Goa were cleared by the National Board for Wildlife. The projects are as follows:

- **Double tracking the railway line:** This project requires a total of 138.37 hectares of forest land. The total number of trees to be felled are 22,882; of which 20,758 will be felled from the protected area. The cost of this project is reportedly estimated at Rs 504 crore.



- **Four-lane highway expansion:** 63.615 hectares of forest land will be required for this project. The total number of trees to be felled are 20,340; of which 12,097 trees will be felled from the protected area. The project will reportedly cost Rs 1794 crore.
- **Laying a 400kv transmission line:** 48.3 Hectares of total forest land is required for this project. The total number of trees to be felled are 15,772; of which 4139 trees will be felled from the protected area. The project is likely to cost Rs 176.8 crore

The fragmentation of this wildlife corridor (the three projects cut through different areas of the national park) will increase cases of human and wildlife conflict. Students have been at the forefront of opposing these projects that would include felling of trees in protected forest areas. In July, 159 tourism professionals wrote to the Central Empowered Committee (CEC) in New Delhi voicing their opposition against the three linear projects passing through the Bhagwan Mahaveer Wildlife Sanctuary and the Mollem National Park of Goa.

## **5.0 Forest Fires as a result of climate change in India**

Forest fires, which pose a serious threat to India's biodiversity, are not only a result of climate change and global warming but also a major cause of ecological destruction. In general, fires release a large amount of carbon dioxide into the atmosphere. Forest fires contribute significantly to climate change by emitting greenhouse gases.

The Ministry of Environment, Forests and Climate Change reported in 2019 that India 712,249 square kilometre of area under forest cover, which is 21.67% of the country's land area, out of which, 152,421 square kilometre or 21.4% is prone to forest fires, according to the Forest Survey of India (FSI) (Bhimwal, 2020).

Forest fires can be broadly categorised into:

1. Ground fires - This pattern is seen when the fire is spread on top of organic matter
2. Surface fires - This type of fire consumes matter like duff, moss or peat present beneath the surface litter of the forest floor. Surface fire usually spreads within no time and it thrives on the small vegetation and surface litter.
3. Crown fire - The crown fire mostly burns the top trees and shrubs and it has no link with surface fire.

## **5.1 Causes of forest fires**

Climate controls the ecology of a region which means that even a slight change in climate can affect the growth, richness, longevity, overall composition, productivity, diversity, and distribution of species in an ecosystem. The different aspects of climate change like the evaporation of moisture from the ground and drying of the soil make the vegetation of the forest land more susceptible to inflammation. On the other hand, though we cannot see it happening in front of our eyes every day, the continuous melting of the snowcaps render the forests to be drier for a longer period of time in a year. Additionally, shifting meteorological patterns can drive the rain away from wildfire-prone regions, a phenomenon scientist discovered in California and have linked to human-made climate change.

Forest ecosystems are one of the most vulnerable ecosystems to any change in the climate. According to the vulnerability evaluation, fragile forested grids can be found all over India (International Panel on Climate Change, 2001). However, in the upper Himalayan stretches, parts of Central India, the northern Western Ghats, and the Eastern Ghats, their concentration is higher. The northeastern forests, southern Western Ghats, and forested regions of eastern India, on the other hand, are thought to be the least vulnerable. Low tree density, low biodiversity status as well as higher levels of fragmentation, in addition to climate change, contribute to the vulnerability of these forests. The mountainous forests (subalpine and alpine forest, the Himalayan dry temperate forest and the Himalayan moist temperate forest) are susceptible to the adverse effects of climate change. This is because climate change is prescribed to be larger for regions that have greater elevations. The most vulnerable regions are northeast and central Asia, says FSI. Mizoram has the most fire alerts, 2,795 in 2018. Seven states in the northeast had 10,210 fire alerts, one-third of the alerts in India. Since 2011, 695 forest fires have damaged property worth INR 90 crore (USD 12 million) in Mizoram (Bhimwal, 2020).

S. Jayakumar of the Department of Ecology and Environmental Sciences in Pondicherry University says, “Forest fires have an impact on the key element, soil. There are lots of microbes in the soil that are beneficial to the entire ecosystem, without which humans can’t survive. After a fire occurs it causes the soil to lose its absorption ability which causes the water to float on top. That leads to soil erosion and infertile soil.”

He further quotes, “When a fire occurs in a region it promotes plant species that can survive and grow after a fire. If the fire is consistent, it has major impacts on biodiversity. In other regions where a fire is occurring once in 10 years or so, it upsets the diversity.” He explains, “A forest is divided into top canopy, understorey and forest floor. High-intensity fires will eradicate the forest floor and understorey, consisting of regenerating species, shrubs and biomes. Low-intensity surface fires enhance the growth of seedlings and saplings and mineralise the soil. The wildlife is completely dependent on plants. Fires disturb the food chain. If the fire burns all the plants, then there is an imbalance in the food chain and the animals have to migrate.”

## **5.2 Uttarakhand Forest Fires**

As the global temperature is rising, increasing incidents of forest fires are increasing the temperature of the earth. Forest fires that are caused due to prolonged winter season leading to scanty precipitation in air serve as a major threat to the country’s biodiversity and wildlife. The dense forests of Uttarakhand are rich repositories of biodiversity and providers of ecosystem goods and services to regional and global communities. In general, people depend on forests for resources like fuelwood, grass and other biomass. Recently, these forests have experienced huge degradation of forest land due to natural and anthropogenic activities. Factors that act as a catalyst in the rate of degradation of these forests are mainly variation in climatic conditions and natural disasters.

Uttarakhand falls under an ecologically sensitive zone and with 45.32% of its geographical area covered with forests the outbreak of every wildfire leads to severe damage to a large geographical area of the state. Conservation of forests in the Himalayan state of Uttarakhand is important because it is the only north Indian state to have more than 33% of the area under forest cover so much so that the total area records as forests is as high as 71.05% when permanently snowbound landscapes and alpine pastures are taken into account, this area also contributes a good share in the state economy. Forest fires generally occur in two phases; late March and early April when the accumulation of fresh litter can burn, and May-June, when **high temperatures, low humidity, extreme dryness** becomes favourable.

The most fire-prone zone is the band oak at the higher altitudes and the chirpine zone, which occupies 17% of the total forest area, and its transition zone with sal (11% of the total forest area) at the lower altitude, a zone with the maximum habitation. Controlled forest fires help in removing and dried litter and allow new growth to come up. However, uncontrolled forest fires, especially summer fires, cause severe damage to the forest biodiversity. Low precipitation during the summer season reduces moisture level in the forest making it more susceptible to catch fire and spread quickly over a large area of the forest land. It has been observed that forest fires occur mainly due to lightning but in the case of Uttarakhand occurrences due to lightning is less as compared to the anthropogenic occurrence. All fires in the chirpine forests of Uttarakhand are man-made intentional or accidental.

India is home to 104 national parks and over 500 wildlife sanctuaries, forest fires pose a great threat to the flora and fauna of these national parks and wildlife sanctuaries. Even though out of the total forest fires incidences in Uttarakhand, 63% were intentional and the remaining 37% were accidental it is important to save the forests from these natural wildfires because it has severe large scale impacts that lead to change in species composition, loss of microflora and fauna, loss of seeds, loss of habitat of particular species, change in microclimate, migration of species, soil desiccation, soil erosion resulting in landslides and invasion by exotic species (Chauhan et al., 2018, p. 45).

## **6.0 India's Response to Climate Change**

- **National Action Plan on Climate Change (NAPCC):** outlines existing and future policies and programs addressing climate mitigation and adaptation. The Action Plan identifies eight core “national missions” running through to 2017: Solar Energy; Enhanced Energy Efficiency; Sustainable Habitat; Water; Sustaining the Himalayan Ecosystem; Green India; Sustainable Agriculture; and Strategic Knowledge for Climate Change. Most of these missions have strong adaptation imperatives.
- **National Clean Energy Fund:** The Government of India created the National Clean Energy Fund (NCEF) in 2010 for financing and promoting clean energy initiatives and funding research in the area of clean energy in the country. The corpus of the fund is built

by levying a cess of INR 50 (subsequently increased to INR 100 in 2014) per tonne of coal produced domestically or imported.

- **Paris Agreement:** Under the Paris Agreement, India has made three commitments. India's greenhouse gas emission intensity of its GDP will be reduced by 33-35% below 2005 levels by 2030. Alongside, 40% of India's power capacity would be based on non-fossil fuel sources. At the same time, India will create an additional 'carbon sink' of 2.5 to 3 billion tonnes of Co<sub>2</sub> equivalent through additional forest and tree cover by 2030.
- **International Solar Alliance:** ISA was launched at the United Nations Climate Change Conference in Paris on 30 November 2015 by India and France, in the presence of Mr Ban Ki Moon, former Secretary-General of the United Nations.
- **Bharat Stage (BS) Emission Norms:** Emissions from vehicles are one of the top contributors to air pollution, which led the government at the time to introduce the BS 2000 (Bharat Stage 1) vehicle emission norms from April 2000, followed by BS-II in 2005. BS-III was implemented nationwide in 2010. However, in 2016, the government decided to meet the global best practices and leapfrog to BS-VI norms by skipping BS V altogether.
- **National Policy on Biofuels** - the Centre's commitment to bolster the country's energy infrastructure while also supporting the sustainability agenda. Increased domestic production, the use of biofuels and renewables, energy efficiency standards, refinery process improvements, and demand substitution for non-renewable sources of energy. India is heavily reliant on nonrenewable fuels and relies heavily on imported crude oil to meet its domestic energy needs. Furthermore, the Ministry of New and Renewable Energy (MNRE) claims that fluctuating crude oil prices in the global market have a significant impact on developing countries. The government has set some ambitious goals for the energy sector which include electrification of all census villages by 2019, 24x7 electricity and 175 GW of renewable energy capacity by 2022, reduction in energy emissions intensity by 33%-35% by 2030 and producing above 40% electricity from non-fossil fuels by 2030 (ProductLine, 2019).

## **7.0 India's response to deforestation and forest fires**

- **The Biodiversity Act 2002:** It was regulated to realise the “equitable sharing of benefits arising out of the use of biological resources and associated knowledge”. This law enforces conservation, promotes sustainable use, and equitable sharing of benefits from the bioresources made available to them.
- **The Forest Conservation Act 1980:** It was enacted by the Parliament of India to bring under control the increasing rate of deforestation of dense forest areas in the country. This Act holds different provisions to control deforestation and encourage afforestation of non-forest areas.
- **Forest Fire Prevention and Management (FPM) Scheme** This is a partnership involving both the forest departments and local communities in natural forest management. The JFM Scheme plays a crucial role in improving the livelihood of the forest dwellers and fringe forest communities by creating employment opportunities like sustainable tourism in villages so that the villagers are discouraged and abstained from illegally cutting down or felling trees. The JFM also provides basic facilities to the people of nearby villages including non-wood forest products so that the pressure on the forest for resources is minimised. Focuses on collecting medicinal plants from these forests for building rural health, ensuring gender balance in the committee and sub-committees, providing training on animal husbandry, poultry farming, dairy development, managing small forestry enterprises and, ensuring the implementation of the National Rural Employment Guarantee programme in fringe forest areas.
- Initiatives of the government of India in managing forest fire - the GoI supplements the efforts of State/Union Territory Governments in prevention and control of forest fire by providing financial assistance under the Centrally Sponsored Forest Fire Prevention and Management (FPM) Scheme. The main objectives and funding patterns of the FPM Scheme are: to minimise forest fire incidence and assist in restoring the productivity of forests in affected areas, to institutionalise the partnership with forest fringe communities for forest protection, to contribute to the larger goal of maintaining environmental stability, to prepare fire danger rating system and devise forest fire forecasting system, to

encourage the State/Union Territories for optimal use of modern technology in planning, developing and operationalising fire prevention and management system, to develop knowledge on impacts and dynamics of forests fire etc.

## **8.0 Analysis**

Over the years, there have been several laws and policies implemented in India with the mission to save the environment, each of them focusing on different aspects and challenges of biodiversity. There also have been several national and international bodies that have been constantly involved in creating awareness amongst the people of the society and taken active steps as an organisation to demand better precautionary measures, laws and policies to ensure the conservation of forests from threats like deforestation and forest fires. A lot of youth-led organisations and the youth of India themselves are now playing a very proactive role in realising the decision-making bodies of the country on the emergence of climate change.

### **Political:**

**Involvement and contribution in the UNFCCC Kyoto Protocol and the Paris Agreement:** India and China are currently amongst the world's top annual emitters, along with the United States (Refer to image (i) in Appendix). The government seems to get diverged on holding responsibility and setting emissions-reduction goals (Maizland, 2021). Despite signing and being a part of the Kyoto Protocol and Paris Agreement, countries have not been too successful in reducing greenhouse gas emissions. Instead, there is a constant rise in carbon dioxide level in the atmosphere resulting in the heating of the Earth at an alarming rate. The argument put forth by developing countries is that the developed must bear the bigger burden to address the climate change issue. The Kyoto Protocol required only developed countries to reduce emission, while the Paris Agreement recognised that climate change is a shared problem and all countries should be involved in setting emission targets (Maizland, 2021).

It has been nearly four years since the Indian government started work to overhaul India's national forest policy which will govern and guide the sector for the next 20-25 years but it is yet to be finalised. Key policies regarding forests and forest management are either missing, delayed or left open-ended as of date. In addition to the missing national forest policy, other pieces of the

forest regulation puzzle is missing including a central policy on inviolate forests and a nationally accepted definition of 'forests'. Compensatory afforestation and involvement of the private sector in managing and re-greening the forests are concerns for environmentalists given the impact of these actions on biodiversity. Also, it is important to keep the interests of the tribal communities and forest dwellers in check.

### **Economic:**

Developing countries, such as India, are only halfway through the process of industrialization, which explains why their per capita emissions are still low. In these conditions, any limitation on carbon emissions equates to a restriction on the economic development of the country. Deforestation facilitates the generation of raw material for a wide range of industries. The short-term economic gains made from deforestation are accompanied by reduced long-term productivity. According to some reports, the global GDP may see a 7% decline by the year 2050 due to deforestation and other factors. The economic activity is adversely affected by siltation, flooding, soil degradation and reduced timber supplies that are observed as a result of deforestation. This, in turn, threatens the livelihood of people. Thus, a sustainable approach to the usage of forest resources is ideal for the economy. Catastrophic wildfires have a significant economic impact on communities, resulting in property destruction, reduced tourism, and even long-term changes in the local economy's structure.

### **Social:**

Since deforestation is often accompanied by the loss of indigenous species, it is not uncommon for new species to flourish in deforested lands. Increased soil erosion (due to deforestation) can result in the formation of pools of stagnant water, serving as breeding grounds for mosquitoes, thus contributing to the **propagation of the human immunodeficiency virus (HIV)**. Wildfires pose a direct threat to lives, and wildfire smoke has the potential to affect all. They disperse toxins thousands of miles away, causing breathing problems in even healthy people, let alone children, the elderly, and those suffering from heart disease, diabetes, asthma, COPD, and other lung diseases.



**Technological:**

The number of technology devices available to customers has increased as technology has progressed. This raises energy demand, resulting in the burning of more fossil fuels (*Technology's Influence On Climate Change*, n.d.). Understand the policies and institutions to deliver the dramatic technological changes and emission reduction necessary for stabilising GHG concentration. Collaboration in technology between the global north and south so that everyone is benefited. The absence of technological cooperation between nations can lead to a global failure.

**Environment:**

Deforestation causes an **increase in the release of greenhouse gases, changes in cloud cover and the rain cycle**. The carbon dioxide emissions caused by deforestation account for approximately 12% of all anthropogenic carbon dioxide emissions. Thus, deforestation is a direct contributor to the greenhouse effect and (consequently) global warming. Trees tend to bind their roots to the soil bedrock, thereby reinforcing the soil. The plant litter generated by trees offers protection to the surface of the soil. In the absence of trees (as a consequence of deforestation), the **soil becomes vulnerable to erosion**. Deforestation of sloped lands is often accompanied by **landslides**, which can be explained by the loss of soil adhesion due to the absence of trees. Approximately 30% of the world's freshwater supply can be sourced from tropical rainforests. Deforestation is accompanied by reduced humidity, owing to the absence of transpiring trees. The water content in the soil and the groundwater levels also decline in the cleared land. The native people depend greatly on the forest for diet contribution, when the forest is removed nutrition levels and overall health decreases. Many species end up on the endangered species list or go extinct before they are even fully discovered. The forest, native species, and the human population are stakeholders whose nonmaleficence and justice are violated with increased carbon emissions from deforestation. Deforestation also leads to **increased levels of forest fragmentation**. The very high fragmentation in Trans Himalayas is attributed mostly to natural factors while in other biogeographic zones, increased fragmentation is due to deforestation. Forest fires kill plants and livestock, deprive local people of fodder and fuelwood, and burn timber and non-timber forest products. Since certain plants grow better on burned soil, a forest

changes after a fire. Ecologists have long researched the succession of plants and animals in areas where natural forest fires occur. When fires create gaps in a forest, the area is vulnerable to invasions by exotic species. For example, *Imperata Cylindrica* (cogon grass) recovers quickly after a fire and responds with an increase in cover. Invasive species can lead to the depletion of the biodiversity of an area, by producing chemicals that influence the growth and survival of other forms of life. As in the case of perpetual forest fires experienced in forest dense parts of Uttarakhand, it has led to change in species composition, loss of microflora and fauna, loss of seeds, loss of habitat of particular species, change in microclimate, migration of species, soil desiccation, soil erosion resulting in landslides and invasion by exotic species.

**Legal:**

Serious repercussions for people deliberately burning down forests, cutting down trees for their personal/organisational gain and hampering the ecological balance in the biosphere. Illegal logging, which accounts for approximately 80% of all logging activities, involves the harvesting and sale of timber in violation of the law. Corrupt government officials may accept bribes from illegal loggers and offer access to protected forest areas in return. Therefore, corruption can be viewed as an indirect cause of deforestation.

**Ethical:**

The ethical issues that revolve around deforestation include biodiversity loss, climate impacts, environmental effects such as soil composition changes, adverse human health effects, and unethical behaviour of companies profiting from deforestation. Deliberate the burning down of forests by humans in order to manage the land.

**9.0 Recommendations**

1. Creating equal participation opportunity for women: Developing strategies to ensure that women are fully involved not just as beneficiaries but also as participants in decision-making. As we involve a diverse range of stakeholders at the national and local level people will eventually feel responsible for bringing about a change. Supporting the

creation of policies and action plans, encouraging early adaptation, as well as long-term strategies such as steering investment toward low-carbon technologies and practices, and eventually incorporating climate change broadly into development assistance at the global, regional, and national levels, are all essential aspects of a climate change strategy. The mission areas covered in the Prime Minister's Climate Change Council are, namely - agriculture, water, forests, sustainable habitat, solar energy and energy efficiency and strategic knowledge need to integrate greater concerns for gender-inclusive agenda.

2. National Forest Policy and the Involvement of Local People: Involving more and more local people from nearby villages to work together and manage the forest. Incentivising the people by crediting them with a significant portion of the income of that particular forest area. Earlier, local villages were credited with 25% for a certain area of the forest. Public support must be generated to achieve the goal of forest production. One of the movements was the Chipko Movement (1972).
3. Conservation of Reserve Forests: This can be done by banning commercial exploitation that is practised in reserve forests of India that are mainly located in the Himalayan, Eastern Ghats, and the Western Ghats along with national parks and sanctuaries.
4. Adopting Afforestation Scheme: Forests are a source of raw materials for the country's commercial sector. Plantation should be encouraged in barren or fallow land to meet the demand for forest-based industries for a longer period of time.
5. Increasing Forest Productivity: This can be managed by proper forest management, managing the supply of inorganic and organic fertilisers that are used to meet the nutritional needs of the plants, controlling disease, pests, and weed by sufficient insecticides, pesticides, and weedicides, and finally the use of the advanced technology for forest tree breeding and tissue culture method.
6. With respect to the Kyoto Protocol, 'equity is a prerequisite for an effective climate agreement.' (United Nations Development Programme, 2009, pp. 1–3). Cooperation at a global level amongst nations is important for a huge-scale global agreement to work out effectively and show results. The concept of equal per capita emission for big and small

nations should be kept in check so that economically backward nations can proceed to exhaust their climate quota while the nations that are already doing economically well cut down on their per capita emissions. The need of the hour is climate responsible and effective action.

## **10.0 Conclusion**

Deforestation and forest fires are definitely important to deal with in order to tackle a bigger problem like climate change. Although most of the forest fires in Indian states are anthropogenic in India, they may happen more frequently than in the recent past as a result of rising temperature and global warming. An imperative change in the attitudes and actions of every group of stakeholders involved is needed to alarm the decision-making bodies. Prevention of forest fire will require long term coordinated efforts by public and private authorities with robust planning and informed policy implementation. Forest fires, although a local issue, seem to have a global impact.

Decreasing the area of forest lands as a result of deforestation and forest fires also reduces carbon sinks that help in keeping the continuously changing climate in control. Forests serve as a carbon sink by absorbing atmospheric carbon dioxide during photosynthesis, which then enters the soil as dead organic matter and contributes to the soil carbon sink. When trees are cleared, plants consume less carbon dioxide, and the ambient carbon dioxide concentration rises over time due to a lack of sinks. With the loss of vegetation cover, there is also a major decrease in soil organic carbon, impacting ecosystem productivity. Productivity is thought to be a measure of a forest's ability to absorb carbon, so the more active the forest is, the more carbon it stores. Tropical forests are both one of the most active and most endangered ecosystems in the world today, with the highest rate of deforestation. As a result, it is important to keep the rate of deforestation under control in order to prevent negative consequences. Reducing methane emissions and carbon footprints would help ensure that we continue to advance technical progress while still caring for the environment. Our society will position itself to mitigate global warming if large companies devote funds and resources to solar and wind energy.

Developed countries are much more responsible for carbon emission as compared to the developing countries because the developed countries could work efficiently and grow their economies, unlike the developing countries that are on their path to growing the economy now. When the Kyoto Protocol was being negotiated, the world came up with the Clean Development Mechanism (CDM) as a way to reward the poorer nations for making the transition. However, it failed. The motive behind CDM was to find the cheapest solutions for lowering pollution in the developing world. As a result, the cost of renewable and other high-tech solutions has never been reflected in the price of the Certified Emission Reductions (CERs) (the Approved Pollution Control unit used in this transaction). It's a low-cost, increasingly corrupt growth strategy. It's also a complex growth process in which governments are obligated by rules not to consider drastic changes. In reality, the current CDM disincentivizes developing country governments from pursuing renewable energy or production policies.

In this paper we have only discussed about the two main environmental aspects of climate change but in reality, climate change is deeply entailed in our lifestyle and more than environmental, it is also a product of political, economic, social, technological, legal, and ethical choices we have made as humans and to bring that under control we need to bring up more scalable and sustainable solutions.

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## Appendix

### (i) Top Greenhouse Gas Emitters in 2007

