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FOREST FIRE IN INDIA: A THREAT TO INDIAN FOREST

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Abstract

The government of India publishes a biennial report called India state of forest report (ISFR). The ISFR report published in 2021 states unequivocally that the country has witnessed 345,989 forest fires between November 2020 and June 2021, an increase of 87,509 forest fires reported in the country during the same time in the year 2018-2019. This is the second-highest report of forest fire in the country. Similarly, there were 136,604 fire points in the country from January 1 to March 31, 2022. The ISFR (2021) Report further states that the total forest cover has gone up by 0.48% between 2013 and 2021 but the rate of forest fire also went up astronomically to the tune of 186% in the same period.A comprehensive study on forest fire reveals that out of the total 764districts in India; more than 30% of districts are susceptible to extreme forest fire, which also, are home to 275 million people. The states namely, Andhra Pradesh, Odisha, Maharashtra, Madhya Pradesh, Chhattisgarh, Uttarakhand, Telangana, and the north-eastern region (NER) states except Sikkim are prone to high-intensity forest fire. The Northeast cluster of forest has a maximum area of forest constituting 55% of all the four clusters in India but it accounts for only 16% of the burnt forest area. The central area, which constitutes 28% area of the forest cover but 56% of it, is burnt because of forest fires. In the Northeast, fires tend to concentrate in a smaller area that is subject to repeated burns whereas in Central and Southern India, they are more expansive.

KEYWORDS: Forest fire, Climate Change,Intergovernmental Panel on Climate Change,forest fire hot spots,soil erosion,Xylem dysfunction,xylem conduits,The Forest Fire Prevention and Management Scheme.

1.Introduction

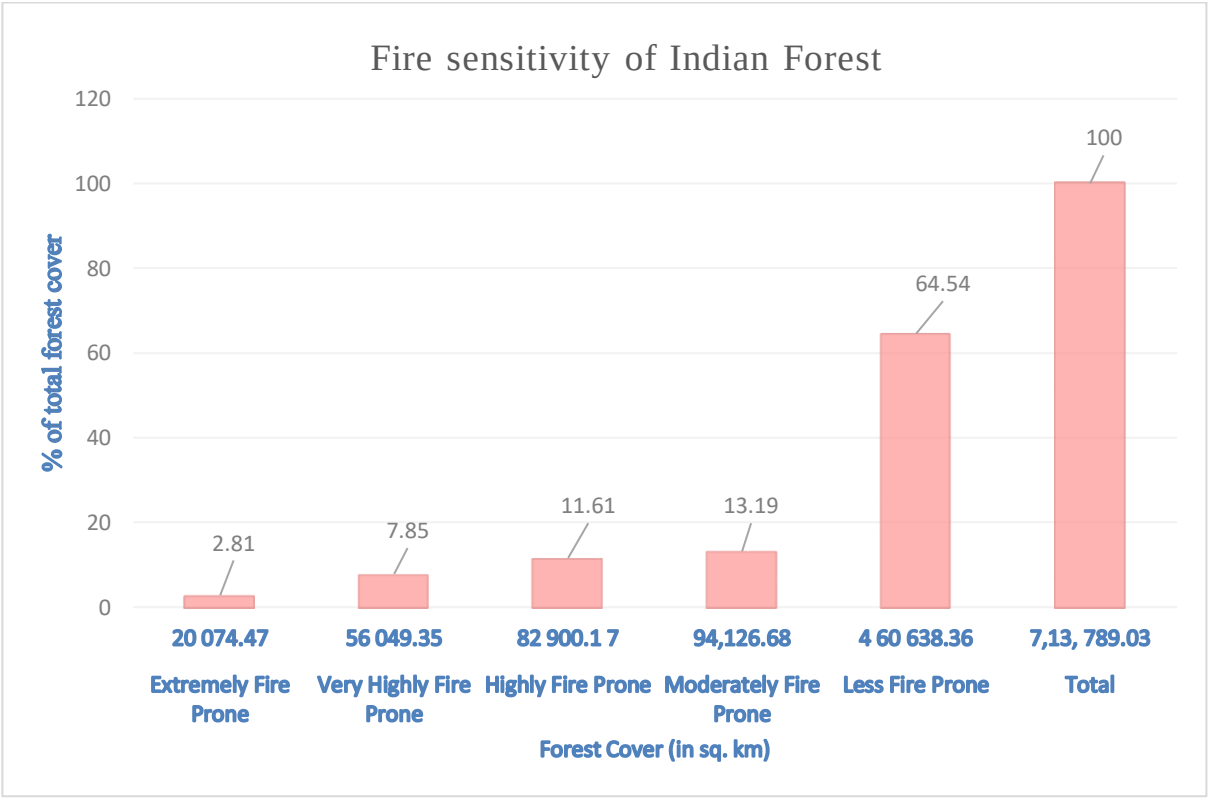
A forest fire has been a forest management tool since time immemorial but with the passage of time and changing climate, this has taken a menacing proposition and has caused incalculable damage to the forest therefore, setting in irreparable and irreversible damage to the forest ecosystem. The ISFR report (2021)has stated in unequivocal terms that the country has witnessed 345,989 forest fires between November 2020 and June 2021, an increase of 87,509 forest fires reported in the country during the same time in the year 2018-2019. This is the second-highest report of forest fire in the country. Similarly, there were 136,604 fire points in the country from January 1 to March 31, 2022.The ISFR (2021) Report states that the total forest cover has gone up by 0.48% between 2013 and 2021 but the rate of forest fire also went up by 186% in the same period. There are many catalysts to the forest fire but high temperatures, low humidity, high winds, and years of vegetation-drying drought that lead to forest fire, which becomes capable of engulfing huge chunks of forests.

There are three main ingredients required to ignite forest fire namely, combustible materials in the form of wood, dry leaves etc.,oxygen and heat. The source of heat can be sparks, flames, friction, sunlight, and chemical reactions. The Forest Survey of India has categorised Indian forests into different classes based on fire sensitivity and states that approximately 22.27 % area of forest cover in India falls under the high and extremely fire-prone category as shown in the Table-1

Table-1: Fire Sensitivity of Indian Forest

S. No	Category	Forest Cover (in sq. km)	% of total forest cover
1	Extremely Fire Prone	20 074.47	2.81
2	Very Highly Fire Prone	56 049.35	7.85
3	Highly Fire Prone	82 900.1 7	11.61
4	Moderately Fire Prone	94,126.68	13.19
5	Less Fire Prone	4 60 638.36	64.54
	Total	7,13, 789.03	100

Figure 1.

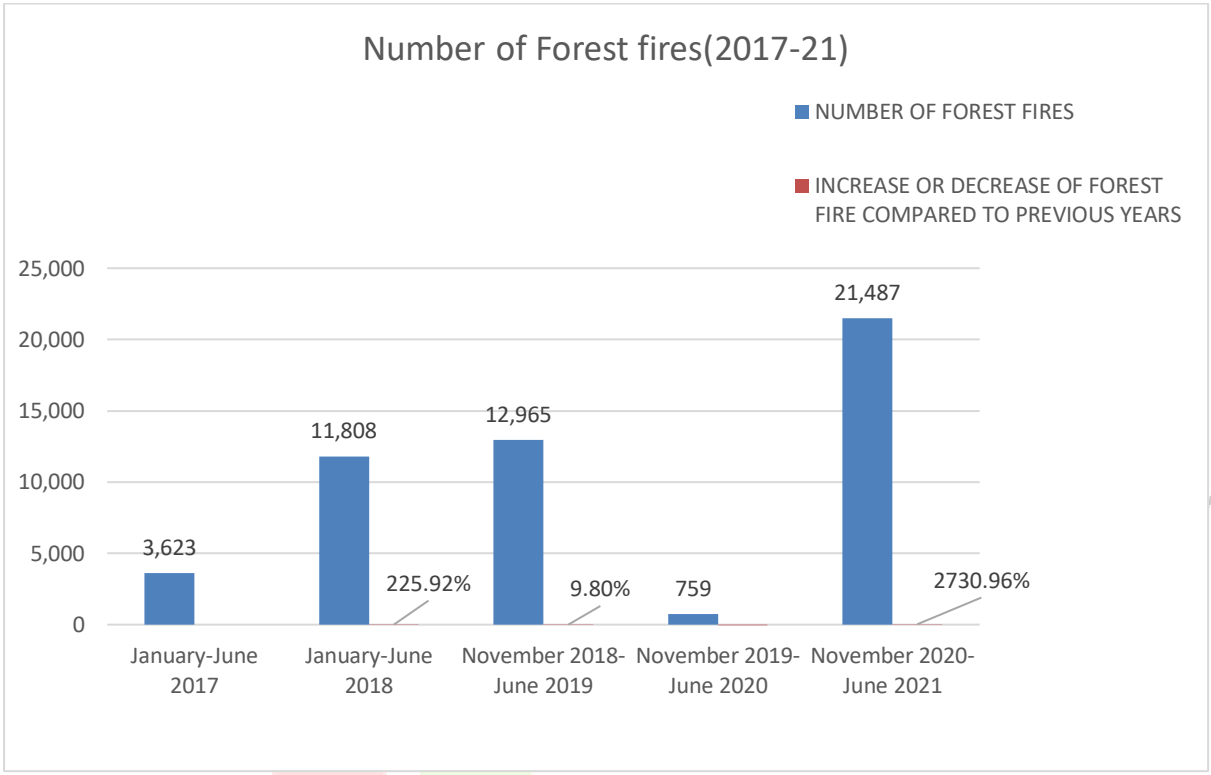


Interestingly, in recent years, the assistance for the fire-fighting budget provided by the Ministry of Environment, Forests and Climate Change witnessed a decline of 26% between 2016 and 2021.The government of India accepted in response to a parliamentary question that the forest fire has multiplied many folds in the recent past (Rajya Sabha on 16.12.2021)as shown in the table-2. The spread of forest fire in the Indian forests is uneven as is reflected in a study by Sewak, R. et al., 2021. In the study, the author has divided the Indian forests into four groups based on their geography namely, North Himalayan, Northeast, Southern, and Central forests. The Northeast cluster has a maximum area of forest constituting 55%of all the clusters in India but it accounts for only16% of the burnt forest area. The central area, which constitutes 28% area of the forest cover but 56% of it, is burnt because of forest fires.In the Northeast, fires tend to concentrate in a smaller area that is subject to repeated burns whereas in Central and Southern India, they are more expansive.

Table-2: Number of Forest fires

YEAR	NUMBER OF FOREST FIRES	INCREASE OR DECREASE OF FOREST FIRE COMPARED TO PREVIOUS YEARS
January-June 2017	3,623	
January-June 2018	11,808	225.92%
November 2018-June 2019	12,965	9.80%
November 2019-June 2020	759	-94.15%
November 2020- June 2021	21,487	2,730.96%

Figure 2.



FOREST FIRE AND HOTSPOT DISTRICTS:

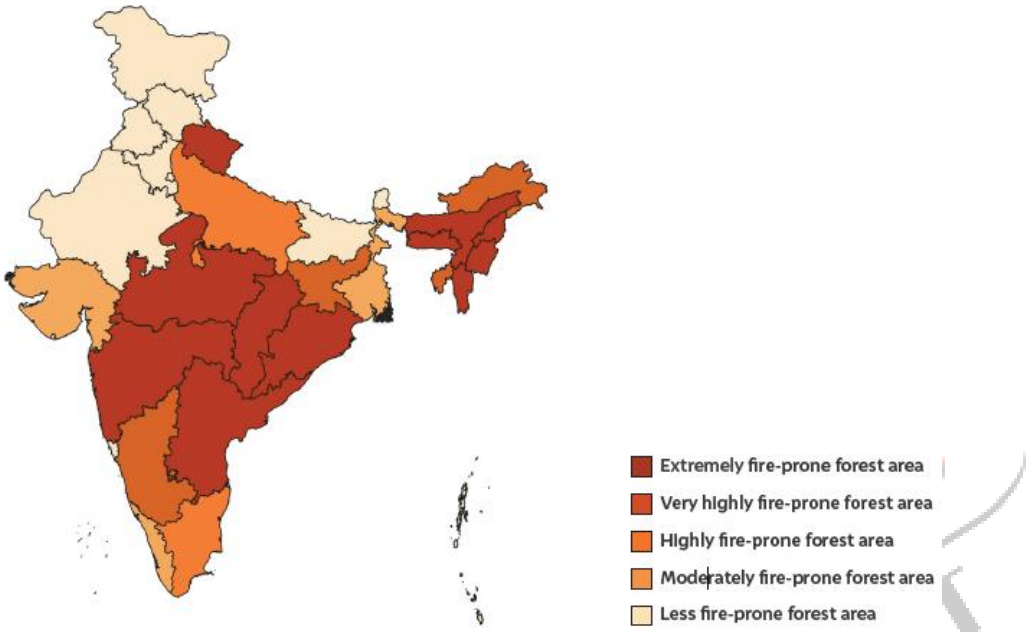
A comprehensive study on the forest fire (Mohanty, et al., 2022) reveals that in 764districts in India; more than 30% of districts are susceptible to extreme forest fire, whichalso, is home to 275 million people. The states namely, Andhra Pradesh, Odisha, Maharashtra, Madhya Pradesh, Chhattisgarh, Uttarakhand, Telangana, and the north-eastern region (NER) states except Sikkim are prone to high-intensity forest fire. The forest fire has gone up between 2000-09 and 2010-19 remarkably high. In a period between 2000 and 2009, the report states that 58% of the Indian states were prone to high-intensity forest fires of which 13% to very high intensity and 10 % were prone to high-intensity forest fires respectively. The rate of forest fire is seen to go up in the decades to follow that is, in a period between 2009 and 2019 65%of Indian states are found to be exposed to high forest fire incidents of which 41% are exposed to extreme forest fire, 13% very high and 10% to high forest fire incidents respectively.

Table-3 Forest fire hotspot states and districts in order of proneness (highest to lowest)

DECADES	STATE HOTSPOTS	DISTRICT HOTSPOTS
2000–19	Andhra Pradesh, Assam, Chhattisgarh, Odisha, Maharashtra, Madhya Pradesh, Manipur, Mizoram, Nagaland, Uttarakhand	Dima Hasao, Lunglei, Lawngtlai, Mamit, Harda, Jabalpur, Hoshangabad, Narayanpur, Udham Singh Nagar, Kandhamal, Garhchiroli

Source: Managing Forest Fires in a Changing Climate, 2022

Figure 3. More than 62% of Indian states are prone to high-intensity forest fire events (2000-2019)



Source: Mohanty, A., and Mithal, V., (2022). Managing Forest Fires in a Changing Climate, COUNCIL ON ENERGY, ENVIRONMENT AND WATER.

IMPACT OF CLIMATE CHANGE ON FOREST FIRE: A REAL THREAT

Until very recently scientists across the world did not relate climate change with the increase in forest fires but a report titled United Nations Environment Programme (2022)warned that the increase in surface temperature has deteriorated forest fire situation across the globe in recent past. The other report called Intergovernmental Panel on Climate Change (IPCC 2007) observed that the intensity and spread of forest fire in Asia have increased over the last 20 years and related this incident largely with the rise in temperature and declines in precipitation.Climate change has put Indian forest on a very high stress level and rising temperature across the country has lengthened the forest fire months compared to the past years. A study on the assessment of long-term forest fire incidents has revealed that forest fire hot spots have increased in the country over the last decades. The study states that the hill districts of Assam have higher percentages of forest fires compared to other districts. Dantewala district of Chhattisgarh and Garhchiroli district of Maharashtra of India occupied third and fourth rank with valuesof 3.1 and 3.0% respectively in the country. Normally, the forest fire season begins in March but now because of rising temperatures the month of January also becomes ideally conducive for the onset of forest fire. The above study finds that most of the forest fires almost to the level of 80% occur in March and spreads to 88% by the time it reaches April (Ahmad et al., 2019). The impact of climate change on forest fire has been so vivid that 89% of the forest fire hot spots are associated with the districts suffering from droughts or drought-like conditions. The study published in Managing Forest Fires in a Changing Climate (Mohanty, et al., 2022) states that forest fire has been seen rising in frequency in districts like Kandhamal (Odisha), Sheopur (Madhya Pradesh), Udham Singh Nagar (Uttarakhand), and East Godavari (Andhra Pradesh) where forest fire hotspot districts show a swapping trend from flood to drought. Not much

research has gone into the forest fire in Indian forests, yet one study quantifies the forest fire in India with particular reference to its time of occurrence.Thisstudy reveals that between 2001 and 2020 more than 70% of forest fires originated in March while some years like 2009, 2012, and 2017 show anomalously high forest fires. The study further states that the role of persistent warmer temperatures and multiple climate extremes in increasing forest fire activity over central India is well understood. Central India experienced a severe heatwave, a rare drought and an extremely strong El Niño, the combined effect of which is linked to increased forest fires (Jain, M., Saxena 2021).

IMPACT OF FOREST FIRE ON FOREST ECOSYSTEM

Forest fire plays an extremely important role in shaping a forest ecosystem and it is the primary reason for deforestation in a forest ecosystem. Forest fire also eradicates a particular species if it happens too frequently, too early or too late in a plant's life cycle. A frequent forest fire brings about irreversible changes in the moisture regime and nutrients of the soil, therefore, making them unconducive for their growth. If the forest fire occurs perpetually before the seed formation in the plants then a seed deficit population becomes extinct in near the future (Tawade,S. 2022). The study on the impact of forest fire is yet to gain momentum in India but a study on Chile's forest states that with the onset of perpetual forest fire, the forest soil becomes the first victim. Soil erosion starts to begin with the excess of salts, pollution, and physical, biological and chemical degradation follows (Valderrama.L, 2018).The crown forest fire in Sal (Shorea robusta) and Teak (Tectona grandis) forest has a serious impact on the timber, branches, leaves and conduction of water through the xylem of the trees. The bud and foliage necrosis is the direct outcome of the crown fire. In a well-hydrated forest when the stem and branches are exposed to nearly as high as 250^0 C of temperature it conducts water rapidly from branches to foliage to meet vapour pressure deficit. This process causesxylem tensions causing embolisms in xylem conduits and leading to cavitation in foliage and branches, which if extensive enough would result in reductions in water transport and conductivity. The Xylem dysfunction may also arise from the forest fire, where excessive heat deforms Xylem tissues irreversibly thereby, stopping hydraulic conductivity completely (Varner JM 2021). There are many other species in Indian forests like *Terminalia chebula, T. bellirica and T. tomentosa,* which contain immense medicinal value declines in yield after the fire has set in the area. The oak and coniferous forests take a very long time to recover from the forest fire and if the forest fire is repetitive, its forest composition changes with time. The study also suggests that due to frequent fire in these areas, species of *Lantana camara, L. indica,* Eupatorium *glandulosum, Parthenium hysterophorus, Cassia tora, and C. occidentalis* have invaded. The oak forests have seen a complete loss of soil organic matter and volatilization of nitrogen, phosphorus and potassium after an intense forest fire. The incidence of perpetual forest fire also minimises the presence of actinomycetes, fungal population and arbuscular mycorrhizal fungi in the forest ecosystem while enhancing bacterial richness (Chandra K. K 2015).Forest fire lowers the species richness as is revealed in a study done in the eastern Ghat. The author studied the impacts of forest fire between 2008 and 2018 in sample plots in Eswaramala Reserve Forest on the diversity, composition, and structure of the plant communities. The author further states that even though basal area increases in the recently burned areas, species richness declines (Neeraja, U. V 2021).

CARBON DIOXIDE EMISSION FROM DIFFERENT FOREST TYPES

The burning efficiency of any plant or tree depends on many variables namely, forest types, fire characteristics, moisture regime, tree types, wind velocity etc. The burning efficiencies of the different forest types depend upon the wood densities of the trees present in a forest type(Srivastava, et al., 2013).The Co_2 emission of any forest type works out as:

$$Es = ME_{fs}$$

Where Es is the total emission of biomass (forest), burning M is the total burnt biomass and E_{fs} is the emission factor.

Table-3 Biomass densities and burning efficiencies for the major vegetation classes

Class Names	Biomass Density (gm/m2)	Burning Efficiency*	C02 Emission Factor(gm/kg of dry matter)
Tropical Evergreen & Semi-evergreen Forest[1]	46800	0.25	1613
Tropical Moist Deciduous Forests[§]	40930	0.25	1580
Tropical Dry Deciduous Forest[@]	18618	0.25	1689
Montarme Subtropical Forest[#]	21080	0.25	1569
Montanne Temperate Forest	32299	0.25	1720
Grasslands *	12740	0.95	1613
Thom Forest/Scrub*	4000	0.85	1613

Source: Parul Srivastav and Amit Garg 2013

CARBON EMISSION FROM INDIAN FOREST

C Sudhakar Reddy (2023) carried out a study on forest fire and carbon dioxide emission in the year 2023 and it finds that the total area affected by fire in the forest, scrub and grasslands are 48765.45^2, 6540.97^2 and 1821.33 km^2, respectively, in 2014. The total CO_2 emissions from fires of these vegetation types in India were estimated to be 98.11 Tg during the same year. Monthly CO2 emissions from fires for different vegetation types have been calculated for February, March, April and May and estimated as 2.26, 33.53, 32.15 and 30.17 Tg, respectively (Reddy, 2017).Forest fire is a regular phenomenon and occurs every year in almost half of the districts of our country. This not only harms existing biodiversity but also the 92 million Indians who live near forest areas and the natural regeneration of the forest to an extent of no return. As per the Fifth Assessment Report of IPCC, forest fires globally contribute 2.5 billion to 4.0 billion tonnes of CO2 to carbon emissions every year.India is losing at least ₹ 1,100 crore due to forest fires every year (Dogra et al., 2018).

DISCUSSION

Forest fires emerging as a global threat to countries in the recent past as never before. A forest fire has accounted for almost 25% of forest loss in the last two decades and this is going unabated and uncontrolled with each passing year. The year 2021 has the distinction of being the second worst forest fire season globally because of the unprecedented loss of boreal forest in the northern hemisphere. The year 2021 has another dubious distinction of having burnt 23 million acres of forest land/land across the world. The tropical forests are equally bad and the fire loss is increasing by 5% per annum without any check. Goa is the latest example of forest fire, which caught everybody's attention when eleven Western Ghat hills continued to rage for weeks together, and the State forest department was helpless in tacking forest fire. Climate change has emerged as one of the important factors in extending forest fire to those areas, which were once untouched by forest fire. Goa like many other areas in the country had maximum temperature ranging between 5^{o}C and 7^{o}C above normal in March 2023 and this happened because of the strengthening of easterly winds, clear sky, no sea breeze and delay in monsoon. Forest fire not only affectsthe biodiversity composition of any forest ecosystem but also the black carbon emerging out of it heats glaciers much faster than expected. A study on the black carbon ambient air of Gangotri Glacier reveals that the equivalent black carbon (EBC) concentration has gone up from 0.01µgm^{-3} to 4.62µgm^{-3} and the monthly mean minimum concentrations were found to be minimum in August (0.089 ± 0.052µgm^{-3}) and maximum in May (0.840 ± 0.743µgm^{-3}) (Negia, 2019).The warming potential of black carbon is huge in the glaciated Indian Himalayan region. Forest fire impacts and alter the animal population and wildlife. In a study on the effect of forest fire on flora, fauna the author States that forest fire can alter the physio-chemical property of the soil, bulk density, pH, nutrients etc. and in turn the

new plants that come in its place become unpalatable for the existing animals and they migrate to some other place. (Jhariya, 2014).

CONCLUSION:

The world has moved to the Internet of Things and artificial intelligence in detecting forest fires but extinguishing forest fires is mostly human-centric in most countries except a very few where choppers are employed. In India, the forest department starts forest fire detection through satellite in 2007-08 and Madhya Pradesh was the pioneer state, which started alerts through mobile SMS text. The state forest department has discontinued the time-tested old practice of keeping forest linescleaned despite advancements in technology in fire detectiontherefore; this resulted in the department's disability to control forest fire. Maintenance of forest fire lines is an annual operation but it does not get the attention it requires. Keeping firewatchers regularly is a protocol and the state forest department keeps them for a fixed time during forest fire seasons to maintain forest lines, clean them and keep them functional. This practice not only keeps the forest healthy but also forest fire free. The state forest departments are not able to engage firewatchers in this operation any longer because they are running short of funds meant for this operation. The Forest Fire Prevention and Management Scheme (FPMS) is a centrally sponsored scheme designed to contain forest firesand has essentially two components that are, central share and state share. Budgets allocated under the FPMS follow two different patterns for example, with a90:10 ratio of central to state funding in the Northeast and Western Himalayan regions and a 60:40 ratio for all other states.On average, the state forest departments across the country get Rs. 50cr per annum from the centre to contain forest fires in the states but 24% of the total allocation remains unspent because states are not able to provide the matching funds thus, making this scheme highly ineffective.There is a popular saying in forests that *"Fire is a good servant but a bad master"* and this is true to a larger extent. State forest department always uses controlled forest fire as a tool of forest management. The use of counter-fires, which were one of the important tools to contain forest fire in India, does not find any mention in the management plans. A fire is purposely lightened ahead of the forest fire and the buoyancy-induced in-drafts pull it towards the flame front thus creating a firebreak of burnt fuel. This technique is fast, effective and safe (Roxburgh, et al., 2008).The NDC of our country states that the Indian forest is to sequester 2.5-3 billion metric tonnes of carbon dioxide by 2030 but a study by Mohanty, 2022finds it tough to achieve becauseit finds 62% of the Indian states are vulnerable to forest fire. A study by the Energy and Resources Institute (TERI) in 2020 states that carbon emission from the different types of forests in India ranges from 74.95 Tg to 123.84 Tg (Mathur, 2020) when studied between 2003 and 2010 and it offsets the total sequestration potential forests in India (Venkataraman, *et al*. 2006). The latest report released by World Meteorological Organisation, (2023)reveals that global temperatures are likely to surge to record levels in the next five years, fuelled by heat-trapping greenhouse gases and a naturally occurring El Niño event. The rise in global surface temperature will certainly help forest fires to go uncontrolled in years to come therefore, each district in the country needs a forest fire action plan on an urgent basis.The forest fire Action plan should aim at providing a set of doable things for implementation, coordination and evaluation of forest fire activities in each district in India that contains forest fire. The action plan must include establishing an early warning system and Inter-Agency Coordination, a Capacity-building programme for front-line forest staff, public awareness and a community outreach programme.

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