FOREST FIRE: IT'S EFFECTS AND MANAGEMENT IN INDIAN FORESTS

Chapter · March 2022

DOI: 10.5281/zenodo.8357787

3 authors, including:

Suyog Bagade

2 PUBLICATIONS **1** CITATION

SEE PROFILE

Volume: I, 15 March 2022,
ISBN: 978-81-953847-8-5

FOREST FIRE: IT'S EFFECTS AND MANAGEMENT IN INDIAN FORESTS

Lalitkumar Maurya[1*], Suyog A. Bagade[2] and Aditi A. Bagade[3]
[1]M.Sc.(Forestry) Scholar, Department of Silviculture and Agroforestry, College of Forestry, Kerala Agricultural University, Thrissur, Kerala State
[2] Assistant Professor (Forestry), SRS Institute of Agriculture and Technology (Affiliated to Tamil Nadu Agricultural University), Vedasandur, Dindigul district, Tamil Nadu State
[3]M.Sc.(Forestry) Scholar, Department of Silviculture and Agroforestry, College of Forestry, Dr. Balasaheb Sawant Konkan KrishiVidyapeeth, Dapoli, Maharashtra State
Corresponding Author: Lalitkumar Maurya
Email: lalitkumarmaurya956@gmail.com

Abstract:
Forest fire is a burning issue of the present scenario over the globe.Indian forests since decades back faces an alarmingforest fireincidences with more predominant in North and North- east Indian regions.In 2021nearly 35.46 percent of the forest cover and out of that 2.81 percent are extremely vulnerable to fire.Forest fires are human caused in over 95% of cases, either intentionally or unintentionally and remaining only 5% by natural causes which uncover disastrous impact on forest landscapes.El-Nino event is also link with forest fires.Every year, fire damages resulting in massive economic losses due to burned wood, deteriorated real estate, degradation of forest, harm to environmental, recreational and aesthetic valuesas well as loss of life.Forest fires, on the other hand, aren'talways detrimental to forest management, but they can also be beneficialin shaping forest's structure, recycle nutrients locked up in litter; to decrease competition of overstocking; suppress or kill insect-pests and diseases; to promote seed germination or cone opening; to generate fire breaks in a wildfire countermeasure.To reduce, prevent, control and monitor fire risks, some of the key fundamentalsilvicultural practices, counter fire, fire retardant chemicals, constructing green fire belt can be employed.

Keywords: *Forest fire, fire types, causes, effects, fireline*

Introduction:

Forest fire is characterised as an open, widely spreading flame that burns natural fuels where as wildfire occurs when a fire burns out of control. Forest fires have been sparked and burnt spontaneously across the forest throughout history. Forest fires, on the other hand, have different impacts. Depending on the prevailing conditions and kind of floral vegetations, fire may be helpful to one habitat but harmful to another. Every year, fire damages thousands of hectares of the world's forests, resulting in massive economic losses due to burned wood, deteriorated real estate, expensive suppression costs, harm to environmental, recreational, as well as aesthetic values, including loss of life.

Remnant of past fires may be found in fossilized trees that lived a long time ago and have transformed into hard rock over time. The fossilised charcoal known as "Fusain" may be found in the trunks of some petrified trees. Fire scars on a live tree are charcoal traces that show that the tree was formerly in the passage of a fire. All of these evidences point to the fact that fire has played an important role in the development of our temperate world's forest environment.

The consequences of fire on all woods are not the same. Depending on the climatic circumstances and kind of vegetation, the same fire that is favourable for one environment may be disastrous for another. Tropical rain forests are least impacted by fires because they are blanketed in fog and are constantly wet in mists and downpours. Fire is exceedingly rare and less harmful in temperate deciduous woods due to profuse rainfall, wetness plus comparatively higher humidity. Coniferous woods and evergreen forests having wide leaves are more sensitive to fire in overall.

Forest fires are a national tragedy that is being overlooked. Forest fires aren't even classified as a natural catastrophe in the National Disaster Management Authority's

framework (NDMA). Only floods, cyclones, earthquakes, wind and landslides were initially listed as disasters in the 2009 National Policy on Disaster Management. Heatwaves and glacial lake explosions were later taken into account. However, the much-needed acknowledgement of forest fires as a disaster remains strangely missing.

Causes of Forest fires:

Fires have always been a problem in Indian forests. To start the fire, three elements are required: fuel, heat, and oxygen, all of which must be present in the right proportions. The "fire triangle" is formed when these elements are combined. The third component, heat, is what really starts a fire there in forest. Heat can come from either natural or manmade sources. Forest fires can be characterised as either natural or manufactured, depending on source of heat.

Forest fires are human caused in over 95% of cases, either intentionally or unintentionally. The remaining 5% fires are generated by natural causes such as lightning, rolling stone friction, volcanic explosions, rubbing of dry boles of trees or bamboo clusters and so on, all of which are pretty uncommon. Lightning, for example, can cause trees to catch fire. The ideal circumstances for a fire to start are high ambient temperatures and little humidity. Natural sources in isolated places are the most common cause of forest fires.

The leading causes of forest fires seem to be anthropogenic everywhere over the world. The situation got worse as the human and cattle populations have grown, as has the demand for shifting cultivation, grazing, and forest products by people and families. Communities sets fire as intentionally to clear forest floors for NTFP gathering, prepare areas for shifting cultivation, and encourage grass growth for grazing and forage. To promote profuse tendu leaf growth; to trespass on forest land; to mask illegal logging; tribal customs and traditions. Hunters and Poacher gangs utilise fire to drive wild animals out of sheltered hiding spots, while unintentional fires caused via reckless tossing of flaming matchsticks and cooking fires escaping from temporary roadworker shelters also contribute to a plethora of forest fires.

Unintentional forest fires are also triggered by careless tossing of flaming matchsticks and cooking fires escaping from temporary roadworker shelters. Farm residues, picnicker campfires, automobile exhaust sparks, transformer sparks (an electric spark), unmanaged prescribed burning, resin tapping, heating coal tar for forest road building, and any other form of ignition.

Forest fires can be exacerbated by high temperatures, wind direction and speed, soil and atmospheric moisture levels, and the length of dry spells. Other causes claimed include less snow, rather dry winters, and even less rainfall in the mid-Himalayas between 3,000 feet to approximately 7,000 feet height, among others (IMPRI, 2021a).

Forest fires have been linked to El-Nino incidents (Parameswaran *et al.,* 2004). El Nino causes lesser rain to fall across many tropical regions, increasing the risk of forest fires ignited by mankind. As per a US research, El Nino triggered forest fires on several continents in 1997-98 (Siegert*et al.,* 2001). Forest fires across South America, Africa, & Asia were also attributed on El Nino in 2015-16 (Burton *et al.,* 2020).

Types of forest fires:

Forest fires are classified into four categories based on their nature, spread speed, behaviour, and magnitude i.e., *Surface fire, Underground fire, Ground fire* and *Crown fire*. Within forest all these types of fire may be the possibility to occur at the same fire event.

Surface fire:

Surface fires burn vegetation and dead stuff along the forest floor, and they are the most common type of forest fire. Surface litter, other loose forest floor detritus, and smaller plants are also burned in this sort of fire. Surface flames burn quickly and do not devour the whole organic layer. Moisture in the organic layers inhibits the humus layer from igniting and shields the soil and soil-dwelling creatures from the heat. It is beneficial to the growth and regeneration of forests in general. However, if this fire gets bigger enough, it will destroy not only ground vegetation but also the forest's undergrowth and middle storey.

Underground fire:

Muck/underground fires seem to be low-intensity fires that destroy the organic matter

underlying the forest floor as well as the surface trash. On top of the mineral soil, a thick layer of organic matter may be found in most dense bush. The fire spreads across the region by devouring such material. Typically, these fires extend entirely underground and flames for so several metres below ground level. Since this fire flames and spreads slowly, it's difficult to spot and put out in the severe cases. This could burn for days or weeks, ruining the ground cover of the soil.

Ground fire:

Normally, ground fires smoulder or creep gradually through the litter and humus layers, destroying all or most of the organic cover and exposes mineral soil or beneath rock. As a result, it's difficult to tell the difference among underground and ground fires. These flames often only occur during prolonged droughts when the whole soil organic layer has dried enough, yet they can burn for extended periods of time until they are extinguished by precipitation and cold temperatures, or they run out of fuel. This fire destroys root as well as other material on or under the surface, i.e. it destroys herbaceous growth on the forest floor as well as a layer of organic materials in various stages of decomposition. They are more dangerous than surface fires because they may entirely damage plants. These flames are the most difficult to spot, as well as the least showy and slow-moving.

Crown fire:

Crown fire is the most unexpected type of fire since it burns the tops of trees and rapidly spread owing to the wind. In most situations, surface fires start these fires. This is among the most dramatic types of forest fires, which often spread from the top to the bottom of trees or bushes, and are more or less reliant on surface flames.Well before fire moves on, trees normally lose 20-30% of its crowns. The crown fire may pull ahead of the accompanying surface fire in crowded conifer stands with a fast wind. It's uncontrolled until it falls to the ground since it's above the head.

Season of forest fire:

The fire season vary from one region to the next, relying upon the type of forest, plant species the climate, and a variety of other factors. Even though the country's peak forest fire season runs during February to June, certain woods are vulnerable to flames all year.

The forest fire data obtained by FSI over two years (2005-06 and 2006-07) aids in pinpointing the critical time of forest fire in various states throughout the country. According to the data, the country's peak fire season is from February to May.

As a result, it is desirable to enhance disaster risk reduction and mitigation measures and concentrate on adaptability. These fires are mostly man-made phenomena with flawed interventions at many layers, ranging from monoculture plantations to the expulsion of forest people from the mountains' woods.

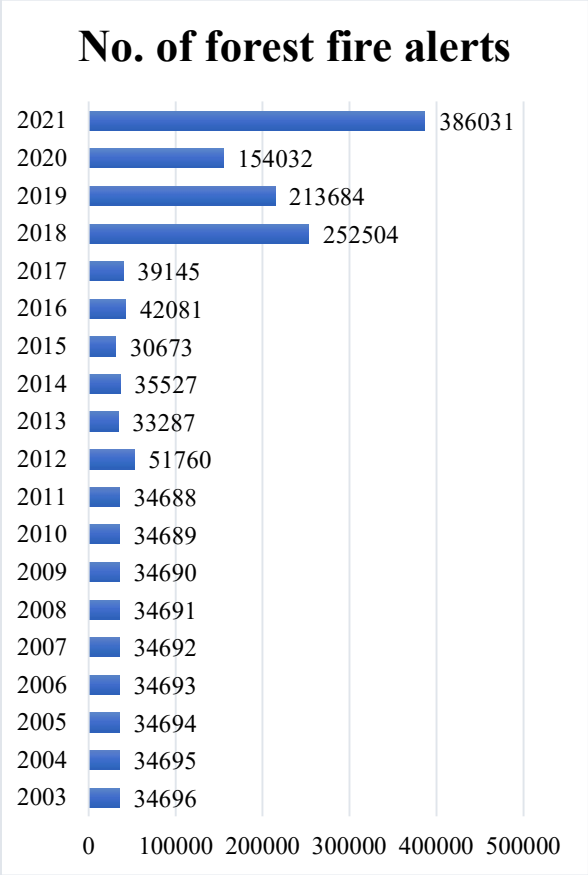
Status of forest fire:

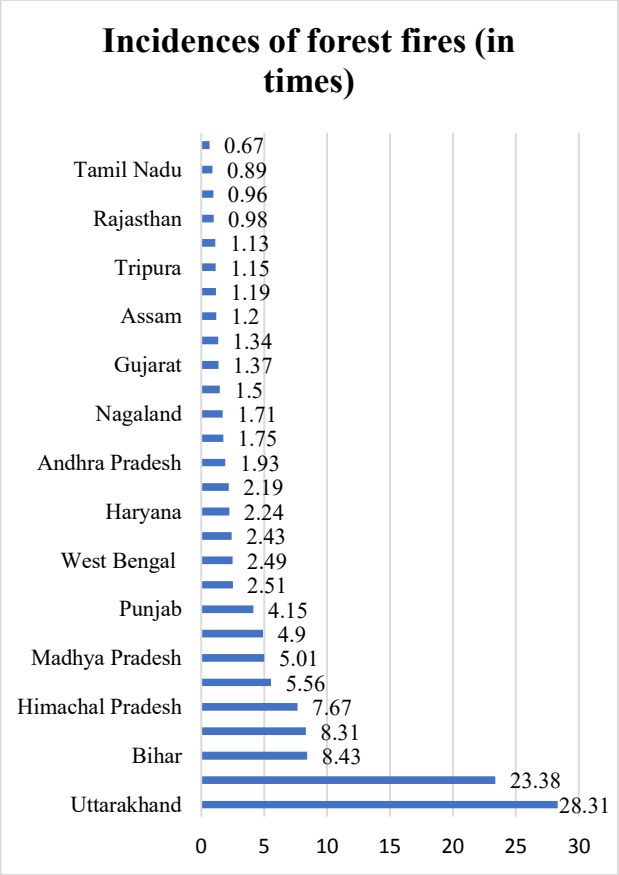
Forest fires have started in Himachal Pradesh, Uttarakhand, Nagaland-Manipur border, Odisha, Gujarat, Madhya Pradesh since the beginning of the year 2021, including those in wildlife sanctuaries. From February 22 and March 1, 2021, at least 5,291 incidents of forest fires were detected in Odisha, according to FSI (2021), the largest in the country during the same period. Forest fires in Odisha are caused by the collection of tendu leaves, mahua flowers, shifting cultivation, as well as grazing in forest areas. During the same time period, Telangana had the second-highest number of fires in the country, with 1,527, preceded by Madhya Pradesh (1,507) then Andhra Pradesh (1,292). According to the FSI, India had 345,989 forest fires during November 2020 to June 2021. This is the country's highest figure during this time period. During the same period in 2018-19, at least 258,480 forest fires were registered, the second-highest number ever. This is 2.7 times the number of fires reported in the period November 2019 to June 2020. Large, ongoing, and recurring forest fires are examples of this. Currently, forest fires menace 35.46 percent of the forest cover, 2.81 percent are extremely vulnerable, 7.85 percent are very highly vulnerable, and 11.51 percent are highly vulnerable. According to a new analysis by the UNEP (UN Environment Programme) and GRID-Arendal (2022), climate change as well as land-use change are expected to increase the frequency and intensity of wildfires, with a global rise of

Volume: I, 15 March 2022, ISBN: 978-81-953847-8-5

roughly to 14% by 2030, 30% for 2050, and 50% by an end of 21st century.

In just one year (2019-20), India lost over 38,500 hectares of tropical forest, or 14% of its total. As one fifth of India's 70.82 Mha of forest land burns every year, India's forests are no longer carbon sinks rather carbon emission regions. These flames would emit far more carbon into the sky than that of the Californian fire estimate of 91 metric tonnes emitted from a forest fire area with just 1.4 Mha. According to GFW, Mizoram had seen the foremost forest loss (47.2 percent), next by Manipur, Assam, Meghalaya, and Nagaland, which collectively lost more than 52 percent of India's tree cover in 2019-20.





Source: Forest survey of India (2021)

The state with the most fires (51,968) was Odisha, followed by Madhya Pradesh and Chhattisgarh are the next two states with 47,795 and 38,106 fire events respectively. Uttarakhand had the country's 6thhighest fire count, with occurrences up 28.3 times over the previous season. According to the survey, climate change zones in Indian forests will be identified based on forecasts for 2030, 2050, and 2080, and the state would see the highest temperature increase and perhaps a drop in rainfall. Forest fire counts in Chhattisgarh were 23.3 times higher than last year, while in Bihar they were 8.4 times higher.

Effects of forest fire:

Forest fires keep releasing billions of tonnes of CO_2 emissions globally, and million people worldwide are assumed to die as a result of illnesses brought on by smoke from forest fires as well as all other landscape fires.

Forest fires are being stoked by global heating, which in turn is igniting further global warming: a lethal cycle. Observations

over the last two decades suggest that rising temperatures and decreasing precipitation, together with escalating land use intensity, were substantially responsible for increasing the intensity as well as prevalence of forest fires throughout Asia (IPCC, 2007).

Mountain forest fires are not a new occurrence. Monoculture plantations assisted in the spread of green cover and the planting of exotics in mountain and plains kinds that are extremely effervescent to fires. Both Uttarakhand and Himachal state governments embarked on large scale Chir-Pine plantation drives, planting trees even now in mixed forests and grasslands (IMPRI, 2021b). After a few years, pine plantations had overtaken the native woodlands, wreaking devastation. These fires are caused by highly effervescent pine needles that fall from the trees. Second, no green flora grows beneath the pine tree, with the exception of Lantana Camara, an non-native shrub that has depleted wide swaths of woodland in the mountains and is also a forest fire enhancer. Third, the pine tree roots are deep and suckers' water even from deep rocks, causing the area to become arid. A pine forest contains no water bodies. Global forest loss is driven by forest fire is estimated about 4.8Mha*i.e.*, 28% of the global forest cover (Curtis *et al.,* 2018).

Forest fires releases harm full polluting gases such as nitrogen oxide, carbon monoxide and sulphur oxide, all of which contribute to climatic changes, global warming and imbalances of water table level all of which have an influence on quality of life(Rather *et al.,* 2018). Forest fires are predicted to emit more than 8 billion tonnes of CO_2 per year (Van Der Werf *et al.,* 2017). Total CO_2 emissions from forest fires in India were 98.11 Tg (Teragrams) in 2014. (Reddy *et al.,*2017).

Forest fires seem to be the primary cause of forest loss, and because no quick afforestation is planned, this land is being encroached onto by encroachers, leaving the rest of it even more prone to flames. According to India's Forest Survey, over 36% of the country's forest cover is severely prone to forest fire.

Effect on vegetation and wildlife:

Many ecosystems operate on fire regimes (intensity, frequency, size, pattern, severity and season), which can alter the structure, composition and functions of forest landscapes (Bowman *et al.,* 2009; Bond, Keeley, 2005; McKenzie *et al.,* 2004). Fire supported fire-tolerant tree species while discouraged fire-sensitive ones, according to Ivanauskas*et al.* (2003). By promoting the mineralization of nutrients contained in organic debris and enabling the invasion of fast-growing early successional vegetation, fires can also impact ecosystem production and diversity(Boerner *et al.,* 2009).

Forests dominated by deodar pine, chir and sal,sesame and bamboo are especially flammable (Rather *et al.,* 2018).Fire has very little effect on mature *Tectonagrandis* and *Shorearobusta* tr ees, and they recover only when suitable climatic conditions return, however young recruits' status is negatively impacted (Chandra and Bhardwaj, 2015). Other important tree species, such as *Terminalia bellirica*, *Terminalia chebula*, and *Terminalia tomentosa*, which do have commercial but also medicinal value, produce low yield and quality after fires, and species such as *Cassia occidentalis*, *Cassia tora*, *Lantana camara*, *Lantana indica*, *Partheniumhysterophorus* and *Eupatorium glandulosum* have invaded due to repeated fire within those areas.Following a fire, the dwarf bamboo *Sinarundinariarollaona* invades wooded regions and takes over, suppressing other natural species (Attri*et al.,* 2020). Fire has the most dramatic effects on oak and coniferous forests, which require a lengthy break to recover because these plant species catches high intensity crown fire despite the high heating value. The low-intensity fire burns litter including organic matter, increases available plant nutrient and enabling herb regeneration and post-fire communal growth. The risk of fire may reduce pollinators,

resulting in a significant reduction in orchid number and diversity (Coats and Dixon, 2007).

Due to their location-based existence, endemic species are pushed to extinction by fires. Many wild cat species, including panthers, leopards, tigers, and cheetahs, are on the verge of extinct as a result of fires and habitat destruction and fragmentation. Ground-nesting birds may be killed before they can fly (Reinking, 2005), whereas arthropods on the forest floor in their egg and early larval stages are often more vulnerable to extinction(Niwaand Peck, 2002).The number of butterfly species in Assam's UltaPani Forest decreased from 200 to 30 after a forest fire in 2012. The flames that raced throughout the continent harmed an estimated 2.5 billion reptiles, 180 million birds,143 million mammals, 51 million frogs, according to The Guardian (2020).The devastating fires in Australia in 2019–20 shot dead or dispersed about 3 billion animals, highlighting the country's natural wildlife devastation.

Effect on soil properties:

The chemical, physical, and microbiological characteristics of soil alter when it is heated by fire. Through leaching, volatilization,
oxidation, erosion, and ash mobility, wildfire affects the soil nutrient composition and pool.

In central India, (Jhariya and Singh, 2017) found that the levels of nitrogen stock, macronutrients, carbon stock and overall microbial biomass carbon were greater in no-fire zones than in fire-prone areas.The no-fire zone had the largest total soil carbon store (0–20 cm soil depth), next by medium (66.55 tonne ha1) and low fire severity (53.69 tonne ha1) fire severity zones. The total soil nitrogen stock varied between 2.60 and 4.08 tonnes per hectare throughout the locations, with the no-fire zone having the highest total soil nitrogen stock, followed by medium and high fire severity. Soil microbial biomass carbon followed a similar pattern, with greater levels in the no-fire zone. Microorganism biomass is reduced by fire, and these organisms are vital in nutrient cycling and energy transfer in the forest ecosystem. Positive (Liu *et al.,* 2007), negative (Choromanska and DeLuca, 2001; Rodriguez *et al.,* 2009), or neutral (Mabuhay *et al.,* 2003) effects of fire on soilmicrobial biomass have been reported (Rutiglianoet *al.,* 2007).

Another study by Chandra and Bhardwaj (2015) found that, higher-intensity fires result in total removal of soil organic matter with volatilization of nitrogen, phosphate, and potassium, while complete combustion of Mn, Mg, Cu, and other micronutrients needs extremely high temperatures. Forest fires reduce the number of actinomycetes, fungal populations, and arbuscular mycorrhizal fungi while increasing the diversity of bacteria.Higher water repellency leads to reduced infiltration and increased runoff, which leads to increased erosion (Bano, 2000).

Economic loss:

Forest fires caused financial losses of Rs 9000 per hectare per year, as perstatementof the UNDP (United Nations Development Program) (Satendra& Kaushik, 2014). Forest fires, on the other hand, caused a total economic loss of INR 4.95billion in 2018. (Paliath, 2018).The data on forest fires is inaccurate since the number of fires measured and the area burnt are understated. This estimate ignores soil moisture, biodiversity loss, wood, enhanced carbon sequestration, and nitrogen loss, among other factors. Furthermore, thorough data on forest losses in terms of area burnt, values, volume and regrowth lost by fire is lacking in India. Due to a lack of accountability, this is the justification (Bahuguna and Singh, 2001).

Fire as a tool:

Since ancient times, fires, either accidental or intentional, have played a fundamental role in shaping forests. Forest fires are not always detrimental to forest management, but they can also be beneficial. It has the following roles in forest ecosystem

management and functioning: to recycle nutrients locked up in litter; to decrease competition, allowing pre-existing trees to grow relatively big; to limit the overstock or growth of unwanted plants and stimulate suitable food plants like legumes for both forage and soil improvement; to enable in the better dispersion of species on even a range or management unit, such as bird habitat; to boost growth during season whenever there is minimal green grazing; to suppress or kill insect-pests and diseases; to increase seed germination or cone opening, whether naturally or artificially; to generate fire breaks in a wildfire countermeasure.

As a result, forest fires are often not catastrophic. Modest, controlled burns, such as prescribed burning, are vitally important and beneficial. Without fire, vegetative changes can occur in fuel loads considerably beyond safety norms, posing a major hazard to the forest if ignited. Reasonably small fires offer social and ecological rewards as well, such as lowering the probability of catastrophic forest fires, boosting silvicultural opportunities, expanding forage and habitat chances for wildlife, and encouraging biodiversity.

Managerial implications:

To reduce fire risk, following are some of the key fundamental principles that can be employed to prevent, control and monitor fire prone areas. Its difficult to implement all the practices at a time but by integrating those its an excellent approach to curtail the future incidences of forest fires.

- *Silvicultural practises:* In attempts to break the vertical continuity of any fuels, useful silvicultural practises are required, such as weeding, cleaning, climber cuttings, removal of dead and dying trees along with litter residue, regulate thinning treatments as per types of vegetation, planned grazing, promoting fire resistant species, and afforestation of burnt areas to recover at resilience.According to Smith et al. (1997), canopy treatments that alter the architecture and structure of the upper most forest canopy not only alter the forest's function as a source of fuel, and yet also redistribute vegetation cover to lower stems and/or allow for forest regeneration.
- *Forest line:* Fire lines are permanently cleared swaths of vegetation in the aim of putting out or delaying a fire. There are two types of it. Internal forest fire line to keep fire from spreading from one area to the next. An external fire line is used to keep fires from entering forest regions from the outside. Forest fire lines can range in width from 5m to 30m, depending on the forest type, terrain, and other factors. However, in order to prevent losses due to timber species cutting, the width of the external and internal fire lines is maintained at 3m and 1.5m, respectively.
- *Counter-fire*: Setting back a fire against fire in order to reduce the intensity and spread of a forest fire. Depending on topography, weather and fuels, the uniformity of the wildfire front, counter-firing may or may not succeed.
- *Constructing green fire belt*: In Nilgris, Tamil Nadu, evergreen plants like as *Eugenia, Wendlandia, Syzygium* and others are frequently cultivated to construct a fire-break zone surrounding Shola woods. Strobilanthes serves as a natural fire barrier in evergreen woods due to its succulent stems. *Sesbaniaaculeata* and *Crotolariajuncea* are also intentionally raised in interspace to check the forest fires in many parts. Species like *Atriplex* and *Tamarix* contains high salt, burns slowly and could act as a firebreak in dry areas.
- *Fire retardant chemicals*: For the management and suppression of wildland fires, aerial application of fire retardant chemicals such as Bentoite, Borate, Ammonium Biphosphate and Ammonium Sulfate (Attri*et al.,* 2020) and Fire-Trol and Phos-Chek is particularly successful.
- *Technological approach:* Ground-based troops spray fire retardant chemicals or pump water to put out the fire using helicopters or

air tankers. These are costly techniques that make sense for preserving a human group, yet they are rarely used in India.

Legal measures:

In 1988, the NFP (National Forest Policy) was revised to emphasise conservation efforts from expansion, grazing and fire.For forest fire management and prevention, India has a solid legislative and institutional framework in place. Setting fire to woodlands is prohibited by national legislation.

According to section 26 and section 33 of the IFA (Indian Forest Act,1927), it is unlawful to burn and enable a fire to continue burning in reserved and protected forests. The Wild Life (Protection) Act of 1972, Section 30, makes it illegal to set fire to wildlife sanctuaries.

Advance tech:

It is vital to use satellite data to track and understand catastrophic fires so that we can effectively manage it in a warming climate. Long-term multilateral datasets that track fires from initial detection and precisely map the magnitude of the area burned are required to understand both of the immediate or long impacts of fire.

Remote sensing and geographic information systems (GIS) are game-changing technologies for fire detection and management, its diagnisis and prevention so they must become an integral element of fire suppression.

Since 2004, the Forest Survey of India has been informing state forest departments about forest fires spotted by NASA's MODIS (Moderate Resolution Imaging Spectroradiometer) sensor onboard the Aqua and Terra satellites. The "Forest Fire Alert System 2.0" has been given to the updated fire alert system, which was inaugurated on January 23, 2017. Highlights include the inclusion of Forest Fire Alerts from the SNPP-VIIRS (Visible Infrared Imaging Radiometer Suite) Sensor with greater resolution. In 2019, it was renovated once more, with the debut of FAST Ver. 3.0, a faster, faster, and more resilient version of the Fire Alert System.Forest fires could be tracked using modern technology-driven smart sensors (labelled "green bots") (Shah, 2020). Apart from being expensive and time-consuming to install, data collected by green bots may be used to generate a real-time forest inventory, which can assist avert forest fires and other calamities.

Initiatives by India:

The Government of India devised strategies and schemes to address and mitigate the forest fire catastrophe. The Ministry's Forest Protection Division released NAPFF (National Action Plan on Forest Fires) in 2018 with the goal of reducing forest fires by educating, training, and incentivizing forest fringe communities to collaborate with state forest departments as well as released a report titled "Strengthening Forest Fire Management in India." In January 2019, the FSI, Dehradun unveiled a quicker and more resilient version of the Fire Alert System on behalf of the Ministry. For locating fir hotspots and issuing early alerts across the nation, the Forest Fire Geoportal and Forest Fire Danger Rating (FFDR) are launched. FFPM (Forest Fire Prevention and Management Scheme) is the only federally financed programme aimed at assisting states with forest fire prevention and management. FFPM efforts, as well as NAPFF, address wide range of preventive techniques outlined in SDG 15 targets 15.5 and 15.7.

Issues in Forest Fire management:

There are key difficulties and lacunas in implementing, adopting and maintaining forest fire management tools and measures right from gross root level to policy makers which need to be addressed in the upcoming future for effective forest management interventions.

- The forest fires in India often extensive and intense, making seclusion a difficult solution.
- For impactful FFPM (Forest fire prevention and management), there is a lack of a coherent policy framework with such a clear strategic goal.

- National FFPM recommendations issued in 2000 are principally unimplemented.
- The FFPM process is being hampered by the lack of a specific FFPM fund at both the federal and state levels.
- Post-fire management is still not considered a necessary component of FFPM.
- Standard for gathering data on forest fires, notably their causes, are inadequate.
- The Forest Departments is lacking with equipment, technology, and infrastructure, as well as manpower and monetary resources.

Way forward:

- Forest fires are extremely devastating, both in the short and long term. Scientific analysis and standardised procedures must be used to cope with it.
- It's crucial to offer FFPM with precise and consistent financing, with an emphasis on allocation optimization.CAMPA funds must be put into practical use.
- To fill field personnel openings, ensure enough budgetary resources and incentives.
- The National Green Mission is an essential asset aimed at increasing the size and quality of India's forests in order to meet the UNFCCC's INDCs.
- In regions wherein green felling is prohibited, the MoEFCC believes that silviculture methods must be comprehensive and transparent.
- To rationalise fire use and avert undesirable fires, communities must be engaged.
- Satellite-based alert systems as well as ground-based detection systems are being improved.
- The formulation of national standard procedures for forest fire response may go a far toward harmonizing the country's forest fire management in resilience.
- Post-fire management is a vital part of the overall FFMP that must be addressed.

Conclusion:

By reviewing literatures, we can say that with increasing population, the anthropogenic causes are becoming major source of forest fires in the country and controlling them is the need of the hour. Many factors involved in fire, and its ecological, social and economic implications. Forest fires offer both advantages and disadvantages. depends on the intensity, frequency, and severity of the event, which alters the structure and composition of the forest ecosystem's biotic and abiotic elements.Background has been provided on the need of exact and reliable baseline data, as well as its inadequacy in India.For building a complete management strategy for fire in a dynamic environment, certain points are advised sector-by-sector having short- and long-term ambitions.MOEFCC and NDMA also must walk the talk and give assistance to state-level mechanisms.In order to maintain harmony with forest fire, there is a need of proper practical implementations of the existing practices and upcoming modern technologies at ground level with the involvement of forest personals, JFM committees, forest dwellers to make it effective at global scale.

References:

1) *Attri, V., Dhiman, R. and Sarvade, S., 2020. A review on status, implications and recent trends of forest fire management. Archives of Agriculture and Environmental Science, 5(4), pp.592-602.*

2) *Bahuguna, V.K. and Singh, S. (2001). The forest fire situation in India. Int. Forest Fire News 26 p.*

3) *Bano, L.F. (2000). The role of fire and soil heating on water repellency in wildland environments: a review. Journal of Hydrology, 231-232: 195-206.*

4) *Boerner, R.E., Huang, J. and Hart, S.C. (2009). Impacts offire and fire surrogate treatments on forest soil properties:A meta-analytical approach. Ecol. Appli., 19: 338-358*

Ivanauskas, N.M., Monteiro, R. and Rodrigues, R.R. (2003).Alterations following a fire in a forest community ofAlto Rio Xingu. For. Ecol. Manage., 184: 239-250.

5) *Bond, W.J. and Keeley J.E. (2005). Fire as a global "herbivore": The ecology and evolution of flammable ecosystems.*

TrendsEcol. Evol., 20, 387–394. DOI: 10.1016/j.tree.2005.04.025.

6) Bowman, D.M., Balch J.K., Artaxo, P., Bond, W.J., Carlson, J.M., Cochrane, M.A., D,Antonio, C.M., DeFries, R.S., Doyle,J.C., Harrison, S.P., Johnston, F.H., Keeley, J.E., Krawchuk, M.A., Kull, Ch.A., Marston, J.B., Moritz, M.A., Prentice,I.C., Roos, Ch.I., Scott, A.C., Swetnam, T.W., van der Werf, G.R. and Pyne S.J. (2009). Fire in the earth system. Science,324, 481–484. DOI: 10.1126/science.1163886.
7) Burton, C., Betts, R.A., Jones, C.D., Feldpausch, T.R., Cardoso, M. and Anderson, L.O., 2020. El Niño driven changes in global fire 2015/16. Frontiers in Earth Science, 8, p.199.
8) Chandra, K.K. and Bhardwaj, A.K., 2015. Incidence of forest fire in India and its effect on terrestrial ecosystem dynamics, nutrient and microbial status of soil. International Journal of Agriculture and Forestry, 5(2), pp.69-78.
9) Choromanska, U. and DeLuca, T.H. (2001). Prescribed firealters the impacts of wildfire on soil biochemicalproperties in a ponderosa pine forest. Soil Science Society of America Journal, 65: 232-238.
10) Coats,D.J. and Dixon, K.W. 2007. Current perspectives in plant conservation biology. Aust. J. Bot., 55: 187-93.
11) Curtis, P. G., Slay, C. M., Harris, N. L., Tyukavina, A., & Hansen, M. C. (2018). Classifying drivers of global forest loss. Science, 361(6407), 1108-1111.
12) FSI(Forest Survey of India). 2017.Forest Fire. India state of forest report 2017. Dehradun, India.
13) FSI(Forest Survey of India). 2021. Forest Fire. India state of forest report 2021. Dehradun, India.
14) IMPRI (Impact and Policy Research Institute),2021a. Forest Fires in North India: A Man-Made Disaster, April 8, 2021.
15) IMPRI (Impact and Policy Research Institute),2021b. Forest fires national disaster. 8 April, 2021.
16) IPCC (2007) 'Climate Change 2007: synthesis report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.' (Eds RK Pachauri, A Reisinger, and the Core Writing Team) (IPCC: Geneva, Switzerland)
17) Jhariya, M.K., and Singh, L. 2021. Effect of fire severity on soil properties in a seasonally dry forest ecosystem of Central India. Int. J. Environ. Sci. Technol. 18, 3967–3978. https://doi.org/10.1007/s13762-020-03062-8.
18) Joseph, S., Anitha, K., and Murthy, M. S. R. (2009). Forest fire in India: a review of the knowledge base. Journal of forest research, 14(3), 127-134.https://doi.org/10.1007/s10310-009-0116-x.
19) Liu, W., Xu, W., Han, Y., Wang, C. and Wan, S. (2007).Responses of microbial biomass and respiration of soilto topography, burning, and nitrogen fertilization in atemperate steppe. Biology and Fertility of Soil, 44: 259-268 Rodriguez, A., Duran, J., Fernandez-Palacios, J.M. andGallardo, A. (2009). Short-term wildfire effects on thespatial pattern and scale of labile organic-N andinorganic-N and P pools. Forest Ecology andManagement, 257: 739-746.
20) Mabuhay, J.A., Nakagoshi, N. and Horikoshi, T. (2003).Microbial biomass abundance after forest fire in pineforests in Japan. Ecological Research, 18: 431-441.
21) McKenzie, D., Gedalof, Z., Peterson, D.L. and Mote P. (2004). Climatic change, wildfire, and conservation. Conserv. Biol.,18(4), 890–902. DOI: 10.1111/j.1523-1739.2004.00492.x.
22) Niwa, C.G. and Peck, R.W. (2002). Influence of prescribedfire on carabid beetle (Carabidae) and spider (Araneae)assemblages in forest litter in south-western Oregon.Environmental Entomology, 31(5): 785-796.
23) PaliathS., 2018. "Forest Fires Increased 158% In 6 Years; Warming A Factor," India Spend, 2018,

https://www.indiaspend.com/forest-fires-increased-158-in-6-years-warming-a-factorexperts-53125/.

24) Parameswaran, K., Nair, S.K. and Rajeev, K., 2004. Impact of Indonesian forest fires during the 1997 El Nino on the aerosol distribution over the Indian Ocean. Advances in Space Research, 33(7), pp.1098-1103.

25) Rather, M. A., Farooq, M., Meraj, G., Dada, M. A., Sheikh, B. A., and Wani, I. A. (2018). Remote sensing and GIS-based forest fire vulnerability assessment in Dachigam National park, North-Western Himalaya. Asian Journal of Applied Sciences, 11(2), 98-114.https://doi.org/10.3923/ajaps.

26) Reddy, C. S., Alekhya, V. P., Saranya, K. R. L., Athira, K., Jha, C. S., Diwakar, P. G., and Dadhwal, V. K. (2017). Monitoring of fire incidences in vegetation types and Protected Areas of India: Implications on carbon emissions. Journal of Earth System Science, 126(1), 11.https://doi.org/10.1007/s12040-016-0791-x Saha, P. K., Bodiuzzaman, M., Uddin, M. N., Hossain, M.

27) Reinking, D.L. (2005). Fire regimes and avian responses inthe central tall-grass prairie. Studies in Avian Biology,30: 116–126.

28) Rutigliano, F.A., De Marco, A., D' Ascoli, R., Castaldi, S.,Gentile, A. and De Santo, A.V. (2007). Impact of fireon fungal abundance and microbial efficiency in Cassimilation and mineralization in a Mediterraneanmaquis soil. Biology and Fertility of Soils, 4: 377-381.

29) Satendra and Kaushik, A.D., 2014. Forest fire disaster management. New Delhi: National Institute of Disaster Management, Ministry of Home Affairs, Government of India.

30) Shah, A., 2020. Modern Technology for Sustainable Forest Management in India. Observer Research Foundation, New Delhi.

31) Siegert, F., Ruecker, G., Hinrichs, A. and Hoffmann, A.A., 2001. Increased damage from fires in logged forests during droughts caused by El Nino. Nature, 414(6862), pp.437-440.

32) Smith, D. M.; Larson, B. C.; Kelty, M. J.; Ashton, P.M. S. 1997. The practice of silviculture: Applied forest ecology. John Wiley & Sons, Inc, New York. 537.p.

33) The Guardian. 2020. "Almost 3 billion animals affected by Australian bushfires". https://www.theguardian.com/environment/2020/jul/28/almost-3-billion-animals-affected-by-australian-megafires-report-shows. Tue 28 Jul 2020.

34) Van Der Werf, G. R., Randerson, J. T., Giglio, L., Van Leeuwen, T. T., Chen, Y., Rogers, B. M., andYokelson, R. J. (2017). Global fire emissions estimate during 1997-2016. Earth System Science Data, 9(2), 697-720.https://doi.org/10.5194/essd-9-697-2017.