FOREST FIRE

NATIONAL DISASTER RESPONSE FORCE
INDIA

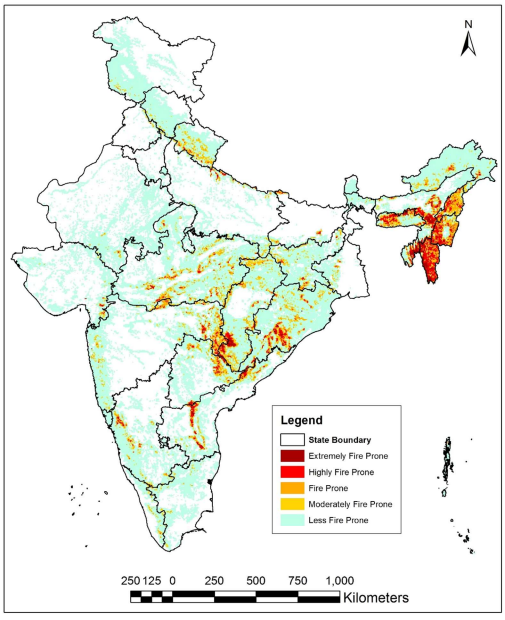
TABLE OF CONTENTS

1. INTRODUCTION TO FOREST FIRE: INDIAN SCENARIO

India constitutes one of the mega bio-diversity zones of the world, abundant with unique and diversified floral and faunal wealth. As per India State of Forest Report (ISFR) 2023 published by the Forest Survey of India, about 21.76% (7, 15,342.61 sq km) of India's geographical area was identified as forest. Tree cover makes up another 3.41% (1, 12,014.34 sq km). Increasing human interference in the natural forest ecosystem has tremendously increased Forest Fire incidents. India has witnessed a significant increase in forest fires over the past few decades. According to the Forest Survey of India, the country has lost over 1.5 million hectares of forest cover to fires between 2000 and 2020.

In India, severe fires are prevalent in numerous forest types, especially dry deciduous forests; whereas evergreen, semi-evergreen, and montane temperate forests are relatively less susceptible (FSI, 2015) 5. As per ISFR 2021, more than 36% of the country's forest cover was estimated to be prone to frequent forest fires. 2.81 % of the country's forest cover was extremely prone to fires, whereas 7.85% of forest cover is found to be very highly fire prone. Based on previous fire incidents and recorded events, forests of the Northeast and Central India regions are the most vulnerable areas to Forest Fire. Forests in Assam, Mizoram and Tripura have been identified as 'extremely prone' to this hazard. States with large forest areas under the 'very highly prone' category include Andhra Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Odisha, Maharashtra, Bihar and Uttar Pradesh. As per the annual report of the MoEF&CC of 2020-2021, Western Maharashtra, Southern Chhattisgarh and areas of Telangana along with central Odisha are turning into 'extremely prone' Forest Fire hotspots.

Forest cover in different fire prone classes



Category	Forest cover (in sq km)	% of Total forest cover
Extremely Fire Prone	20,081.71	2.81
Very Highly Fire Prone	56,077.94	7.85
Highly Fire Prone	82,947.06	11.61
Moderately Fire Prone	94,182.53	13.19
Less Fire Prone	4,60,933.88	64.54
Total	7,14,223.12	100.00

- 36% of the country's forest cover has been estimated to be prone to frequent forest fires
- Most of the fire-prone forest areas are found in the North-eastern region and the central part of the country

61

1.1 Causes of forest fire:

The forest fire season in the country is normally from November to June with majority of fires being caused due to man-made factors. Natural fires caused by lightening or friction of dry bamboo are very rare occurrence. As per the Forest Survey of India (FSI) analysis, more than 95 percent of the Forest Fires in the country are man-made and almost 50 percent of the forest areas are fire-prone.

Traditionally Indian forests have been affected by fires. The menace has been aggravated with rising human and cattle population and the consequent increase in demand for forest products by the individuals and communities.

Depending upon the source of the heat, the causes for forest fire may be classified as natural or artificial. While lightening, volcanic explosion, friction of rolling stone etc. are the natural causes for forest fire; the anthropogenic causes may be subdivided into two categories i.e. deliberate causes and unintentional or accidental causes.

Forest fires in the country can be segregated in four prominent clusters:-

a) Fires in the Western Himalayan region (Jammu & Kashmir, Uttarakhand, and Himachal Pradesh) on account of fires in pine forests and by transhumance pastoralists.

b) Fires in western part of the country on account of drier vegetation and extensive grassland habitats.

c) Fires in Central Indian states, Western and Eastern Ghats on account of large scale collection of NTFPs.

d) Wide spread fires in North-Eastern states due to shifting cultivation.

NATURAL	**ANTHROPOGENIC**	
	DELIBERATE CAUSE	**ACCIDENTAL CAUSE**
Friction of rolling stones	Shifting cultivation	Collection of non-timber forest produce
Rubbing of dry bamboo clumps	To flush growth of Tendu leaves	Burning farm residues
Volcanic explosion	To have good growth of grass and fodder	To scare away wild animals
Lightening	To settle score with forest department or personal rivalry	Throwing burning bidis/cigarettes
	To clear path by villagers	Camp fire by picnickers
	To encroach upon forest land	Sparks from vehicle exhaust
	For concealing illicit felling	Sparks from transformers
	Tribal traditions and customs	Uncontrolled prescribed burning
		Resin tapping
		Making charcoal in forest
		Heating coal tar for road construction in forest

1.2. Effects of forest fire:

Forest fire damages all form of life at different levels of organisms. Several million hectares of forest land is burnt worldwide annually which has significant impact on the economy, Environment, human health and wildlife of the affected country.

"Fire is a good servant but a bad master" the saying is true for forest fire too. Limited and controlled forest fires have been very useful and essential for healthy forest growth. But uncontrolled forest fire may engulf and destroy healthy thick forest cover within no time. Besides direct loss to forest cover, forest fire also kills wildlife, damages environment, degrades soil quality and retrogrades forest regeneration.

Even ordinary ground or surface fire damages seedling and results in regeneration or loss of growth. In repeated fires, regeneration of native species may be lost completely. Valuable species disappear and their place is taken by other fire hardy species and weeds. Forest fire leaves the soils bare to the action of natural elements like sun, wind and rains consequently soil erosion starts and results in the loss of fertile soil.

Forest fire damages the protective power of the forest thus increasing the threat of floods and landslide. It also causes loss of habitat for wildlife making them susceptible to death due to poaching, adverse weather conditions or killing by predator species.

Large uncontrolled forest fires result into health problems due to fire generated smoke. Breathing problems, skin irritation, loss of visibility and other related problems are very common during forest fires.

1.3. Effects of forest fire on wildlife.

The adverse effects of forest fires are directly related to animal injury and destruction of nesting and breeding areas, shelters and food sources. Typically the most affected are the slower-moving animals like turtles, badgers, elderly and very young animals that are unable to escape. The main effects observed were temporary displacement, which make it difficult to find new suitable areas, increase territorial conflicts and decreased survival and reproductive success.

It is important to inform the public and stake holders involved in extinguishing the fire (fire fighters) how to act in the presence of an animal victim of forest fire. They should not disturb the animals that escape fires, keep pets inside the house to avoid conflicts, supply food and create water bodies for them without making any dependence on humans, capture injured animals and forward them to formal institution with veterinarian/forest department assistance.

2. FOREST TYPES OF INDIA

India is one of the few countries rich in bio diversity. As per the Forest Survey of India Report 2023, India has forest cover of 7, 15,342.61 sq km, comprising 21.76% percent of the total geographic area of the country. The country shows much variation in its forest vegetation due to its diversified climatic and physiographic conditions. The forest vegetation in India varies from tropical evergreen forests in the Andaman & Nicobar Islands to dry Alpine forests high up in Himalayas. In between the two extremes, the country has semi-evergreen, deciduous, littoral and swamp, thorn, sub-tropical broad-leaved hill pine and montane-temperate forests. In physical terms, the forests of the country vary from those that contain trees over 70 meters in height to those that have trees less than 7 meters in height and has stratification of trees that varies from single to many storied. According to Forest survey of India, the country has sixteen types of major forests.

i) Physical features

Covering an area of 3,287,263 sq km, India is the seventh largest country of the world. India physically comprises of four broad geographical areas, namely the Great Himalayas (East and West), the vast Indo-Gangetic Plains, the Great Thar Desert and the Southern peninsula bounded by Western and Eastern Ghats. India, which is bounded by the Himalayas in the North, stretches south flanked by the Bay of Bengal and Arabian Sea and tapers off into the Indian Ocean. The land mass of the country lies within latitudes 8.4 and 37.6 degrees North and longitudes 68.7 and 97.25 degrees east. Physiologically and biologically India is primarily tropical. However, due to altitude variations and other habitat factors, a range of climates can be observed influencing its ecology, flora and fauna. There are also considerable differences among the states in their pattern of development and other socio-economic and demographic profiles influencing forest eco-system In India, the forests on the basis of average annual rainfall can be categorized broadly into five categories:-

a) **Tropical evergreen and semi evergreen forests**- they are found in western slope of the Western Ghats, hills of the North-eastern region and the Andaman and Nicobar Islands. These forests are dense and multi-layered. Trees in this forest are dense, tall and very green. They harbour many types of plants and animals.

b) **Tropical deciduous forests (monsoon forest) -** These are found in both tropical and subtropical region. These are also called monsoon forests. Leaves regrow during monsoon and shed during summer. Trees are tall with broad, branched trunks.

c) **Tropical thorn forests**- it has dense, scrubs like vegetation. Trees remained leafless for most part of the year and water is stored in stem of the trees and consist of a variety of grasses and shrubs.

d) **Montane forests**- mountainous region with increase in altitude and temperature decrease. Chir (pine) is the main tree but oak, jamun and rhododendron are also found in these forests.

e) **Littoral/swamp forests**- some of these forests are dense and impenetrable. Only a limited number of plants are found in this evergreen forest. They have roots that consist of soft tissue so that the plant can breathe in water. These forests stabilize the shoreline and protect the coastal areas from erosion.

Forest type	climate conditions	Main features	Examples of species/regions
Tropical evergreen forest	Hot, humid, heavy rainfall (>250 cm)	Dense, multilayered, evergreen	Andaman & Nicobar, western Ghats, northeast states. Species: rosewood, ebony, mahogany
Tropical deciduous forest	100-200 cm rainfall	Shed leaves in dry season, most widespread type in India	Teak, sal, shisham, palash, neem, babul
Tropical thorn forest	Less than 70 cm rainfall. arid/ semi arid	Thorny shrubs, scattered small trees	Rajasthan, Gujarat, mp, Species: acacia, date palm, cactus
Montane forests	Found in Himalayan ranges: vary by altitude	Mixed vegetation, temperate to alpine types	Oak, pine, deodar, rhododendron. Juniper, birch (alpine)
Littoral & swamp forest	Wetlands, marshy areas	Water-tolerant trees with still roots	Along coastal belts, deltas. Species: Keora, screw pine, myristica swamps.

3. TYPES OF FUELS AND FOREST FIRE

Fuels are the combustible biomass found in the forests. Fuels include everything from needles, grasses and small twigs to progressively larger fuels such as shrubs, branches on the ground, downed trees and logs. Forest fuels are considered as the most important contributing fact than any other environmental factor in forest fire.

3.1 Properties of forest fuel: It includes size, shape, height, depth, load, bulk density, and vertical and horizontal arrangement. Fuel description is required to predict fire behaviour.

3.2 Types of forest fuel: There are three main types of fuels:

(i) **Crown fuel:** All the combustible dead or alive material located in the under storey and above the forest canopy is included in this type of fuels. These fuels are separated from the ground by more than a meter. The main aerial fuels include:-

(i) Branches and foliage of trees
(ii) Trees and shrubs of the under storey
(iii) Standing dead trees, and
(iv) Mosses, lichens and epiphytic plants on trees.

The crown fuels provide much needed combustible material for the spread of forest fire. The inferno in case of crown fires spreads by consuming aerial fuels.

(ii) **Surface fuel:** This type of fuel is the most common type of fire fuels. This may include: -

(i) Tree leaves and the fine litter.
(ii) Grasses, weeds, ferns and the other herbaceous plants.
(iii) Seedlings and saplings of trees
(iv) Fine deadwood on the forest floor
(v) Large logs and stumps, and roots of trees.

These fuels ignite very readily and provide the basic combustible material for the forest fires. This fuel is found on the surface of the forest floor and has varied rates of combustion e.g. herbs, shrubs, fallen leaves, grass and woody fuel including fallen trees.

(iii) **Ground fuel:** Ground fuel involves all the combustible material below the loose litter of the surface. The materials which constitute the ground fuels can be summarized as follows: -

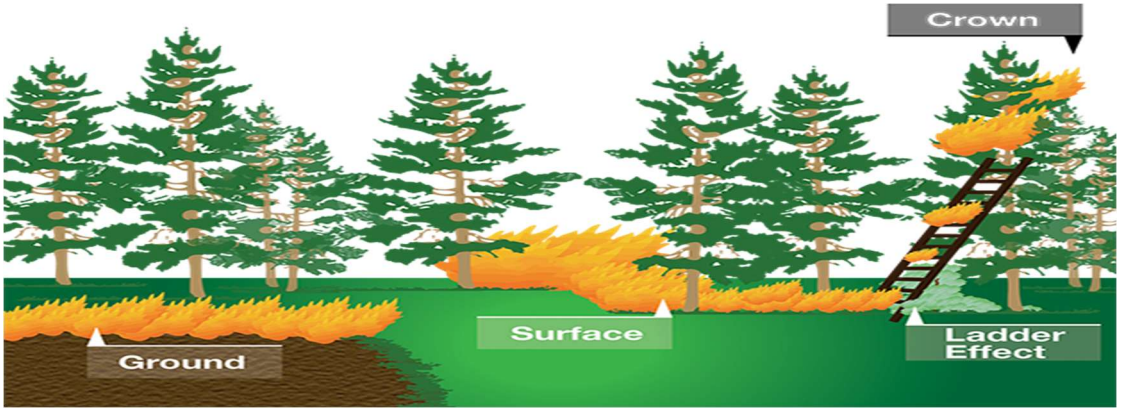
(i) Various decayed stages of the humus
(ii) Trees, shrubs and roots
(iii) Muck and peat

Ground fuel always supports the glowing combustion and not the flame. This does not ignite till the moisture content drops very low (less than 20 percent). The combustion becomes very persistent once the ground fuels ignites. This fuel is formed when the surface fuel mostly degrade over the years and reaches the surface level e.g. partly decayed vegetative matter (duff), lichen, moss and litter etc.

3.3

Stratum		Category
Canopy		Trees, snags, ladder fuels
Shrubs		Primary and secondary layers
Nonwoody vegetation		Primary and secondary layers
Woody fuels		All wood, sound wood, rotten wood, stumps, and woody fuel accumulations
Litter-lichen-moss		Lichen, litter, and moss layers
Ground fuels		Duff, basal accumulations, and squirrel middens

3.4 Types of forest fire: Forest fires are not always same; they may differ, depending upon its nature, size, spreading speed, behavior etc. Basically forest fires can be sub grouped into four types depending upon their nature and size –



(i) **Ground fire**:

These fires are fires in the sub surface organic fuels, such as duff layers under forest stands, Arctic tundra or taiga, and organic soils of swamps or bogs.. This fire burns root and other material on or beneath the surface i.e. burns the herbaceous growth on forest floor together with the layer of organic matter in various stages of decay. They are more damaging than surface fires, as they can destroy vegetation completely.

Ground fires burn underneath the surface by smouldering combustion and are more often ignited by surface fires. Ground fires consume the organic material beneath the surface litter of the forest floor. A ground fire spreads by slowly smouldering edge with no flame and little smoke and is hard to detect. With wind and other favourable conditions, may change into other types of fires such as surface or crown. It is difficult to control as it is mostly not noticeable.

(ii) **Surface fire**: -

Surface fire is the most common type of fire and accounts to 70% in India. Surface fire burns surface litter, dead materials along the floor of the forest, small vegetation and tall shrubs. It is clearly visible by the flames spreading the forest floor.

In general, it is very useful for the forest growth and regeneration. But if grown in size, this fire not only burns ground flora but also engulfs the undergrowth and the middle story of the forest. Surface fires spread by flaming combustion through fuels at or near the surface- grass, dead and down limbs, forest needle and leaf litter or debris from harvesting or land clearing. This is the most common type of fire in timber stand of all species. It may be a mild, low-energy fire in sparse grass and pine needle litter, or it may be a very hot, fast moving fire where slash, flammable under story shrubs or other abundant fuel prevails.

Surface fire can easily turn into crown fire when suitable inflammable material is found that can give the ladder effect. This type is seen in grasslands, forest floor rich in fallen leaves and pine needles. Surface fire can be characterized as: -

a. **Low vigour surface** – slow rate of spread with visible flames or unorganized flame front and can be control easily. Direct methods with fire beater, water sprayers or clearing of fire lines can be helpful in responding to low vigour surface fire.
b. **Moderate vigour surface fire**- Organized flame front and moderate rate of spread with visible flame. Flame height must be considered for direct method of firefighting.
c. **High vigour surface fire**- it is characterized by high rate of spread with organized flame front. Flame height is more and can lead to the torching effect. Indirect methods like cutting of fuels surrounding the area must be used to combat such fires. Air operation can also be employed.
d. **Extremely vigorous surface fire**- this type of fire has very high rate of spread. It is characterized by long range spotting, embers and heavy black or copper smoke. Firefighting methods are generally ineffective. It is advisable to wait for the intensity of fire to reduce. Extremely vigorous surface fire is very rare in India.

(iii) **Crown fire**:

Crown fire is the most unpredictable fire that burns the top of trees and spread rapidly by wind. In most of the cases these fires are invariably ignited by surface fires. This is one of the most spectacular kinds of forest fires which usually advance from top to down of trees or shrubs, interdependent of surface fires. In dense conifer stands with a brisk wind, the crown fire may race ahead of the supporting surface fire since it is over the heads of ground force it is uncontrollable until it again drops to the ground, and since it is usually fast moving, it poses grave danger to the fire fighters becoming trapped and burned.

Crown fire is the burning of tree crown which can occur due to friction of crown against each other or through surface fire through ladder effect. They are very difficult to control as the intensity and the rate of spread is very high. There are mainly two types of crown fires: -

a) Active crown fire (running crown fire) – crown fire where the flame spreads from one tree to another through the tree crown. Fire tornado occurs due to extremely favourable fire weather and is mostly uncontrollable.
b) Passive crown fire – it is the type of crown fire where individual tree crowns or small group of tree crown burn mostly due to torching effect.

(iv) **Firestorms:**

Among the forest fires, the fire spreading most rapidly is the firestorm, which is an intense fire over a large area. As the fire burns, heat rises and air rushes in, causing the fire to grow. More air makes the fire spin violently like a storm. Flames fly out from the base and burning ember spew out the top of the fiery twister, starting smaller fires around it. Temperatures inside these storms can reach around 2,000 degrees Fahrenheit. Along with nature and behaviour, the forest fires can also be categorized according to human management action. On this basis, fires in forest may be categorized

as management ignited fires and prescribed natural fires. Management ignited prescribed fires are ignited in order to meet a land management plan objective, such as debris removal or wildlife habitat improvement. Prescribed natural fires are those that are allowed to burn under an approved plan and preserve the natural role of fires in the ecosystem.

The fire may further be categorized based on their peculiar behaviour. There is specialized vocabulary used by the wild fire community for describing different types of fire behaviour.

(i) A fire is said to be running when it is spreading rapidly

(ii) It is creeping when it is spreading slowly with low flames

(iii) A fire is smouldering when it burns without a flame and is barely spreading.

(iv) A fire is said to be spotting when it is producing sparks or embers that are carried by the wind or by the combustion column caused by the fire and start new fires beyond the main fire. The new ignition points are called spot fires.

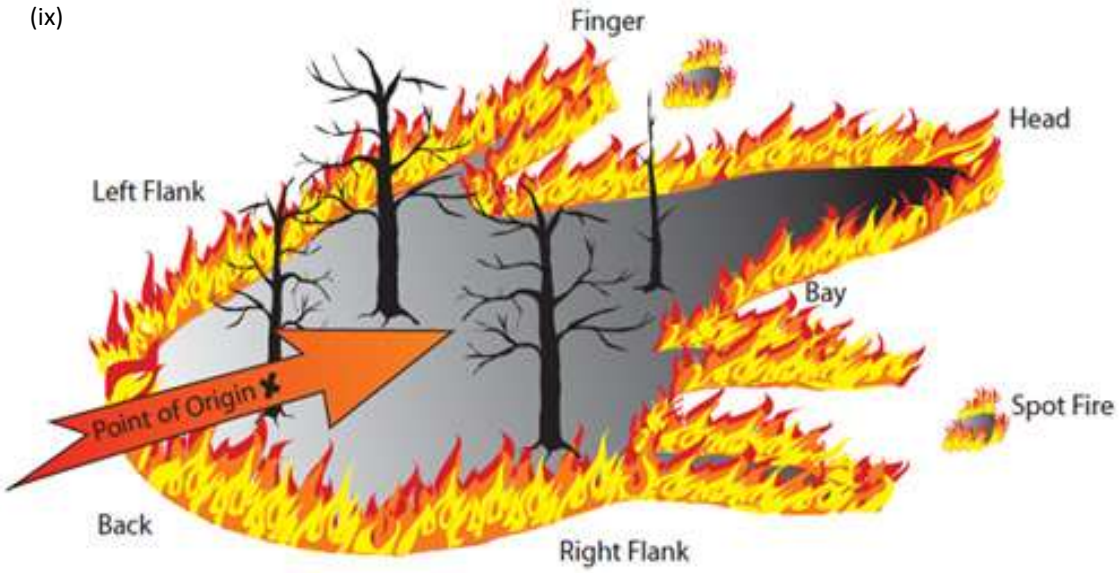
(v) A fire is torching when it moves from one crown to another fire into the crowns of individual trees, but not necessary from one crown to another.

(vi) It is crowning when it spreads from tree to tree usually in conjunction with, but sometimes completely independent of the surface fire.

(vii) A flare-up is a sudden acceleration of fire spread or intensity, of relatively short duration for a portion of the fire.

(viii) A blow-up, on the other hand is a dramatic change in the behaviour of the whole fire, the point of rapid transition to a severe fire.

(ix)



4. FIRE BEHAVIOR AND FIRE WEATHER:

Forest fire results from a combination of natural and anthropogenic factors. These factors are interlinked to each other. Categories of Factors influencing Fire Danger: -

Constant Elements:

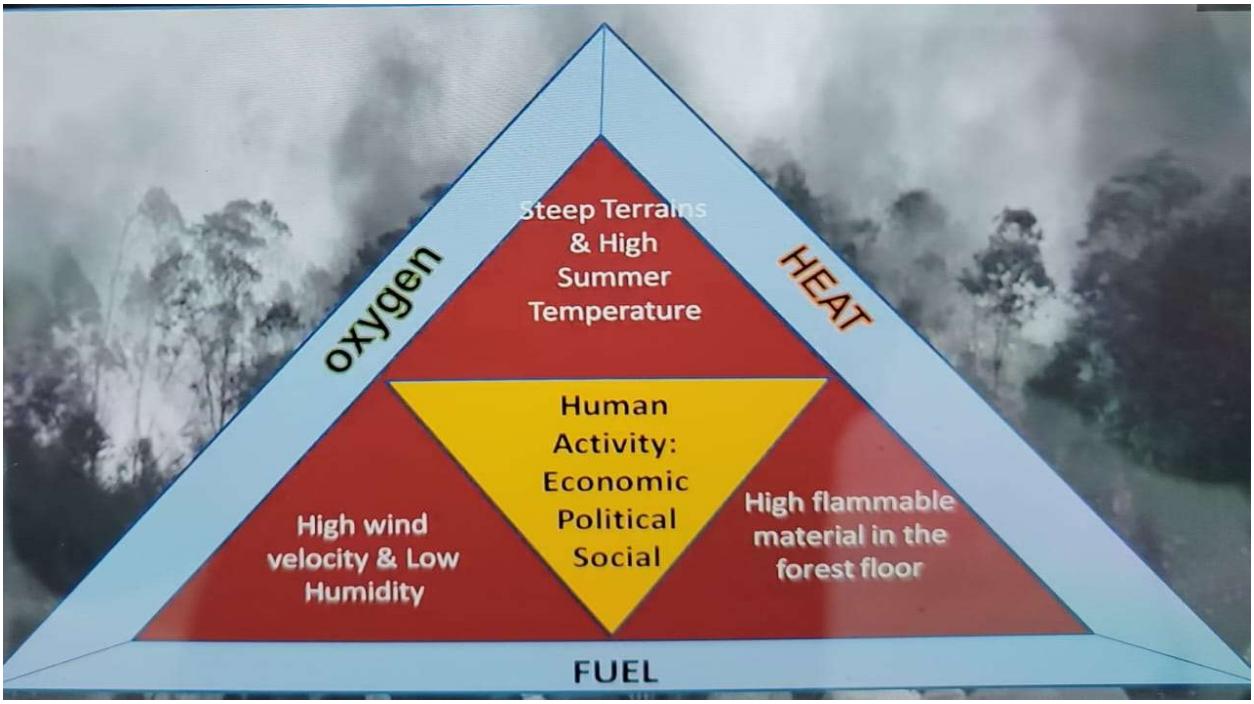
(i) Climate
(ii) Topography
(iii) Solar radiation
(iv) Values at risk

Variable Elements:

(i) Weather
(ii) Fuel Moisture
(iii) Condition of Vegetation
(iv) Fire Risk or Ignition source

4.1 Fire behaviour triangle:

Fire behaviour depends on three main factors namely climate factors, edaphic factors and forest and its fuel itself.



4.2 Climate factors:

Since wildfires burn forest vegetation, the type and characteristics of forest fuels available are a key factor in fire behaviour. Three key factors are monitored: -

(i) **Moisture Content**: Dead vegetation loses moisture more quickly than living vegetation and dryer fuels ignite and burn more easily.

(ii) **Size**: Smaller items, such as twigs, grass and leaves ignite and burn more quickly but larger items, such as trees and branches, take longer to ignite but burn hotter.

(iii) **Continuity**: Fuels that are spread out consistently, such as dry underbrush in a forest, allow fire to spread faster and burn more intensely. Lower branches on trees also allow fire to travel up the trees.

(iv) **Wind**: Higher wind speeds increase fire activity. Changing wind directions may change the direction a fire is spreading. Wind helps reduce the moisture content in fuel.

(v) **Temperature**: Higher temperatures increase fire activity.

(vi) **Humidity** : Lower humidity helps dry fuels and increases fire activity

4.3 Edaphic factors:

Topography is the shape of the landscape. The shape of the land changes the fire behaviour:

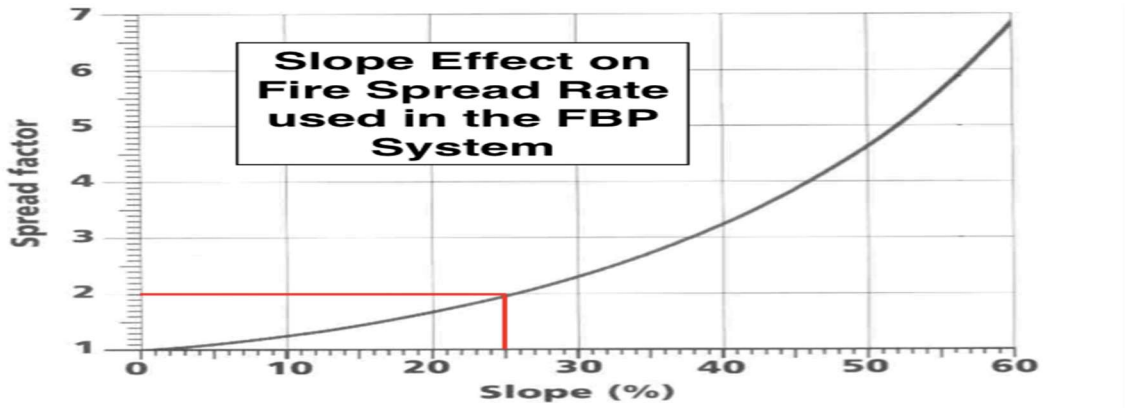
(i) **Slope**: Fires tend to spread more quickly and burn uphill, especially when driven by upslope winds. Down slope winds and burning material rolling downhill increases down slope spread.

(ii) **Aspect (the compass direction a slope faces)**: South-facing slopes receive more sunshine which dries fuels, warms temperature and increases fire activity.

(iii) **Terrain**: Wind speed may be increased by valleys. Mountainous regions can affect wind speed and direction.

(iv) **Elevation/altitude**: fire intensity is lower at higher elevations compared to lower elevation as the higher altitude is naturally cooler and has less fuel loads.

4.4 Slope- spread factor:



4.5 Effect of slope on fire:

4.6 Forest fuel factors:

High fuel load, low moisture in the fuel and highly inflammable fuel nature are the main factors which favour the high occurrence and high spread of forest fire.

4.7 Fire weather:

The world is getting warmer with erratic weather patterns which are increasing day by day. Fire weather is basically derived from the short-term (minutes to days) variations in the atmosphere i.e. the influence of the parameters of atmosphere and the occurrence of fire. Weather is expressed in terms of temperature, precipitation, humidity, cloudiness, visibility and the wind. These weather components are used in the **Fire Danger Alert System** for predicting and forecasting.

4.8 The Nesterov index:

The Nesterov index is a simple fire-danger rating system that came about in 1949.It represented as follows: -

$$P=\sum(t-D)*t+W$$

P- Represents the ignition index

W - Is the number of days since the last rainfall greater than 3mm

t - Is the temperature in degree Celsius

D - Is the dew-point temperature in degree Celsius. The computations begin on the first spring day when the temperature is just above the freezing point which is generally after the melting of snow and continues until a rainfall reaches 3mm, where after the process starts anew.

Value of P	**FIRE DANGER**
Between 0 and 300	Minimal
Between 301 to 1000	Moderate
Between 1001 to 4000	High
Above 4000	Extreme

5. **FOREST FIRE MANAGEMENT:**

Traditionally there are four stages in forest fire management namely: -

(i) Prevention
(ii) Detection
(iii) Suppression
(iv) Restoration of the affected area

5.1 Prevention:

In forest areas, many preventive operations and activities are carried out to prevent Occurrence of forest fire. Some of the important activities are: -

a. Fire line/fire breaks: These are the breaks which are made with an aim to discontinue the supply of fuel which is the cause of forest fire. Before the season in most parts of India i.e. before 15th of February, fire lines are prepared to prevent forest fire. There are several types of fire lines depending on the importance and the place where it is made.

Width of fire line	**Place**
3m	Coupe roads, forest roads, on the sides of state and national highways
6m	Compartment boundary
12m	Range boundary
15m	Division boundary, below high-tension power lines
30m	District boundary, circle boundary

b. **Controlled Burning:** Controlled burning is another activity undertaken by the forest department to break the continuity of fuel on the forest floor.

c. **Removal of the Undergrowth:** Before the onset of the fire season, reducing the fuel load on the forest floor is essential preventive measure. The vertical fuel up to 3m is removed to prevent the fire spreading upwards. Minimizing the branches touching the power lines, weeds like lantana, prosopis etc. which are the potent flammable materials in the forest area are removed or reduce in quantum.

d. **Awareness raising/capacity building of the local people:** Local people who are the prime detectors and responders for any forest fire are made aware about the importance of fire prevention and about the adverse effects of fire in their livelihoods including their immediate c=ecosystem. The local people are made to involve themselves in firefighting training and are also used as fire watchers by the forest department.

5.2 Detection:

Early detection of fire and immediately responding by firefighting can reduce the losses caused by the fire. There are several methods to detect forest fires which include**: -**

a. The local villagers information network: The local villagers are the first to respond and share information to the forest department about the occurrence of forest fire.

b. Watch towers: Watch towers located at the high points can help in noticing the occurrence of fires in the surrounding areas.

c. FSI alert system: Nowadays satellite based fire alert system is being used which sends the fire detection messages to the concerned field officials. This helps in early suppression of fire.

d. Regular Patrolling: Regular patrolling is conducted by the forest department in their respective forest areas and detects fires in any.

e. Drones are becoming an important tool for detecting and monitoring forest fire because they can reach remote, risky areas quickly and safely. Drones equipped with thermal infrared cameras can spot heat signature before flames are visible, detect small, hidden fires or hotspots that ground patrol may miss and allow drones to track fires even in darkness or heavy smoke. It can also provide live aerial video feed of fire spread, smoke movements and hotspots. Helps in situational awareness for commanders. Drones can also fly in rugged terrain, dense forest or areas too dangerous for fire-fighters. Drones are not only for fire management but also an effective deterrent against illegal activities in forest like poaching, illegal logging, encroachment and smuggling.

5.3 Suppression:

Once forest fire occurs in any forest area, immediate response is necessary for suppression but also to reduce the losses.

a) Direct method of fire control-

This is the method in which we control fire by directly beating or spraying water or fire retardants. This is possible with the fires having low intensity. This method can be used for both surface and ground fires.

b) Indirect method of fire control-

This is the method in which we control fire not directly but indirectly by backfire and cutting fire line surrounding the fire. This is used for fires having high intensities. This method is used for fire sloppy terrain surface fires especially where the intensity and rate of spread is very high to control by direct method.

5.4 Post Fire Restoration:

Damage assessment of the forest area affected by the fire is done post fire. Suitable local grasses, shrubs and tree species are planted along with soil moisture conservation works to restore the area. Awareness programs are conducted to prevent any future occurrences of forest fires.

6. FSI FIRE ALERT SYSTEM:

The Forest survey of India is a vital government organisation under the ministry of environment forest and climate change (MoEFCC). It play crucial role in assessing, monitoring and managing India forest. Established in 1981 Head Quartered in Dehradun. Responsible for conducting forest surveys, preparing forest cover maps and providing data -driven support for forest policy and planning.

Since 2004, Forest Survey of India (FSI) has been alerting the State Forest Departments and other agencies regarding forest fire detections using remote sensing and latest Information Technology. Currently during fire season, the following countrywide forest fire related services are being provided: -

a) Near Real-Time Forest Fire Monitoring: The activity is carried out using MODIS and SNPP-VIIRS sensor detections. Based on these sensor detections, the alerts are generated and disseminated to the subscribers.

b) Large Forest Fire Monitoring: The activity involves use of SNPP-VIIRS sensor for large forest fire detections. The system identifies three contiguous SNPP-VIIRS sensor detections and regularly monitors using the subsequent satellite pass over a buffer as long as the fire is active.

c) Pre-fie Alert Based on Forest Fire Danger Rating System: Pre-fire alerts are generated on weekly basis using forest fire danger rating. The Forest Fire Danger Rating involves overlaying and analysis of layers including Canadian Fire Weather Index (FWI) module, Forest Types and Indian meteorological data for categorizing forest into different danger ratings. For generating pre-fire alerts, only two top classes - Extreme and Very High danger ratings are selected for further dissemination.

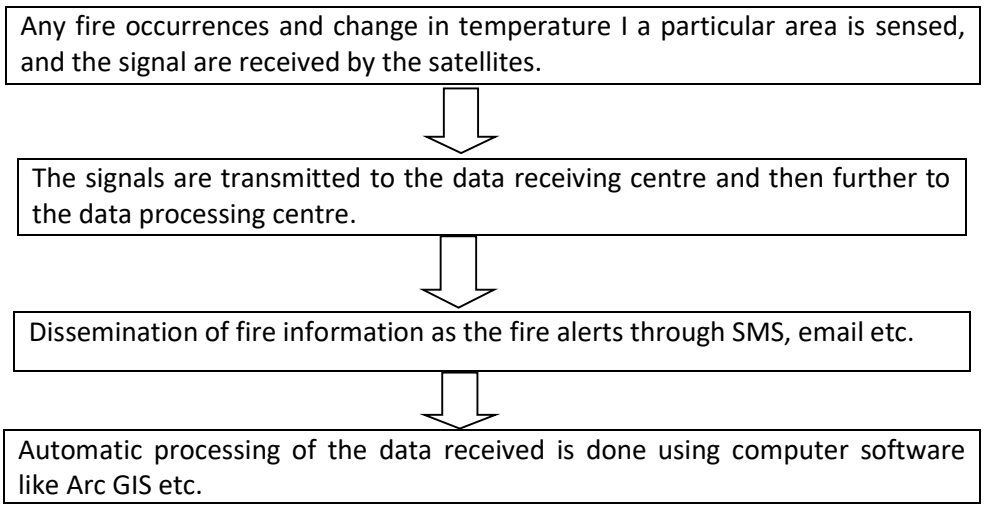
d) Forest Fire Risk Zonation Mapping in West Himalayan States: A study has been carried out to zonate different risk areas based on static factors for better management and prevention of forest fires in the West Himalayan region. For this purpose, different layers including forest cover, forest type, topographical gradients and plot-level field inventory data of the National Forest Inventory has been used to derive the causative factors for the spread of forest fires and to generate forest fire risk zone maps.

e) FSI VAN AGNI Geo-Portal: The geo-portal is a user-friendly, interactive portal for visualizing the forest fire data (Near Real-Time Detections of MODIS and SNPP-VIIRS, Large Forest Fire Detections, Forest Fire Danger Rating and Fire Prone Forest Areas) generated by FSI.

f**) Identification of Fire Prone Forest Areas**: Based on the archival near real-time forest fire detections, 5 km X 5 km grid layer covering the entire forest area of the country is categorised into different fire prone regions.

g) Sharing of WMS (Web Map Service) & WFS (Web Feature Service) with State Forest Departments: WMS and WFS is created and shared with the SFDs, so that SFDs can synchronize FSI information with their respective portals.

6.1 Near Real Time Fire Monitoring (MODIS & SNPP-VIIRS):



6.2 How to get fire alert in mobile or in mail

(i) go to the link **https://fsi.nic.in**

(ii) go to FSI forest fire portal in forest fire tab of FSI website

(iii) The page of FSI alert system (FAST) version 3.0 opens. In the list given under features, click on dashboard for near real time monitoring of forest fire based on MODIS and SNPP-VIIRS

(iv) Forest fire alert system 3.0 opens. Click new user and sign up.

(v) The registration form opens. Fill the registration form and request the information for the desired administrative level (beat or range or division)

(vi) Click "submit" button after filling registration form. OTP will be sent to your registered mobile number.

(vii) For verification, enter OTP received on your mobile number then click "submit" button. After clicking submit button you will receive a SMS showing that you have successfully registered for the forest fire alert system.

(viii) The registration is complete, and the registered person will receive fire alerts whenever fire is detected in his administrative jurisdiction. The fire alert message has latitude and longitude references of the area of fire which can be used to move or navigate to that area.

7. Experience of Different Countries Vulnerable to Forest Fires:

Forest Fires not only lead to loss of human life but block communications, destroy power cables, cut mobile connectivity and landlines, devastated homes and industries, and imbalance people's lives. Due to climate change and global warming, the ecology of many nations has come to be affected adversely making them vulnerable to Forest Fires. Five nations rich in flora and fauna and experiencing challenges in the domain of Forest Fires have been identified to glean some information on how they manage the threat from Forest Fires. From the experience of these nations and their concepts, India can seek to learn considerably about technologies and strategies while Forest Fires make a threatening impact on our environment. However, the most important aspect to acquire from the experience of these nations is their organizational structures and the tasking philosophy for fighting Forest Fires. Brief but relevant aspects of these nations as relating to Forest Fires are given in succeeding paragraphs.

7.1) Greece:

The 1998 forest fire season in Greece was unusual and somewhat controversial due to a sudden decision by the Greek government to transfer the responsibility of forest firefighting from the Greek Forest Service (GFS) to the Fire Service. The decision was taken at the end of 1997. It was prompted by what was considered poor results of the Forest Service in the previous years. The decision was considered knee-jerk and did not examine all the parameters of the undertaking. The decision lacked any serious scientific justification or planning. Although Greece has done nothing to reverse this decision, there is considerable demand to do so. The GFS has lost its expertise over a while. Its close liaison and relationship with local communities was always a source of progressive learning, something which an

urban or rural fire service cannot easily acquire. Lesson learned – the responsibility of Forest Fire fighting should preferably remain the domain of the Forest Service of a nation with a specialized Forest Fire fighting service and supplementary well-trained organizations who can add their weight when situations become far more challenging.

Dowsing Forest Fire

7.2) **Indonesia:**

Forest Fires are a national disaster for Indonesia. The government also regards this as a serious matter and gives it the necessary financial support. The support system works to create posts that carry out multilevel operations at the village, regional and national levels. In each region, groups are formed from the community and are called fire care communities (MasyarakatPeduliApi or MPA). MPA assists officers in monitoring and handling forest fires. Troops formed and trained for control of forest and land fire to assist the local governments are felt a necessity. The government also conducts technical training and awareness campaigns related to the prevention and management of forest fires for the public. Routine anti-fire patrolling is conducted for early detection. Nationally, the government establishes a central command post for monitoring hotspots in Indonesia using various satellites that cover most of the nation, especially the vulnerable western and eastern parts. The emphasis in Indonesia is on community awareness and response supplemented by regional first responders.

7.3). **United States:**

Five federal agencies are responsible for wildfire management. USDA's Forest Service, the department of the Interior's Bureau of Indian Affairs, Bureau of Land Management, Fish and Wildlife Service and National Park Service. Over the past decade, these agencies have made several changes to the management of wildland fires. For instance, they collaborated with partners from multiple jurisdictions (i.e., tribal, state, and local governments, non-governmental partners and public stakeholders) to complete the National Cohesive Wildland Fire Management Strategy in 2014.

Dowsing Forest Fire by MAFFS II

A National Inter-agency Fire Centre (NIFC) monitors the existence of Forest Fires around the country. This is like a repository of intelligence on all such fires gathering information from multiple sources through a system of feedback. The National Interagency Coordination Centre (NICC) is the focal point for coordinating the mobilization of resources for forest fire and other incidents throughout the United States. Located in Boise, Idaho, the NICC also provides Intelligence and Predictive Services related products designed to be used by the internal Forest Fire community for Forest Fire and incident management decision-making. The NIFC establishes preparedness levels throughout the calendar year to ensure suppression of resource availability for emerging incidents across the country. Preparedness levels are dictated by fuel and weather conditions, fire activity and fire suppression resource availability throughout the country. This aspect is important in assessing the threshold of the deployment of a specialized force (the NDRF in our case, if it is fully trained to handle the emergency).

The US also has a system of outsourcing and privatization of Forest Fires fighting for early response by dedicated personnel who understand and are familiar with the ground.

7.4) **Canada:**

In most of Canada's forests, provincial and territorial agencies have the responsibility for wildland fire management. Areas, where federal government agencies are responsible, include national parks and military bases. Wildfire risk management incorporates the four integrated phases of emergency management: prevention and mitigation, preparedness, response and recovery. Although mitigation can be part of preparedness, Canada considers them as two separate phases; prevention focusing on preventing wildfires, and mitigation aiming to reduce the impacts when they do occur. Wildfire preparedness is the action that contributes to a state of readiness to manage wildfire before its occurrence. The actions taken to manage wildfire incidents when they do occur are referred to as a response. The recovery phase includes all efforts to repair or rebuild conditions during and after a wildfire disaster. The federal government has agreements with the provinces and territories respecting the management of wildfires on federal lands. Indigenous Services Canada and provincial and territorial wildfire management agencies have fire control agreements to ensure Indigenous Communities on Federal Reserves are prepared and able to respond to the threat of wildfire. Similar agreements are made with National Defence and the provinces and territories

to manage wildfires on federal lands owned by the National Defence. The provinces and territories also have agreements with Parks Canada to address the shared management of wildfires along their borders.

Use of Mi-17-V5 for Forest and Facility Fires.

Thus, like almost everywhere, forest fires in Canada too are the responsibility of the Provincial Governments.

7.5) **Australia:**

Firstly, Australia is more prone to bushfires and has some unique systems to manage these. Fire Management Programs include staff training, site-specific fire management and response plans, assessing and managing fuel loads, creating fire breaks, managing access tracks and coordinating with the neighbours. This preparation helps respond to and control summer bushfires, helping reduce their intensity and safeguarding ecological, cultural and structural assets. Improving the processes based on lessons learned is a key focus. Australia believes that one of the best tools to combat bushfires is the fire itself. Quite literally, fighting fire with fire and making use of local community knowledge.

The Australasian Fire Authorities Council (AFAC) is the peak body responsible for representing fire, emergency services, and land management agencies in the Australasian region. However, the provinces have their structures. For example, the New South Wales Rural Fire Service (NSW RFS) is a volunteer-based firefighting agency and statutory body of the Government of New South Wales. Urban areas are the responsibility of Fire and Rescue NSW; thereby maintaining separation between urban and rural fire threats. The NSW RFS is the world's largest volunteer fire service, with 71,234 volunteer members. There is 936 paid staff too. It is therefore a mix of official and community volunteers which makes up the response organization.

Dousing Forest Fire

7.6) **Some Pointers from Foreign Experience of Managing Forest Fires: -**

(a) It is clear that the majority of the highly affected countries prefer a decentralized approach to tackle Forest Fires.

(b) Urban fires remain the responsibility of the Fire Service department and Forest Fires fall under the ambit of regions/states/provinces.

(c) There are agreements between the national and state governments regarding reinforcing capability if in need. In some cases, even outsourcing is resorted to fighting forest fires.

(d) The strengthening of surveillance and early warning through satellite reconnaissance is a key technology for investment. Centres for this exist in all regions/states/provinces and a central facility for monitoring and receiving data has been created in most countries.

(e) Almost everywhere there has been a realization regarding training and sensitizing local communities and making them stakeholders. They are the first reactors followed by State authorities and supplemented by a National organization. In India too this is fully realized and efforts to involve greater community commitment are constantly on.

(f) While manual methods of spraying, beating and creating fire lanes remain important, it is aerial spraying by fixed wing aircraft which is proving more and more beneficial; rotary wing aircraft are useful, particularly in mountains but limited by capacity. More fixed wing resources are something in which India may have to invest, over and above the equipment resting with the Indian Air Force. It is discussed at the end of this report.

(g) The expertise and experience gained by these countries could be exploited by nominating some officials of the Forest Service who look after the fire domain and master trainers from the NDRF for further specialized training. In due course, joint training exercises with these countries will help build more expertise.

7.8) Existing Mechanism for Handling Forest Fires in India:

The Government of India, Ministry of Environment, Forest and Climate Change (MOEFCC), National Action Plan on Forest Fire emphasises on a clear line of command for assuming the lead role and duties in the event of a forest fire. It also implores the National Disaster Management Authority (NDMA), National Disaster Response Force (NDRF), and the State Disaster Management Authorities (SDMAs) to be involved in a consultative role for building training and awareness. The objective of this National Action Plan on Forest Fires (NAPFF) is to minimize forest fires from taking place by informing, enabling and empowering forest fringe communities and by incentivizing them to work in tandem with the forest departments. This will substantially reduce the vulnerabilities of forests across the diverse forest ecosystems in the Indian subcontinent against fire hazards, enhancing the capabilities of forest and other personnel and institutions in fighting fires, and speed up recovery after a fire event.

Dousing Forest Fire in Uttarakhand- 2018

7.9) **The existing structures, system and shortcomings are explained in a little more detail below:**

As per the Indian Constitution, the Central and State governments are both empowered to legislate on forestry issues. However, the implementation part of the program lies exclusively with the latter. The latest forestry management practices are ushering a new culture amongst the rural masses i.e., involvement of community-based organizations including Panchayats, local bodies, Mahila Mandals, NGOs etc. (recall earlier mention of the importance of local communities as the chief stakeholders). A strong central component for the development of the Early Warning Fire Forecasting System using satellite data and Fire Danger Rating System for early detection of forest fire has been introduced. However, at present, the structure for the management of forest fires is being streamlined and varies in different states. The task of engaging with forest fires in almost all the states is assigned to the local fire service officials with assistance from the local community. Some pitfalls have been found in this system as the fire services department essentially deals with urban fires and lacks expertise for forest fires.

In 2003, the Govt. of India adopted the Incident Response System (IRS) for disaster response mechanism which is applicable in the event of forest fires as well. In this, Responsible Officers (ROs) have been designated at the state and district levels as overall in-charge who manage the incidents through Incident Response Teams (IRTs) which are pre-designated at all levels i.e. state, district, sub-division, tehsil

and block. The Command Staff includes Incident Commander, Information & Media Officer and Safety Officer while the General Staff includes Operations, Planning and Logistics Section. Now designated as Incident Response System (IRS) most of the states have adopted the system and notified it too. However, its application to forest fires appears to be slightly lacking. The vagueness in the division of responsibility and the enormity of the forest fire hazard has probably prevented a more structured form of response. All vulnerable states must be urged to adopt the IRS for this hazard and notify it.

7.10) Shortcomings: The management of forest fires at present appears to be affected by many gaps thereby sometimes leading to incoherent action in times of contingencies. Following shortcomings are critical which need to be addressed effectively: –

(i) **Policy and Planning:** There is a requirement of clear-cut guidelines on forest fire management clearly defining the role of various stakeholders in the action plan both at the national and state level. Significant attention is required to be given to issues like preparedness, mitigation, human resource development, provision of scientific input and creation of awareness. An institutional mechanism is the need of the hour to set right the system:

(ii) **Need for Co-ordination:** Much is desired in terms of coordination of forest departments with other agencies like research institutes, meteorological and disaster management organizations and other offices. The mechanism for coordination ensures information sharing and prevents loss of valuable and timely support in firefighting.

(iii) **Capacity Building Initiatives:** For prevention and control of the forest fire, knowledge and understanding of the challenges are the solutions. Training of the stakeholders and the community is of paramount importance. The training programs should cater to present-day requirements revolving around the IRS system. The SDRF needs to be made a mandatory organization in each state to avoid dependence only on NDRF**.**

(iv) **Preventive and Preparedness Measures:** Preparedness activities need to be fine-tuned with proper drills and rehearsals among the stakeholders. The techniques and methodology of early warning systems also need up-gradation. Similarly, the contingency drills and SOPs need to be updated to meet the current scenario in keeping with the best practices in the world.

(v) **Provision of Funding:** There is no provision for a separate budget for forest fire management at the State level in general. Forest fire management activities are usually carried out using forest protection funds. The state forest departments are reportedly being financially supported under ad-hoc schemes through which allocation of funds is insufficient and irregular. We need to recall that cyclones too wreaked havoc on our coastal states just two decades ago. The National Cyclone Risk Mitigation Program (NCRMP) with adequate funding and management has been a run-away success. We may consider for the forest fires hazard a National Forest Fires Risk Mitigation Program (NFFRMP).

7.11) **Challenges:** The challenges in Forest Fire management can be broadly identified as five-fold, as enumerated below: -

(i) **Establishing an Institutional Setup for Forest Fire Management and Stakeholders Co-ordination:**

The Today's challenge is to develop a well-defined institutional framework both at the national and state level covering all aspects of forest fire management identifying the role and responsibilities of various stakeholders to ensure seamless coordination and reaction on the ground. The fire services department needs to be divested of this responsibility but must contribute some trained manpower to any new department proposed to be set up in lieu. Thus the policy framework needs to incorporate clear guidelines and also strengthen the legal framework by making it more practical and implementable to achieve the desired objective. Empowering the local community would be a vital aspect of the scheme of things. Whether the NDMA's Aapda Mitra scheme can be extended to this domain could also be examined.

(ii) **Responsibility of First and Subsequent Responders**:

Besides timely pick up of information on the initiation of Forest Fire, it is the time response that is essential. While the NDRF bears no responsibility towards fire hazards it can be trained as a central resource to respond as a reinforcing element to supplement an ongoing state effort. A timely first response by NDRF may never be possible due to the paucity of resources and large distances involved. Hence the need for joint responsibility as first responders should rest with the local community-based organizations and a well-trained element within the State Disaster Response Force (SDRF); this will drastically cut down first response time. An SDRF of optimum strength needs to be legislated for each state and Union Territory under the DM Act when revised. It needs to be built to the optimum level with some central funding supplementing the state resources.

(iii) **Knowledge Management, Capacity Building and Awareness Generation:**

The operational skills needed to implement fire prevention, preparedness and suppression activities need to be updated and upgraded. Therefore, awareness creation and capacity building are important aspects for urgent attention. A culture of innovation, safety, resilience and institutionalization of training with good practices is the challenge. Incorporation of information in State Disaster Management Plans (SDMPs) will ensure that the issue remains under focus and there is knowledge enhancement in this sphere.

iv) **Technical Options to Reduce Underlying Risks:**

There appears a dire need to undertake technological innovations to enhance resilience, preparedness and response capacities and also imbibe those already in use the world over. Along with this, enhancing the sustainable application of warning systems and translating it to useful information for action by stakeholders on the ground would go a long way in ensuring timely action. Thus, pre-emptive measures would greatly help to limit the problem which appears to be gaining magnitude and severity.

(v) **Training and Expertise:**

The correctly identified personnel must be put through familiarization and experts training in some of the countries with a high threat of forest fires. As the Master Trainer concept needs to be employed in different stakeholders.

8. NDRF IN FOREST FIREFIGHTING

8.1 Organization and Current Deployment:

NDRF is raised under the DM Act of Dec 2005 with a mandate to deal with all man-made and natural disasters except fire which comes primarily under the mandate of fire services. The core competencies of the Force revolve around Flood Water Rescue (FWR) operations, Collapsed Structure Search & Rescue (CSSR) which includes response during earthquakes, landslides and incidents of building collapse, and Chemical, Biological, Radiological and Nuclear (CBRN) Contingencies. All NDRF Rescuers are trained as Medical First Responders. NDRF has 16 field Units located in various parts of the country. Each Unit has an area of responsibility distributed so as to cover all the states as per their vulnerability profile. Besides, there are 28 Regional Response Centres (RRCs) and 12 tactical pre-deployment positions (TPLs) to ensure rapid deployment in the event of any disaster.

8.2 Factors to be considered for deployment of NDRF in Forest Fire:

a) The core competence of NDRF is its training and equipment to deal with Collapsed Structure Search & Rescue (CSSR) operations arising out of earthquakes and landslides. Such eventualities at times lead to a fire in confined spaces. NDRF has very limited basic fire equipment like portable fire-extinguishers, fire proximity suits and breathing apparatus; they are barely sufficient to safeguard its personnel during the CSSR operations. Therefore, at present, it is not in a position to respond to incidents of fire during the golden hour on account of lack of specialized training and high-end fire-fighting equipment. Additional training and equipment are both necessary.

b) The system of fighting Forest Fires as gleaned from five countries that handle these regularly, reveals that while the Central Government assists with the acquisition of technologies and early warning through various command and surveillance centres at the central level, it is the provinces/states which are responsible for raising the forces, training them and deploying them for fighting Forest Fires. Such forces are based upon local communities with knowledge of the lay of the ground and conditions.

c) NDRF has a very limited presence in different parts of the country thereby hindering timely response during the forest fires. In the past, NDRF has responded to various incidents of forest fire including the Uttarakhand Forest Fire of 2016, Shikarbadi forest fire in Udaipur, Rajasthan in 2007 and the recent Forest Dzukou Valley forest fire in Manipur & Nagaland in 2020-21. However, the role of NDRF in these eventualities was largely proximal and limited to creating fire lines, a task that is generally assigned to local fire service officials.

d) Given the NDRF's excellent reputation for disaster response, built painstakingly over a while, there is a demand to give it a supplementary role in fighting forest fires too. Its current deployment, including RRCs, caters to hazard-prone areas as identified by historical hazard evidence. Thus thrusting responsibility of forest firefighting as the first responder on NDRF would force considerable redeployment and spread it thin on ground adversely affecting its capacity to bring relief during other disasters.

e) Given the above, it is felt that NDRF being a Central Force may be inducted in the management of forest fire as a supplementary responder only. Further, NDRF should be utilized only for specialized action like aerial insertion with assistance from helicopters and not for routine reinforcement. Thus, no pre-emptive or preventive deployment roles and tasks should be assigned to the Force. NDRF should preferably be requisitioned only in the event of the State having exhausted its options of deploying the local agencies viz. Forest Department and other agencies of the State including SDRF.

f) Because of the above and also keeping in mind an important fact that the forest fire season is the lean period for NDRF during which there is significant thrust on the conduct of various types of training interventions, mock exercises and familiarization exercises which come to a standstill during the long period of active Flood Water Rescue Operations from June – Nov every year, engaging a large component of the Force may not be desirable.

g) To ensure this threshold level on the ground, all the States affected by Forest Fires should identity, train and equip sufficient manpower to deal with this hazard as first responders, in the form of community-based response and SDRF.

h) The NDRF would always have to be on warning the moment the SDRF is launched. If the detection of the fire has been late the threshold situation may arrive much earlier and the response may actually be near simultaneous. However, certain principles will need to be followed to determine a threshold situation. None of these are sacrosanct and only experience over time will provide the correct inputs to be included in these considerations. These principles are given below: -

(i) Continuous monitoring to determine the size and nature of fire.
(ii) The nature of the terrain, vegetation and ambient climatic conditions.
(iii) Use of computer modelling to determine the likely spread should be resorted to.
(iv) Determining risk should be through frequent consultation between remote sensing scientists, the controllers at the SDMA and the concerned NDRF RRC.
(v) Availability of means and equipment should be confirmed and reconfirmed.
(vi) Whether aerial spraying of chemicals or dousing by water from the air would be useful.
(vii) Meteorological conditions for this will have to be monitored at all times and a link established with the local IMD representatives.

8.3 <u>Utilisation of NDRF in Forest Fires</u>:

The fact, that NDRF is a versatile, well trained and equipped force should be kept in mind while deploying the force in forest firefighting to draw maximum advantage of its presence. For maximum effectiveness of NDRF in forest firefighting, following capabilities of the force should be utilised: -

(i) NDRF keeps and updates database of the vulnerability and preparedness of the state for disaster response by conducting familiarisation exercises in the districts over a period of time. Forest department should associate in such exercise so that the relevant data of forest fire vulnerability and preparedness could also be maintained.

(ii) NDRF, due to its vast experience of response during various disasters, can be utilised as an advisor, guide and coordinator during vast forest fires involving multiple agencies.

(iii) NDRF can also contribute in capacity building of the community and other stakeholders.

(iv) NDRF can be utilised for rescue operation for any trapped victims or evacuation from any vital installation through ground or aerial intervention.

(v) NDRF can also be used for providing medical first response or evacuation of the injured.

(vi) NDRF veterinary set up can provide medical care to the injured animals.

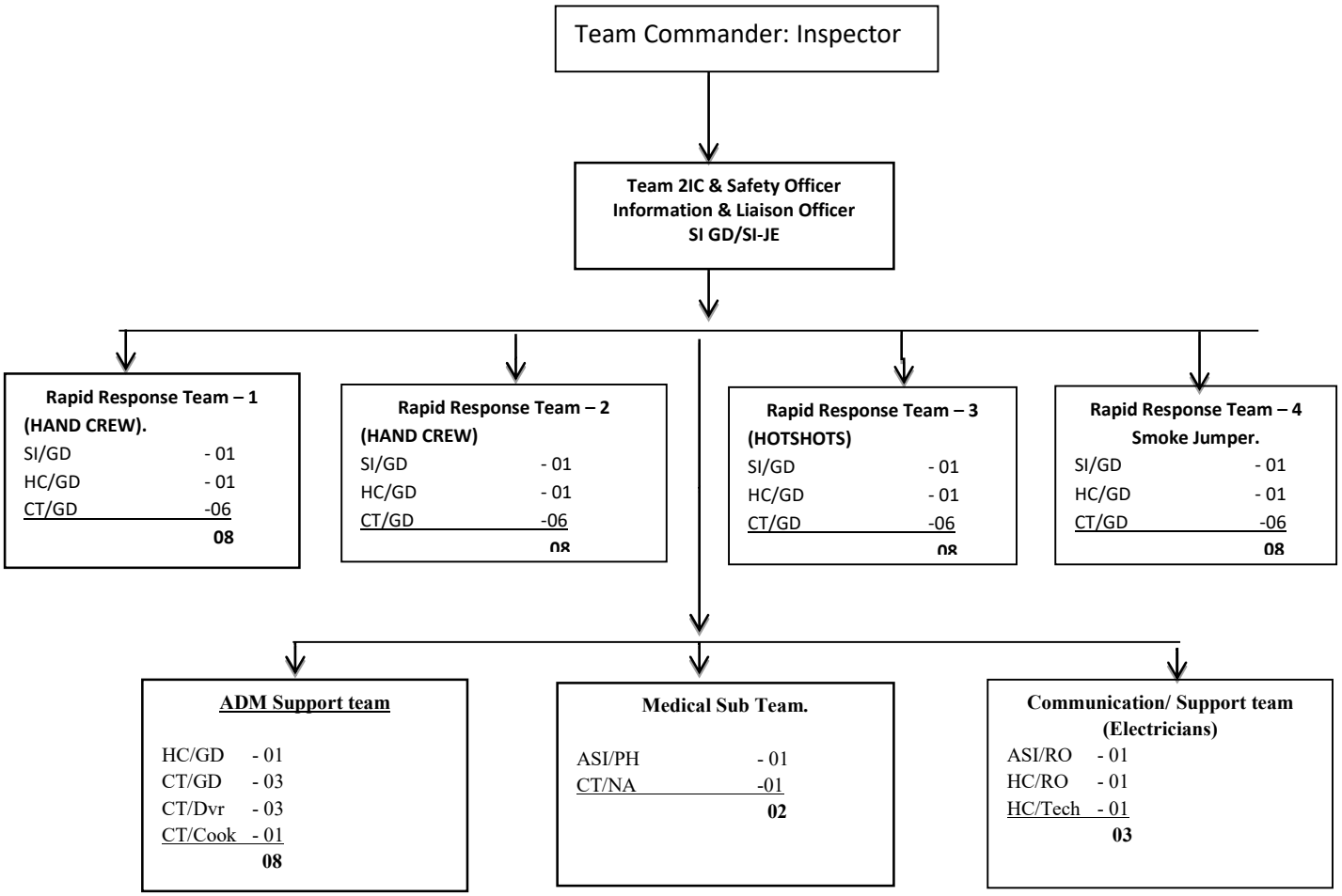
(vii) NDRF can conduct operations in the areas where mountaineering skills are required to reach the disaster site.

(viii) FWR skills of NDRF can be utilised for negotiating the waterways in the forest area.

(ix) NDRF also has the capability to work in smoky, gaseous environment.

(x) Cutting equipment with NDRF can be useful in clearing the fallen trees obstructing the route. NDRF is in the possession of and in process of procuring equipment for creating and cleaning of the forest fire lines.

8.4 Structure of NDRF Forest Fire Team



Inspr/GD	SI/GD	SI/ JE	ASI/RO	ASI/PH	HC/ RO	HC/GD	HC/Tec	CT/ GD	CT/NA	CT/ Dvr	CT/ Cook	**Total**
01	04	01	01	01	01	05	01	27	01	03	01	**47**

8.5 Role and Tasks of the Team:

a) Team Commander:

It will be the responsibility of Team Commander of Forest Fire team to ensure that all aspects of this SOP must be adhered. On receipt of warning orders, Team Commander will ensure the following: -

(i) Collect all concerned information about incident from DC (Ops)/Unit Control Room and will plan his strategy as per ground conditions of the concerned State/ District.

(ii) Chalk out the shortest route to be followed by the vehicles during the movement and discuss it with the DC (Ops) and will mark it on the digital maps of the drivers.

(iii) Before mobilization, team commander will prepare and submit marching out statement to the Unit Control Room immediately.

(iv) Detail a suitable person to carry camera and recording equipment with spare battery.

(v) Availability of forest firefighting equipment, Communication equipment and emergency medicines with the team.

(vi) On the way to the incident site, he will collect the required information from local sources/media and liaise with local administration for essential requirements and ask for a guide.

(vii) Upgrade the information from local administration, Unit Control Room, media and other stake holders.

(viii) On arrival at incident site, team commander will assess the situation and plan the employability of his team accordingly for prompt response.

(ix) Brief Sub-team commanders and team members to familiarize them with their area of operation. He will also brief them about the safety instructions, local customs and culture.

(x) Ensure efficient and multiple communication means like HF/VHF/QDA/Sat Phone with Unit HQ and HQ NDRF.

(xi) Liaise with the other agencies working in the area for better co-ordination during the operation.

(xii) Physically monitor the operation and record the outcomes.

(xiii) Maintain seamless communication with Control Room of the Unit with all the progress related to forest fire fighting.

(xiv) Brief the Crew Commander on the progress of the operation and discuss the further planning of the operation.

(xv) Ensure the rest, recoupment and administrative arrangements of his team.

(xvi) To ensure good quality photographs & videos of operational activities and will send the same to Unit control room at a regular interval.

(xvii) Team commander will not get himself engaged unnecessarily with electronic & print media and no ambiguous or partial statement will be given by him during the operation.

(xviii) If Crew Commander is not present at incident site, then team commander may communicate with the media but will limit himself to the operational activities by his team only.

b) <u>Team 2IC</u>:

He will assist the team commander and ensure the following: -

(i) Responsible for proper unloading of TEAs and establishment of BOO on arrival of team.

(ii) Monitor the operation carried out by the team.

(iii) Ensure that all the firefighting operation is conducted in a planned manner.

(iv) Ensure proper rest and relief for the crew members.

(v) Team 2IC should be well versed with the role of Team Commander and will perform the duties of Team Commander in his absence.

c) Safety Officer:

(i) Responsible for operational worthiness of tools and equipment.
(ii) Mark the entry and exit routes for access and extrication.
(iii) Ensure that safety and security considerations are included in action plan and briefing.
(iv) Safety officer will brief the well-established warning system and evacuation plan. He will further ensure that it must be properly briefed and executed on ground during any emergency.
(v) Safety officer will brief about the field signals, whistle signals or any other signals by using loudhailer before commencement of fire operation.
(vi) Ensure that team is working with proper PPE on the site.
(vii) Ensure that team personnel do not work alone and in isolation. He will ensure the buddy system during firefighting.
(viii) Ensure biomedical control measures are adhered to; i.e. body recovery, patient handling, Sanitation & hygiene etc.
(ix) Ensure that personnel and equipment decontamination practices are followed prior to leaving the work site.
(x) Ensure that all team personnel are in contact with means of communications during the operation.
(xi) Safety officer will ensure rest, rotation and hydration of crew members.
(xii) Maintains his position so that he is visible to all commanders present at work site during operation.

d) Liaison Officer:

(i) Coordinate activities to protect units from collateral damage, achieve mutual understanding and undertake disaster management.
(ii) For incident management, liaison officers act as first contact officers for all agencies that are helping with the situation.
(iii) Liaison officers often serve as mediators, so their duties also include negotiating with others, developing and fostering relationships, getting people to understand others' points of view, and understanding their parent business and how it impacts its stakeholders.

e) Information Officer:

(i) Responsible for the preparation of a variety of informational materials to increase public awareness of all hazards emergency preparedness.

(ii) Responsible for regional disaster public information.

f) Hand crews:

(i) Initial dousing of fire with a qualified incident commander.
(ii) Responsible to construct fire line.
(iii) Use drip torches to burn-off excess vegetation before the head of a fire approach, securing the fire line even further.
(iv) With help of air resources can drop water to wet, or cool down vegetation reducing fire intensity.

g) Hotshots:

(i) Skills to work in isolated locations for long periods with little or no logistical backup.

(ii) Hotshot firefighter's primary goal is to provide a safe, secure, professional, transportable, and highly competent hand crew across all phases of firefighting, including incident management.

(iii) They are staffed, trained, prepared, and qualified to handle a wide range of strategically and operational wildfire missions.

(v) Pre-positioned against initial attack or conduct ready reserve responsibilities.
(vi) Supplying a regimented, self-contained, and highly changeable workforce.

h) Smoke Jumpers:

(i) Provide Rescue & First –Aid service.
(ii) Heavily involved in prescribed fire management and hazardous fuels reduction efforts.
(iii) Initial-attack firefighting and working with a variety of aircraft.
(iv) To get in remote fires safely and quickly.
(v) Helping high-risk fires small.

j) Medical Team:

(i) To provide medical support to the Firefighting team during forest fire operation.

a. Medical team will consist of one medical officer and two Para-medics or as per the Requirement/gravity of the incident.
b. To carry all emergency medicines.
c. Ensure the availability of Ambulance equipped with BLS.
d. Ascertain the details of hospitals/ medical facilities near the incident site.
e. Medical officer will liaise with doctors of nearby hospitals for advance medical care.

k) Adm Team:

(i) Receive Adm. related instructions from the Team Commander/Team 2IC.
(ii) Ensure all Adm. Arrangements for rescuers.
(iii) Ensure to provide food and water timely to the crew members. Ensure the safety and security of the Adm. Base.
(iv) Ensure the replenishment of fuel, gasoline, tools and accessories.

8.5. **Important aspects to be considered during Responding to the forest fire**:

To be effective in forest firefighting, it is necessary to strategically define it. It should satisfy the basic

Principles of firefighting: -

(i) Controlling the fire in the initial stage and

(ii) Contain the spread and extent of fires which could not be suppressed during the earlier stage.

After locating the fire and knowing its precise location:

The first step is to assess various parameters before the actual freighting procedure begins:-

(i) The waypoints to the area and escape route(s) or safe zone(s) from that area which includes access roads and paths.
(ii) Estimation of the fire area and its perimeter at the time of detection.
(iii) Type of fuel which is burning.
(iv) Wind speed, direction and the variability if any.
(v) Slope and aspect (topography of that area)
(vi) Behaviour of fire during previous incidences in that area and the current fire behaviour.
(vii) Natural and artificial fire barriers if any (roads, rocks, lakes or cultivation land)
(viii) Type of forest fire.

The second step in decision making include various decisions to be taken before actual implementation which include: -

(i) Where to initiate the attack for firefighting.
(ii) Type of attack-direct, indirect, backfire.
(iii) Location and width of fire line and the way to make it.
(iv) Reinforcement to be called in (whether more special force is required or not, air operation etc.)

After decisions are made, the crew would get command from the team commander to implement the decisions made.

9. MEDICAL EMERGENCIES IN FOREST FIRE:

Medical emergencies are a critical concern in forest fire response, as fire fighters, forest staff and nearby communities are exposed to intense heat, heavy smoke and hazardous terrain. Common emergencies includes burns from direct flame contact, smoke inhalation leading to respiratory distress and heat related illness such as dehydration, exhaustion or heat stroke. In addition, falling trees, rough landscapes and collapsing structures often cause trauma injuries, while smoke and ashes can aggravate asthma and other pre-existing conditions. These risks highlight the need for rapid first aid, trained medical teams and efficient evacuation system to ensure the safety and survival of those affected during forest fire incidents.

BURNS

Definition: Injuries caused by exposure to excessive heat from thermal, chemical, electrical or radiation.

Burns can injure the skin, muscles, blood vessels, nerves and bones. The eyes, ears and the respiratory system can also be affected. Apart from the physical damage, the victim suffers psychologically and emotionally.

9.1 **Causes of Burns**:

i) Thermal: heat (fire, vapour and hot objects)

ii) Chemical: includes several caustics such as acids and alkalis.

iii) Electrical: electricity, i.e., house current, lightning.

iv) Radiation: ultraviolet rays (including sunlight) and radioactive agents.

9.2 **Burn Severity**:

The two primary factors considered in rating burn severity are body surface area (BSA) and location. Burn severity can be rated as follows:-

a) **Minor Burns**:

(i) Full-thickness burns of less than 2% BSA, excluding face, hands, feet, genitalia, or respiratory tract
(ii) Partial thickness burns of less than 15% BSA.
(iii) Superficial burns of 50% BSA or less.

b) **Moderate Burns**:

(i) Full-thickness burns of 2% to 10% BSA, excluding face, hands, feet, genitalia, or respiratory tract
(ii) Partial thickness burns of 15% to 30% BSA.
(iii) Superficial burns over 50% BSA.

c) **Critical Burns**:

(i) All burns complicated by injuries of the respiratory tract, other soft-tissue injuries, and injuries of the bones.
(ii) Partial- or full-thickness burns involving the face, hands, feet, genitalia, or respiratory tract.
(iii) Full-thickness burns of more than 10% BSA.
(iv) Partial-thickness burns of more than 30% BSA.
(v) Burns complicated by musculoskeletal injuries.
(vi) Circumferential burns.

d) **Pre-hospital Treatment for Burns**:

Use universal precautions, secure the scene and alert EMS.

i) Stop the burning process: Run cold water over the scald burns. Flush away chemicals with water for 20 minutes or more.

ii) Remove any smouldering clothing and jewellery: If you meet resistance or if you see pieces melted into the skin, cut around the area. Do not try to remove them.

iii) Perform initial assessment: Most victims die from blocked airway, inhaled toxins or other trauma rather than from the burn itself. Treat life-threatening injuries.

iv) Administer oxygen: If your patient's breathing is inadequate, provide ventilation with supplemental oxygen.

v) Determine the severity of burns, using the rule of nines:

vi) Cover the burns. Use dry sterile dressings or a disposable sterile burn sheet. Do not use grease or fat, ointment, lotion, antiseptic, or ice on the burns. Do not break any blisters. If a burn involves the eye, be sure to cover both eyes. Fingers with second- or third-degree burns require dressing each finger individually.

vii) Keep the patient warm and treat for shock.

9.3) **Inhalation Injury:**

This type of injury occurs when a patient inhales super-heated air, smoke and/or toxic products. Symptoms for these injuries may appear mild initially and then become more severe.

a) Signs and symptoms of inhalation injury:

(i) Singed nasal hair
(ii) Burns to the face
(iii) Specks of soot in the sputum
(iv) Sooty or smoky smell on the breath.
(v) Respiratory distress
(vi) Hoarseness, cough, or difficulty in speaking
(vii) Restricted chest movement
(viii) Cyanosis

b) Pre-hospital treatment for inhalation injury:

i) Administer oxygen if needed.
ii) Monitor patient's airway and breathing.
iii) Be prepared to ventilate. Environmental Emergencies

9.4) **Heat Exposure**:

The exposure to excessive heat can produce serious health conditions. There are three common emergencies brought about by exposure to excessive heat:

a) Heat cramps
b) Heat exhaustion
c) Heat stroke

9.5) **Heat Cramps:**

Heat cramps consist of pains and muscle spasms that occur when the body loses a large quantity of salt through excessive sweating.

a) **Signs and symptoms of heat cramps**:
(i) Severe muscle cramps, usually in the legs and abdomen.
(ii) Exhaustion
(iii) Nausea
(iv) Periods of fainting

b) Pre-hospital treatment for heat cramps:

i) Move the patient to a cool area.

ii) Give the patient water. The muscle cramp should be alleviated after drinking water. The patient needs the water more than the salt. Do not delay giving water to look for salt.

iii) Commercial electrolytes or oral rehydration solution (ORS) can also be used.

9.6) **Heat Exhaustion:**

Heat exhaustion can occur when a person in poor physical condition exerts himself or herself during physical activity in a very hot environment, causing blood flow to be affected.

a) Signs and symptoms of heat exhaustion:

(i) Rapid, shallow breathing
(ii) Weak pulse
(iii) Cold, clammy, pale skin and mucous membranes, with a lot of sweating
(iv) Weakness
(v) Dizziness, sometimes leading to fainting

b) Pre-hospital treatment for heat exhaustion:

i) Move the patient to a cool place to rest.
ii) Remove or loosen clothing as necessary to cool the patient without causing chills.
iii) Place the patient in a supine position with legs elevated 20 to 30 cm.
iv) Administer oxygen if needed.
v) Give water, but not to an unconscious patient.

9.7) **Heat Stroke:**

Heat stroke is a very serious life-threatening condition. The body becomes overheated and, in many cases, the patient stops sweating. If left untreated, brain cells will begin to die.

a) Signs and symptoms:

(i) Deep, rapid breathing
(ii) Rapid, strong pulse followed by a rapid, weak pulse
(iii) Dry, hot skin, sometimes red
(iv) Dilated pupils
(v) Loss of consciousness
(vi) Convulsions or muscular tremors

b) Pre-hospital treatment for heat stroke:

Use universal precautions, secure the safety, and alert EMS.

i) Cool the patient quickly in any way possible. Move the patient far from the source of heat. Remove his or her garments and wrap the patient with wet sheets. Pour cold water on the sheets. This should normalise the patient's core temperature and help prevent brain cells from dying.

ii) Place cold bags or ice packs below each armpit, behind the knees and around the ankles, and one on each side of the neck.

iii) Look for a large container or bathtub and submerge the patient in cold water up to the neck. Use ice to cool the water.

9.8) **Cold Emergencies:**

Many forests in India are situated in Himalayan region which experience extreme cold climate. Hence precautions against the cold are essential for safety of the rescuers. Exposure to excessive cold can cause hypothermia.

Hypothermia: When cooling affects the entire body, this causes a condition known as hypothermia, or generalized cooling. Hypothermia can develop in temperatures well above freezing. There are two types of hypothermia i.e. Mild and Severe.

a) Signs and symptoms of mild hypothermia:

(i) Chills
(ii) Drowsiness
(iii) Rapid breathing, slow pulse
(iv) Loss of vision
(v) Sluggish pupils
(vi) Uncontrollable shivering

b) Signs and symptoms of severe hypothermia:

(i) Extremely slow breathing rate
(ii) Extremely slow pulse rate
(iii) Unresponsiveness
(iv) Fixed and dilated pupils
(v) Rigid extremities
(vi) Absence of shivering

c) Pre-hospital treatment for hypothermia:

Handle patient very gently and offer comfort and reassurance. Use universal precautions, secure the scene, and alert EMS.

i) Conduct initial assessment and physical exam.
ii) Remove the patient from the cold environment.
iii) Maintain open airway and administer oxygen if needed.
iv) Remove any wet clothing and cover patient with a blanket. Keep the patient dry.
v) If the patient is alert, offer warm liquids (non-stimulant) slowly.
vi) Constantly assess vital signs.

10. FOREST FIRE FIGHTING TOOLS AND EQUIPMENT

a) **Fire Broom (Jhaapa)**

(i) Specially designed to beat the fire and control the ground fire.

(ii) Work well for mop-up by sweeping light debris back into the black.

The purpose of developing this tool is to avoid loss of biodiversity and not using green branches by the fire fighters.

b) **Fire Beater (Fire Pressed)**

(i) Developed to put off fire hidden under lumps.

(ii) Used in post fire operation.

(iii) Useful in mop-up operation.

c) **Adjustable Rod**

It is of multiple uses and can be fitted with all types of developed tools. It is adjustable to various lengths.

d**) Pathal (Cutting material**)

Designed to cut the small branches and twigs for clearing way for crew members.

e) **Fire Rake**

Used for raking light litter-to break the fuel continuity

f) **Pulaski**

It has both an axe and an adze in one head. The Pulaski is used for constructing firebreaks, able to both dig soil and chop wood.

g) **Power Chain Saw**

It is used for cutting big branches and affected trees from the site and reduce the fuel load.

h) **Leaf blower**

It removes dry fuels (leaves and fallen twigs) from fire lines and road sides. It is used for making small fire lines

ESSENTIAL EQUIPMENTS OF FOREST FIRE

MAKING OF FIRE LINE

10.1 **PPEs for fire fighting: -**

Jump suit, Fire gloves, Helmet with face shield, half face respirator, Face protector hood, Goggles, Safety boots

10.2 **Equipment with NDRF that can also be used for Forest Fire Fighting: -**

i) **Husqvarna Chain Saw:** For cutting the branches to trim the canopy and in making fire lines.

ii) **Rotary Rescue Saw:** For cutting tree trunks obstructing the movement.

iii) **Reciprocating Saw:** For cutting the small branches to clear the path**.**

iv) Telescope petrol pole saw: For pruning the branches at the height for clearing/trimming the canopy.

V) AQUA Floating Pump: For extracting water from nearby sources to douse the fire**.**

11. Community participation in forest fire management:

Local people are the prime detectors and responders for any forest fire. They should be made aware about the importance of fire prevention and about the adverse effects of fire on their livelihoods including their immediate ecosystem. The local people should be made to involve themselves in firefighting trainings and used as fire watchers by the forest departments. Early detection of fire and immediately responding by the firefighting can reduce the losses caused by fire. There are several methods to detect forest fire which includes: -

i) **The local villager information network:** the local villagers are the first to respond and share information to the forest department about the occurrence of forest fires.

ii) **Watch towers:** watch towers located at high points can help in noticing the occurrence of fires in the surrounding areas.

iii) **Community involvement:** democratising forest management is essential to include local communities who lived in and around forest.

iv) **Integrate Scientific and community knowledge**: integrate scientific research with local community knowledge for effective forest fire management.

11.1 **Importance of community engagement:**

i) **First responders:** ensuring local communities are trained and equipped to act as first responders during forest fires.

ii) **Awareness campaigns:** conduct awareness campaigns to educate the public on preventing forest fires and the importance of forest conservation.

iii) **Traditional knowledge:** leverage traditional knowledge and practices in forest management and fire prevention.

iv) **Sustainable livelihoods**: promote a sustainable livelihood that depends on healthy forest, reducing the incentive for activities that leads to forest fire.

v) **Comprehensive approach:** a multifaceted approach involving scientific research, community participation, legal reforms and sustainable practices is crucial to manage forest fire and preserve forests.

The involvement of communities in Forest Fires from taking place by informing enabling and empowering forest fringe communities and by incentivizing them to work in tandem with the forest departments. This will substantially reduce the vulnerabilities of forests across the diverse forest ecosystems in the Indian subcontinent against fire hazards, enhancing the capabilities of forest and other personnel and institutions in fighting fires, and speed up recovery after a fire event.

12. ORGANISATIONAL STRUCTURE OF THE FOREST DEPARTMENT:

The forest department at state level is headed by principal chief conservator of forests (head of forest force) (PCCF & HOFF)

Principal Chief Conservators of forest (PCCFs) social forestry wildlife. Support the PCCF &HOFF in administrative works.

⇩

Additional principal chief conservator of forests (APCCF) (various wings)

⇩

Chief conservator of forests (CCFs) (in charge of circles)

⇩

Conservator of forests (CF) (in some states, CFs oversee a circle)

⇩

Deputy conservator of forest (DCF)

OR

Divisional forest officer (DFO) (in-charge of divisions or district)

Assistant conservator of forests (ACFs) (in-charge of sub-division)

Range forest officer (RFO) (in-charge of range)

Deputy ranger

Round officer/forester (in-charge of round)

Beat officer/forest guard (in-charge of beat)

13. **DO'S AND DONT'S DURING FOREST FIRE FIGHTING**

To be effective in forest fire fighting, it is necessary to strategically define it. It should satisfy the basic PRINCIPLE of fire fighting. (i) Controlling the fire in the initial stage and (ii) contain the spread and extent of fire which could not be suppressed during the earlier stage.

The safety of the fire fighting personnel should be given the utmost importance. Thus some Dos and DONTs can be discussed as under:

DO's

1. Assess fire behaviour, wind direction, slope and fuel type before engagement.
2. Establish communication with command/control before action.
3. Wear complete PPE (helmet, fire-resistant clothing, gloves, boots, goggles and mask.
4. Follow IRS/ICS command instruction strictly.
5. Create fire lines and fire breaks using tools and machinery.
6. Use controlled back-fire/ counter-fire only under proper supervision.
7. Maintain hydration and rotate duty shifts to avoid heat exhaustion.
8. Rescue and provides first aids to injure person immediately.
9. Monitor weather updates for wind changes and fire spreads.
10. Conduct mop-up operation after main fire is controlled to avoid re-ignition.

DONT's

1. Don't work alone- always in teams with lookout.
2. Don't underestimate small spot fire – they can flare up.
3. Don't stand uphill or downwind of the fire front.
4. Don't use machinery carelessly – sparks can worsen the fire.
5. Don't ignore safety zones and escape routes.
6. Don't overexert – fatigue reduces judgement and increases risk.
7. Don't abandon equipments in field unless absolutely necessary.
8. Don't re-enter without post-fire safety assessment. (unstable trees, ash pits, toxic fumes)

For civilians/general public

DO'S

1. Report immediately – call forest officials, police or fire service.
2. Evacuate quickly when instructed - don't wait
3. Cover nose/mouth with wet clothes to reduce smoke inhalation.
4. Move to safe zones- open field, riverside or already burned areas.
5. Assists vulnerable people- children, elderly, disabled during evacuation.
6. Wear protective clothing- cotton, woollen clothes, sturdy shoes, head coverings.
7. Stay updated through local announcements, radio or alerts.

DONT's

1. Don't try to fight a large fire on your own
2. Don't run uphill directly- move sideways or downhill if trapped.
3. Don't block emergency vehicle routes.
4. Don't leave camp-fires and cigarettes unattended.
5. Don't spread rumours or unverified news.
6. Don't return until authorities declared it safe.

GLOSSARY

MOEF & CC : Ministry of environment, forest and climate change. The central Ministry that looks after India's environment, forests, wildlife and climate change issues

Anthropogenic: Human made or human caused impact on the environment

Transhumance pastoralist: Communities or group of people who practice a type of seasonal movement of livestock between fixed summer and winter pastures. (Cyclical migration of herders and their animals)

NTFP: Non-timber forest products. (All biological resources from forest other than timber wood)

Fire hardy species: Fire resistant species, that can survive, regenerate, or even thrive after forest fire. (Thick bark, deep root system, ability to sprout quickly from stamps, roots, seed adaptive. egs: SAL, TEAK, KHAIR, EUCALYPTUSS, PINE)

Humus: Dark, organic component of soil that forms when plants and animal matter decays.

Peat: Partially decompose accumulation of plant material found in waterlogged areas such as Bogs, Swans and Marshes.

Muck: A soil type in highly decomposed organic matter that originally come from PEAT or plant remains.

FSI: Forest survey of India. (India's nodal agency for assessing, monitoring, and reporting forest resources and cover using satellite and ground survey, including forest fire)

Backfire/Counter fire: Controlled fire set intentionally by fire fighter ahead of an advancing forest fire

USDA: United States Department of Agriculture (USS Government body responsible for agriculture, food safety, forestry and rural development).

MAFFS: Modular airborne fire fighting system (Aerial fire fighting system fitted into military place to drop large amount of fire retardant or water for controlling forest fire).

MODIS: Moderate resolution imaging spectroradiometer satellite sensor that gives medium resolution images of earth widely used for environmental and disaster monitoring.

SNPP – VIIRS: Suomi national polar orbiting partnership – visible infrared imaging radiometer suit (a satellite sensor system that provides high quality earth observation data, especially valuable for forest fire detection, environmental monitoring and disaster management).

"Only you can prevent forest fires—stay alert, stay safe, and respect the wild."