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Azadi Ka  
Amrit Mahotsav



# FIELD MANUAL

## FOREST FIRE PREVENTION AND MITIGATION STRATEGIES



Central Academy for State Forest Service,  
Ministry of Environment, Forest & Climate Change,  
P.O. New Forest, Dehradun, Uttarakhand

#### Concept and Guidance

- Shri Bharat Jyoti, IFS, Director, Indira Gandhi National Forest Academy, Dehradun
- Shri Anurag Bhardwaj, IFS, Director, Directorate of Forest Education, Dehradun

#### Editing

- Smt. Meenakshi Joshi, IFS, Principal, CASFOS, Dehradun
- Shri Pradeep Wahule, IFS, Lecturer, CASFOS, Dehradun

#### Text & Design

- Dr. T. Beula Ezhil Mathi, IFS, Lecturer, CASFOS, Dehradun

#### Contribution

- Shri Nishant Verma, IFS, Chief Conservator of Forests, Uttarakhand
- Dr. Sivabala S IFS, Associate professor, IGNFA, Dehradun
- Shri Amlendu Pathak, IFS, Lecturer, CASFOS, Dehradun
- Smt. Abharna K.M., IFS, Lecturer, CASFOS, Dehradun
- Shri Vaibhav Singh, IFS, DFO, Uttarakhand
- Shri Ashutosh Singh, IFS, DFO, Mussoorie
- Shri Ankit Gupta, Scientist-C, CASFOS, Dehradun
- Shri Bharat Singh, ACF (Retd.), Dehradun
- Shri V.K. Dhawan, Scientist (Retd.), ICFRE, Dehradun



Shri Bharat Jyoti, IFS.,  
Director,  
Indira Gandhi National Forest Academy,  
Dehradun



## FOREWORD

In the current times the Forest Fire incidents have become severe in intensity and expanse due to impact of climate change coupled with other factors. In many cases, these become disastrous, and to combat, mitigate and control them, the support of specialized forces like National Disaster Response Force, State Disaster Response Force besides the local community and locally available organizations viz. Home Guards, CPMF, Fire & Accident Department and the staff of local line departments become necessary.

In view of the ascending severity of the problem of forest fires and the country's endeavour in effective response for mitigation, control and prevention of all kinds of disasters, the National Disaster Management Authority has included the forest fires in the categories of disasters, and the services of the National Disaster Response Force and the State Disaster Response Force and other such uniformed combat trained workforce are to be taken in situations that warrant their collaborative support.

The forest fires as accidents and disaster phenomena have their own peculiar, varied and daunting nature and characteristics, and the ways and means of preventing, containing, controlling and suppressing the forest fires are also specialized tasks requiring specific knowledge, understanding, acquaintance and skills. In this context, the personnel of the National Disaster Response Force need training for competency in dealing with the forest fires whenever the situations demand their joining the control operations.

To fulfil this competency need, the Ministry of Environment Forest and Climate Change, Government of India, the National Disaster Management Authority and the National Disaster Response Force (NDRF) have decided to conduct training programmes for the Battalions of NDRF, and initially 3 Battalions at Dehradun, Vijaywada and Guwahati are to be trained by the Central Academy of State Forest Service (CASFOS), Dehradun, Coimbatore and Burnihat under the guidance of Director, Forest Education and mentorship of Director General, NDRF and Director, IGNEFA.

The first training programme under this scheme has been organized during 6-18 February 2023 for the two NDRF Battalions (Dehradun and Vijaywada) at CASFOS, Dehradun and Coimbatore. This training programme has been customised over consultations with the NDRF to best suit the training needs of the battalion workforce in terms of essential contextual understanding of forest fire, basic knowledge about science and management of forest fires, operational strategies, techniques, and use of tools, together with hands-on practice and field demonstrations and rounds of mock-drills in jungles.

The training acquired by the 2 Battalions will have to be perfected by periodic collaborative deployment in the forest fire control operations of the State Forest Departments of Uttarakhand and Andhra Pradesh and Telangana in the upcoming forest fires season in the current year (March – June/July 2023) in coordination with the SFD authorities.

It is a matter of satisfaction that within the very short time available for the preparation of this special task, CASFOS, Dehradun and Coimbatore have conducted the training programme with considerable effectiveness. The Principal, CASFOS, Dehradun and Coimbatore and their team deserve compliments for this accomplishment.

In the process, the CASFOS, Dehradun has also come out with a manual on the forest fire training for the NDRF. I hope that this manual will be further improved and will be useful not only for training of NDRF and SDRF but also for all such training programmes / modules wherein practical capabilities and competencies in the tasks of control, containment, mitigation, and prevention of forest fire disasters are to be enhanced. This document will also serve as a reference and resource material for developing specific training manuals for State Forest Training Institutes, and other training organizations. The Principal, CASFOS, Dehradun and her team merit special appreciation for this.

18.2.2023, Dehradun

Bharat Jyoti  
Director, IGNEFA



Shri Anurag Bhardwaj, IFS  
Director,  
Directorate of Forest Education,  
Dehradun



## **P R E F A C E**

Fires have been historically and intrinsically associated with forests since time immemorial. Though natural fires have been beneficial to the forests to restore and enhance themselves, the uncontrolled man-made forest fires pose enormous threats with colossal negative consequences on the survival of natural flora and fauna and subsequently human beings themselves.

Forest fires are traditionally managed by State Forest Departments by involving the forest personnel, seasonal fire watchers and local communities. However, with increasing frequency and duration of forest fires, it becomes imperative to have a specially trained force to tackle this ever increasing forest fire menace. The National Disaster Management Authority (NDMA), Ministry of Home Affairs, Govt. of India, in collaboration with the Ministry of Environment, Forest & Climate Change (MoEF&CC), Govt. of India has come up with a specialised training programme to train the National Disaster Response Force (NDRF) Battalions of the country in Forest Fire Prevention and Mitigation Strategies. The Central Academies for State Forest Service (CASFOS), Dehradun & Coimbatore, under the aegis of the MoEF&CC have been assigned the responsibility of conducting a specialized training to this effect.

I congratulate the teams led by Principals of CASFOS, Dehradun & Coimbatore for successful conduction of two-weeks special training for NDRF Battalions on Forest Fire Prevention and Mitigation Strategies.

Team CASFOS, Dehradun deserves special appreciation for compiling the learnings from this training programme and preparing a user-friendly Field Manual on Forest Fire Prevention and Mitigation Strategies which will prove to be of immense help.

Anurag Bhardwaj, IFS  
Director,  
Directorate of Forest Education

Smt. Meenakshi Joshi, IFS  
Principal,  
Central Academy for State Forest Service,  
Dehradun



## P R E F A C E

Since long, forest fires have played an important role in shaping the forest eco systems, their conservation and management. Though natural fires are beneficial in terms of clearing the forest floor and paving way for re-generation of new grass, herbs, and saplings, but fires due to anthropogenic causes result in huge losses to flora, fauna and consequently human lives. In the recent past, increase in frequency and intensity of forest fires is being observed which requires a multidimensional approach of fire management involving use of modern technology alongside the traditional fire management practices, better equipment and involvement of forest department personnel, community involvement and deployment of highly skilled National Disaster Response Force (NDRF) in the country.

Effective involvement of the NDRF in forest fire situations requires appropriate capacity building of the personnel on operational techniques and tools for Forest Fire Prevention, Suppression and Mitigation. It is in this context, a specialised 2-week training module was designed combining elements of classroom-based lecture-demo sessions followed by a week of field based mock drills with the Uttarakhand and Tamil Nadu Forest departments at actual sites. The Central Academies for State Forest Service (CASFOS), Dehradun and Coimbatore under the aegis of the MoEF&CC were assigned the responsibility of conducting a specialized training to this effect.

This **'Field manual on Forest Fire Prevention and Mitigation Strategies'** has been prepared from the learnings generated in this training programme. The information has been presented in a simple user-friendly format with appropriate illustrations. I am sure the forest personnel, personnel from NDRF, SDRF, and all those involved in such activities will find it immensely useful in their work. I take this opportunity to congratulate Dr T. Beula Ezhil Mathi Lecturer CASFOS Dehradun and her team for compiling the learnings and preparing this manual at a short notice.

Meenakshi Joshi, IFS,  
Principal, CASFOS, Dehradun



## **ACKNOWLEDGMENTS**

I extend my sincere gratitude to all those who have played a significant role in the development of this manual on 'Forest Fire Prevention and Mitigation Strategies', which has been developed out of the training programme conducted for National Disaster Response Force (NDRF) 15 Battalion, Dehradun from 6<sup>th</sup> to 18<sup>th</sup> February 2023. I would like to express my heartfelt thanks to Shri Bharat Jyoti, IFS, Director, Indira Gandhi National Forest Academy (IGNFA), for his unwavering support and guidance throughout the training programme and manual development process.

I am also grateful to Shri Atul Karwal, Director General, NDRF, for showing enormous support and helping us in organizing the training programme. I would like to extend my heartfelt thanks to Shri Anurag Bhardwaj, Director, Directorate of Forest Education, Shri Sushil K. Awasthi, IFS, Additional Director IGNFA, and Shri Rajkumar Bajpai, IFS, Additional Professor, IGNFA, for their valuable contribution and support. I would like to extend my special thanks to Shri Kunal Satyarthi, IFS, Joint Secretary, National Disaster Management Authority (NDMA), for his encouragement and support, which has been a crucial factor in the completion of this training programme. I would like to place a special note of thanks to Shri C.P. Goyal, Director General of Forest & Special Secretary, Ministry of Environment, Forest & Climate Change (MOEF&CC) Government of India, Shri Raghu Prasad, Inspector General (Forest Protection), MOEF&CC, Shri Anand Prabhakar, DIG (RT), MOEF&CC, and the entire team of MOEF&CC for their continuous support and facilitation.

I would like to place my special gratitude to Uttarakhand Forest Department for their co-operation & co-ordination. Special thanks to Shri Vinod Kumar Singhal, PCCF & HoFF, Uttarakhand, Shri Nishant Verma, IFS, CCF (FF & DM), Uttarakhand, Shri V.K Singh, DFO Narendra Nagar, Shri. Ashutosh Singh, DFO Mussoorie and Shri Nitish Mani Tripathi, DFO Dehradun. I would like to express my gratitude to officers & staff of Fire service Dehradun. I would like to thank all officers & staff of SDMA & SDRF for their co-operation. The contribution made by all the guest speakers & resource persons namely Shri Vaibhav Singh IFS, Shri V. K. Dhawan Scientist (Retd.), Shri Bharat Singh ACF (Retd.), Shri Ashutosh Singh IFS, DFO, Dr Sivabala S. IFS, Smt. Vijaya Ratre IFS of this training programme is enormous & valuable, I thank one and all.

I thank Principal, CASFOS Dehradun, all faculty colleagues, staff members and IT team of CASFOS Dehradun for their behind screen motivation, encouragement & support. I thank SFS officers' trainees of CASFOS, Dehradun for having involved themselves in Hindi translation of the manual. Finally, I extend my gratitude to all trainee of NDRF 15 Battalion, Dehradun whose enthusiasm and active participation had been a significant source of Inspiration. I wish them all the best in their future endeavours.

Course Director

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## 1-INTRODUCTION TO FOREST FIRE-INDIAN SCENARIO

Fires have been historically and intrinsically associated with forests since time immemorial. Forest fires are a regular phenomenon in our country often observed during summers. Though natural fires have been beneficial to the forests to restore and enhance themselves, the uncontrolled man-made forest fires pose enormous threats with colossal negative consequences on the survival of natural flora and fauna and subsequently human beings themselves.

### 1.1 Causes of Forest fire in India

The forest fire season in the country is normally from Nov to June with majority of fires being caused due to man-made factors. Natural fires (caused by lightening, friction of dry bamboo etc.) are of rare occurrence in India. More than 95% fires in India are man-made.

In Central India, people set fire during the collection of tendu leaves, Mahua flowers and other minor forest produce. The local people also set fire to ensure fresh growth of grass to be used as fodder for their livestock. In northeast India, shifting cultivation is the main reason for forest fires. Negligence leading to fire from nearby agricultural land spreading to forest areas, embers from road tarring works, electricity induced fires, tourists or villagers throwing cigarette butts, bidis etc. are the other possible causes of forest fires.

### 1.2 Effects of forest fires:

The effects can be beneficial or harmful based on the duration and extent of fire.

Low intensity fire kills harmful insects and other pathogens. It also kills unwanted weeds on the forest floor. It increases the temperature of soil in high altitude forests (Chir and Fir) and helps in improved regeneration. The temperature rise helps in regeneration of hard coated seeds like teak etc. Control burning (which is a managemental and low intensity fire) in wildlife areas is an integral part of forest management. New flush of grass which grows after controlled burning provides good fodder for the herbivores like deer, rabbits etc. Control burning also helps in the recycling of soil nutrients.

High Intensity fire in the forest areas can cause loss of lives (both human and wild animals), property and loss of forest ecosystem and its services. Some of the negative consequences include loss of biodiversity, soil erosion, loss of scenic and recreational value of the area.

### 1.3 Indian Scenario

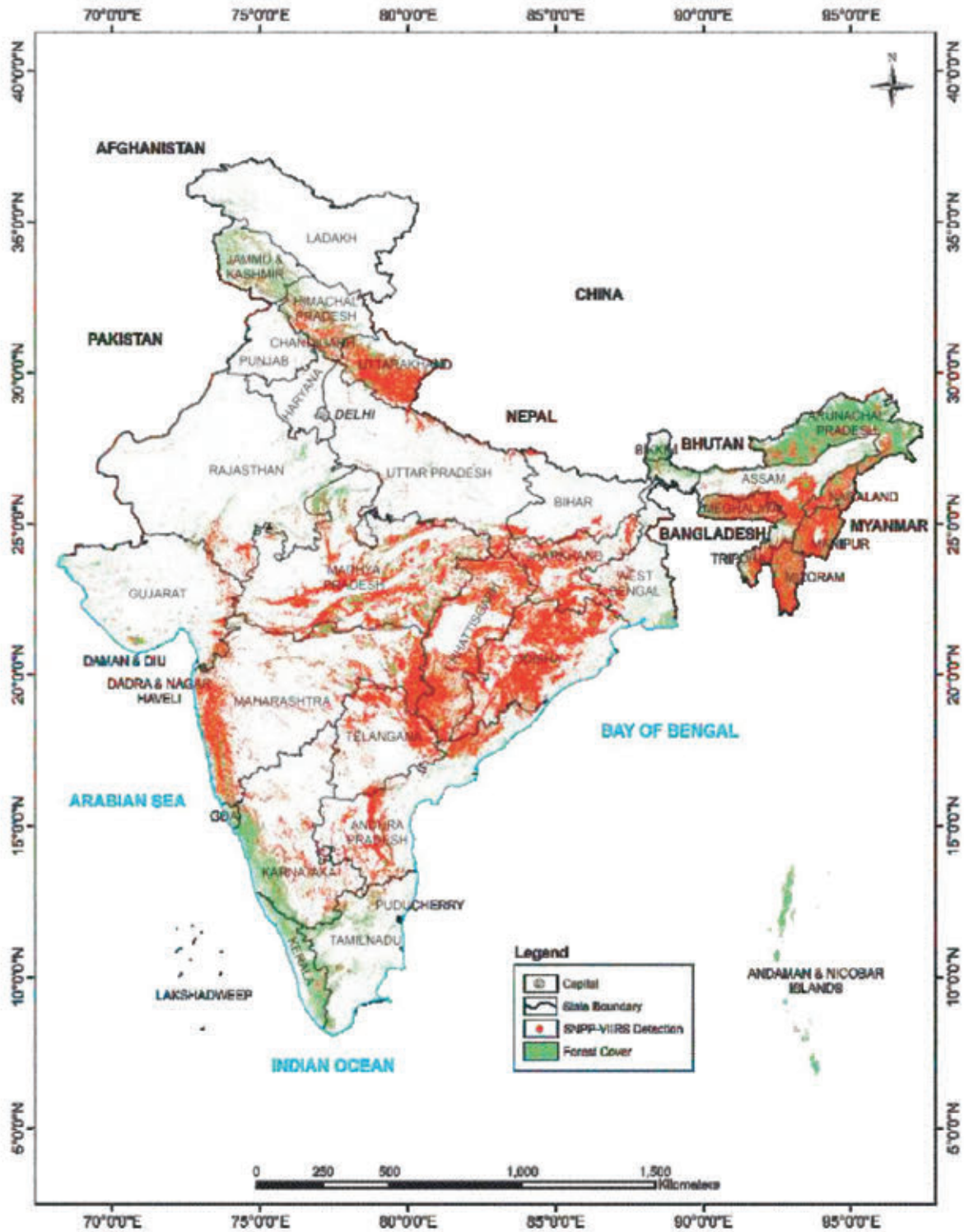
More than 36 % of the country's forest cover has been estimated to be prone to frequent forest fires. Nearly 4% of the country's forest cover is extremely prone to fire, whereas 6% of forest cover is found to be very highly fire prone (ISFR 2019).

S. No.	Category	Forest cover (in sq km)	% of Total forest cover
1.	Extremely fire prone	20,074.47	2.81
2.	Very highly fire prone	56,049.35	7.85
3.	Highly fire prone	82,900.17	11.61
4.	Moderately fire prone	94,126.68	13.19
5.	Less fire prone	4,60,638.36	64.54
<b>Total</b>		<b>7,13,789.03</b>	<b>100</b>

(Source ISFR, 2021)



Map Showing SNPP-VIIRS based hot spots detected during 2020-2021 forest fire season



(Source ISFR-2021)

## 2- FOREST TYPES OF INDIA

The revised forest type classification of Champion and Seth (1968) is the most widely used classification system for forests of India. Champion and Seth classified forests into six major groups based on climatic factors. These major groups have been further divided into 16 type groups based on temperature and moisture content.

Major Forest Groups	Types of Forests
<b>I. Moist Tropical forests</b>	1. Tropical Wet Evergreen Forests 2. Tropical Semi-evergreen Forests 3. Tropical Moist Deciduous Forests 4. Littoral and Swamp Forests
<b>II. Dry Tropical forests</b>	5. Tropical dry deciduous forest 6. Tropical thorn forests 7. Tropical dry evergreen forests
<b>III. Montane Subtropical Forests</b>	8. Subtropical broad-leaved hill forests 9. Subtropical pine forest 10. Subtropical dry evergreen forest
<b>IV. Montane Temperate Forests</b>	11. Montane wet temperate forests 12. Himalayan moist temperate forests 13. Himalayan dry temperate forests
<b>V. Sub alpine forests</b>	14. Sub alpine forests
<b>VI. Alpine Forests</b>	15. Moist-Alpine Scrub 16. Dry-Alpine scrub

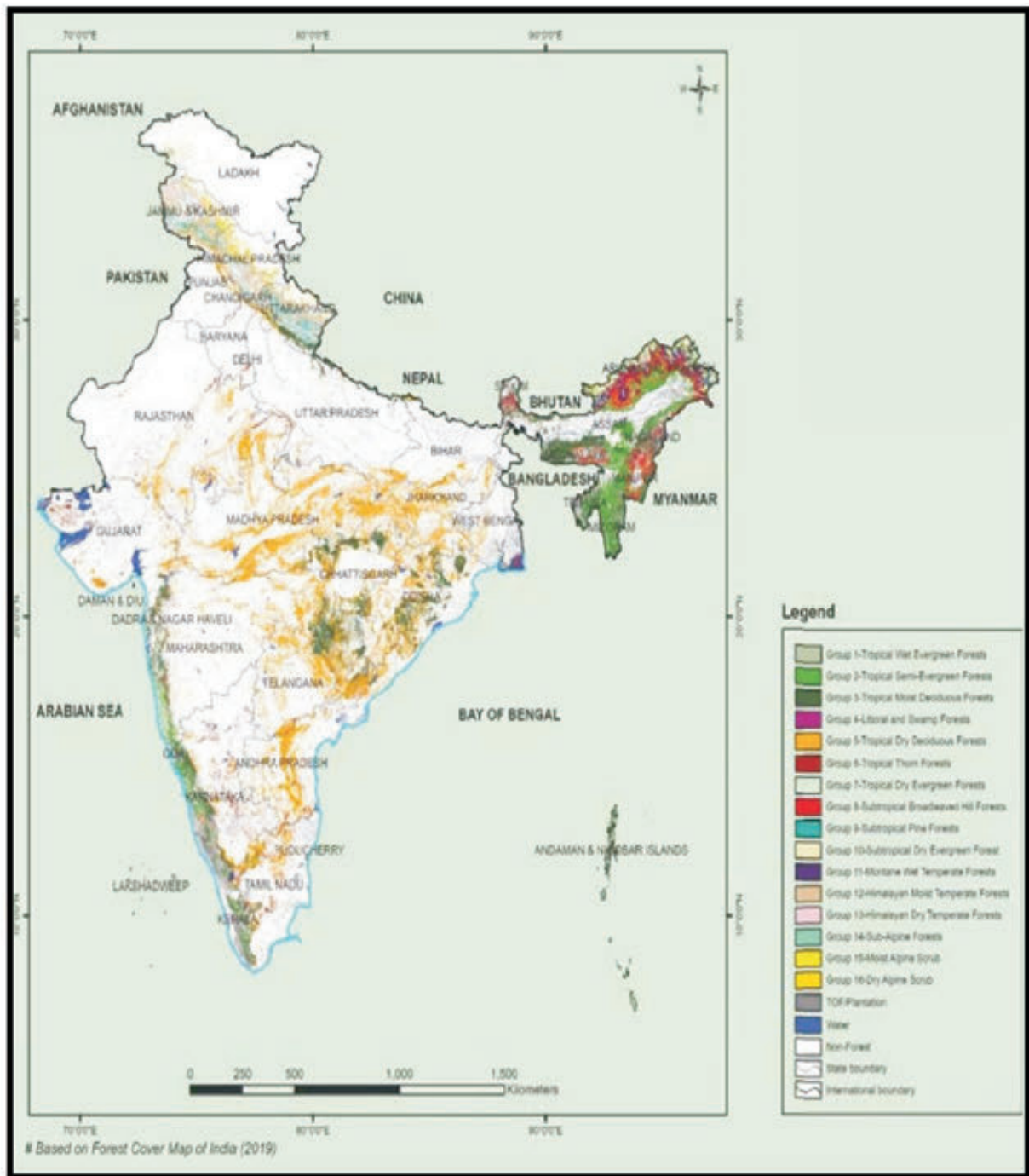
Severe fires occur particularly in dry deciduous forest, while evergreen, semi-evergreen and montane temperate forests are comparatively less prone. Most of the fire-prone forest areas are found in the North-eastern region and the central part of the country.

- As per the long-term trend analysis performed by FSI, nearly 10.66% area of Forest Cover in India is under extremely to very highly fire prone zone.
- States under North-Easter Region showed the highest tendency of forest fire, and these states fall under extremely to very highly forest fire zone.
- States like Mizoram, Tripura, Meghalaya, and Manipur in Northeastern part of India exhibit the highest fire probability in terms of its frequency of event occurrence.
- Parts of Western Maharashtra, Southern part of Chhattisgarh, Central part of Odisha and few parts of Andhra Pradesh, Telangana and Karnataka are showing patches of extremely and very highly fire prone zones.

*(Source ISFR 2021)*



Forest type map of India showing type groups as per Champion Seth Classification-1968



(Source Atlas Forest types of India FSI)

### 3- TYPES OF FUELS & TYPES OF FOREST FIRES

Fuel is the combustible biomass found in forests. Fuels include everything from needles, grasses, and small twigs (“fine fuels”) to progressively larger fuels such as shrubs, branches on the ground, downed trees, and logs.

Forest fuels are considered as the most important contributing factor than any other environmental factor in forest fires.

#### 3.1 Properties of Forest Fuel

It includes size, shape, height, depth, load, bulk density, and vertical & horizontal arrangement. Fuel description is required to predict fire behavior.

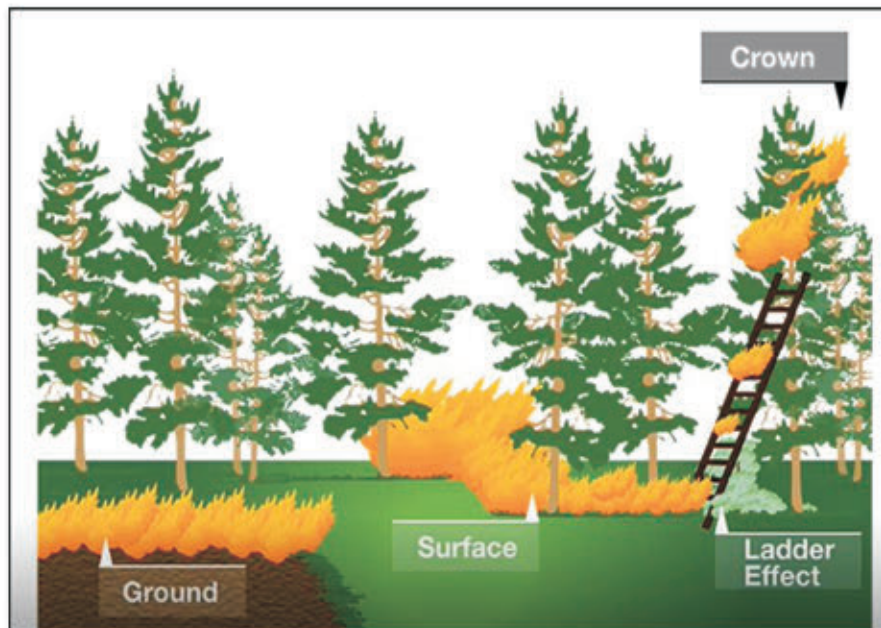
#### 3.2 Types of Forest Fuels:

There are 3 main types of fuels—

- 1) Crown fuel
- 2) Surface fuel
- 3) Ground fuel
  1. **Crown fuel:** This fuel is found above the surface or ground level which includes Trees, Tree ladder etc.
  2. **Surface fuel:** 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
  3. **Ground fuel:** This fuel is formed when the surface fuel mostly degraded over the years and reach the subsurface level e.g., partly decayed vegetative matter (Duff), lichen, moss, litter etc.



## TYPES OF FOREST FIRES



There are 3 types of forest fires mainly based on the type of fuels discussed above. They are (i) Crown fire (ii) Surface fire (iii) Ground fire

- i. **Crown Fire:** Crown fire is the burning of tree crowns which can occur due to friction of crowns against each other or through surface fires reaching the crown (ladder effect). It is not so common (10% occurrence in India). 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)-** It is the type of crown fire where the flame spreads from one tree to another through the tree crowns.  
**Fire tornado-** It occurs due to an extremely favorable 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 crowns burn (mostly due to torching effect)

- ii. **Surface Fire:** It is the most common type of fire and accounts to about 70% in India. It is clearly visible by the flames spreading in the forest floor. 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 grass lands, forest floor rich in fallen leaves and pine needles.



a. **Low vigour surface fire**

Low vigour surface fire is characterized by slow rate of spread with visible flames or unorganized flame front and can be controlled easily. Direct methods with fire beater, water sprayers or clearing of the fire lines may be helpful.

b. **Moderate vigour surface fire**

Moderate vigour surface fire is characterized by its moderate rate of spread with visible flame but has an organized flame front. Flame height must be considered for direct method of firefighting.

c. **High vigour surface fire**

High vigour surface fire is characterized by high rate of spread with organized flame front. Flame height is more and can lead to the torching effect. Such fires are usually not tackled by direct methods of firefighting. Instead, beating and indirect methods (cutting of fuels surrounding the area) must be used to combat such fires. Air operations can also be employed.

d. **Extremely vigorous surface fire**

Extremely vigorous surface fire is very rare in India, but 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.

- iii. **Ground Fire:** Ground fire is the burning of the surface fuel present below the ground. It is mainly depicted by the smoke without any flame coming from below the ground. It can smoulder for a long time without notice and with wind and other favorable conditions, may convert into other types of fire such as surface or crown. It is difficult to control as it is mostly not noticeable.





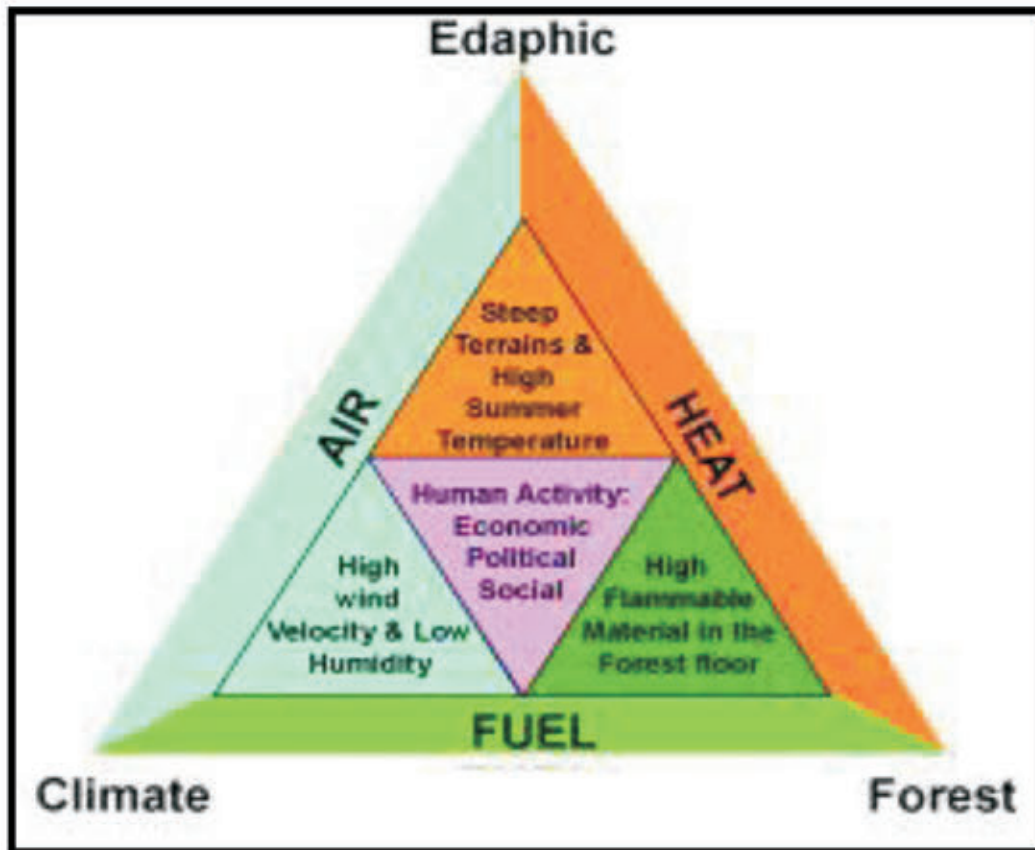
It is not so common (10-15% occurrence in India). It is common in the Oak forests as the litter and other ground fuel is more.

Direct firefighting method using water hose or water sprayers is useful. Fire beating will not work in this type of fire as there is no discernible flame.

#### 4-FIRE WEATHER AND FIRE BEHAVIOUR

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

Fire Behaviour Triangle



##### 4.1 Climatic factors -

**i. Wind /Air:** Wind direction has direct impact on the direction of fire spread. Wind speed has direct influence on its rate and intensity. Surface fire can be turned into active crown fire if the wind velocity is high. The rate of ignition and rate of spread from the lower altitude to higher altitude during winds is also very high.

**ii. Temperature:** Increase in temperature is always related to greater chance and spread of forest fires.

**iii. Moisture:** Low moisture in fuel and the environment leads to greater chance and spread of forest fires. Hence the combination of high wind velocity, high temperature and low moisture favours high occurrence and high spread of forest fire.

##### 4.2 Edaphic factors-

**i. Slope:** Fire spreads very rapidly in slope. The effects of slope on fire spread become greater as the slope increases i.e. greater the slope, greater is the rate of spread of fire. When the fire moves down from a slope, the intensity of fire is very high due to the accumulation of fuel load below.



**ii. Elevation/Altitude:** Fire intensity is lower at higher elevations compared to lower elevations as the higher altitude is naturally cooler and has less fuel loads.

**iii. Aspects:** Southern aspects of the hills are hotter with less moisture due to more exposure to sunlight thereby more prone to forest fires as compared to Northern aspects of the hills which are relatively cooler having more moisture and therefore less prone to forest fires.

Hence the combination of slope with northern aspect and less to moderate elevation favours high occurrence and high spread of forest fires.

#### **4.3 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 fires.

#### **Fire Weather**

The world is getting warmer with erratic weather patterns which is 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, humidity, precipitation, cloudiness, visibility, and wind. These weather components are used in the Fire Danger Alert System for predicting and forecasting.

#### **The Nesterov Index**

The Nesterov Index is a simple fire-danger rating system that came about in 1949.

It is represented as follows:

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

P represents the ignition index

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

t is the temperature in degrees Celsius

D is the dew-point temperature in degrees 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 3 mm, whereafter the process starts anew.

<b>VALUE OF P</b>	<b>FIRE DANGER</b>
Between 0 and 300	Minimal
Between 301 and 1000	Moderate
Between 1001 and 4000	High
Above 4000	Extreme

## 5- MANAGEMENT PRACTICES FOR FOREST FIRES

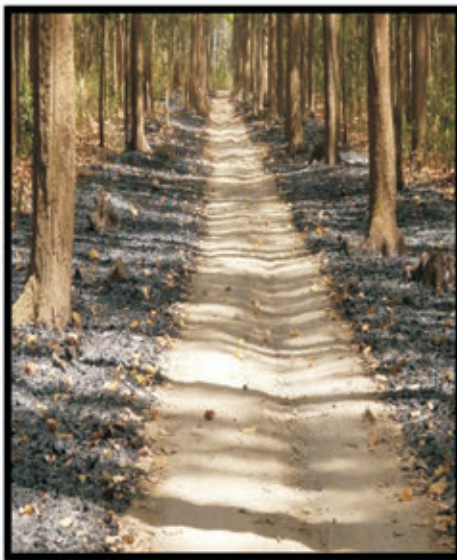
Traditional Forest fire management has 4 stages namely-

1. Prevention
2. Detection
3. Suppression or fire fighting
4. Restoration of the affected area

### 5.1 Prevention:

In forest areas, many operations are carried out to prevent occurrence of forest fires. Some of the important ones are as discussed below:

#### a. Fire lines/Fire breaks



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

Width of Fireline	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

Control burning is another operation undertaken by the forest department to break the continuity of fuel on the forest floor.



**b. Removal of under growths/bushes/weeds-**



Before the onset of fire season, reducing the fuel load on the forest floor is an 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* sp, *Prosopis* sp etc. which pose as potent flammable material in the forest area are removed or reduced in quantum.

**c. Awareness raising, capacity building of 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 on their livelihoods including their immediate ecosystem. The local people are made to involve themselves in firefighting trainings and are also used as fire watchers by the forest department.

#### d. Conversion of fuel to useful products



The fuel for forest fire is converted to innovative products like briquettes, furniture, handicrafts etc. Pine needles are used to make briquettes, bio ethanol, handicrafts and also used in water conservation works. Lantana shrubs are used to make furniture, handicrafts etc.

#### 5.2 Detection

Early detection of fire and immediately responding by firefighting can reduce the losses caused by fire. There are several methods to detect forest fires which includes (i) The local villager information network (ii) Watch towers (iii) Fire alert system (iv) Regular patrolling.





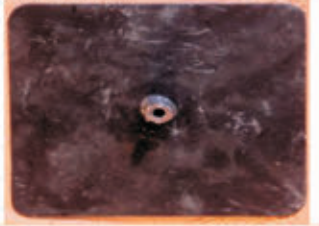


- (i) **The local villager information network-** The local villagers are the first to respond and share information to the forest department about the occurrence of forest fires.
- (ii) **Watch towers-** Watch towers located at high points can help in noticing the occurrence of fires in the surrounding areas.
- (iii) **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 (Discussed in detail in the next chapter)
- (iv) **Regular Patrolling-** Regular patrolling is conducted by the forest department in their respective forest areas and detect fires if any.









#### 5.3 Suppression



Once forest fire occurs in any forest area, immediate response is necessary for suppressing it but also to reduce the losses. Traditionally there are some firefighting equipments which are used to suppress the forest fires. They are listed below with their respective uses:



S. No	Fire equipment	Uses
1.	Fire rake (arrow shaped) 	Used to remove twigs and small branches- to break the fuel continuity
2.	Fire rake (Nail type) 	Used for raking light litter-to break the fuel continuity
3.	Fire rake (peg tooth type) 	Used for raking thick litter-to break the fuel continuity
4.	Fire Broom (Jhapa) 	It cuts the oxygen required for burning. It's a smothering tool. Specially designed to beat the fire and control the surface fire.
5.	Fire Beater 	Developed to put off fire by beating It is also used in post fire mop up operations
6.	Adjustable Rod 	It is adjustable to various lengths and can be fitted into various fire equipments like beater, rakes etc.
7.	Sickle (pathal) 	It is designed to cut the small branches and twigs for clearing way for crew members. It is also used in clearing bushes and under growths

8.	<b>Power Chain Saw</b> 	<p>It is used for cutting big branches and affected trees from the site and reduce the fuel load.</p>
9.	<b>Pulaski</b> 	<p>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.</p>
10	<b>Leaf blower</b> 	<p>It removes dry fuels (leaves and fallen twigs) from fire lines and roadsides. It is used for making small fire lines</p>
11.	<b>Drip Fire Torch</b> 	<p>A drip torch used to set backfires, burnouts, and prescribed burns.</p>
12.	<b>Knap-Sack water sprayer</b> 	<p>It is used to spray water and control smouldering ground fires</p>
13	<b>Torch/headlight</b> 	<p>It is a portable torch which can be fitted on the head of crew members during forest fire operations at night.</p>



14	Fire safety gear 	The gear ensures the safety of the firefighting personnel
15	Water bottle, jaggery and channa 	This takes care of the energy level and hydration status of the firefighting personnel

### 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.



### Indirect method of fire control-

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



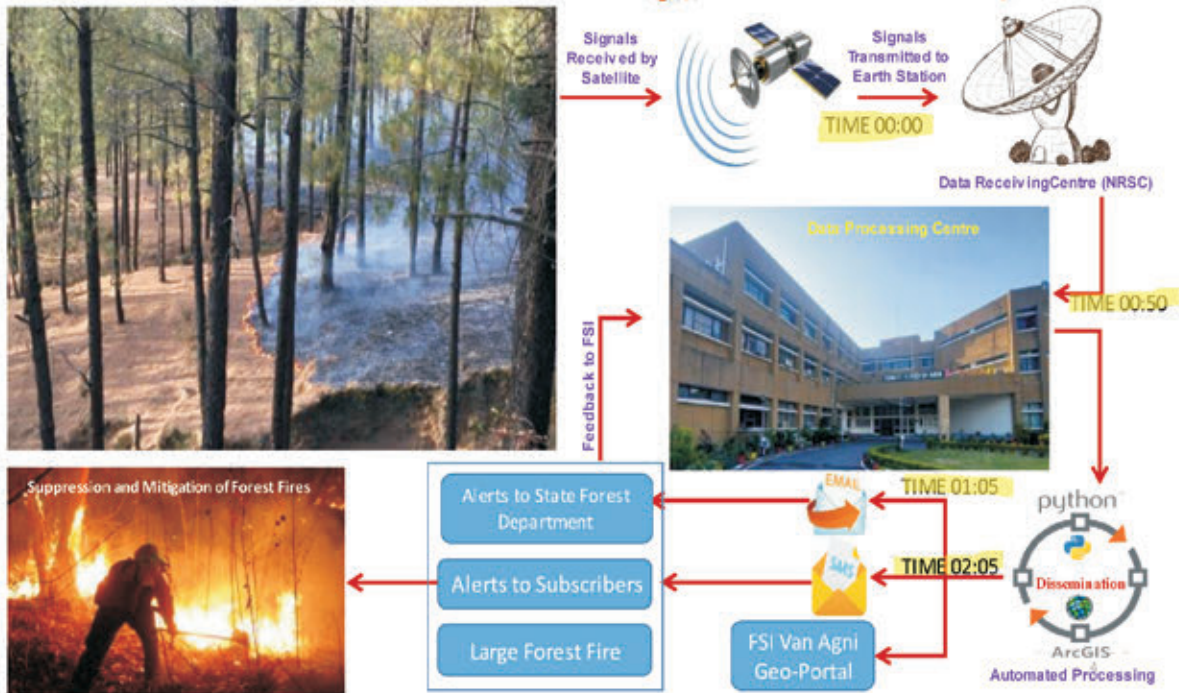
## 5.4 Post Fire Restoration

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

How the Forest Fire Alert System works?

### Near Real Time Forest Fire Monitoring (MODIS & SNPP-VIIRS)



(Source : FSI website)

Any fire occurrences and change in temperatures in a particular area is sensed and the signals are received by the satellites

The signals are transmitted to the data receiving centres and then further to the data processing centres.

Automatic processing of the data received is done using computer softwares like Arc GIS etc.

Dissemination of fire information as fire alerts through SMS, email etc.



### How to get fire alerts in mobile or in mail?

1. Go to the link <https://fsi.nic.in>
2. Go to *FSI Forest fire portal* in Forest fire tab of FSI website
3. The page of FSI Fire 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
4. Forest Fire Alert System 3.0 opens. Click on *new user?* Sign up here.
5. The *registration form* opens. Fill the *Registration Form* and request the information for the desired administrative level (e.g.-beat or range or division)
6. Click "*Submit*" button after filling registration form. OTP (One Time Password) will be sent to your registered Mobile number.
7. For verification, enter the 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
8. 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- COMMUNITY PARTICIPATION IN FOREST FIRE MANAGEMENT

The present scenario of forest management is mainly the participatory management of forests along with the people residing nearby the forest areas which is crucial and important. In case of any occurrence of forest fires, the local people or the villagers are the primary detectors and they automatically also become the first respondents. They provide information about the fire and its location. This is crucial for mitigation of forest fires.

### Awareness programmes



Awareness programmes are conducted in the villages, schools and nearby villages to create awareness about the detrimental effects of fire on their livelihoods and their immediate ecosystem. The forest department also urge the villagers to prevent forest fires and lend their support in firefighting activities.

### Training programmes for the fire watchers/plantation watchers



Fire watchers and plantation watchers are the contractual staff appointed by the forest department from nearby villages to protect the forest land from fires. These temporary staff are also given requisite trainings to handle various firefighting equipments like blowers, fire rakes etc. They are also trained for cutting fire lines and employing other firefighting methods. In some States like Karnataka, they are also given insurance for their lives.

### Joint Forest Management Committee (JFMC)/Eco Development Committee (EDC)

Joint Forest Management Committees are formed in the villages having adjoining forest area. Some forest area is allotted to the committee as such for protection and conservation. In an event of forest fire, the members of JFMC mobilize themselves in extinguishing the fire along with the Forest department staff. They not only help in fighting the forest fire, but the villagers have good knowledge about the routes, terrain, and being repository of all the required



information of the area. In some States, the committees are provided incentives in the form of prize money when their respective areas are devoid of any forest fire incidences.



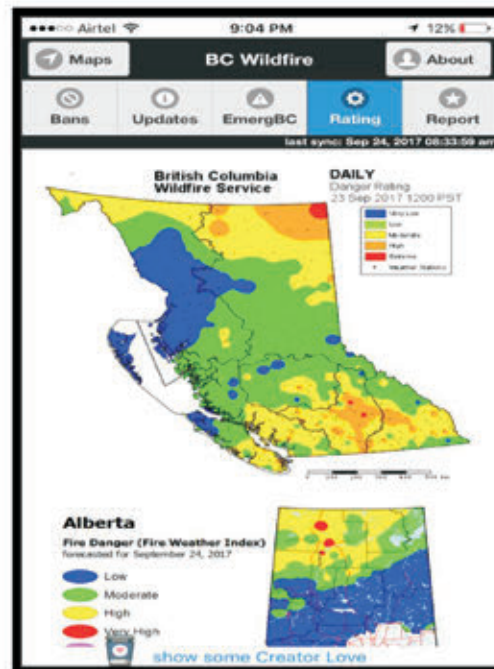
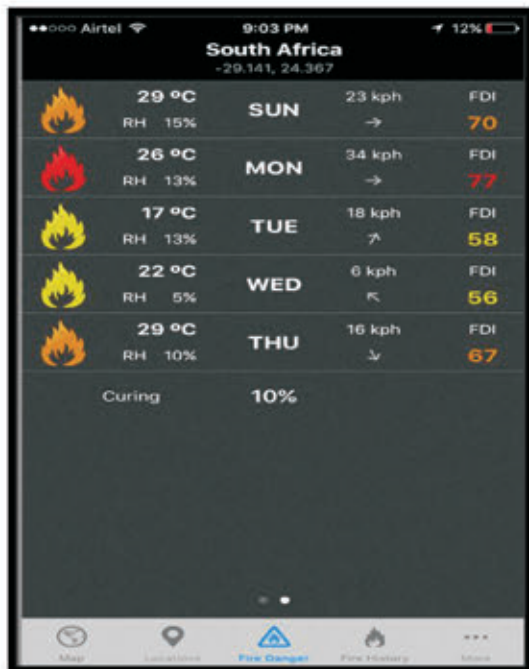
### **Involvement of Van Panchayat/Self-Help Groups/Youth Groups**

In most of the States, people participate through van panchayat or Self-Help Groups or Youth Groups and help forest department in preventing and fighting forest fires. The forest department has several schemes through which they help the villagers by providing employment like that of fire watchers etc. and improve their livelihood by implementing developmental schemes. The participatory forest management always help the reduction of fire occurrences and quick mitigation of forest fire events.

## 8- RECENT ADVANCES IN FOREST FIRE MANAGEMENT-GLOBAL SCENARIO

### 8.1 Fire detection - Fire Danger Prediction and Alert System

Presence of Fire Danger Rating and Behavior Prediction System through decades of research is available in most of the fire prone countries like Canada and Australia. It however does not exist in India. The Canadian Forest Fire Danger Rating System (CFFDRS) is the most widely applied fire danger rating system in the world.



Similar systems are being used successfully in different countries e.g. the apps developed by South African and British Columbian Fire Service for wildfire management.



## 8.2 Advances in Forest Fire Fighting

### 1. Fire Retardants/Foams

Fire retardants are chemicals which usually inhibit or delay the spread of fire by suppressing the chemical reactions in the flame or by the formation of a protective layer on the surface of the flammable material. They are harmful and can cause health problems and not used in India.



2. **Fire Balls-** They are small auto fire extinguishers which can be used in small areas of fire.



3. **Fire Shelters-** A fire shelter is a safety device of last resort used by Forest firefighters when trapped in wildfires. It is usually two layered. The outer layer is a woven silica laminated to aluminium foil. The inner layer is fiberglass laminated to aluminium foil.



4. **Fire Blankets-** Fire blankets are used to smother flames. For small fires, the fire blankets are usually made of glass fibre. The fire blankets are also made with wool impregnated or treated with chemical fire retardants when used in large fires.



5. **Firebombs-** Fire bombs usually contain carbon dioxide and are dropped by air on the fire below.



6. **Smoke jumpers-**Smoke jumpers are elite group of wildfire fighters who are dropped by air near the area of fire where they carry out direct or indirect methods of firefighting to contain the spread of fire.
7. **Water cannons-** Force full ejection of water on the fire extinguishes the fire. But only applicable to small areas and is dependent on availability of water.





8. **Jet packs**-Jet packs are used to go to a particular area of fire and perform firefighting exercise by direct or indirect attack.



9. **Drones** – Drones are used to locate the fire, understand its intensity, and accordingly navigate. Drones are also used to drop fire balls.

## 9-IMPORTANT ASPECTS TO BE CONSIDERED DURING FIRE FIGHTING

To be effective in forest fire fighting, 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.

When fire is detected and after knowing its precise location:

1. The first step is to assess the various parameters before the actual firefighting procedure begins-
  - a. the way point to the area and escape route(s) or safe zone(s) from that area which includes access roads and paths
  - b. estimation of the fire area and its perimeter at the time of detection
  - c. type of fuel which is burning
  - d. wind speed, direction, and variability if any
  - e. slope, and aspect (topography of that area)
  - f. behavior of fire during previous incidences in that area and the current fire behavior there
  - g. natural and artificial fire barriers if any (roads, rocks, lakes, or cultivation land)
  - h. type of forest fire
2. The second step is decision making including various decisions to be taken before actual implementation which includes-
  - a. where to initiate the attack for fire fighting
  - b. type of attack-direct, indirect, backfire
  - c. location and width of fire line and the way to make it
  - d. reinforcements to be called in (whether more special force is required or not, air operations etc.)
3. After decisions are made, the crew would get command from the commanding officer to implement the decisions made-

S No	Type of fire	Action suggested
1.	Ground fire where no flame is seen	Water spraying using sprayer or hose pipe
2.	Surface fire, flame length is less than 4 ft, slow to moderate spread	Direct attack using beater, rake, blower to put off
3.	Surface fire flame length more than 4 ft moderate to high spread	1. Indirect attack, making fire lines around the fire to cut the fuel load 2. Width of Fireline can be decided based on the wind velocity, slope etc.
4.	Crown fire	No direct or indirect attack. Air operations must be called in or wait for the reduction in the intensity
5.	Grass fire	Very rapid in spread, hence fire line and backfire works. Only trained personnel should work in such fires

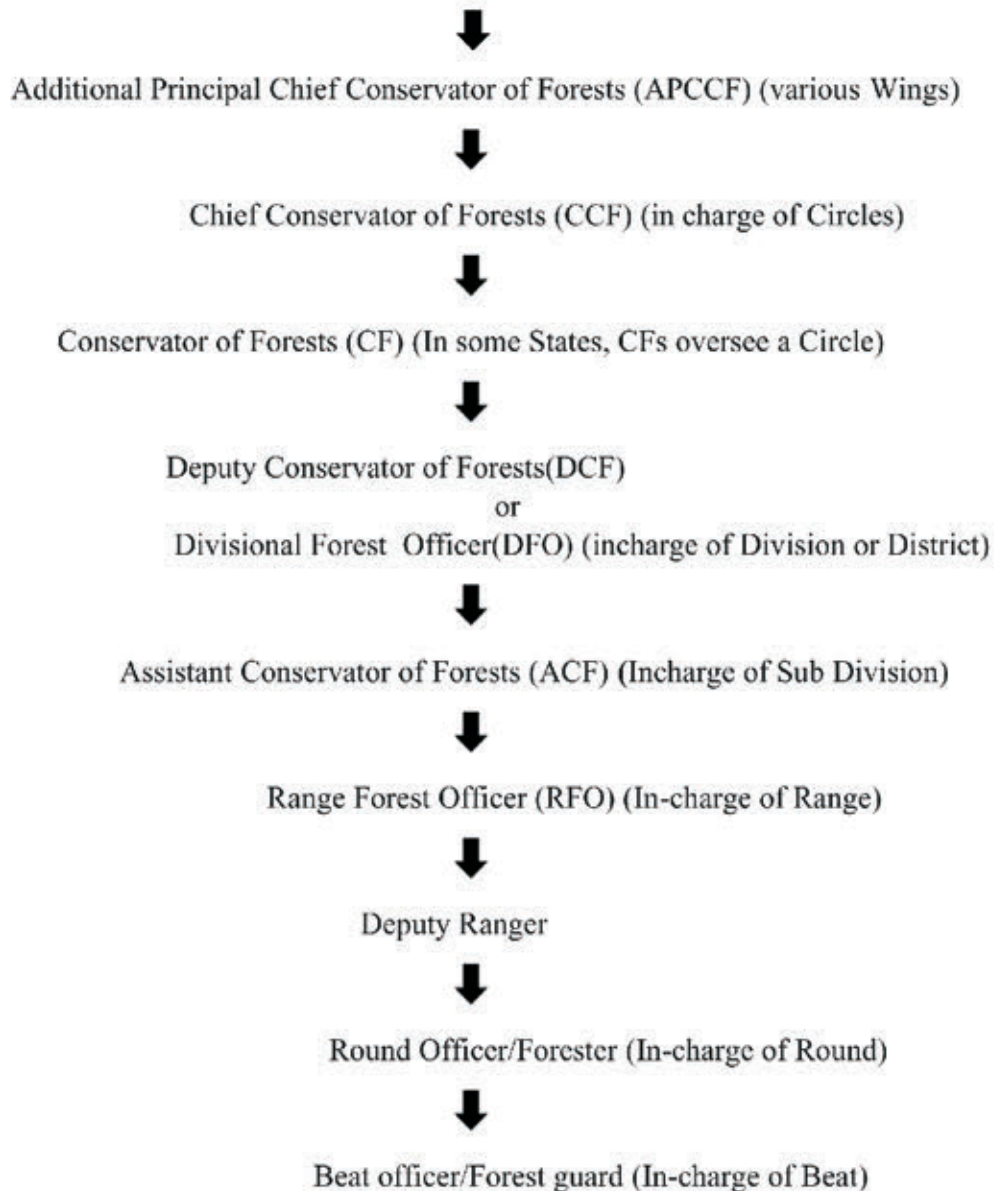


4. The safety of the firefighting personnel should be given utmost importance and a firefighting team (optimally less than 10) should work only for 3-4 hours after which a fresh team should be sent to replace them. Firefighting team should wear fire safety gears (at least helmet, face shield, mask, boots) while in operation and should keep water, jaggery and chana for sustenance.

## 10-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)

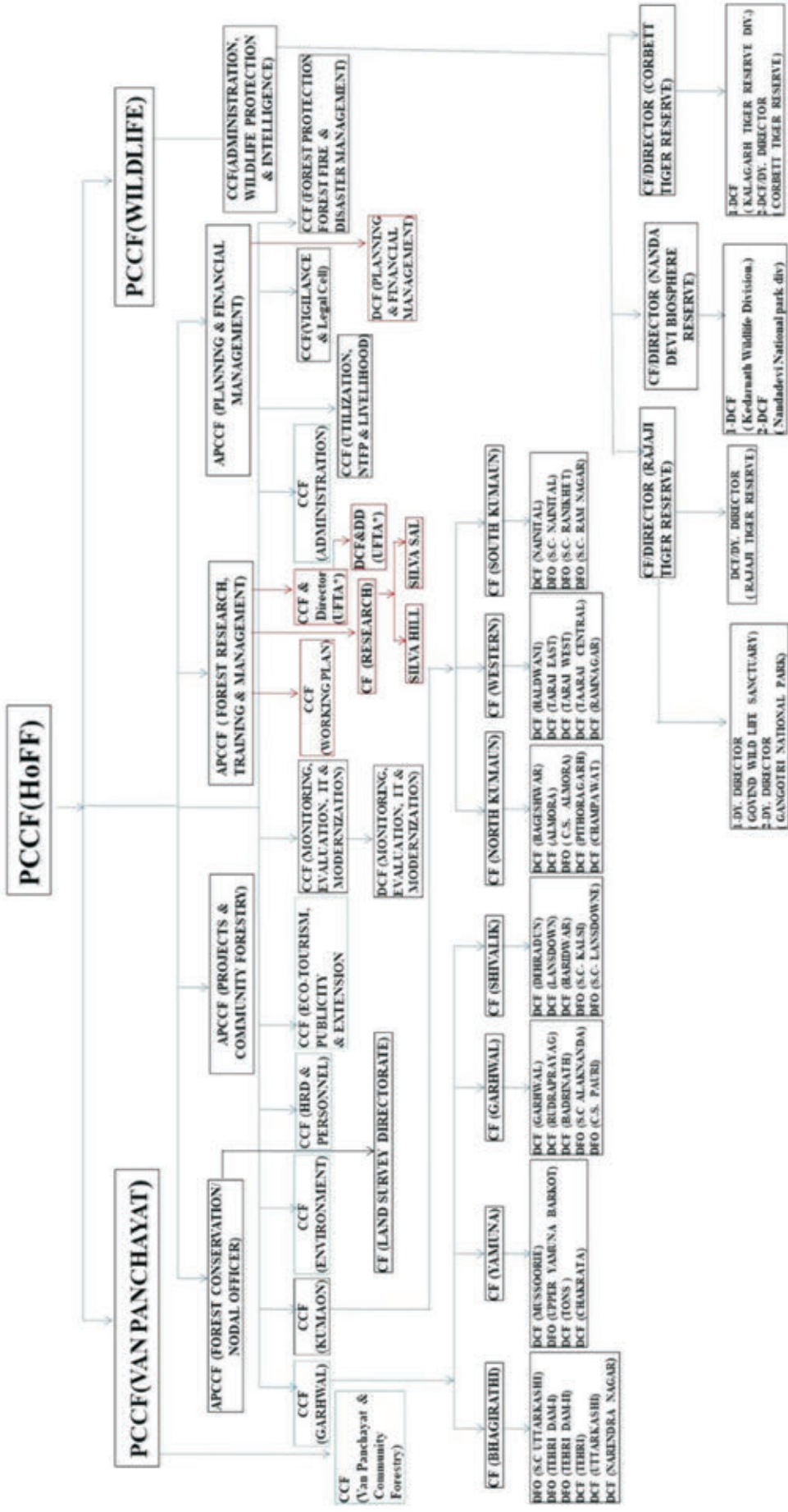
Principal Chief Conservators of Forests (PCCFs)-social forestry, wildlife etc. support the PCCF&HoFF in administrative works



Structure of Forest Department of the State of Uttarakhand is attached in the next page for reference.



# UTTARAKHAND FOREST DEPARTMENT ORGANOGRAM





## Central Academy for State Forest Service, Dehradun

Ministry of Environment, Forest and Climate Change,

Tel : 0135-2754575 / E-mail: [casfos.dd-mef@gov.in](mailto:casfos.dd-mef@gov.in)

Website: <http://casfosddn.nic.in>

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