GOVERNMENT OF ARUNACHAL PRADESH
DEPARTMENT OF ENVIRONMEN FOREST & CLIMATE CHANGE
ITANAGAR

No. FOR.10/PRO/2017/Pt-I/4171-209 Dated Itanagar 27th Feb /2023

Sub: - State Action Plan on Forest Fire 2023-28 -reg.

The State Action Plan on Forest Fire prepared for Arunachal Pradesh is enclosed herewith for further necessary action. The action plan provides guidelines for controlling forest fire in all situations of exigencies. The copy of the Action Paln on forest fire is also uploaded in the departmental website www.arunachalforest.nic.in.

Enclo: - As above

(S.S Kandpal)
Addl. PCCF (RE)

Copy to:

1. **PCCF (P&D) / PCCF (WL&BD) & CWLW.**
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3. **All DFOs including of Wildlife Divisions.**
4. **Incharge nic for uploading a copy of the action plan on forest fires 2023-28 on the departmental Website.**

27/2/23
(S.S Kandpal)
Addl. PCCF (RE)

ARUNACHAL PRADESH

STATE ACTION PLAN ON FOREST FIRE

(2023-2028)

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List of Abbreviations

NAPFF	National Action Plan on Forest Fire
SAPFF	State Action Plan on Forest Fire
MoEF&CC	Ministry of Environment, Forest and Climate Change
SFD	Tripura Forest Department
Addl. PCCF	Additional Principal Chief Conservator of Forests
DFO	District Forest Officer
RFO	Range Forest Officer
FSI	Forest Survey of India, Dehradun
NRSC	National Remote Sensing Centre
NER	North-eastern Region
CAC	Central Arunachal Circle
WAC	Western Arunachal Circle
EAC	Eastern Arunachal Circle
SAC	Southern Arunachal Circle
GIS & IT Cell	Geographic Information System and Information Technology Cell
ICFRE	Indian Council for Forestry Research and Education, Dehradun
RFRI	Rain Forest Research Institute, Jorhat
DPR	Detailed Project Report
MODIS	Moderate Resolution Imaging Spectroradiometer
SNPP-VIIRS	Visible Infrared Imaging Radiometer Suite – Soumi National Polar-orbiting Partnership
ISFR	India State of Forest Report
CSS-FPM	Central Sponsored Scheme – Forest Fire Prevention and Management
APO	Annual Plan of Operation
SDMA	State Disaster Management Authority
DDMA	District Disaster Management Authority
CAMPA	Compensatory Afforestation Fund Management and Planning Authority
FDA	Forest Development Agency
WLS	Wildlife Sanctuary
TR	Tiger Reserve
NP	National Park
PAs	Protected Areas
RFs	Reserve Forests
COVID-19	Coronavirus Disease - 19
NTFP	Non-Timber Forest Produce
NGOs	Non-Governmental Organizations
SHG	Self Help Group
MNREGA	Mahatma Gandhi National Rural Employment Guarantee Act

1. Arunachal Pradesh-at a glance

The state of Arunachal Pradesh, earlier known as the North East Frontier Agency (NEFA), located in the north-eastern part of India, is the fourteenth largest state of the country in terms of geographical area and twenty seventh with respect to population. The mountainous area is bordered by Bhutan in the west, separated from China in the north and northeast by the McMahon Line, Myanmar (Burma) in the southeast, and the states of Assam and Nagaland in the south. The state consists of 27 districts and is inhabited by 26 major tribes. Itanagar is the capital of the state.

The state has a complex hill system with elevation ranges varying from 50 m up to about 7000 m. The important hill systems are Kangto and Namcha Barwa Massif. The state has the largest catchment area of Brahmaputra and its major tributaries including Dibang (Sikang), Lohit, Subansiri, Kameng and Tirap which originate or flow through Arunachal Pradesh.

1.1 Geographical Extent

The state covers a geographical area of 83,743km2 and extends between 26°28' to 29°30' North latitude and 91°30' to 97°30' East longitude. It is a sparsely populated state in the eastern Himalayas and its foothills. Arunachal Pradesh is bounded by Assam and Nagaland in the South. The total length of international border is about 1,628 km shared with the China in North, Myanmar in East and Bhutan in West.

1.2 Climate

Climate of Arunachal Pradesh follows an altitudinal gradient and ranges from sub-tropical to temperate. The climate is hot and humid across the Brahmaputra Plain, Sub-Himalaya and Naga-Patkai ranges, cooler in Lesser Himalayas and chilling in the Alpine zone at higher and Tethyan Himalayan zones. The state has four seasons viz.- (a) Summer: starting from April and ending in May with maximum temperature rise up to 38°C mainly in Sub-Himalayan zone (b) Monsoon: starting from June and ending in September, with an average annual rainfall of more than 3,000mm and June and July being the wettest months (c) Post-monsoon season: from October to December and (d) Winter: starting from December and ending in February, generally, cold and wet. Average temperature in Sub-Himalaya and Brahmaputra Plains varies between 0ºC to 5ºC and in higher altitude (> 2000m), it drops below freezing point with occasional mild to heavy snowfall.

1.3 Physiography

Arunachal Pradesh is almost completely under rugged mountainous terrain. The eastern Himalayan part of the state consists of very high relative relief with deep gorges and valleys. The mountainous range and sub-mountainous terrains along the northern part is tattered by the river that flows through. Physiography of Arunachal Pradesh can broadly be divided into four regions, viz., (i) Brahmaputra plain, situated along the border areas of Assam, generally having an average elevation of 100m, (ii) The Outer Himalayas in the South rising immediately from the Brahmaputra Plains, (iii) The Middle Himalayas with an elevation range from 2500-4000m and (iv) The Inner or the greater Himalayas in the north having very high relief with an elevation greater than 6000m and steep slopes with deep gorges.

1.4 Demography

Arunachal Pradesh is divided into 27 districts. As per the 2011 census, the total population of Arunachal Pradesh is 1.38 million which is 0.11% of total population of the country. Out of the total population, the rural and urban has contributed 77.06% and 22.94%, respectively. Arunachal Pradesh is a tribal state as major population i.e. 68.8% is belonging to the tribal communities which are about 8.6% of the total population of India. The state is the home of 24 major tribes and more sub-tribes with distinctive dialects of their own.

The state has population density of 17 persons per sq. km which is lowest in India. More than 70% people live in rural areas. Overall population growth rate of Arunachal is 26.03% while it is 22.56% in rural areas and 39.27% in urban areas. The high growth rate in urban area is because of having comparatively good basic facilities like medical, employment, drinking water, transport etc. The sex ratio and child sex ratio of the state are 938 and 972; while the national ratios are 943 and 919, respectively.

2. Forests of the state

2.1 Forest Cover

The state has a geographical area of 83,743 km^2 out of which, 66,431 km^2area is under forest cover. Most of the area are falling under Moderately dense forest (30,176 km^2) followed by Very Dense forest (21,058 km^2) and Open forests (15,197 km^2) (Figure 1.1 and Table 1). The total recorded forest area in the state is 51,540 km^2 which is 61.46% of total geographical area of the state (Table 1.3). Of the total recorded forest area, 20.60% is under reserved forest, 19.02% is under protected forests and 60.38% is under unclassed forests. Total forest cover inside the Recorded Forest Area in state is 63,838 km^2 while the total tree cover (all tree patches of size of less than 1 ha occurring outside of recorded forest area) is 1,001 km^2.

The tree outside forests (TOF) constitutes 8,752 km^2 (forest cover outside the RFA and tree cover) of the State. As per the India State of Forest Report (ISFR) 2021, there is a net loss of 257 km^2 in the forest cover of the state as compared to assessment of ISFR 2019. The recorded growing stock of the Forest area and TOF are 418.99 million m^3 and 73.48 million m^3, respectively.

Table 1 Forest and Tree Cover in Arunachal Pradesh

Very Dense Forest (Km^2)	Moderately Dense Forest Km^2)	Open Forest (Km^2)	Total Forest (Km^2)	Tree Cover (Km^2)	Total forest and tree cover (Km^2)
21,058	30,176	15,197	66,431	1,001	67,432
					(Source: FSI, 2021)

2.2 Forest Type

Arunachal Pradesh has great altitudinal variation and resulting varied climatic conditions which support diverse vegetation. Based on the altitude, rainfall, humidity and species composition the vegetation of the state is broadly grouped into three forest types and 10 sub forest types. Same is presented in table 2 and fig 2.

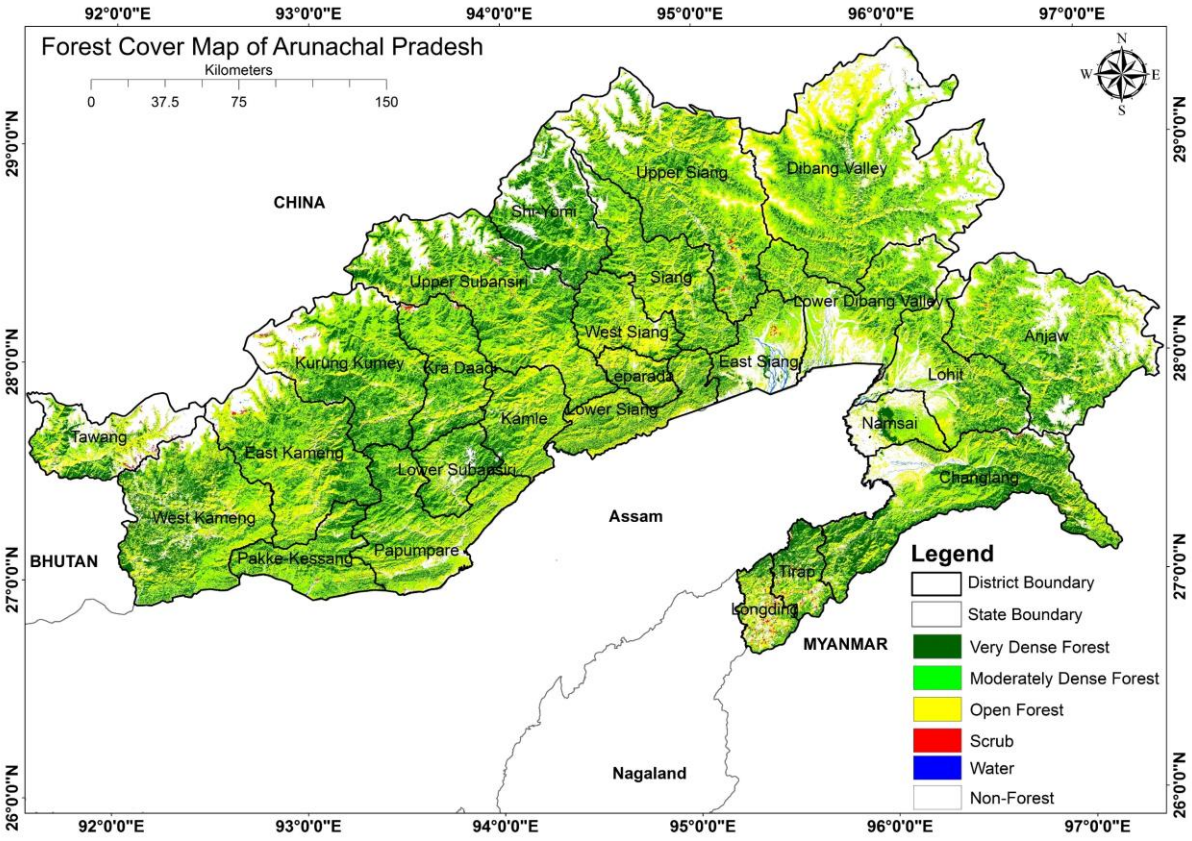

Figure 1: Forest Cover Map of Arunachal Pradesh

Table 2: Forest types of Arunachal Pradesh

Forest type	**Sub type**	**Altitude (m)**	**Dominant genera/species**
Tropical	Northern Tropical Semi-Evergreen Forests	60	*Amoora wallichii, Pterospermum acerifolium, Stereospermum chelonoides, Altingia excelsa*
	Northern Tropical Evergreen Forests	>60	*Kayea assamica, Mesua ferrea, Dysoxylum procerum, Echinocarpus* spp.
	Northern Tropical Moist Deciduous Forests	250 - 1000	*Shorea robusta, Tectona grandis, Bombax* spp., *Pinus roxburghii*
	Secondary Bamboo Brakes	extends up to 1,200	*Bambusa pallida, Schizostachyum polymorphum, Bambusa tulda, Dendrocalamus hamiltonii*
Sub-tropical	East Himalayan Sub-tropical broad-leaved Forests	1000 - 2000	*Bombax ceiba, Lagerstroemia parviflora, Terminalia bellirica, Sterculia villosa*
	Sub-tropical Pine Forests	1400 - 1800	*Pinus roxburghii, Pinus wallichiana* and *Pinus merkusii*
Temperate	Temperate broad-leafed Forests	2,000	*Quercus spp., Fagus* spp., *Acer* spp., *Betula* spp.
	Temperate Conifer Forests	1,800	*Abiess* pp., *Tsuga dumosa*
	Sub-alpine Woody shrub	3,000 - 4,000	*Rhododendron* spp., *Primula* spp., *Saussaurea* spp., *Saxifraga* spp.
	Alpine Meadow (Montane tundra)	1,000 - 3,353	*Diapensias* pp., *Drabas* pp., *Gentiana* spp., *Impatiens* spp., *Leontopodiums* pp., *Rhododendron* spp., *Saussurea* spp.
Source: Champion and Seth, 1968; https://arunachalforests.gov.in/			

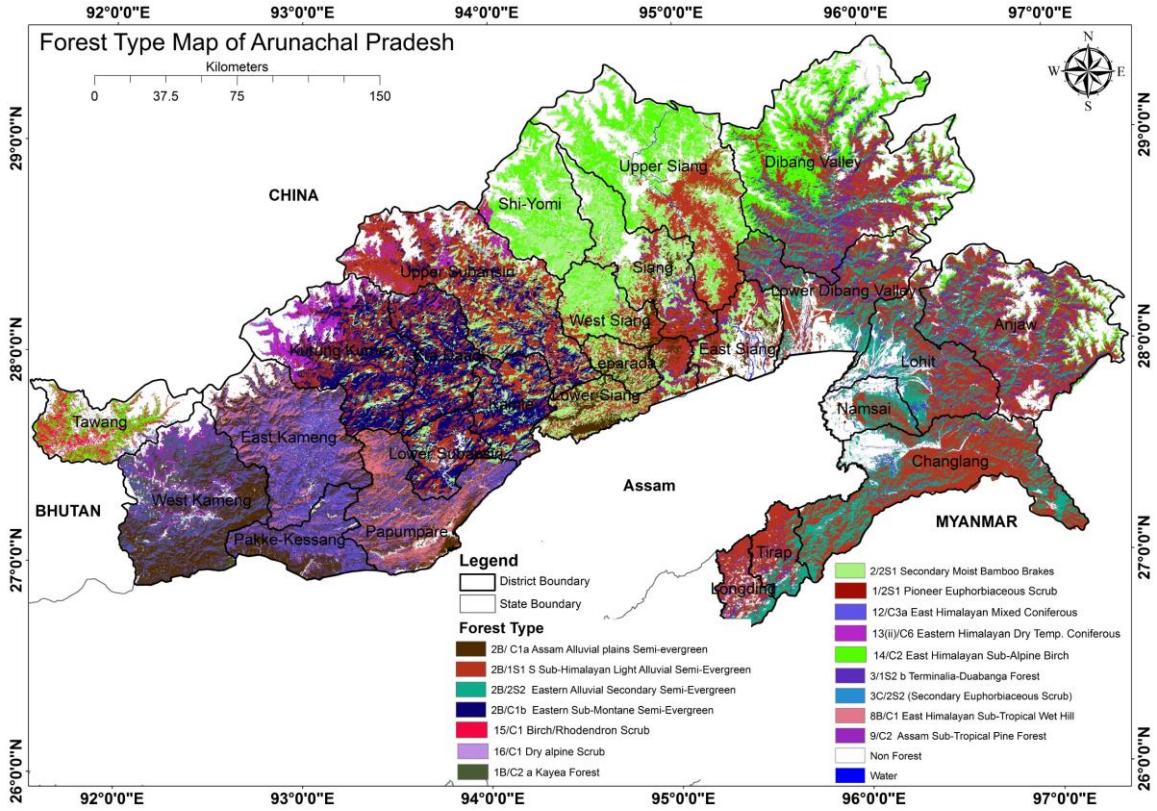

Figure 2: Forest Type map of Arunachal Pradesh

2.3 Protected Areas

The state has 2 national parks (NP), *viz*. - Mouling NP and Namdapha NP; 11 wildlife sanctuaries (WLS) namely D'Ering Memorial (Lali) WLS, Dibang, Eagle Nest, Itanagar, Kamlang, Kane, Mehao, Sessa Orchid, Tale Valley, and Yordi-Rabe Supse; and three tiger reserves namely Pakke, Namdapha and Kamlang.

3. Land Use / Land Cover

In Arunachal Pradesh, land use is mostly influenced by the traditions and customary laws where the vast territories including forest area, hills and slopes etc. are held by the clan or an extended family. The state has diverse land use and land cover system that includes forest areas, snow-covered areas, agriculture areas, wasteland, human settlements, water bodies (lakes, rivers, wetlands), wide river channels etc.

A total of 12 major land use/cover classes *viz*., Forests (Very dense forest, Moderate Dense forest and Open forest), Scrub, Grassland, Shifting Cultivation-Fallow, Shifting Cultivation-current, Agriculture, Open/Barren Land, Settlement, Snow Cover and Water bodies have been delineated and mapped. The distribution of area under different land use/cover classes is given in table 3 and shown in figure 3. The data indicate that forests, grassland and scrub together form the most widespread land use/cover occupying 83.0 % of the area in in Arunachal Pradesh. Snow cover, and water including all wetlands cover 9.6% area. Agriculture including both permanent and shifting cultivation (fallow and current) and open/barren land together cover 7.1% of the area while settlement occupy only 0.3% of the area.

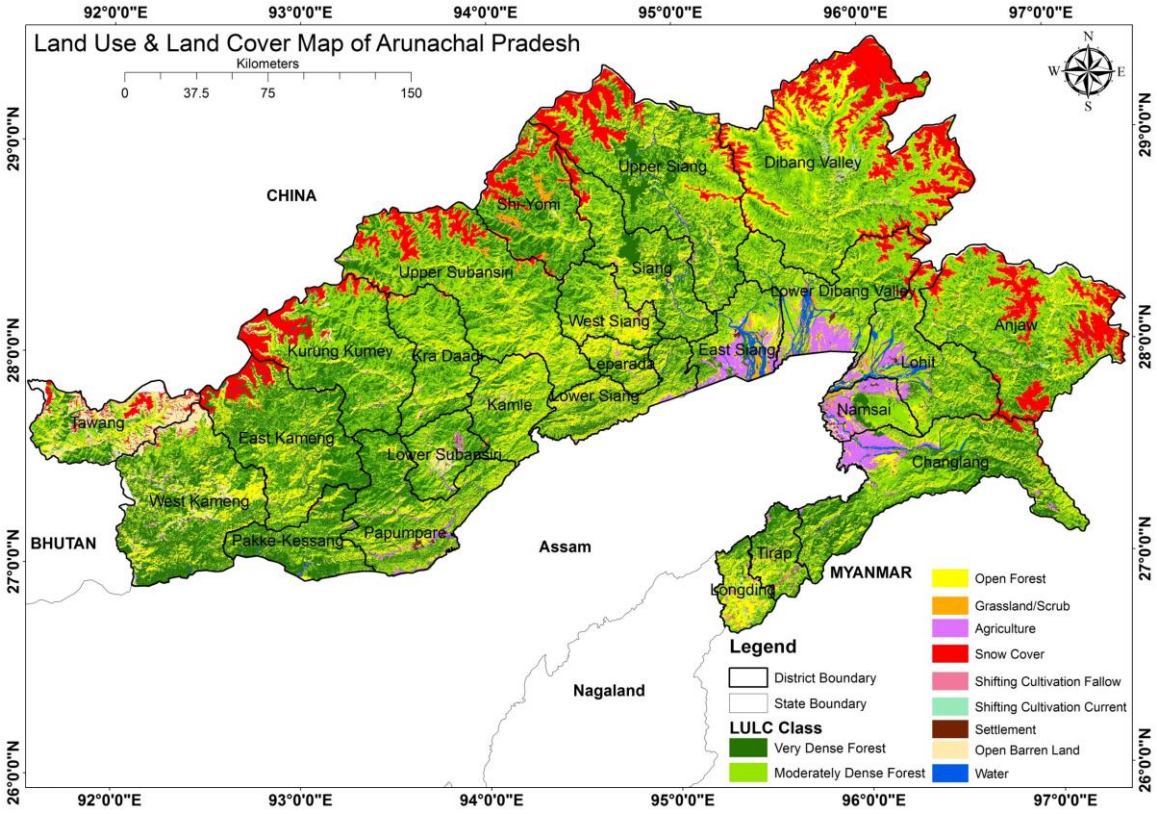

Figure 3: Land use/cover map of Arunachal Pradesh

Table 3: Distribution of area under different land use/cover categories

SN	LULC	Area (ha)	%
1	Very dense forest	20,72,100	24.74
2	Moderate Dense forest	30,95,500	36.96
3	Open forest	15,28,800	18.26
4	Scrub	24,700	0.29
5	Grassland	2,29,274	2.74
6	Shifting Cultivation-Fallow	19,449	0.23
7	Shifting Cultivation-current	33,743	0.40
8	Agriculture	2,00,002	2.39
9	Open/Barren Land	3,38,983	4.05
10	Settlement	24,932	0.30
11	Snow Cover	7,67,317	9.16
12	Water bodies	39,500	0.47
	Total	**83,74,300**	100.00

4. Biodiversity

State of Arunachal Pradesh exhibits rich biodiversity due to its variations in topographic, climatic, and vegetative conditions. State occupies only 2.5% geographical area of India but contributes significantly to floral and faunal biodiversity. Itis considered as one of the Mega diversity regions of the world and one of the world's 18 biodiversity hotspots. Located in the eastern Himalayan region, Arunachal Pradesh is a part of the Himalayas biodiversity hotspot, and one of the 200 globally important eco-regions (Saikia et al., 2017).

Flora: As per the Botanical survey of India about 77% of the total plant families reported in India are found in Arunachal Pradesh, with about 4117 species of Angiosperms belonging to 1,295 genera and 192 families. Of the total Angiosperms, Dicotyledons consist of 2986 species belonging to 970 genera and 165 families and Monocotyledons consist of 1131 species under 325 genera and 27 families, including 550 species of orchids. In case of Gymnosperms, there are 39 species covering 21 genera and 8 families. Pteridophytes have 452 species under 133 genera and 43 species. There are around 300 species of Bryophytes of which 206 are mosses and 94 are liverworts. A total 331 species under 72 genera and 41 families of Lichens, and 54 species belonging to 23 genera of Algae have been reported in Arunachal Pradesh (Alfred, 2006).

Fauna: The wildlife of Arunachal Pradesh is rich and varied. The state is a home for Elephant, Tiger, Leopard, Jungle cat etc. inhabiting the foothills and grasslands. There are 143 species of fishes, under 61 genera, 21 families and 8 orders, 39 species of amphibians belonging to 11 genera, 6 families and 2 orders, 78 species of reptiles under 46 genera and 12 families, and 473 species of birds. The mammals are represented by 105 species and subspecies under 58 genera. The order Carnivora in India is represented by 7 families, 26 genera and 55 species: of this the state has a share of nearly 13 species under 10 genera. Besides, 7 species of primates are also found in the state. Additionally, 1592 species of Insects are reported from Arunachal Pradesh (Alfred, 2006).

A total of 29 tigers which is 0.98% of the total tiger population of India, 1614 elephants which is 5% of the total Elephant population of India and 489 leopards which is 3.92% of the total Leopards population of India are found in Arunachal Pradesh. The important primate white browed gibbon is distributed in Tirap and Lohit districts. The high attitude and cold climate of Himalayas are home of red pandas and musk deer. The state is home of amazing bird with an inordinately large beak known as the great Indian Hornbill (Alfred, 2006).

5. Nature of forest fire

Forest fire are caused by both anthropogenic and natural reasons.

Anthropogenic (intentional/unintentional) fire

When a source of fire like naked flame, cigarette smoking, electric spark or any man-made cause of ignitions come into contact with inflammable materials within forest, it causes forest fire. Such fires may be intentional or accidental. People living in the vicinity of forests often intentionally ignite fires for inducing growth of grass or clear forest floors for collecting Non-Timber Forest Produces. Such fires many times become uncontrollable. In case of northeastern hills of country and Arunachal Pradesh is no exception, burning of jhum lands for shifting cultivation many a times lead to forest fires in adjacent areas. Flowering of bamboo leads to the drying of entire patch of bamboo forest and sometimes communities burn this area to clear the dry bamboos. In northeast, 95% forest fires occur during the process of burning of jhum or shifting cultivation.

Natural fire

Some forest fires start from natural causes like lighting, rolling stones, friction of dry bamboos and stems of trees. Moreover, high atmospheric temperatures and dryness (low humidity) offer favourable circumstance for a fire to commence. In Arunachal Pradesh, setting of natural forest fire is almost nil as humidity is relatively high and atmospheric temperature is also relatively low.

5.1 Types of Forest Fire

Forest fire are generally of three types.

Surface Fire

Surface fire is very fast-moving fire, which consumes small vegetation and surface litter along with loose debris. This type of forest fires mostly common in Arunachal Pradesh.

Crown Fire

Crown fire advances from top to top of trees or shrubs without any close link with surface fire. It is the fastest way to spreading fire and most destructive for trees as well as wildfire. It is rarely observed in Arunachal Pradesh.

Ground Fire

A true ground fire is not easily predictable as it spreads within, rather than top of organic matter. It consumes organic matter like duff, musk or peat present beneath the surface litter of the forest floor. It has unique characteristic of having a smoldering edge with no flame and little smoke. Ground fires are most hard to tackle.

5.2 Fire as a Forest Management Tool

Not all fire in the forest is bad, while it still imperative to prevent catastrophic wildfires. Fire is necessary for the proper functioning of forest ecosystems. There is the tradition of prescribed or control burning in forest area to get the best benefits of fire. This prescribed or controlled burning is one of the important tools of forest management. Fire can be used for a number of management goals, including (but not limited to); the restoration of natural ecosystems, reduction of wildfire hazards, to improve wildlife habitat, to increase regeneration of native species, removal of pests and diseased trees and the reduction of invasive species population. However, use of controlled burnings a management tool has reduced in Arunachal Pradesh over the years.

5.3 Forest Fire Detection System

Advances in satellite remote sensing have enhance the ability to provide information for near real time detection of forest fires, fire progression, burnt area assessment and inputs from ecological damage assessment. In this context, the Forest Survey of India (FSI) has employed geospatial point data showing forest fires provided by National Remote Sensing Centre (NRSC). The active fire spots or fire points are generated by using MODIS and SNPP-VIIRS satellite sensors. The locations of fires as received from NRSC are regardless of land use and land cover. Forest fire detection and dissemination of alerts is done twice daily during forest fire season *i.e.* November to June. After processing the data received from satellites, detected active fire points are

conveyed to the State Nodal Officer, Environment, forest and climate change department, Government of Arunachal Pradesh through e-mail. The information is also uploaded on FSI website and Van Agni Portal. The information received is processed from Headquarter and quickly conveyed to field staffs which are acted upon and followed. Hence, verification of such forest fire points has been done with ground truth in all forest divisions in the State.

Besides this, SFD, Arunachal Pradesh also developed an android based application **"e-Forest Fire App"**, which is a Fire Reporting System, an effort to ease governance by involving people and to promote e-Governance. With the help of the app, people of Arunachal Pradesh can report fire incidents of their nearby forest areas and can also be in direct touch with Divisional Forest Officers. Further, it helps improving Fire Predictive Model, that not only improves the prediction at village level, about higher chances of fire incidences but also greatly helps the Govt. agencies (Forest Dept.) in tackling cases of the forest fire, thereby, minimizing the damage of life and property to a great extent, especially, in the tribal state of Arunachal Pradesh. Due to some reason this android based application is not working anymore and also not available on Play Store.

6. Forest Fire Scenario in Arunachal Pradesh

Arunachal Pradesh is having largest forest cover among northeastern states (excluding Sikkim), but the minimum fire prone forest cover. All forest fire points in India detected by Forest Survey of India (FSI) during the fire seasons of last ten has shown that there is least fire point detected in Arunachal Pradesh among northeastern states. As per FSI Forest Fire portal, there were a total of 1,35,340 forest fire incidences recorded during the fire seasons of 2020-21 and 2021-22 in whole northeast (excluding Sikkim), out of which only 7.2% were in falling in the forests of Arunachal Pradesh (Fig. 4) despite having 40% forest cover of northeastern India. Although, forest fire incidences are less in Arunachal Pradesh, still one forest fire incident may nullify all efforts of conservation and plantations done in the past several years. As per the recent report of Forest Survey of India (FSI), most of the forest cover (87.67%) falls under less fire prone category. The report shows that 12.33% (8,199.17 km^2) of state's forests are prone to firesand of this, only 0.05% (35.16 km^2) are extremely fire prone and 1.44% (959.78 km^2) are very highly fire prone as shown in table 4.

Table 4: Forest area under different fire prone classes in Arunachal Pradesh

Fire Prone classes	Forest Cover (km2)	% of total forest cover
Extremely Fire prone	35.16	0.05
Very Highly fire prone	959.78	1.44
Highly fire prone	2,744.5	4.13
Moderately fire prone	4,459.73	6.71
Less fire prone	58,231.82	87.67

Source: ISFR, 2021

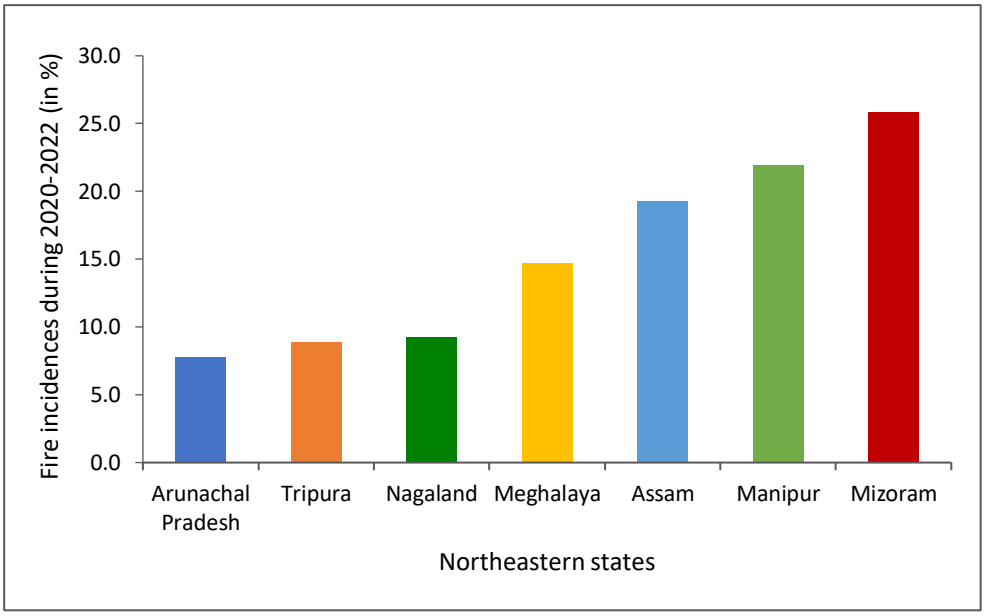

Fig 4: Fire incidences (%) in NER states during fires seasons of 2020-21 and 2021-22 (Source: Forest Fire Portal of FSI)

Forest fires in Arunachal Pradesh are mostly restricted in the southern portion of the state. This zone is adjacent to Nagaland and Myanmar, and most affected due to the wide spread shifting cultivation practices. As forest fires in the state are largely man-made (intentional/unintentional) and therefore preventable to a large extent. Potential sources of forest fires and the main reasons thereof are given at table 5.

Table 5: Potential sources of forest fires in Arunachal Pradesh

S. No.	Potential sources of forest fire	Main reason
1.	Jhum/Shifting Cultivation	Burning of jhum lands for shifting cultivation many a times lead to forest fires in adjacent areas if done in careless manner and without taking precautions like making fire line or fire breaks between forest and shifting cultivation land. Southern and Eastern zone are most affected by this kind of fire.
2.	Burning of dried up leaves and grasses during the lean season	During dry season, local communities especially in central and Western zone of the state, burn dried-up leaves and grasses during winters. This fire also cause damage to the ground flora as well as wild animals. Flowering of bamboo leads to the drying of entire patch of bamboo forest and sometimes communities burn this area to clear the dry bamboos. Sometimes, this burning goes uncontrolled and cause forest fire in nearby forests
3.	Encroachment	Encroachers also burn forest area to clear it and subsequent encroachment for agriculture and habitation.

4.	Deliberate fire in private forest areas	Sometimes, few notorious people burn community/private forest land in enmity with other people. This also cause forest fire in community forests and private forests.
5.	Unintentional burnings	Careless throwing of burning cigarette butts and other fire causing material by travelers, tourists, picnicker, etc. cause unintentional forest fire. This type of fire is very less in Arunachal Pradesh.

7. Detection of Forest Fire Points in the State by FSI

7.1 District-wise Detection of Forest Fire Points

A total of 9784 geospatial point data showing forest fires in the different circles/zones of state provided by the Forest Survey of India and also available on forest fire portal of FSI for the fire season of 2020-21 and 2021-22 are month wise delineated in fig. 5. Winter season is the forest fire season in Arunachal Pradesh which starts from January and goes up to April. Maximum fires detection points (51%) are recorded in March during the fire season of 2020-21 and 2021-22.

FSI is still using old district boundaries of Arunachal Pradesh of 2001 when state was having only 13 districts. There is creation of many other district by bifurcation of erstwhile districts like erstwhile Lohit district is bifurcated into two districts Lohit and Namsai. Analysis of forest fire points based on old districts in the state shows that more than 46% of total forest fire detection points of last two years are falling in Lohit (16.4%), Changlang (15.7%) and West Kameng (14.3%) districts. This is followed by Tirap (10.0%), West Siang (9.7%), Papumpare (7.3%)and Dibang Valley (7.0%) districts. There are less than 7% forest fire detection points in each remaining district (fig. 6).

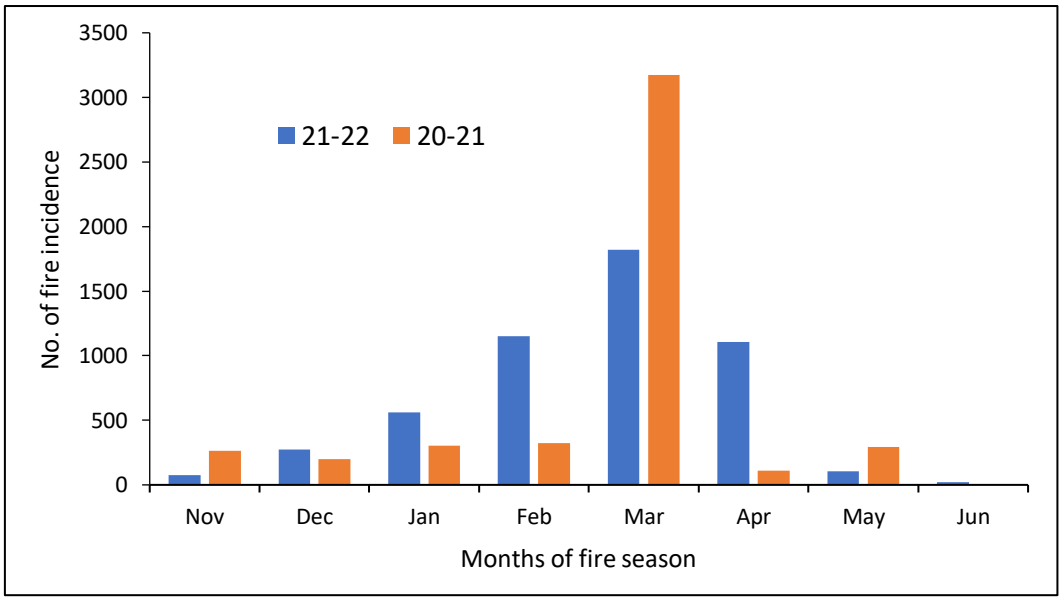

Fig. 5: Number of forest fire points in different months during 2020-22

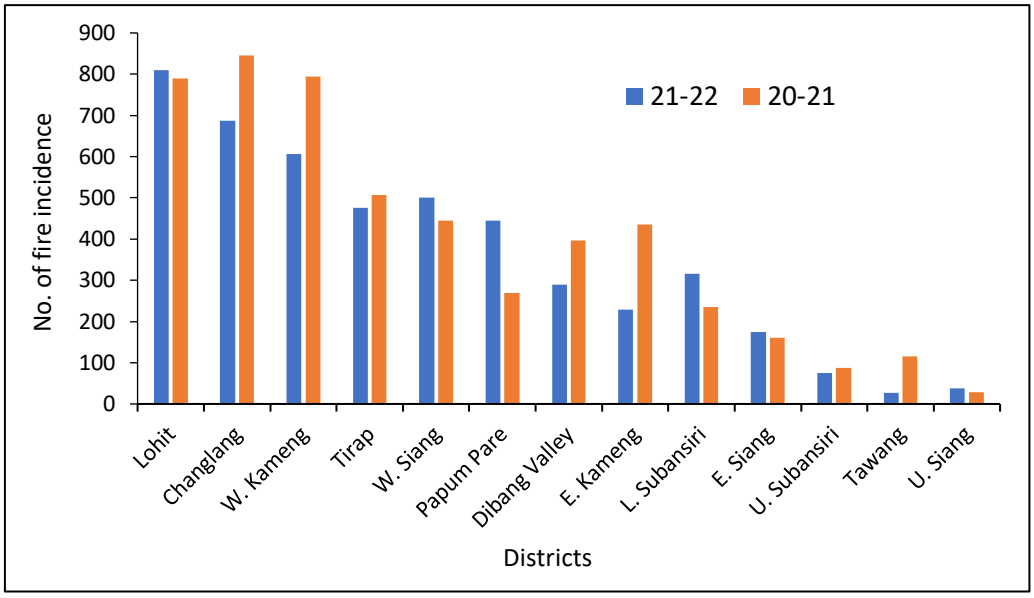

Fig. 6: District wise variation of forest fire points during 2020-22

7.2 Forest Division-wise Forest Fire Points

Forest fire points detected by the FSI were plotted on the forest division map of the state and forest fire points in each forest divisions including protected areas were estimated. Variation of Forest Division-wise detection of forest fire points during 2020 and 2022 are delineated in Fig. 7. Nampong (604) is the most affected forest division by forest fire followed by Namsai (418), Along (462), Anajw (328), Bomdila (354), Kanubari (303) and Seppa (258) forest divisions during the fire season of 2021-22.

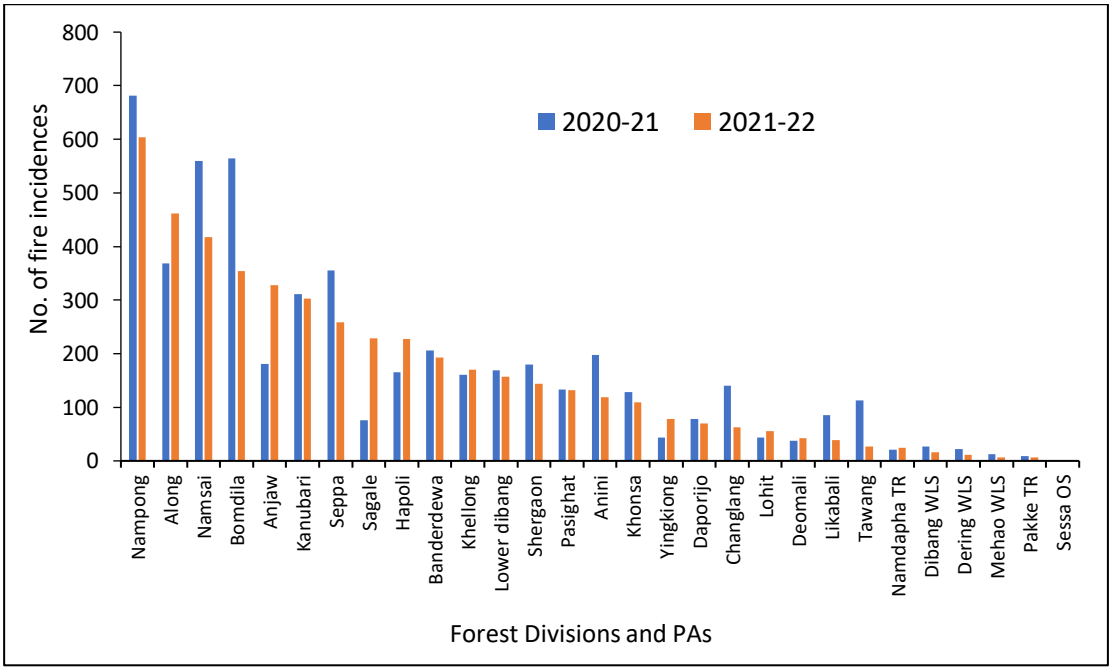

Fig. 7: Forest Division wise variation of forest fire points during 2020-22

More forest fire points were detected during 2020-21 than 2021-22. During the COVID-19 pandemic when lockdowns were imposed and other business were closed,

agricultural activities were almost unaffected during this period. Therefore, agricultural intensification increased rapidly as villagers were allowed to move to jhum lands. Even abandoned jhum lands have been cleared again for cultivation of crops in which burning of bamboos, shrubs and weeds contributed to more fire points during 2020-21. Comparison of variation in forest circle-wise detection of forest fire points during 2018-19, 2019-20, 2020-21 and 2021-22 are shown at fig. 8. Maximum fire points were detected in the western circle, whereas density of fire point was much more in southern circle and most of the Southern Arunachal Pradesh was affected by the forest fire. Analysis of fire points of last four years shows that the forest fire including jhum burnings are increasing rapidly.

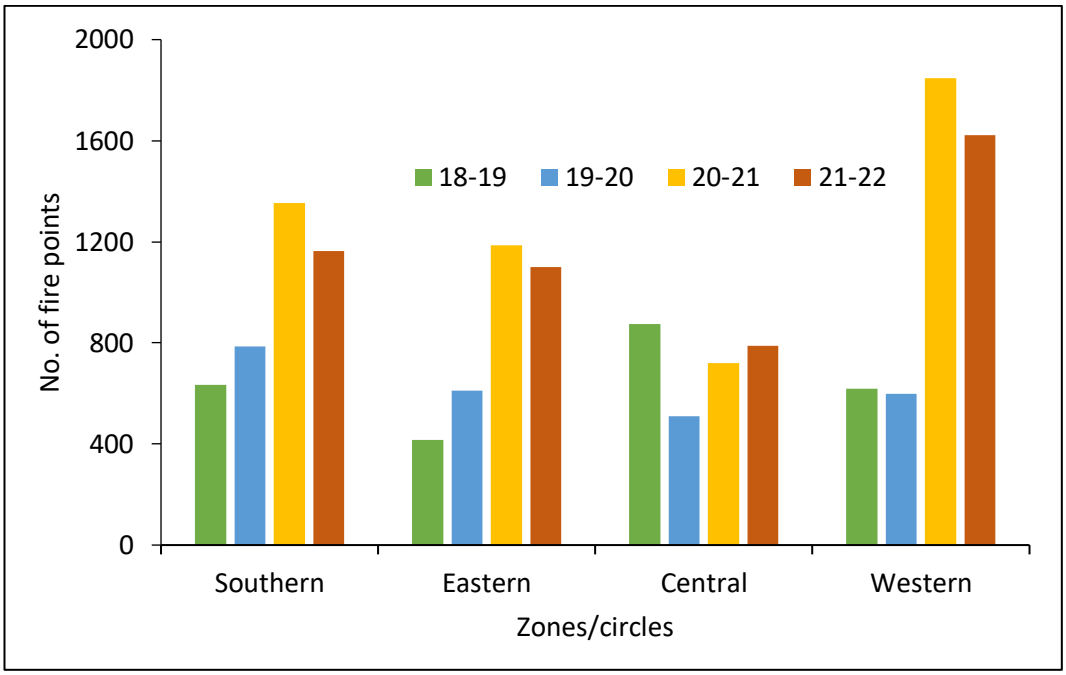

Fig. 8: Forest circle wise variation of forest fire points during 2018-22

8. Current Policies, Plans and Regulatory Scoping

Forests, being on the concurrent list of subjects under the Constitution of India, are the responsibility of both the central and state governments, though most of the forest areas of the country are owned and directly managed by the respective state governments. The central government, Ministry of Environment, Forest and Climate Change (MOEFCC) and agencies under its purview, are responsible for overall policy guidance, administration of centrally-sponsored schemes, coordination of training and research. State governments, on the other hand, being the repository of the manpower of the forest departments carry the primary responsibility of implementing forest fire prevention and management practices. The following table provides a summary of selected applicable laws, rules and regulation which have a direct bearing on forest fire management in the State.

Table 6: Summary of selected applicable laws, rules and regulation regrading forest fire

S. No.	Acts/Rules	Objectives	Responsible Institutions
1	Assam Forest Regulation Act, 1891	Section 25 (a) and (b) prohibited to set fire in any reserved forests, Section 27 penalize causing fire willfully or by gross negligence in a reserved forest by any person	SFD
2.	The wildlife (Protection) Act, 1972	Section 27(2) makes mandatory that every person is bound "to extinguish any fire in such sanctuary of which he has knowledge or information and to prevent from spreading, by any lawful means in his power, any fire within the vicinity of such sanctuary of which he has knowledge or information".	SFD
3.	The Prevention of Damage to Public Property Act, 1984	Section 4 provisions the punishment of rigorous imprisonment for a term which shall not be less than one year to mischief causing damage to public property by fire or explosive substance.	Police Department
4.	The Indian Forest Act, 1927	Section 26 (1a), (1b) and (3) prohibit to set fire in any reserved forests Section 79 (1a) and (1b) bound every person, who exercises any right in a reserved forest, to assist Forest-officers and Police-officers to extinguish any forest fire and to prevent by any lawful means in his power any fire in the vicinity of such forest.	SFD Communities who are benefited from reserved forests

9. Pattern of Investment on Forest Fire Prevention and Management

Forests, being on the concurrent list of subjects under the Constitution of India, are the responsibility of both the central and state governments, though most of the forest areas of the country are owned and directly managed by the respective state governments. The central government, MoEFCC and agencies under its purview, are responsible for overall policy guidance, administration of centrally-sponsored schemes, coordination of training and research. State governments, on the other hand, being the repository of the manpower of the forest departments carry the primary responsibility of implementing forest fire action plan in the state.

The MoEFCC has launched a Centrally Sponsored Scheme (CSS) Forest Fire Prevention and Management Scheme (FPM) in 2009 to focus mainly on forest fire. Annual Plan of Operation (APO) is prepared by the State and submitted to MoEFCC every year as per Operational Guidelines and fund is received accordingly with 90:10

(Central Share: State Share) sharing basis. Hence, the State Forest Department is being financially supported under FPM scheme. As per the APO submitted prepared by SFD for carrying out of activities under state CAMPA also include fire prevention works like fireline creation and maintenance, etc. Therefore, there is allocation of budget from State CAMPA fund also for forest fire management. Fund received under FPM scheme during the past five years along with allocation of fund from State CAMPA fund is presented at table 7. During2018-2020 fund was not received under CSS-FPM and revalidated to subsequent years.

Table 7: Investment pattern for forest fire management during last five years

Financial Year	FPM Scheme (Rs. in Lakh)		Total
	CSS	SMS	
2017-18	102.00	10.20	112.20
2018-19	89.08	-	-*
2019-20	89.08	-	-*
2020-21	89.08	9.89	98.97
2021-22	89.77	9.97	99.74

*revalidated to next financial year.

Source of data: State Forest Department, Arunachal Pradesh

10. Challenges and Key Gaps in Forest Fire Management in the State

Discussion was held with divisional forest officers, community members and other stakeholders regarding the management of forest fire in the state. Stakeholder discussions and analysis of forest fire points and available literature revealed that though the state has relatively less loss due to forest fires as compared to other North Eastern states, there is still a lack of scientific and systematic approach of forest fire management in the state. The major key gaps in the overall forest fire management system are as enlisted under.

i) Huge Geographical Area and steep terrain

The state has a geographical area of 83,743 km^2 out of which, 66,687km^2area is under forest cover. The whole area is almost completely under rugged mountainous terrain. The eastern Himalayan part of the state consists of very high relative relief with deep gorges and valleys. The mountainous range and sub-mountainous terrains along the northern parts is tattered by the river that flows through. The huge geographical area along with tough terrain restrict access of people and equipment to the area also the spread of fire upslope is unmanageable.

ii) Lack of proper institutional mechanism

State forest department is the apex body in the state which looks after the forest fire management task. There is a lot of community forest which is not in direct control of forest department, most of the forest fire points fall in the community forest. There is lack of proper coordination between forest department and community organizations for the management of forest fire. There is no separate establishment, even in higher fire prone regions to look after the forest fire.

iii) Less emphasis of preparedness and awareness

A 24x7 control room has been set up in the headquarter to quickly receive and disseminate forest fire alerts to the field functionaries. But working of this control room is basically is working on the response mechanism. Though SFD is conducting awareness campaigns, pre - fire season workshops for coordination among line departments and elected bodies and NGOs, training and capacity building on firefighting methods for frontline staff, NGOs and village communities but due to irregularity in funds, there is no enough emphasis on mitigation, preparedness, human resource development, awareness, etc.

iv) Lack of scientific approach for data collection on forest fire

SFD, Arunachal Pradesh developed an android based application **"e-Forest Fire App"**, which is a Fire Reporting System, an effort to ease governance by involving people and to promote e-Governance. With the help of the app, people of Arunachal Pradesh are able to report fire incidents of their nearby forest areas and can also be in direct touch with Divisional Forest Officers. Further, it helped in improving Fire Predictive Model, that not only improves the prediction about higher chances of fire incidences at village level, but also greatly helps the Govt. agencies (Forest Dept.) in tackling cases of the forest fire, thereby, minimizing the damage to life and property to a great extent, especially, in the tribal state of Arunachal Pradesh. But due to some reason this android based application is not working anymore and also not available on Play Store. In present scenario SFD is dependent on the communications of FSI regarding the detection of forest fire. This **e-Forest Fire** application is need to be revived. Besides this information related to area burnt, damage to forest, environment and wild life along with indirect loss to soil and hydrology should also be computed every year with thorough research and investigation by involving forestry research organizations. This exercise should also be done for the community forest also. Forest fire vulnerability map at division level should also be prepared.

v) Lack of budget for fire management

As reported by the state forest department, there is irregularity as well as lack of funding from central government under Centrally Sponsored Scheme (CSS) Forest Fire Prevention and Management Scheme (FPM). During 2018-2020 fund was not received under CSS-FPM and revalidated to subsequent years. There is already some allocation of budget from State CAMPA fund also for forest fire management. Keeping in view

of the forest area of Arunachal Pradesh, budget allocation for fire management should be increased.

vi) Lack of manpower/frontline staff

Task of forest fire management is taken care by the state forest department and there is shortage of manpower especially frontline staff in forest department. Compared to the neighbouring state of Assam, Arunachal Pradesh have a very low forest staff to geographical area ratio (1:40 km^2 in Arunachal Pradesh and 1:3.5 km^2 in Assam).Forest fire cannot be controlled in the scarcity of manpower.

vii) Lack of localized meteorological forecasting

There is lack of localized meteorological forecasting system in the state which further aggravate the problem. The efforts made are only reactionary. There is sufficient technological development in fire forecasting system in the country which is in practice in various states. But, the techniques and methodology used by the State government is not showing changes and whatever efforts made are only reactionary. There is an urgent need to revitalize the localized meteorological forecasting system using modern techniques and train the field staff to use them more effectively. The meteorological, fire, disaster management departments, etc. can play significant role in forest fire management; however, coordination of the forest department with these departments and their regional and local level offices is poor; which prevents their valuable support in detecting, identifying forest fire and its suppression.

viii) Lack of sensitization of tourists and picnickers

Nature based tourism and recreational activities are increasing in the state. More tourists are going into wilder areas for recreation which is increasing the cases of accidental fires. But, there is lack of environmental sensitization among tourist and picnickers and careless throwing of burning cigarette butts and other fire causing material carefully by them sometimes cause unintentional forest fire.

ix) Lack of Infrastructure for firefighting

The success of forest fire prevention and suppression depends not only on the manpower and applied methods, but also on the provision of adequate equipment, facilities and qualified staff. In recent past few years, efforts have been made to procure PPE, firefighting equipments, and fire extinguishers under state CAMPA fund, but still forest department is not much equipped with firefighting equipments either in State level, division level or at the village levels.

11. State Action Plan on Forest Fire

11.1 Statement of purpose

Fires have always been a vital factor shaping the forest resources. In Arunachal Pradesh, most of the forest fires that are attributable to anthropogenic reasons because communities use it to prepare lands for shifting cultivation to clear forest floor for NTFP collection, and to promote grass growth for grazing and thatching. Criminal

gangs of poachers use it to force wild animals come out of safe hiding places. Unintentional fires caused by careless throwing of burning matchsticks, cigarette butts and escape of cooking fire from picnickers and temporary shelters for road workers also account for many forest fires. There is a need to check all type of forest fires and an action plan therefore is needed for implementation in the field to prevent and check occurrence of forest fires.

Forest Survey of India has reported 9,784 forest fire points in Arunachal Pradesh during 2020-2022which are almost double from the fire points (5,050) recorded during 2018-2020 (fig. 9). Although these fire points are the lowest in comparison with detected forest fire points in other northeastern states, there is a need to check all types of forest fires and an action plan therefore is needed for implementation in the field to prevent and check occurrence of forest fires. This will substantially reduce the vulnerabilities of forests across the diverse forest ecosystems in the State against fire hazards, enhancing the capabilities of forest and other personnel and institutions in fighting fires, and speedup recovery after a fire event.

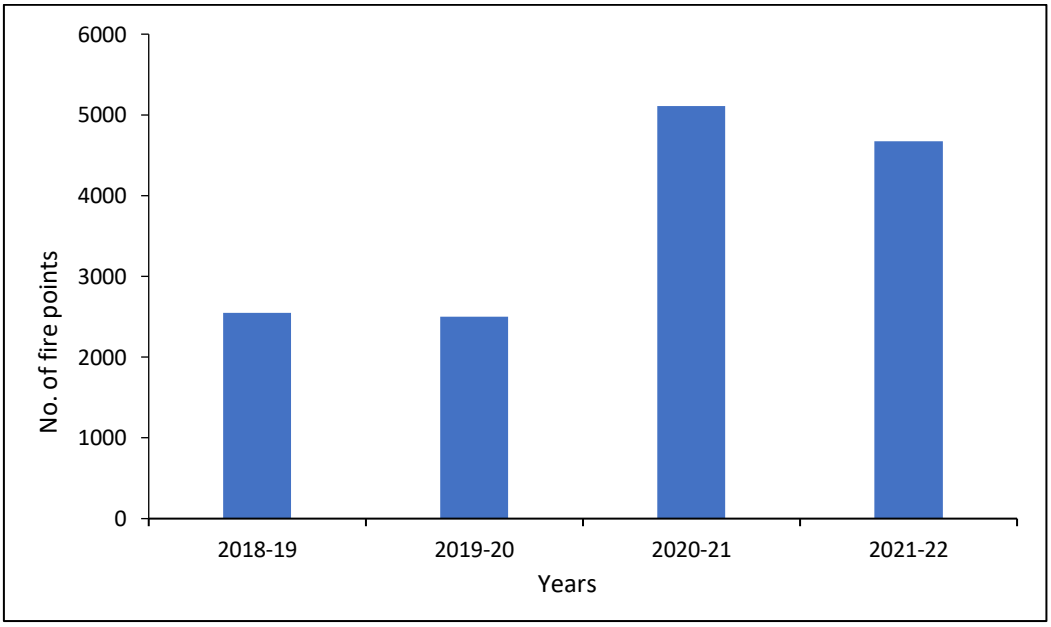

Fig.9: Incidences of forest fires during 2018-2022 (as per FSI)

The objective of this State Action Plan on Forest Fires, hereinafter referred to by its abbreviations SAPFF, is to minimize forest fires from taking place by informing, enabling and empowering forest fringe communities and may be incentivizing them to work in tandem with the forest department along with providing training and skill development of the forest officials besides strengthening of the forest department. 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. This action plan will contribute towards better coordination between key stakeholders at different levels, and in particular at local levels; and provide a framework within which to report performance and success.

11.2 General Principles

The prescribed actions in this SAPFF are in the line of National Action Plan for Forest Fire and these are as follows:

i. To guide and assist the policy makers, administrators, forest officers, frontline staff, forest user agencies, forest fringe communities, visitors to forests, and civil society, for holistic management of fires in forests.
ii. To prevent fires from taking place and improving resilience of the forests against fire hazards shall form priority in forest management policies, strategies and programs with well-defined aims of conservation of biodiversity, wildlife and forest wealth.
iii. To accord the highest priority during fire events to the safety of the people, both resident and transient, firelighters, and fire managers shall always be accorded the highest priory during fire events.
iv. To have a clear line of command for assuming the lead role and duties in the event of a forest fire.
v. To ensure that the Districts form the units for Forest Fire Management planning and implementation for ease in coordination with the Disaster Management Authorities at the national, state and district levels.

11.3 Fire Risk Zonation and Mapping

The main purpose of fire risk zonation is to divide the area or forest division according to the degree of occurrence of forest fire incidences during the past two years (i.e. 2019-2022) so that appropriate strategies to deal with the problems can be drawn accordingly. Therefore, forest fire risk zonation provides a scientific basis for identifying the areas of priority areas, and monitoring the effectiveness of both fire tower and ground patrol reporting, thus facilitates central command to strategize and dispatch fire suppression Team. Forest fire incidences occurred in the state during last two years are shown in table 8 and fig. 10 and fig. 11. Enlarged zone-wise maps of the fire incidences are also shown in fig. 12 to fig. 19.

Forest fire risk zonation is generally done on the basis of various factors like fuel load, topography, accessibility, internal road network, remoteness and availability of permanent water bodies. But in the forests of Arunachal Pradesh, the occurrence of natural forest fires is very rare and almost all forest fires are man-made either intentionally or accidentally. Therefore, the forest fire risk zonation is done only on the basis of the forest fire points detected by FSI through MODIS and SNPP – VIIRS satellites during past two years. Frequency of detected forest fires in any area over a period of time indicates proneness of the area to forest fires. For the purpose of fire risk zonation, analysis of the forest fire points detected by FSI during the fire season of last four years has been carried out in GIS framework for the entire state. Map showing fire prone forest areas/zones in the state under different categories is presented in fig. 20. Most of the southern Arunachal Pradesh (except Namdapha Tiger Reserve), most of the area of Bomdila, Seppa, Sagale, Hapoli and Bandardewa forest divisions

of western Arunachal Pradesh and Basar and Aalo forest ranges of Aalo forest division in central circle are falling in extremely fire prone zone. Ahmed et al. (2018) also conducted the same exercise for the period of 2008 to 2016 and their observations were almost similar to present observations. As per ISFR 2021, the State's forest cover stands at 79.33% from the total geographical area wherein most of the forest cover (87.67%) falls under less fire prone category. The report shows that 12.33% (8,199.17 km^2) of state's forests are prone to fires and of this, only 0.05% (35.16 km^2) are falling in extremely fire prone zone and 1.44% (959.78 km^2) are in very highly fire prone zone. It is proposed that these risk zones shall be reviewed and updated at least once every five years to respond to any changes in the above-mentioned factors.

Table 8: Variation in forest fire point detection in forest divisions and protected areas

S. No.	Division/PAs*	Year of fire season	
		2020-21	2021-22
1	Nampong	682	604
2	Along	368	462
3	Namsai	559	418
4	Bomdila	564	354
5	Anjaw	181	328
6	Kanubari	311	303
7	Seppa	355	258
8	Sagale	76	229
9	Hapoli	165	228
10	Banderdewa	206	193
11	Khellong	161	170
12	Lower dibang	169	157
13	Shergaon	180	144
14	Pasighat	133	132
15	Anini	198	119
16	Khonsa	128	109
17	Yingkiong	44	78
18	Daporijo	78	70
19	Changlang	140	63
20	Lohit	43	55
21	Deomali	38	42
22	Likabali	85	39
23	Tawang	113	27
24	Namdapha TR	21	24
25	Dibang WLS	27	16
26	Dering WLS	22	11
27	Mehao WLS	12	7
28	Pakke TR	9	6

29	Sessa Orchid Sanctuary	1	0

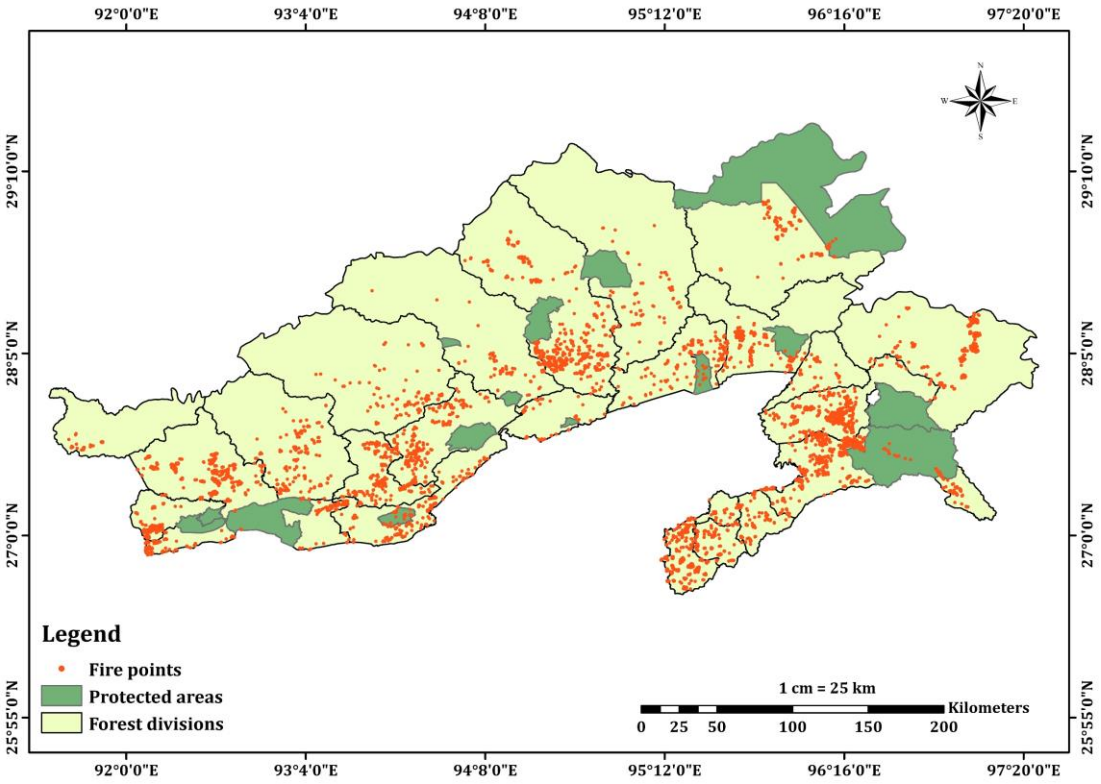

Fig. 10: Forest fire points collected from FSI portal for the year 2021-22

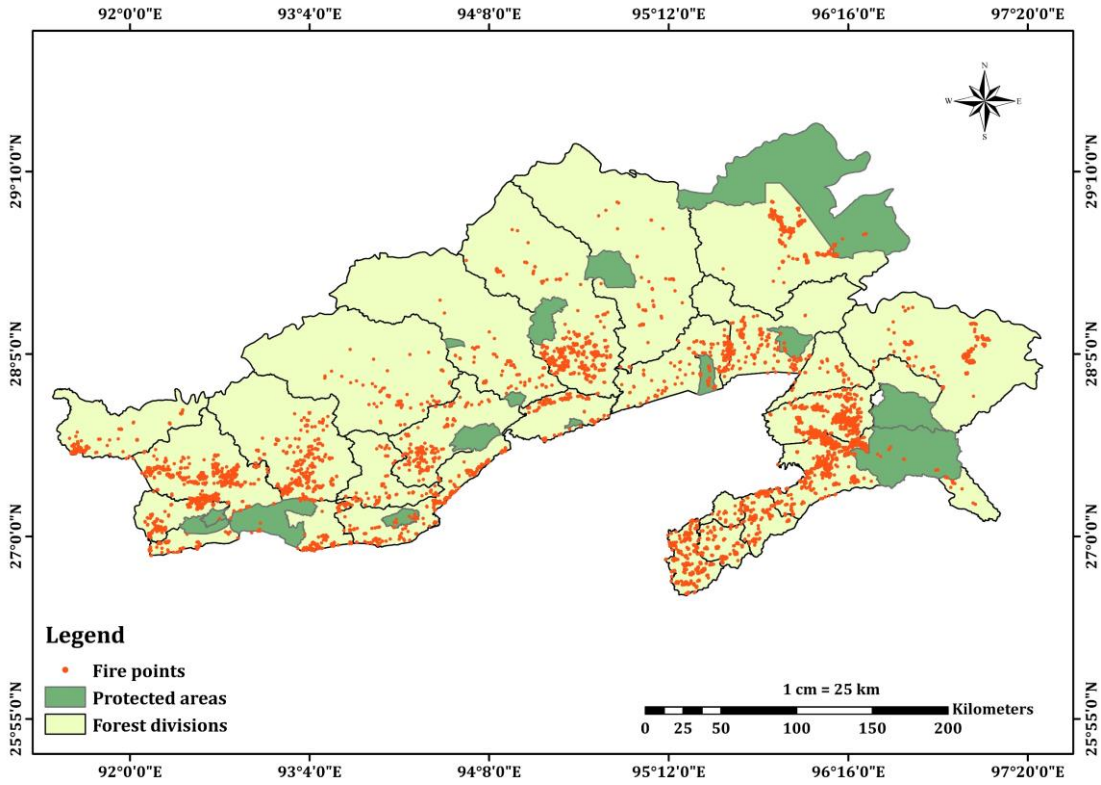

Fig. 11: Forest fire points collected from FSI portal for the year 2020-21

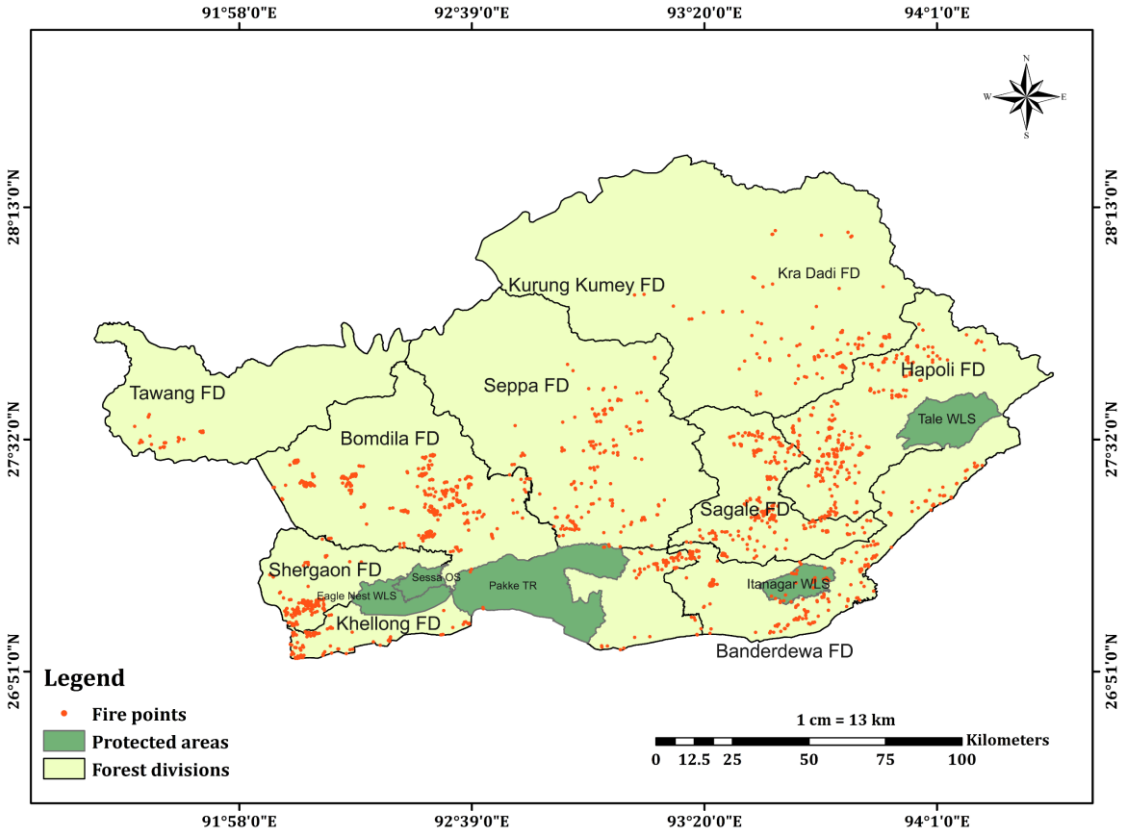

Fig. 12: Forest fire points collected from FSI portal for the year 2021-22 in WAC

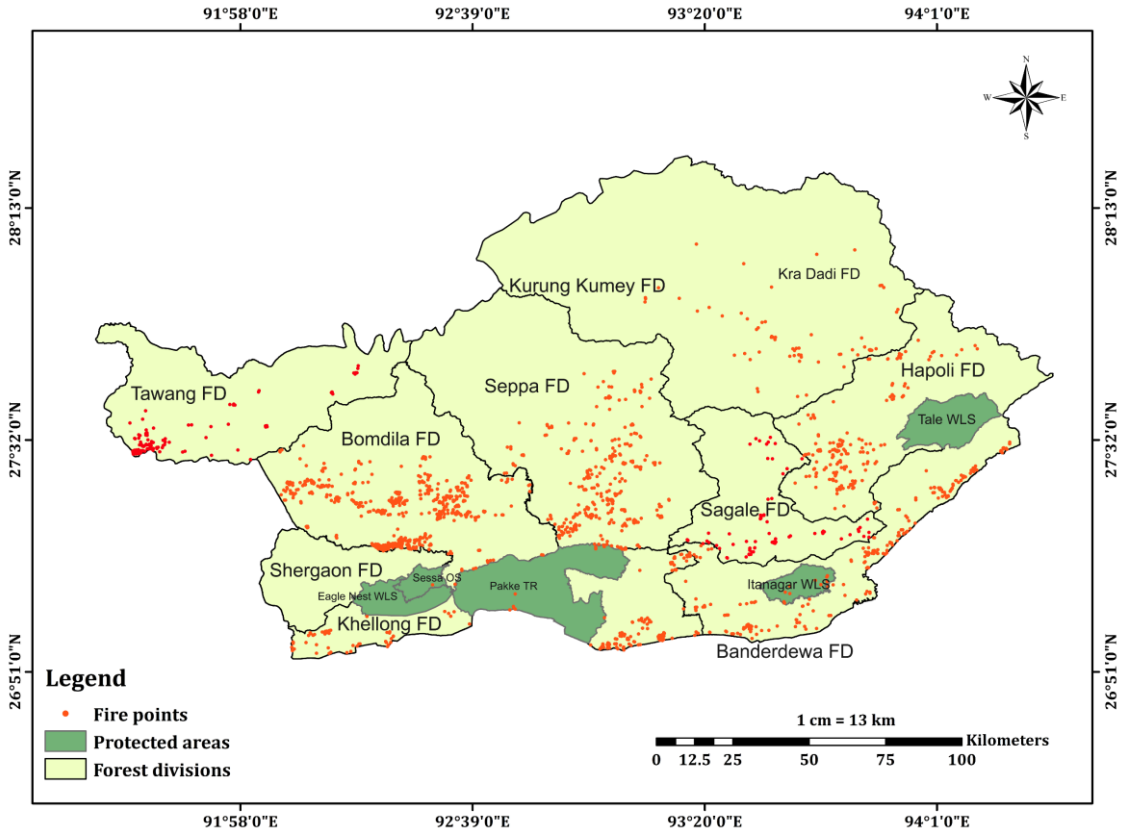

Fig. 13: Forest fire points collected from FSI portal for the year 2020-21 in WAC

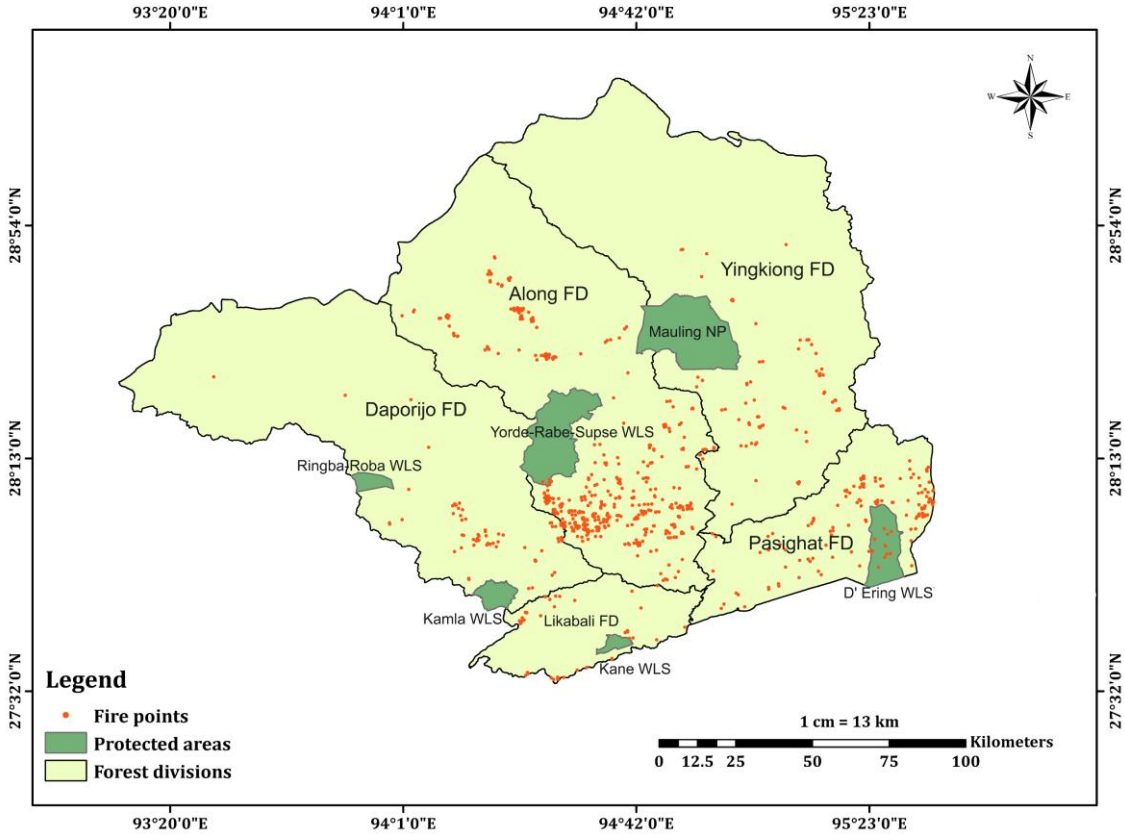

Fig. 14: Forest fire points collected from FSI portal for the year 2021-22 in CAC

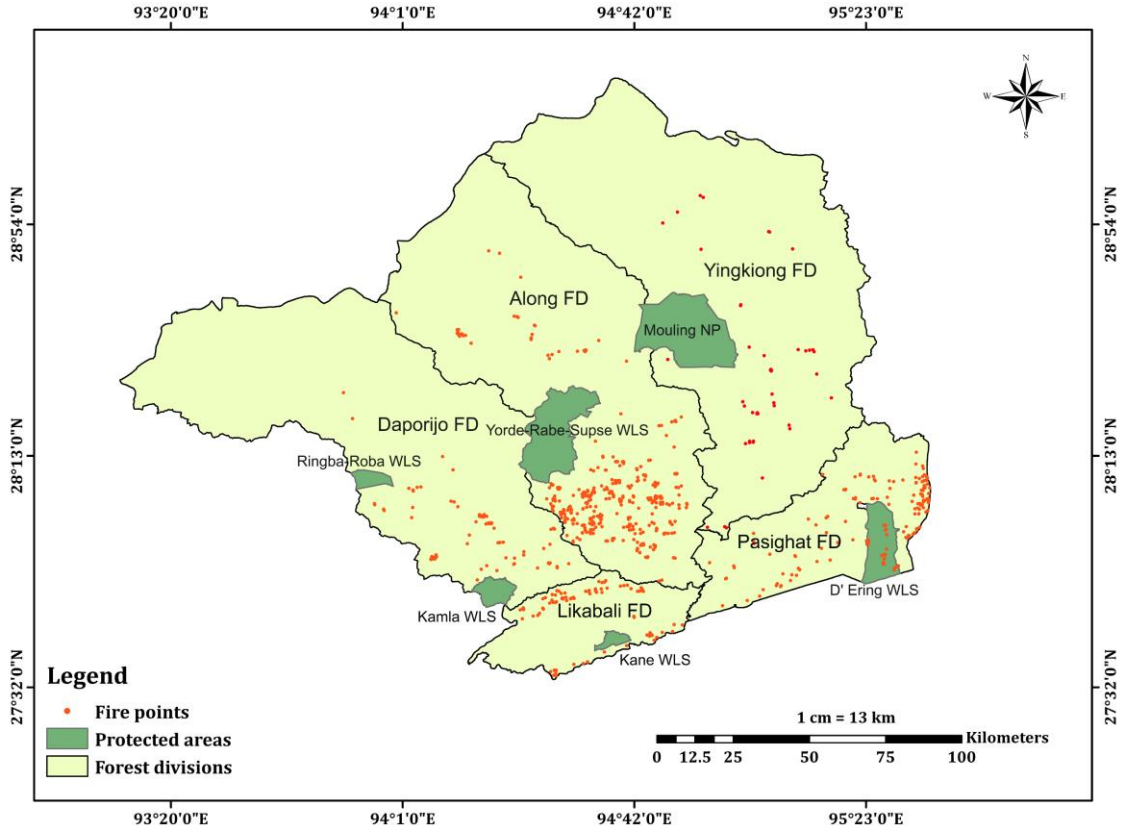

Fig. 15: Forest fire points collected from FSI portal for the year 2020-21 in CAC

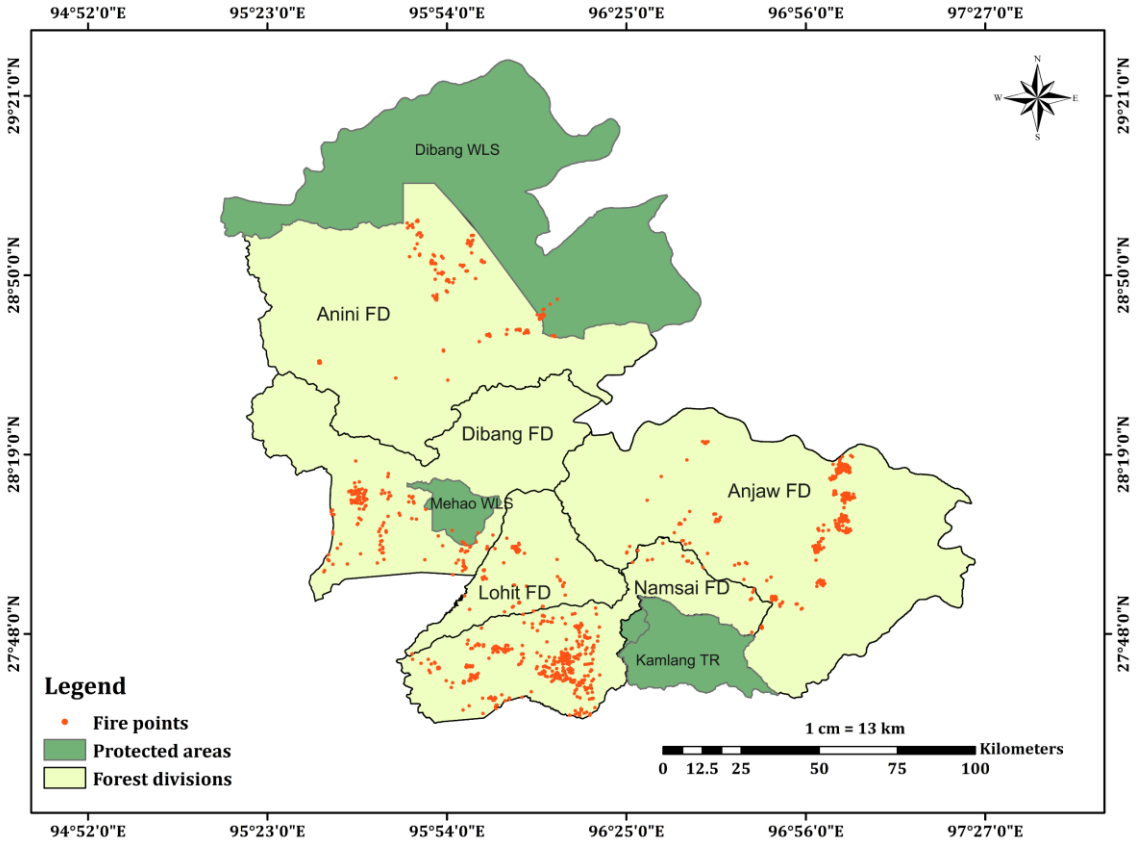

Fig. 16: Forest fire points collected from FSI portal for the year 2021-22 in EAC

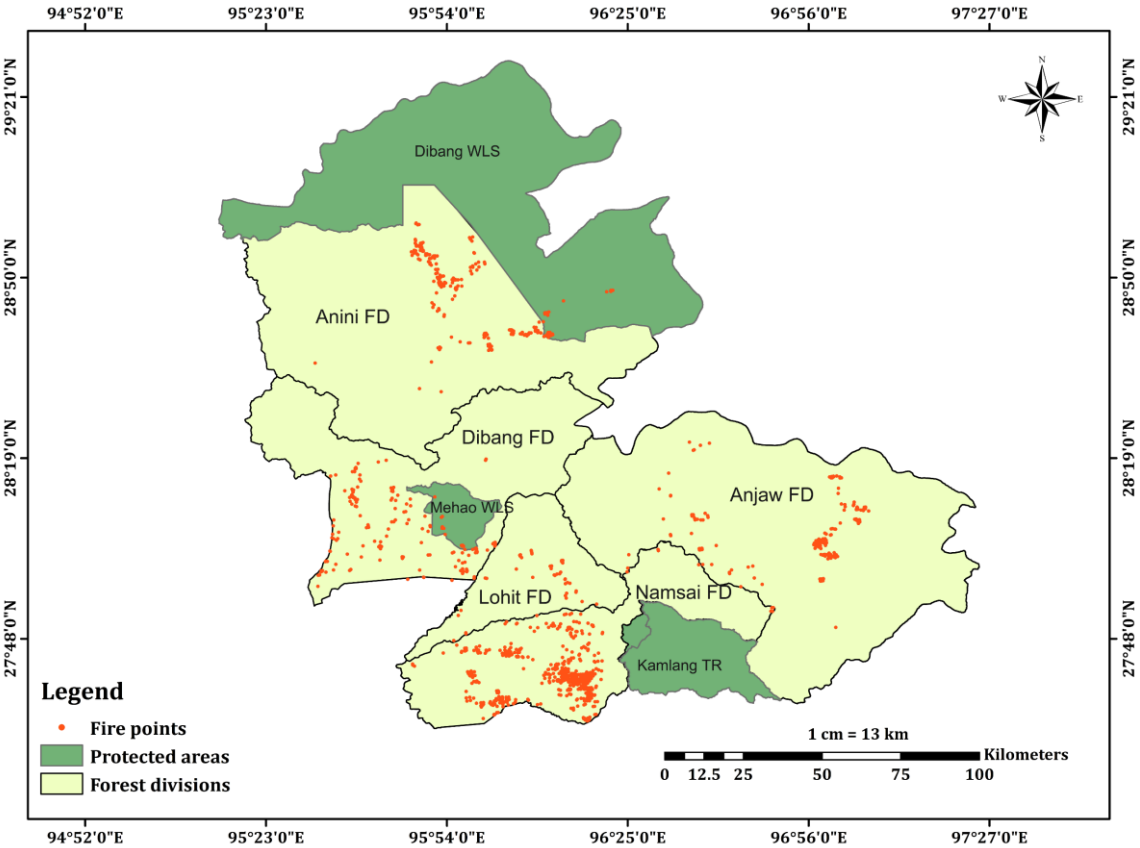

Fig. 17: Forest fire points collected from FSI portal for the year 2020-21 in EAC

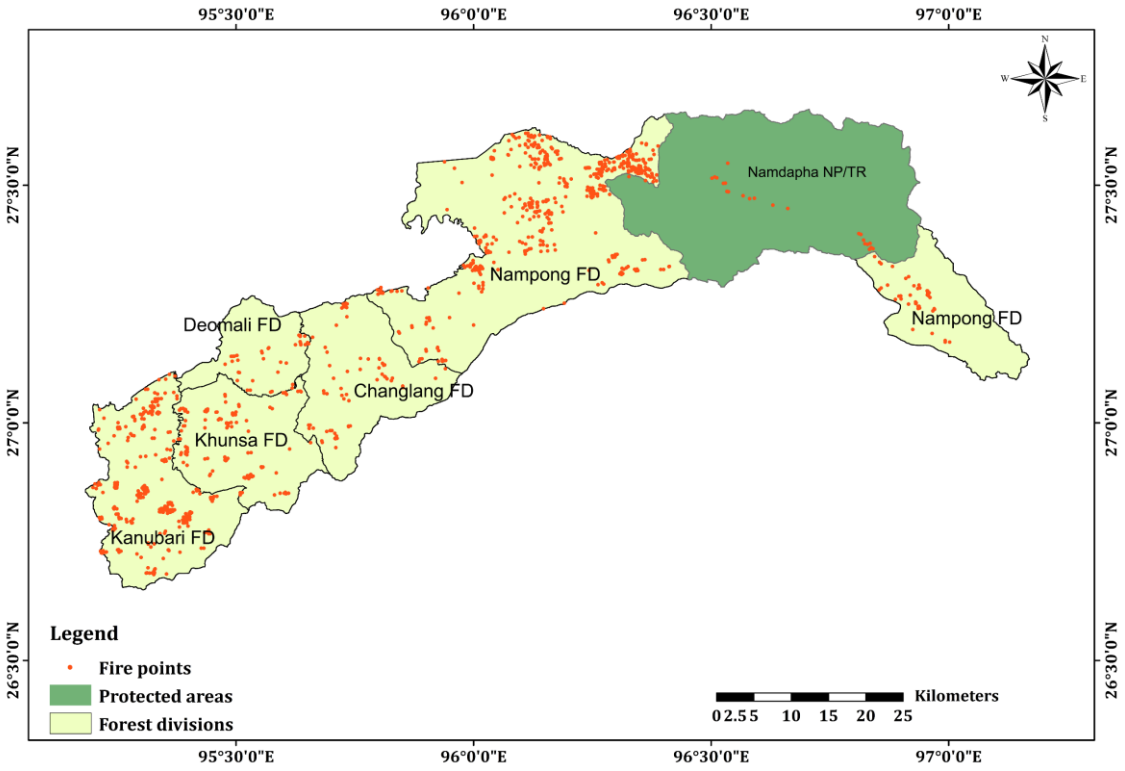

Fig. 18: Forest fire points collected from FSI portal for the year 2021-22 in SAC

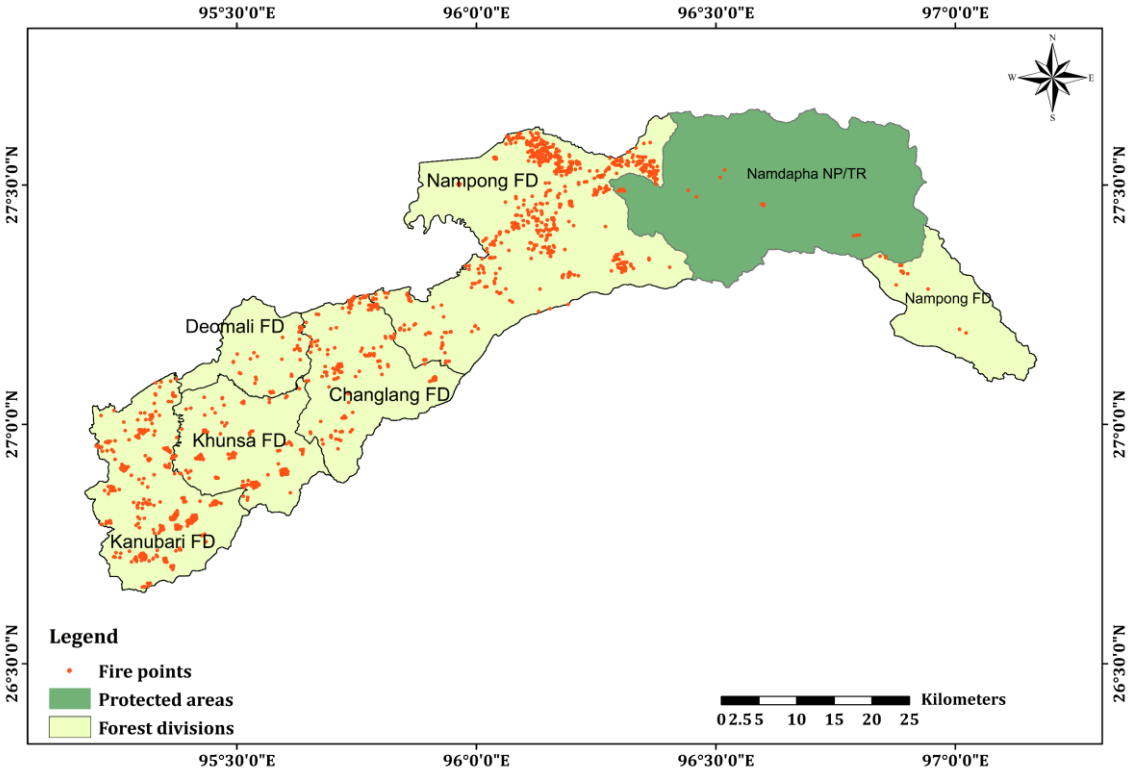

Fig. 19: Forest fire points collected from FSI portal for the year 2020-21 in SAC

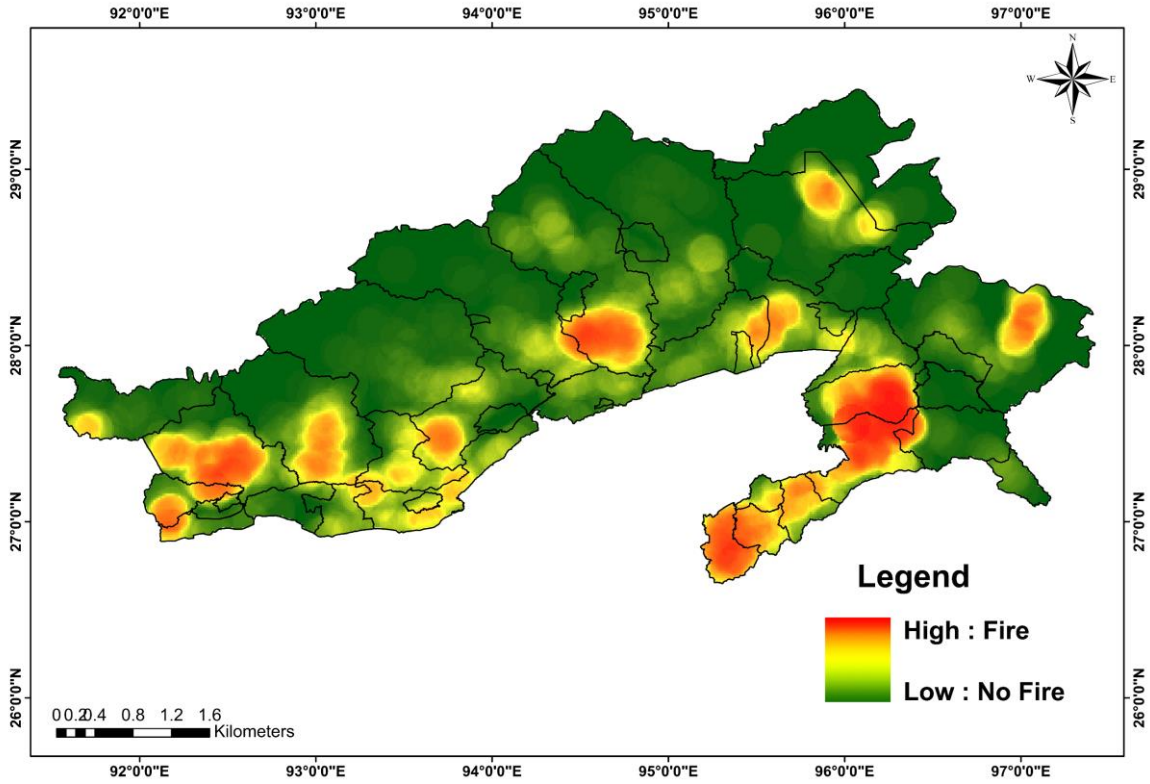

Fig. 20: Forest fire hotspot map using fire points over the period of 2008–2016

11.3.1 Use of fire risk zones in forest planning

The findings of the forest fire risk zonation shall be translated into concrete management actions under the forest working plans/schemes. The Working Plan Officers (DFOs in the case of Plans already in operation) shall identify activities or interventions to mitigate fire risks or reduce impact of the fire hazards in high-risk areas. These may include creation of additional fire lines between shifting cultivation areas and forest and other infrastructure in vulnerable areas. The Annual Plan of Operations (APOs) of CSS-FPM, CAPMA or other schemes for all forest divisions and circles, and protected areas, shall include the approved activities and interventions mentioned above. The same shall be examined speedily by the appropriate authorities for approval and making provisions for financing the approved activities.

11.4 Prevention of Forest Fires

As described in earlier paragraphs that, in Arunachal Pradesh, the occurrence of natural forest fires is very rare and almost all forest fires are anthropogenic (intentionally or accidentally) and are linked to culture, socio-economic and livelihood activities of the communities living in and around the forests. Hence, in order to minimize the chances of forest fire occurrence, it is imperative to make the local forest dependent communities aware of the many ecosystem services lost to them, both individually and collectively, due to forest fires. Following actions are proposed to be taken in this regard.

11.4.1 Discourage Shifting Cultivation

Shifting cultivation is the biggest source of forest fire in the state. Even most of the fire points detected by the FSI are basically burnings for shifting cultivation. Along with deterring shifting cultivation, there is a need to push for scientific management of Jhum as well and dissemination of better practices whereby the jhum fire is not converted into forest fire. This can be achieved by awareness and increasing livelihood options for tribal communities. This is especially significant in that with the growth of population and consequent decrease in the land/person ratio, not only more areas are subjected to shifting cultivation, but also the fallow period for regeneration has been reduced from the initial thirty years to two years (Satendra and Kaushik, 2014).

11.4.2 Effective communication Strategy for Awareness Generation

Forest fringe communities are highly dependent on natural resources including forest resources and exploiting forests in various forms such as shifting cultivation, bamboo and NTFP collection, hunting, timber extraction, grazing their livestock etc. All these activities are a source of risk of forest fire. Therefore, creating mass awareness is an important component of prevention of forest fires. A strategy for conducting mass awareness programmes for different target groups in a well-planned and concerned manner must be framed with respect to forest fire prevention. These programmes shall be focused on creating awareness among general public regarding their role in effective prevention of forest fires and sensitizing local communities and district/state authorities to get their support and cooperation in implementation of this action plan. Information on forest fire and its adverse effects including existing laws and customary practices in forest fire management shall also be disseminated. The SFD can adopt various mass media communication methods like videos shows, awareness campaigns, brochures, posters, booklets and pamphlets, sign boards, advertisements and celebration of important days like World Environment Day, Wildlife Week, World Forestry Day, etc.

11.4.3 Empowering Communities to Deliver on their Responsibilities

Section 25 (a) and (b) of **Assam Forest Regulation Act, 1891** and other existing forest laws bound every person, who exercises any right in a reserved forest, to assist forest-officers to extinguish any forest fire and to prevent by any lawful means in his power any fire in the vicinity of such forest. Under the Forest Right Act, 2066 the forest areas recognized under community rights are mandated to be sustainably used by the right holding forest dweller community which places on them the responsibility of conservation of these areas. Similar responsibilities rest on the communities practicing shifting cultivation for protection of forests against damage by fires. These communities will be better placed to discharge these responsibilities if they are adequately empowered with delegated authority and funding.

The communities in high fire prone zones specified above should be more encouraged maximum community involvement. Although communities are also taking care of the forest fire up to some extent, communities should also be incentivized for their efforts in fire prevention and control measures in the form of money, reward, social

recognition, preference in government schemes, etc. Respective DFO should recognize the contribution of local communities in forest fire management may recommend Fire Prevention Award (cash award along with trophy and certificates) for them at village and division levels.

Some communities have evolved the system of imposing fines at village level on person causing Forest Fire in co-ordination with Forest Department. The local courts act as biggest deterrence and must be strengthened.

11.4.4 Capacity Building of Communities

The control and management of forest fires is the joint responsibility of individuals, the community and SFD. Since shifting cultivation and forest dwelling have been a deep-rooted practice for tribal communities in Arunachal Pradesh, the community has developed its fire management around this tradition. Most of the time they take care of the spread of fire to the surrounding forest while burning for shifting cultivation. Still, the capacity of community organizations in prevention and control of forest fires should be enhanced by periodic training and capacity building programmes. These training programmes should involve knowledge of existing forest fire related laws, role of communities, steps to be taken on identification of forest fires, handling of firefighting tools, development of fire alarm system, etc. Details of vulnerable areas, location of natural & man-made water sources, other infrastructure available for fire prevention and management etc. should be documented and made available to the communities and can also be annexed with peoples' biodiversity registers.

11.5 Increasing the Resilience of Forests to Fires

Following management interventions for increasing resilience of forests to fires has been planned according to the vulnerability to forest fires as reflected in the forest fire hotspot maps.

11.5.1 Moisture and Water Conservation

Risk of forest fires is more in the drier and deciduous habitats and other areas where the growth of grasses, bamboos and undergrowth is more. Site specific management actions are required to retain moisture for lean seasons and appropriate preventive measures to ensure that minor fire incidences do not escalate into major fire events. A long-term plan for improving the hydrological regime of the forest areas based on opportunities and feasibility is planned for reducing vulnerability to fires. The procedures required for moisture conservation can be broadly divided into two categories, i.e., mechanical measures and biological measures. The modern moisture and water conservation strategy is a judicious mixture of both options.

Mechanical measures in highly fire prone areas near to shifting cultivation lands, for control of moisture loss generally include bunds (contour and graded), contour trenches, moisture conservation pits, percolation ponds, grassed waterways, etc. These structures reduce surface water flow velocity and promote infiltration. In the hills, construction of retaining wall, check dams, gully plugs are common method to reduce the speed of run-

off water. Where flow and quantity of runoff water and slope is high, check dams may be construct by stones with or without gabions and in streams, where speed and quantity of runoff water is no high, vegetative check dams by using bamboos, wood logs, shrubs, etc can also be constructed.

RFRI, Jorhat has prepared a DPR for the rejuvenation of river Brahmaputra and whole Arunachal Pradesh is considered as the riverscape and various forestry interventions are proposed for the rejuvenation of catchment of different tributaries of Brahmaputra in Arunachal Pradesh. Activities proposed in said DPR and other existing programs for catchment area treatment plans and rejuvenation of water springs, etc. should also be employed for this kind of work.

11.5.2 Forest Floor Biomass Management

The accumulation of dry biomass on forest floor, which act as dry fuel during fire season near to the possible source of forest fire like shifting cultivation land, roads, habitations, picnic/ecotourism areas needs to minimize during the fire season. The dry biomass includes litter, dry grasses, dry bamboos, etc. The dry biomass on the forest floor leading to fire danger could be gainfully utilized for the benefit of the society in identified areas. A management framework is recommended as given below. It is also proposed that local forest administration DFOs/RFOs should also make efforts in search of other innovative locally viable methods for utilization of dry biomass of forest floor. Policies for permitting women SHGs to use forest floor biomass with appropriate safeguards for micro entrepreneurship may be put in place.

- **Bio-briquetting**
  Arunachal Pradesh is having considerable pine in highly and moderate fire prone zones especially in western and center circles. Collection of fallen pine needles for use in briquets may be encouraged by organizing series of awareness and capacity building programmes. Relaxation in different restrictions can also be granted for collection of pine needles from the forest. Briquetting of pine needles will solve dual purpose on one hand it will remove the fire-hazardous dry biomass from forest floor and other hand it will reduce the falling of trees for charcoal burning in winters.

- **Removal of dead bamboos**
  Arunachal Pradesh is having 15,739 km^2 bamboo bearing area inside the recorded forest area/green wash, which is 10.53% of country's total bamboo bearing area. Due to aging, sporadic and gregarious flowering a lot of bamboos get dried every year inside the forest. These dried bamboos form fire-hazardous dry biomass. Most of the bamboos bearing forests are in highly and moderately high fire prone zones. Guidelines may to be framed for sustainable removal of dead bamboo in the event of mass flowering to reduce risk of fire.

11.5.3 Weed Management

Chromolaena odoreta, Mikania micrantha, Ageratum conyzoides and *Lantana camara* are the major invasive weeds inside the recorded forest area in the state (ISFR, 2021) and spread over an area of 295 km^2, 277 km^2, 73 km^2 and 63 km^2 respectively. *Chromolaena odoreta* and *Mikania micrantha* are mostly found in southern and eastern circles, whereas Lantana camara is invading in western and central circles. Although invasive species have less prevalent spreading in the state but it is increasing year after year due to degradation of forest area. Due to which danger of forest fire is also increasing. Following actions are recommended for weed management:

i. A baseline study to quantify the extent and spread of invasive weeds as well as future possible area of spread of weeds may be initiated by SFDs in consultation with RFRI, Jorhat.

ii. Periodic removal of weeds along with their biological control should be strategized at SFD head quarter level and must be included in APOs of various activities conducted in forest area under different schemes like CAMAP, FDA, CSS-FPM, etc ensuring that it does not regrow on treated lands. Removal should be organized as an attractive economic opportunity for the local communities.

iii. Rehabilitation of treated areas with appropriate species and soil and moisture conservation measures should form part of the weed removal plan and APOs of above-mentioned schemes.

11.6 Forest Fire Preparedness

Preparedness in forest fire management leads to effective response to fire disasters resulting in reduced impact and quicker recovery. The following steps are recommended for preparedness against forest fires.

11.6.1 Forest Fire Detection and Alert

Satellite based Forest Fire Alerts are operational under Forest Survey of India (FSI). The following actions are to be taken to improve the efficacy of the FSI fire alert system in the state.

i. Digitization of Forest Boundaries

FSI is still using the old boundaries (2011) of district/division of the state. The digitization of new forest boundaries up to forest range or even below level should be undertaken to improve the alert system screening of fire detections by FSI. Latest forest boundaries will help FSI to exclude fire incidences occurs in non-forest land. Currently burning for shifting cultivation is also considered as forest fire by FSI. This needs to be corrected.

ii. Revival of State's Fire Reporting System and "e-Forest Fire App"

SFD, Arunachal Pradesh developed an android based application **"e-Forest Fire App"**, which is a Fire Reporting System, an effort to ease governance by involving people and to promote e-Governance. With the help of the app, people of Arunachal

Pradesh were able to report fire incidents of their nearby forest areas and could also be in direct touch with Divisional Forest Officers. But due to some reason this android based application is not working anymore and also not available on Play Store. In present scenario SFD is dependent on the communications of FSI regarding the detection of forest fire. This **e-Forest Fire** application needs to be revived. This will promote greater adaptation of the forest fire alert system as well as improve the ground-based detection of forest fires.

iii. Dedicated Phone Lines

A toll-free telephone number for fire detections and other required support shall be established at SFD headquarters and telephone numbers of DFOs, RFOs and local responsible forest officials at prominent places shall be displayed to ensure early detection of forest fires and to obtain information on forest fires from tourists, passersby and local people.

iv. Wireless Network

Most of the forest in higher ridges in Arunachal Pradesh is in remote places, where mobile telephone network is not well developed and frontline staff are unable to get the information coming on the Forest Fire Alert Alarms. In such cases, forests communication system may be supplemented by a dedicated wireless network. DFOs may prepare a list of such places in their divisions especially in highly fire prone areas and may proposed it under suitable plans and schemes.

v. Monitoring and Evaluation

FSI has put in place a system to review all fire alert detections, and their ground verification. DFOs must ensure that ground verification reports are sent to the concerned officer of the department and forward the verification reports to FSI for validation. This process may be strictly monitored by the Addl. PCCF (RE) at SFD headquarters.

11.6.2 Digitize the Location of Critical Resources and Assets

DFOs shall conduct inventory mapping of inventory mapping of critical resources for forest fire prevention and management and make relevant information available to the GIS & IT cell of the department for digitization. Resources and assets to be inventoried may include the following:

Forest department resources - watchtowers, jungle roads, ground crew stations, controls rooms, plantations, RFRs/PRFs, PA networks, ecotourism sites and fire lines

Non-department resources -locations of fire stations, fire tenderers and National and State Disaster Response Forces, and army and paramilitary camps.

Shifting cultivation areas – locations of year-wise fallow lands through areas of upcoming burning for shifting cultivation can be identified in advance.

Important infrastructure – footpaths, roads, railways, and telecommunications networks

Natural resource – the locations of water bodies and natural fire breaks that could assist in preparedness and planning for response to forest fires.

11.6.3 Forest Fire Lines

Clearing the forest fire lines are the most important component for forest fire preparedness. Fire line stops fires from spreading in vast forest area and also provide space to firefighters to suppress the fire. Mapping and digitizing of locations of existing fire lines along other infrastructures such as roads, transmission line and rail lines that may function as fire breaks is very much essential.

- DFOs shall undertake the digital mapping of these and will send the digital data to the GIS & IT Cell of the department for maintaining and further processing.
- Forest division wise .KML files shall be prepared enabling forest officials at field level to use the information in their mobile through google earth application.
- RFOs will ensure clearance of the fire lines in all vulnerable forests in the range and DFOs will ensure the completion of the fire line maintenance and will report to Addl. PCCF (RE) before onset of fire seasons.
- A review of the maintenance status, functionality, and adequacy of these fire lines, and in assessment of the need for new fire lines, may be undertaken considering past fire data, forest types, habitations, and other relevant factors. Proposals for new fire lines should be made on a scientific basis and protected areas like NP, WLS, etc. should be given special concern in this exercise.
- New roads are being build up in different parts of the state which are increasing the risk of accidental forest fires. To check the forest fires in such area creation of new fire lines may be proposed under appropriate plan/scheme. DFOs shall also ensure that plantations are not be raised on existing or proposed fire lines.

11.6.4 Control Burning

Control burning is the age-old management tool for preventing spread of forest fire but its use reduced in Arunachal Pradesh over the years. This may be due to the shortage of manpower and timely availability of funds. As per the ISFR, 2021, State's forest cover stands at 87.41% from the total geographical area wherein most of the forest cover (87.67%) falls under less fire prone category. The report shows that 12.33% (8,199.17 km^2) of state's forests are prone to fires and of this only 0.05% (35.16 km^2) are falling in extremely fire prone zone and 1.44% (959.78 km^2) are in very highly fire prone zone. Although, very less forest area of the State is under highly fire risk zones, control burning is required at some places for preventing spread of fire. The following actions are recommended to improve the consistent performance and effectiveness of control burning wherever necessary:

- Control burning should be performed in vulnerable areas especially near to the shifting cultivation lands and road/rail sides at least in the forest divisions of highly fire prone areas as well as in protected areas.
- DFOs shall monitor the performance of control burning in respective forest divisions, and monitoring data will be integrated into database maintained by the department;
- Headquarters shall ensure the timely release of funds for control burning prior to the onset of the peak fire season and the provision of advance/ad-hoc release as needed;
- SFD shall also develop and notify specific guidelines for control and prescribed burning.

11.6.5 Meetings with Community Members

Before onset of fire season, Range Officer will convene a meeting of panchayat presidents/village chiefs of all the forest fringe villages in his jurisdiction and analyse and discuss the success and failure of efforts in previous years to extinguish forest fire. He will decide the strategy after due consultation with panchayat presidents/village chiefs, Foresters, Forest Guards and squad members for current year. Range Officer will also apprise the community representatives/members about incentive scheme for checking forest fire by villagers.

In highly fire prone zones, The DFO shall procure required quantity of firefighting equipments and safety kits for fire vulnerable ranges. Safety kits will include first aid medicines, mask, hat, water bottle, torch with batteries besides other necessary items. DFO will organize necessary training programme on use and maintenance of equipments at the site and also ensure mock drills are conducted.

11.7 Fire Suppressing

Fire suppression is a variety of firefighting methods used to extinguish or suppress forest fires. Firefighting efforts require different techniques, equipment and training. In addition, immediate response to forest fires after receipt of information is of utmost importance. Therefore, it is important to develop a culture of fire emergency response in which all available resources are used to extinguish fires. This needs intense training at all levels, strengthening of infrastructure, and coordination with communities and other relevant agencies.

11.7.1 Training for Field Staff, Fire Watchers and Community Firefighters

Fire suppression requires specialist personnel and equipment. The principal need for forest fire suppression is to have adequate competent, trained, and equipped workforce on the ground, ready to respond and take immediate action. Training programmes should be taken up for field officers, seasonal firewatchers, and community volunteers involved in firefighting as routine schedule analyzing the past experience to improve future fire suppression programme with modern technology. The type of training

provided to fire fighters should be tailored according to the landscape, nature of terrain, their level of responsibility and role in the command structure in responding to fires.

i. A modern and standardized training curriculum should be developed by the SFD by involving other agencies like local Revenue Department, SDMA, Fire & Emergency services of Police Department, SHGs and NGOs.

ii. In extremely high fire prone zones, mock drills should also be organized before the fire season at divisional levels involving above-mentioned agencies for identification of gaps in the existing mechanism and better preparedness during the crisis time.

iii. Training programme on firefighting shall also be extended beyond state managed forests to Unclassified state forest and village forest reserves.

11.7.2 Equipping the Firefighters

i. Firefighting is tough and life-threatening job; therefore, safety of firefighters should be ensured by the DFOs. The firefighting squad including field staff, seasonal firewatchers, and community firefighters should be provided with adequate firefighting equipment including leaf litter blowers, and protective clothing.

ii. DFO shall assess the requirement of various firefighting equipments in their division and shall put-up their requirement before the Forest Protection Cell of the department for the same. Forest Protection Cell shall ensure the timely availability of firefighting equipments to local needs in consultation with other relevant institutions.

iii. Sufficient practice session shall be conducted for the firefighting personnel in the use of the modern firefighting equipments to enhance their efficiency in actual firefighting.

11.7.3 Development of Adequate Infrastructure for Fire Suppression

It is important to respond to forest fire at the right time through the effective communication network. Following actions are recommended for improvement of adequate infrastructure for fire suppression:

i. Wireless equipments should be employed where mobile network is inaccessible to ensure effective communication network.

ii. To ensure the mobility of firefighters in the event of firefighting, adequate financial provision may be made for each Forest Division for hiring if vehicles. This will ensure prompt access to field and movement of firefighting personnel to the fire spots at the earliest.

iii. CCFs of each circle of forest department should develop, and enforce, a protocol for ensuring prompt access to field vehicles from nearby forest divisions for movement of firefighting personnel to the fire spots at the earliest.

iv. DFO shall ensure the proper maintenance of forest road network in highly fire prone areas for quick movement of fire fighting forces to the fire site.

11.7.4 Arrangements for Adequate Manpower in Fire Prone Areas

As discussed earlier that the lack of adequate manpower is one of the major challenges in forest fire management in the state; therefore, it is imperative to increase manpower and mobilize community resources to fight forest fires. The following actions are recommended to ensure arrangements of adequate manpower in fire prone areas.

i. The State Forest Department should fill all the vacancies on priority basis especially at the level of frontline forest officials in the highly fire prone areas

ii. Trained personnel, if any, may also be mobilized from other agencies such as Police, Fire services, SDRF, etc. or from even army in extreme cases.

iii. List of ex-servicemen should be maintained at Forest Division level. Services of these trained personnel can be utilized during fires suppression.

iv. The Communities/NGOs living near the fire prone areas should also be sensitized, mobilized and incentivized towards fire suppression activities.

v. Local Tribes must be recruited in Forest Protection Squads and Village Forest Protection Team to minimise the Forest Fire incidents and they should be given proper training. Voluntary fire fighters may be master trainers for communities or NGOs, a database of such volunteers should be maintained at the Forest Division level.

vi. In case of burning of dry tree, solid logs, branches, where fire usually last for long period, local fire station may be called with water tank to extinguish the forest fire.

11.8 Post Fire management

11.8.1 Assessment of Loss Due to Forest Fires

- DFO shall assess the areas burnt due to the forest fire on annual basis in a specific format and forward the information to the Forest Protection Cell of the department and the Cell shall create a state level database for burnt area assessment.
- Standardized protocols and procedures are needed to facilitate the reporting of the area affected and losses due to the forest fire. As envisaged in NAPFF, institutions like FSI/RFRI, Jorhat may be assigned the task to develop standardized methodologies for assessing losses due to forest fire including loss of tangible and intangibles such as ecosystem services.
- Estimation of monetary value of losses due to forest fires on per hectare basis for different density class in each forest type should also be standardized.

11.8.2 Proper Investigation of the Causes

DFOs shall ensure that the causes for every fire incident are properly investigated; and adequate measures taken immediately including legal actions where necessary. The driving force behind the cause should also be investigated.

11.8.3 Restoration of Fire Affected Areas

A proper restoration plan is needed for the fire affected areas with the objective of restoring to its natural profile. In the affected areas, appropriate silviculture practices may be taken up in line with the ecological successional dynamics. The following sections are recommended in this regard.

- All the fire affected areas should be included for restoration in APOs different schemes like CAMPA, FDA, State Plan, CSS-FPM, etc.
- As per the severity of the damage aided natural regeneration (ANR) or artificial regeneration (AR) may be employed in the fire affected areas.
- Adequate soil moisture conservation (SMC) shall be taken up in the fire affected areas for enhancing the moisture retention capacity of the land.
- Fire affected area must be protected after restoration work takes place. Indigenous plants which act as vegetative barrier may be identified and planted around the fire affected area.

11.9 Coordination with Other Agencies and Entities

Forest fire management is a multifarious activity in which a frictionless interface with a range of institutions and social groups becomes very important for effective functioning. While forest fire management will remain the responsibility of the forest department, other agencies and institutions must be involved in both fire prevention and suppression. These agencies, including the village functionaries, NGOs, fire & emergency services department, disaster management authorities and police are often called upon to assist the state forest department in responding to especially large or damaging forest fires. Institutionalization of close coordination with relevant institutions is thus already a reality in the state but it needs to be strengthened further. Following actions are recommended in this regard.

- DFO works closely with the DDMA to ensure that the forest fires are contained and mitigated. The department may also coordinate with the SDMA in this regard.
- Functioning of the Crisis Management Groups for Forest Fires at all level may be reviewed to ensure that Standard Operating Procedures (SOPs) are in place related to command and control, compilation of availability of extent and location resources required in case of occurrence of fires and for monitoring its spread.

- Organizing mock drills is a very efficient way of ensuring preparedness. Joint trainings and mock exercises with all relevant agencies may be organized to facilitate coordination during a fire event.
- DFOs may also seek the assistance of the Defense forces in the vicinity, at the time of such disaster.

11.10 Mobilization of Financial Resources

On analysis of fire points detected by FSI during last 4-5 years, it is evident that forest fire incidences (including burning for jhum cultivation) have increased significantly, which is causing serious threat to state's forests. In view of climate change scenario, role of forests of Arunachal Pradesh in achieving the national determined contributions (NDCs) become more crucial. Therefore, emphasis on the adequate protection of existing forest resources from fire hazards should become high priority attracting adequate funding. Hence, the following recommendations are suggested for sustainable funding mechanism.

- DFOs shall ensure that the works under CSS-FPM are executed properly to ensure adequate management resilience of forest fires.
- SFDs will ensure sufficient budgetary allocation for fire mitigation under different schemes like CAMPA and State plan budget.
- Community development works and entry point activities in the forest enclosures and fringes should develop fire protection arrangements on the borders of habitations.
- External financial aid like climate funds, etc. under existing global bilateral or multilateral mechanisms for activities leading to adaptation to the changing climate can be a good source for funds and must be accessed.
- MNREGA and community development/welfare programs aimed at generating employment through creation of assets with labour intensive activities are a good source of funding for some aspects of forest fire protection and should be made use of. DFOs in partnership with the district administration could work towards this.
- Crowd Funding is a popular means of financial resource mobilization for any common cause where interested people can contribute. Environmental causes like forest fire protection can garner enormous support from public. Local community organizations working in vicinity of vulnerable forests can thus be encouraged to organize crowd funding for work at community levels.
- Arunachal Pradesh is a hill state and a number of river valley hydroelectric projects are coming up at different places. Fire prevention works along with moisture conservation works should be made mandatory in Environmental Management Plan (EMP) and Catchment Area Treatment (CAT) Plans of these projects. This can reduce fire hazards to a great extent in the state.

11.11 Monitoring Strategy

Monitoring strategies are used to assess the overall performance of management and identify short-term improvement needs. Performance indicators were assigned for each management objective. Agency/level who are responsible for different actions are also identified. Baseline values are determined for each efficacy indicator based on information provided in the different sections of the action plan. These values should be reviewed during the implementation of the action plan to assess whether envisaged goals have been achieved. The matrix of evaluations or performance indicators is shown in Table 9.

Table 9: The matrix for evaluation or performance indicators

Components	**Action to be taken**	**Performance indicators**	**Action taken by**	**Means of measurement**
Fire Risk Zonation and Mapping	Fire risk zonation is to divide the area according to the degree of occurrence of forest fire	Fire risk zonation and mapping is done	GIS & IT Cell of SFD	Analysis of FSI data, ground truthing and periodic updated fire incidences
Prevention of Forest Fires	Effective communication Strategy for Awareness Generation	Students, farmers (Jhum cultivators and others), NTFP collectors, infrastructure related professionals, urban dwellers, tourists, etc. are well aware.	DFO RFO	1. No. of awareness programme conducted. 2. Reports 3. Process documentation
	Empowering Communities to deliver on their responsibilities	Contribution of local communities in forest fire management is recognized and incentivized with cash award along with trophy and certificates	DFO	Fire Prevention Awards are given away
	Capacity building of communities	Communities are capacitated and mock drills are organized	DFO RFO	1. No. of training programme organized. 2. Reports 3. Process documentation
Increasing the resilience of forests to fire	Moisture and water conservation	Construction of various moisture and water conservation structures	DFO, RFO, Village panchayat	1. Moisture level and water retention increased. 2. Reports 3. Process documentation
	Forest floor biomass management	Introduction of bi-briquetting		No. of bio-briquetting units established
		Removal of dead bamboos	DFO, RFO, Jhum cultivators,	1. Area cleared from dead bamboos 2. Reports

			communities	
	Weed Management	Baseline study to quantify the extent and spread of invasive weeds	RFRI, Jorhat	1. Reports 2. Maps
		Periodic removal of weeds	DFO, RFO	Area cleared from weeds
Forest Fire Preparedness Fire suppression	Forest Fire Detection and Alert	Digitization of forest boundaries	DFO, GIS & IT Cell	Available of digitized maps
		Revival of State's Fire Reporting System and "e-Forest Fire App	SFD	e-Forest Fire App is working properly
		Establishment dedicated phone lines and display of important phone numbers at appropriate places	Forest Protection Cell DFO	Physical verification of signboards and phone numbers
		Strengthening of wireless network	SFD, DFO	No. of wireless devices available
	Digitize the location of critical resources and assets	Digitize the location of critical resources and assets done	GIS & IT Cell	1. .KML files are available with field functionaries 2. Reports
	Forest Fire Lines	Fire line constructed and maintained	DFO, FRO	1. No. of new fireline created in fire prone zone 2. No. of fireline cleared
	Control burning	Control burning are done prior to the onset of fire season	DFO, RFO	1. Photographs 2. Reports 3. Process documentation
	Meetings with community members	Meetings with community members conducted	RFO	1. Reports 2. Proceedings of meeting
	Training for field staff, fire watchers and community fire fighters	A standardized training curriculum is developed	SFD	Training curriculum document
		Mock drills are organized before onset of fire season in highly fire prone divisions	DFO	1. Reports 2. Process documentation
	Equipping the firefighters	Firefighting equipments are available	SFD, DFO	Physical verification and procurement bills
	Development of adequate infrastructure for fire suppression	Wireless equipments, vehicles and forest roads are up to the mark	SFD, DFO	Physical verification and procurement bills
	Arrangements for adequate manpower in Fire prone areas	Vacancies of frontline staff are filled	SFD	No. of vacant posts of frontline staff
		Communications are made with other agencies regarding arrangement of	SFD, DFO	1. Reports 2. Process documentation

		manpower during emergency		
		Voluntary fire fighters are selected from villages and are given training	DFO	List of volunteers and proceedings of trainings
Post fire management	Assessment of loss due to forest fires	Standard methodologies are developed for the assessment of losses due to forest fire	SFD	Reports
		Damages due to forest fire assessed	DFO	Reports
	Proper investigation of causes	The causes for every fire incident are properly investigated and adequate measures taken immediately	DFO	1. Reports 2. Process documentation
	Restoration of Fire Affected Areas	Fire affected areas are included for restoration in APOs different schemes	DFO, SFD	1. Reports 2. Verification of APOs
		Soil moisture conservation (SMC) is taken up in the fire affected areas	RFO	1. No. of SMC works carried out 2. Reports 3. Process documentation
Coordination with Other Agencies and Entities	Proper coordination with other agencies and entities in dealing with land and fires	Coordination at all level – State, division and range level are maintained properly	SFD, DFO, RFO	1. Reports 2. Process documentation
Mobilization of financial resources	Ensuring adequate investment and funding mechanism	Works under CSS-FPM are properly executed	DFO	1. Physical verification 2. Reports
		Sufficient budgetary allocation for fire mitigation under different scheme	SFD	1. Reports 2. Sanction letters
		Entry point activities are taken under MNREGA	RFO	1. Physical verification 2. Reports
		External international aids are searched	SFD	Reposts
		Bank account for crowd funding is opened and widely advertised	SFD	1. Reports 2. Process documentation
		Moisture conservation works included in EMP and CAT Plans of developmental projects	SFD	Reports

References

Ahmad, F., Goparaju, L., Qayum, A. (2018). Himalayan forest fire characterization in relation to topography, socio-economy and meteorology parameters in Arunachal Pradesh, India. Spatial Information Research 26(3):305-3015.

Alfred, J.R.B. (ed.) (2006). Fauna of Arunachal Pradesh, State Fauna Series, published by the Director, Zoological Survey of India, Kolkata, 13(Part-l), pp 1-396

Champion, H.G. and Seth, S.K. (1968). A revised survey of Forest types of India. Delhi: Manager of Publications, Government of India. 404 p.

FSI. (2021). India State of Forest Report 2021. Forest Survey of India: Dehradun (U.K.), India.

MoEF&CC (2018). National Forest Fire Action Plan.

Saikia, P., Deka, J., Bharali, S., Kumar, A., Tripathi, O. P., Singha, L. B., Dayanandan, S. and Khan, M. L. (2017). Plant diversity patterns and conservation status of eastern Himalayan forests in Arunachal Pradesh, Northeast India. Forest Ecosystems, 4:28.

Satendra and Kaushik, A.D. (2014). Forest Fire Disaster Management. National Institute of Disaster Management, Ministry of Home Affairs, New Delhi

Websites:

https://arunachalforests.gov.in

https://fsiforestfire.gov.in/index.php

https://www.webgis.co.in/download-app