सत्यमेव जयते

TECHNICAL INFORMATION SERIES

Volume 3 No. 1 2026

Assessment of Forest Fire Burnt Area Report 2023-24



भारतीय वन सर्वेक्षण

Forest Survey of India

Ministry of Environment, Forest & Climate Change

Government of India Dehradun-248195

© Forest Survey of India
ISBN: 978-81-950073-6-3

FSI TECHNICAL INFORMATION SERIES

Volume 3 No. 1 2026

Assessment of Forest Fire Burnt Area Report 2023-24

FOREST SURVEY OF INDIA
Ministry of Environment, Forest & Climate Change
Government of India
Kaulagarh Road, Dehradun-248195

© Forest Survey of India
ISBN: 978-81-950073-6-3

PROJECT TEAM

Overall guidance of	Shri Santosh Tewari, IFS Director General, Forest Survey of India Shri Anoop Singh, IFS Former Director General, Forest Survey of India Ms. Shivani Dogra, IFS Joint Director, Forest Geo-informatics Division (FGD), Forest Survey of India Smt. Meera Iyer, IFS Former Joint Director, FGD Forest Survey of India
Project investigator	Shri Arvind Dattu Mundhe, IFS Deputy Director, Forest Survey of India Dr. Sunil Chandra, Deputy Director (Retd.), FGD, Forest Survey of India
Technical investigator	Shri Vikas Gusain, STA, FGD, Forest Survey of India Shri Satyendra Kumar, Sr.TA, FGD, Forest Survey of India Shri Rashpal, Sr.TA, FGD, Forest Survey of India Shri Priyonath Adhikary Sr.TA, FGD, Forest Survey of India
Image analysts	Shri Satyendra Kumar, Sr. TA Shri Rashpal, Sr. TA Shri Anupam Pal, Sr. TA Shri Manish Uniyal, Sr. TA Shri Kanwal Preet Singh, Ex. Sr. TA Smt. Triparna Barman, Sr. TA Shri Digvijay Singh, Sr. TA Smt. Sonam Bahuguna, TA Shri Rahul Jay Prakash Sharma, TA Km. Malavika M., Ex TA Shri Akhilesh Panwar, TA Shri Das Jay Sapan, TA

ABBREVIATIONS & ACRONYMS

AWiFS	-	Advanced Wide Field Sensor
CFFDRS	-	Canadian Forest Fire Danger Rating System
CSV	-	Comma-separated Values
DEM	-	Digital Elevation Model
DIP	-	Digital Image Processing
dNBR	-	Digital Image Processing
FC	-	Forest Cover
FCC	-	False Colour Composite
FCM	-	Forest Cover Map
FFRZ	-	Forest Fire Risk Zonation
FSI	-	Forest Survey of India
FTM	-	Forest Type Map
FTG	-	Forest Type Group
FWI	-	Fire Weather Index
GA	-	Geographical Area
GIS	-	Geographical Information System
GOI	-	Government of India
GT	-	Ground Truth
GW	-	Green Wash
IDW	-	Inverse Distance Weighted
ISFR	-	India State of Forest Report
K_{HAT}	-	Kappa Coefficient
KML	-	Keyhole Markup Language
LFF	-	Large Forest Fire
LLRM	-	Log-linear Modeling Regression
LULC	-	Land Use Land Cover
MCDA	-	Multi-Criteria Decision Analysis
MDF	-	Moderately Dense Forest
MMU	-	Minimum Mappable Unit

MODIS- Moderate Resolution Imaging Spectroradiometer

MoEFCC- Ministry of Environment, Forest and Climate Change

NASA - National Aeronautics and Space Administration

NBR - Normalized Burnt Ratio

NDMA- National Disaster Management Authority

NDRF - National Disaster Recovery Force

NDVI - Normalized Difference Vegetation Index

NF - Non-Forest

NFI - National Forest Inventory

NIR - Near Infra-Red

NRSC - National Remote Sensing Centre

NTFP - Non-Timber Forest Products

NWFP - Non-Wood Forest Products

OA - Overall Accuracy

OF - Open Forest

PA - Protected Area

PCCF - Principal Chief Conservator of Forests

PF - Protected Forest

QCQA - Quality Check & Quality Assurance

RF - Reserved Forest

RFA - Recorded Forest Area

SDMA - State Disaster Management Authority

SE - Standard Error

SFD - State Forest Department

SNPP - Suomi National Polar orbiting Partnership

SOC - Soil Organic Carbon

SOI - Survey of India

SRTM - Shuttle Radar Topography Mission

SWIR - Short Wave Infra-Red

USGS - United States Geological Survey

UT - Union Territory

VDF - Very Dense Forest

VIIRS - Visible Infrared Imaging Radiometer Suite

WFS - Web Feature Service

WMS - Web Map Service

GLOSSARY

Accuracy Assessment	It is an integral component of most mapping projects incorporating remotely sensed data. It has been used to assess the accuracy of classified data in comparison with the field data.
Alert	A warning signal disseminated through email and SMS
Anthropogenic	Resulting from or produced by human activities.
Biodiversity	Biodiversity, or, "Biological diversity" means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems. (Source – Convention on Biological Diversity)
Biomass	Biomass is the organic material that comes from plants or animal. Biomass can be above- ground, or below-ground, as defined above.
Biotic influences	Any influence of living organisms. Usually restricted to the influence of animals including man. Usually in forests, the biotic influences could include grazing, browsing, man-made fire, pollarding, illicit felling, and lopping.
Canopy	The cover of branches and foliage formed by crown of trees.
Canopy density	Percent area of land covered by canopy of trees. It is expressed as a decimal coefficient, taking closed canopy as unity.
Correlation	The correlation between two variables is the degree of association between two variables. This degree of association is expressed by a single value called a correlation coefficient (r), which can take values ranging between -1 and +1.
Crop composition	It refers to the type of species or group of species, which are contained in a forest. According to crop composition, forest can be either pure or mixed.
Crown Fires	These fires spread rapidly through the tops of trees, consuming the canopy layer. These fires are often the most destructive, generating intense heat and spreading quickly, especially in dry, windy conditions.
Difference Normalized Burnt Ratio	The difference between the pre-fire and post-fire NBR are used to calculate the dNBR, which then can be used to estimate the burn severity.
Digital Image Processing	Interpretation and classification of digital satellite data using computer and software.

Emission	The release of greenhouse gases and/or their precursors into the atmosphere over a specified area and period of time. (UNFCCC Article 1.4) (Source - 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories – Glossary)
Error Matrix	It is a means to quantitatively assess the accuracy of classification of an interpreted satellite data. Under this, the reference data (ground truth) is compared with the corresponding results of the classification on the randomly selected locations on category-by-category basis. It is presented in a square matrix.
False Colour Composite	The image generated by projecting any three spectral bands of the satellite data on the red, green and blue channels and does not show features in true colours.
Forest Area	The area recorded as a forest in the Government records. It is also referred to as "Recorded Forest Area".
Forest Cover	All lands, more than or equal to one hectare in area, with a tree canopy of more than or equal to 10%, irrespective of ownership and legal status; and includes orchards, bamboo, and palm
Forest ecosystem	A forest ecosystem is a dynamic complex of plant, animal and micro-organism communities and their abiotic environment interacting as a functional unit, where trees are a key component of the system. Humans, with their cultural, economic and environmental needs, are an integral part of many forest ecosystems.
Forest Inventory	Forest inventory is the systematic collection of data on the forestry resources within a given area. It allows assessment of the current status and lays the ground for analysis and planning, constituting the basis for sustainable forest management. (Source - fao.org/ sustainable-forest-management/toolbox/modules/forest-inventory/basic-knowledge/ en/?type=111, 26.07.2024)
Forest resources	Forest resources encompass all the assets and elements derived from forests, including timber, non-timber products, biodiversity, clean water, recreational opportunities, and ecosystem services.
Forest stand	Forest stand is an aggregation of tree or other growth, possessing sufficient uniformity in composition, constitution, age arrangement or structure and to be distinguished from adjacent crops forming a silvicultural unit.
Geographic Information System	A computer based system for capturing, storing, manipulating, analysing and displaying data, which are spatially referenced to the earth.
Green wash area	The extent of wooded areas generally shown in light green colour on the Survey of India topographic sheets.

Ground Fires	These fires burn the organic matter in the soil and under the forest floor, including roots and peat. Ground fires can smoulder for long periods and are often difficult to detect. They typically occur in areas with thick layers of leaf litter or peat.
Habitat	A physical portion of the environment that is inhabited by an organism or population of organisms. A habitat is characterized by a relative uniformity of the physical environment and fairly close interaction of all the biological species involved.
Hotspot	An area which is prone to adverse climatic conditions
Indicator species	An indicator species is a species or group of species chosen as an indicator of, or proxy for, the state of an ecosystem or of a certain process within that ecosystem.
***Jhum* cultivation**	It is a traditional agricultural technique that involves clearing land of trees and other vegetation, burning it, and then cultivating it for a set number of years. Shifting cultivation and slash and burn cultivation are other terms for jhum cultivation.
Kappa Coefficient	This coefficient measures the agreement between classification and truth values. A kappa value of 1 represents perfect agreement, while a value of 0 represents no agreement.
Landscape	An area of distinct character with significant ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values
Large forest fire	Alert generated when fire is detected in 3 Contiguous Pixels Connected in the Side or in adjacent pixels
Large Forest Fire Detections	The large forest fire detection program detects the candidate large fire (three or more contiguous hotspot pixels) using SNPP-VIIRS sensor and regularly monitors the large fire in each passes unless the fire is completely doused.
Litter	Woody material of trees having diameter <5cm and >2mm, which is not decomposed.
Low Burnt Areas	Areas where only the ground has been effected due to forest fire. Low burnt area experiences minimal damage to trees and understory vegetation.
Management ignited fires	Management ignited fires are ignited in order to meet a land management plan objectives, such as debris removal or wildlife habitat improvement.
Moderately Burnt Areas	Areas where the ground and some part of trunk has been effected due to forest fire.

Moderately Dense Forest	All lands with forest cover having a canopy density between > 40, and less than 70 percent.
Multi-Criteria Decision Analysis	It is a structured approach used to evaluate and prioritize different decision alternatives based on multiple conflicting criteria. It helps decision-makers analyze various factors—such as cost, benefits, risk, environmental impact, and feasibility—when choosing the best option. MCDA uses quantitative and qualitative data to provide a comprehensive view of options, supporting informed, objective decisions in complex situations where trade-offs between different goals need to be considered.
Normalized Burnt Ratio	This index highlights burnt areas by using NIR and SWIR bands. The NBR values ranges from -1 to 1. A high NBR value indicates healthy vegetation while a low value usually indicates dark features including forest fire burnt areas. Non-burnt areas are normally attributed to values close to zero.
Open Forest	Lands with forest cover having a canopy density between ≥10 and <40 percent
Overall Accuracy	It is calculated by summing the number of correctly classified values and dividing by the total number of values. The correctly classified values are located along the upper-left to lower-right diagonal of the confusion matrix.
Physiographic Zone	A physiographic zone constitutes geographical areas that exhibit broad similarities in factors responsible for the growth of tree vegetation. Physiographic zones have been used as strata for assessing tree cover in the country.
Plantation	A stand composed primarily of trees established by planting or artificial seeding.
Post Fire Satellite Data	Satellite data acquired after the forest fire incidence.
Pre-Fire Satellite Data	Satellite data acquired before the forest fire incidence.
Prescribed natural fires	Prescribed natural fires are those that are allowed to burn under an approved plan and preserve the natural role of fires in the ecosystem.
Producer Accuracy	It is the probability that a value in a given class was classified correctly. It is derived by dividing the number of correct predicted values in one class by the total number of values as derived from the reference data.
Recorded Forest Area	Area recorded as forest in Government records.

Remote Sensing	Remote sensing is the process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance. (Source: www.usgs.gov/faqs)
Scrub	Forest lands having canopy density less than 10 percent, generally with Shrubs interspersed with trees.
Severely Burnt Areas	Areas where the ground, trunk and the leaf has been effected due to forest fire.
Soil erosion	The displacement of the soil by the action of water or wind. Soil erosion is a major process of land degradation.
Soil organic matter	It is the organic component of soil containing small plant residues, small living soil organism and decomposed organic matter.
Spatial Resolution	The minimum area on earth's surface that can be captured by a satellite sensor as being separate from its surroundings and is represented by a "pixel".
Spectral Resolution	It refers to the width and number of spectral bands. The range of wavelengths that a satellite imaging system can detect. The narrower the bands, the greater the number of spectral resolution.
Surface Fires	These fires burn the vegetation on the forest floor, including grasses, shrubs, and small trees. These fires are usually less intense than crown fires and can be beneficial for the ecosystem by clearing underbrush and promoting new growth.
Surface Fuel Load	Surface Fuel Load refers to the amount of combustible material, such as dead vegetation, leaves, twigs, and branches, on the forest floor. It plays a crucial role in the spread and intensity of wildfires, as it determines how much fuel is available for combustion during a fire event.
Thematic Maps	A thematic map is a map created to display information about a topic or theme
Tree	A large woody perennial plant having a single well defined stem (bole or trunk) and more or less definite crown. It also includes bamboos, palms, fruit trees, etc., and excludes non- perennial non-woody species like banana and papaya, and tall shrubs or climbers.
Tree cover	Tree cover comprises all tree patches outside the forest area, which are less than one hectare in extent including all the scattered trees found in the rural and urban settings, and not captured under the forest cover assessment.
Tree Outside Forests (TOF)	It refers to all trees growing outside recorded forest areas irrespective of patch size.
User Accuracy	It is the probability that a value predicted to be in a certain class really is that class. The probability is based on the fraction of

	correctly predicted values to the total number of values as derived from the reference data.
Van Agni Geo Portal	The VAN AGNI Geo Portal FSI is an online platform developed by the Forest Survey of India to monitor and manage forest fires. It provides real-time data, satellite imagery, and maps to detect, assess, and track forest fires, aiding in forest fire management and mitigation efforts.
Very Dense Forest	Lands with forest cover having a canopy density of 70 per cent and above.
WFS	The Web Feature Service (WFS) is an interface specified by the Open GIS Consortium (OGC) that allows for the exchange of geographic data across the Web. It defines the rules for requesting and retrieving geographic information using the Hyper Text Transmission Protocol (HTTP).
WMS	A Web Map Service (WMS) defines an interface that allows a client to get maps of geospatial data and gain detailed information on specific features shown on the map, without the facility of editing. A “map” is defined here as a visual representation of geospatial data, not the geospatial data itself.

Chapter -1

Assessment of Forest Fire Burnt Area

1.1 Introduction

Timely detection of Forest fire incidents is crucial for managing fires in the nascent stage. Besides, it is equally important to assess the area affected by these fires to plan restoration measures. The information on forest fire effected areas is crucial for determining the extent of losses to the forest, biomass, biodiversity, soil fertility, habitat, production, underground water recharge, forest productivity, degradation of landscapes; and the disruption of livelihoods[1]. Currently, there is no comprehensive data or maps available on the annual extent of forest area burnt due to fires across the country. Accurate global data and information about wildfires is fragmented and inconsistent in many areas of the world[2]. The same is important for policy formulation for rejuvenation of such areas through a scientific intervention. Although a majority of fires in India are surface fires, yet their impact varies from region to region and have short to long lasting consequence on fauna and flora of the region.

1.1.1 Global scenario on burnt scar assessment

According to the Joint Research Centre of the European Commission, an estimated 90% of fires are readily contained and contribute less than 10 % of the total area burned. An estimated 7.20 billion ha of land (i.e. not limited to forests) was burned in 2001–2018 at an average of just more than 400 million ha per year[3]. Satellite imagery derived global burned area product provides information on spatial and temporal attributes of areas affected by fires, but they do not contain information on single wildfire events[4].

[1] Food and Agriculture Organisation, 2020. Global Forest Resources Assessment 2020: Main report. Rome. https://doi.org/10.4060/ca9825en
[2] Bowman, D., 2018. Wildfire science is at a loss for comprehensive data. Nature 560, 7–7.
[3] Artés, T., Oom, D., de Rigo, D., Houston Durrant, T., Maianti, P., Libertà, G. & San-Miguel-Ayanz, J., 2019. A global wildfire dataset for the analysis of fire regimes and fire behaviour. Scientific Data, 6: 296. doi: 10.1038/ s41597-019-0312-2
[4] Mouillot, F. et al, 2014. Ten years of global burned area products from spaceborne remote sensing-a review: Analysis of user needs and recommendations for future developments. Int. J. Appl. Earth Obs. 26, 64–79, https://doi.org/10.1016/j.jag.2013.05.014

Fire is an ecological driver in forest having large grassland areas which burns cyclically. On an average, tree-covered areas accounted for about 29 % of the total area burned by wildfires between 2001 and 2018. The findings of FRA 2020 indicates that 98 Mha of forest, or 3 % of global forest area, was affected by fire in 2015. Ongoing changes in global fire activity in terms of location, intensity, severity and frequency will likely have immense costs in terms of biodiversity, ecosystem services, human well-being, livelihoods and national economies. Reliable time-series data on the fire affected forest areas are important to better understand trends in wildland and forest fires[5]. Various techniques world over are being adopted to map the extent of forest fires. The objective is to utilize this information for various planning and management interventions. Satellite based remote sensing methods provide a useful solution for capturing forest fires in the near real time mode and estimate the affected area. However, the careful selection of burnt scars and their classification remains a challenge owing to various factors that include climate, environment, forest types and topography.

1.2 Use of remote sensing techniques for burnt area assessment

Satellite remote sensing plays an important role in the detection and monitoring of forest fires and further assessment of fire affected forest areas. An important component of remote sensing data is the availability of suitable spectral and temporal bands that helps to delineate burnt scars in near real time mode. High temporal satellite sensors such as MODIS (Moderate Resolution Imaging Spectro-radiometer) or VIIRS (Visible Infrared Imaging Radiometer Suite) provides information on the timing, distribution, and events of forest fires[6].

Small intensity fires despite their limited extent, often remains undetected by coarse-resolution sensors due to the limitations of the spatial resolution. Ground surveys to assess such areas are challenging due to time, financial, and human resource constraints. The availability of mid-resolution satellite data makes it possible to identify fire-affected areas as they exhibit a distinct signature in the imagery, making them distinguishable from other features. Additionally, the high frequency of data collection ensures that fire scars can be captured shortly after the fire occurs, reducing the chances of these signatures fading over time.

[5] Food and Agriculture Organisation, 2020. Global Forest Resources Assessment 2020: Main report. Rome. https://doi.org/10.4060/ca9825en

[6] Fangjun, L., *et al., 2018,* Comparison of fire radiative power estimates from VIIRS and MODIS observations. J. Geophys. Res.: Atmosphere

Often, burnt scars fade or disappear due to climatic factors like rainfall, making it difficult to accurately map the affected areas. As burnt scars have significant adverse effect on social, economic, ecological and cultural aspects, there is a clear need for precise assessment of burnt areas due to forest fires. Accurate assessment of burnt area assists in post-fire rehabilitation treatments, that are important in minimizing damage to soil, water and plant resources[7]. Rehabilitation methods such as grass seeding, logging, building of branch barriers and mulching may be used for replenishing the burnt forest areas[8]. The information on burnt areas can be useful for forest management, planning or decision making, as well as control and prevention of forest fires. Vegetation loss, soil exposure and change in moisture content of soil & vegetation due to varying burn severity results in change in reflectance making remote sensing data a good alternative for mapping burnt area[9]. World-wide various satellite data have been used for burnt area assessment and mapping. Although high temporal data would be effective for mapping of wildfires, yet small intensity fires may not be detected and mapped even using best satellite band combinations. In India, majority of fires have a small and discrete distribution on the ground owing to their short existence time. In few instances, they occupy a large area on the ground. Remote sensing data plays a useful role in providing information on affected areas in the near real time mode. The image processing techniques are quite helpful in discerning burnt scars where feature separation is quite distinct. In certain instants, the mixing of scars with other dark features and leaf stress conditions causes mixing of signatures. This makes their delineation difficult. To avoid this problem, field inventory data supported with machine learning tools are effective for precise mapping of burnt scars. However, for a national level mapping exercise, such an approach may not be feasible, owing to selection of data, time involved in training, testing of algorithms and complexity of datasets. In such a scenario, burnt area ratio techniques further supported with field based data has been much effective for generation of results with higher precision.

1.3 Objectives

[7] Vallejo, R., Hatzistathis, A., Bellot, J. & Serrasolses, I., 2000. Reclamation of Mediterranean Ecosystems affected by wildfires: Forest management recommendations. In P. Balabanis, D. Peter, A. Ghazi, & M. Tsogas (Eds.), Mediterranean desertification. Research results and policy implications (pp. 407–416). Belgium: European Commission.

[8] Robichaud, P. R., 2000. Fire effects on infiltration rates after prescribed fire in Northern Rocky Mountain forests, USA. Journal of Hydrology, 231, 220–229

[9] Jakubauskas, M.E., Lulla, K.P. and Mausel, P.W.,1990. Assessment of Vegetation Change in a Fire-Altered Forest Landscape. *Photogrammetric Engineering and Remote Sensing*, 56, 371-377.

The major objectives of the present study are:

- Develop approach for burnt scar assessment at national level using remote sensing data, field inventory and image processing tools
- To identify burnt scars signatures using different indices for precise estimation of burnt scars and their severity classes.
- Estimate area under different severity classes and produce results at district, state and country level
- Generate burnt scars maps at state and country level

1.4 Data Used

Appropriate section of data is a pre-requisite for country level analysis of burnt scars. In the present study, high temporal resolution data along with another ancillary data has been used in the study for precise estimation and mapping of burnt scars and their severity classes. The details of the datasets used are as follows:

1.4.1 Satellite Data

In the present study, high temporal and better spatial resolution Sentinel-2 satellite data have been used. The sensor is well suited for forest fire studies as it has the necessary spatial, spectral, temporal and analytical characteristics for mapping burnt area. One of the main advantages of Sentinel-2 remote sensing data is its temporal availability and presence of Short Wave Infra Red (SWIR) band that makes it a suitable data for fire studies. SWIR band in the optical range is very sensitive to fire affected areas when compared with other bands. It is important that the data required for such studies shall be of a closed period with respect to fire incidence so as to capture the signatures in near real time. Together, Sentinel-2A and Sentinel-2B has a revisit time of 5 days and one can get up to date images of a burnt region before it fades away. It also increases the chances of getting a cloud free imagery of the area. The present study focused on the identification of burnt scar and assessment of their severity. The specifications of Sentinel-2 spectral bands are shown in the Table 1.1:

Table 1.1 Specifications of the Sentinel-2 spectral bands

Bands	Central Wavelength (µm)	Resolution (m)
Band 1 - Coastal Aerosol	0.443	60
Band 2 - Blue	0.490	10
Band 3 - Green	0.560	10
Band 4 - Red	0.665	10
Band 5 - Vegetation Red Edge	0.705	20
Band 6 - Vegetation Red Edge	0.740	20
Band 7 - Vegetation Red Edge	0.783	20
Band 8 - NIR	0.842	10
Band 8A - Vegetation Red Edge	0.865	20
Band 9 - Water Vapour	0.945	60
Band 10 - SWIR - Cirrus	1.375	60
Band 11 - SWIR	1.610	20
Band 12 - SWIR	2.190	20

Limitations in the availability of cloud/smoke-free scenes in certain parts of the country has been the constraint in the assessment of burnt area. For such areas, satellite images from other datasets have been used. For few areas in the North-East and Western Ghats of the country, cloud free data was not available for the months of May and June. The burnt scars in the images have been analysed based on their spectral reflectance and correlating them with previous date imageries, besides delineation of scars using suitable band combinations, geometry and textural variability as shown in Figure 1.1.

Sentinel-2 data of 08 April 2024
(Pre-Fire Date)

Sentinel-2 data of 28 May 2024
(Post-Fire Date)

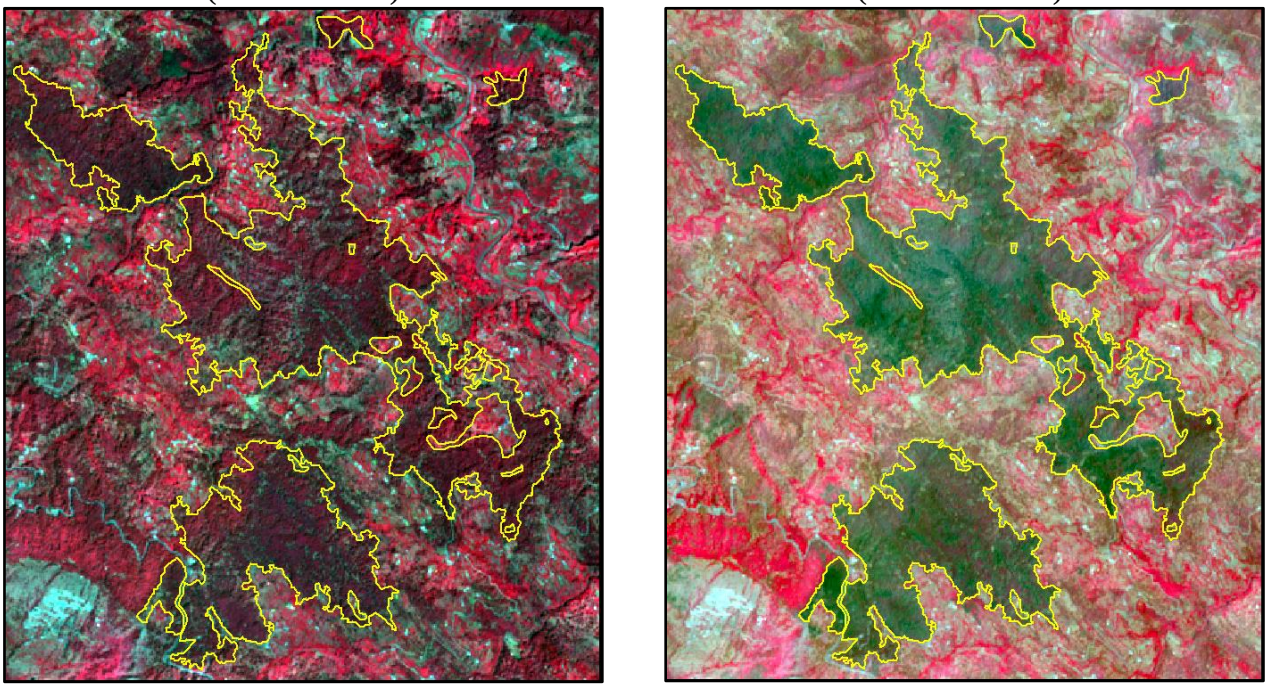


Figure 1.1 Sentinel-2 data to delineate burnt scar based on spectral reflectance variability

1.4.2 Ancillary Data

Apart from high temporal and mid spatial resolution satellite data, use of ancillary data helps in better delineation of burnt scars. In the present study, Near Real-Time Forest Fire Detections and Large Forest Fire Detections helped in better identification and delineation of the burnt areas. Geo-coordinates of the near real-time detections helped in the identification of the locations of the scars nearby and the polygons of the large forest fire detections helped in the identification of the extent of the scars. The near real-time detections and large forest fire detections are briefly described in the following sections:

1.4.2.1 Near Real-Time Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used to identify and map burnt scars. Map showing near real time forest fire detections using SNPP-VIIRS sensor is shown in Figure 1.2. Table 1.2 shows district-wise number of near real-time forest fire detections using MODIS and SNPP-VIIRS sensor during the aforesaid period.

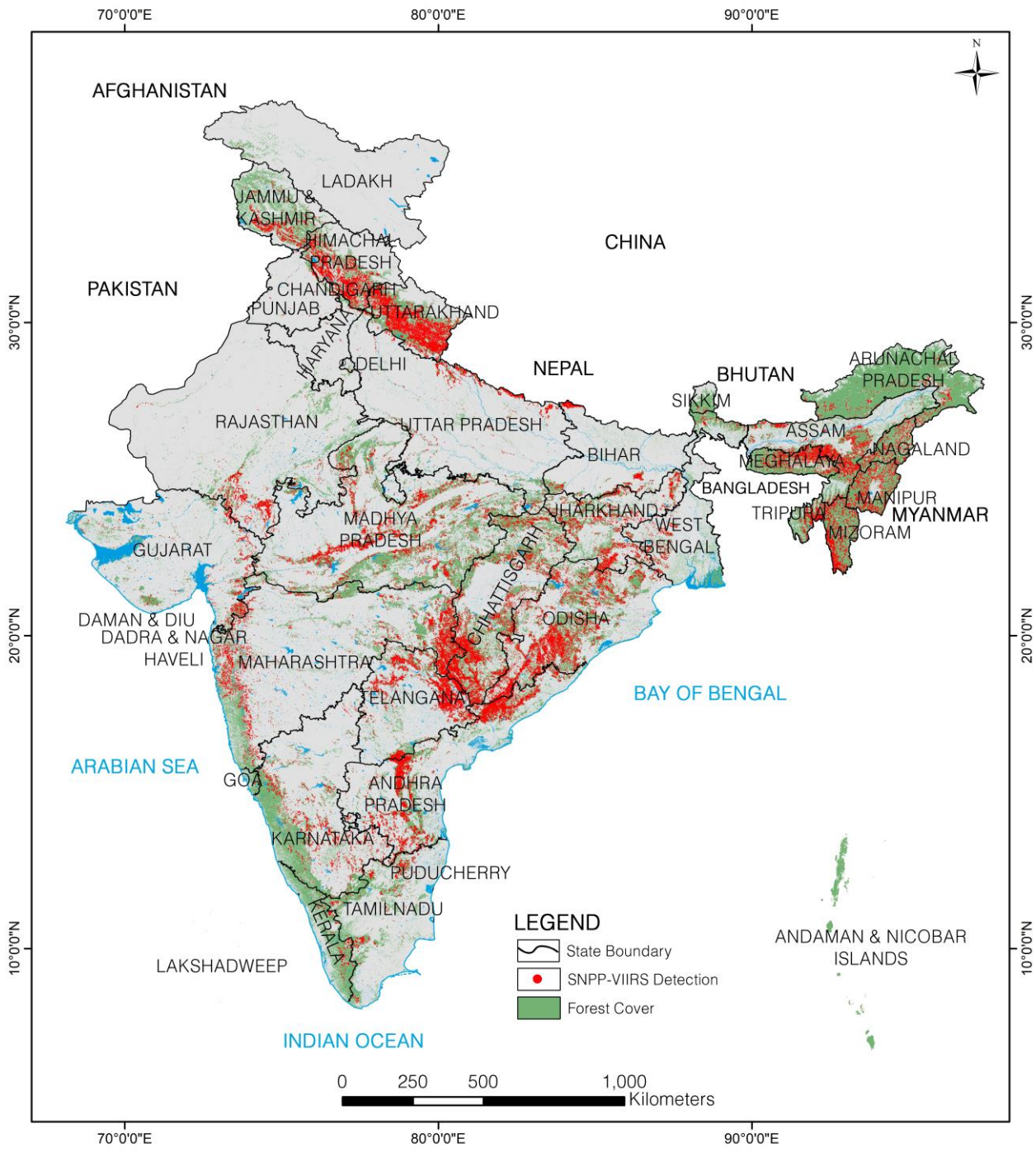


Figure 1.2 Map showing SNPP-VIIRS sensor detections during fire season 2023-24

Table 1.2 State/UT-wise number of forest fire detections

S. No	State/UT	No. of MODIS detections	No. of SNPP-VIIRS detections
1	Andhra Pradesh	1,793	18,174
2	Arunachal Pradesh	687	2,053
3	Assam	2,106	7,639
4	Bihar	273	2,763
5	Chhattisgarh	1,347	18,950
6	Delhi	2	16
7	Goa	3	36
8	Gujarat	287	3,182
9	Haryana	30	166
10	Himachal Pradesh	985	10,136
11	Jharkhand	381	7,525
12	Karnataka	853	5,500
13	Kerala	149	1,110
14	Madhya Pradesh	1,592	15,878
15	Maharashtra	1,515	16,008
16	Manipur	1,318	4,498
17	Meghalaya	1,082	4,319
18	Mizoram	2,366	6,627
19	Nagaland	761	2,609
20	Odisha	2,047	20,973
21	Punjab	124	605
22	Rajasthan	469	4,352
23	Sikkim	21	101
24	Tamil Nadu	624	3,380
25	Telangana	1,085	13,479
26	Tripura	441	2,089
27	Uttar Pradesh	916	4,424
28	Uttarakhand	2,442	21,033
29	West Bengal	355	2,020
30	Andaman & Nicobar Islands	6	21
31	Chandigarh	0	1
32	Dadra & Nagar Haveli and Daman & Diu	0	16
33	Jammu & Kashmir	327	3,829
34	Ladakh	3	32
35	Lakshadweep	0	0
36	Puducherry	0	0
	Total	**26,390**	**2,03,544**

1.4.2.2 Large Forest Fire Detections

The data on large forest fire detections have also been used in the study to delineate and validate the burnt scars. The large forest fire detections program detects the candidate large fire (three or more contiguous hotspot pixels) using SNPP-VIIRS sensor and regularly monitors the large fire

events in each satellite passes unless the fire is completely doused. Map showing large forest fire events during November 2023 to June 2024 is shown in Figure 1.3.

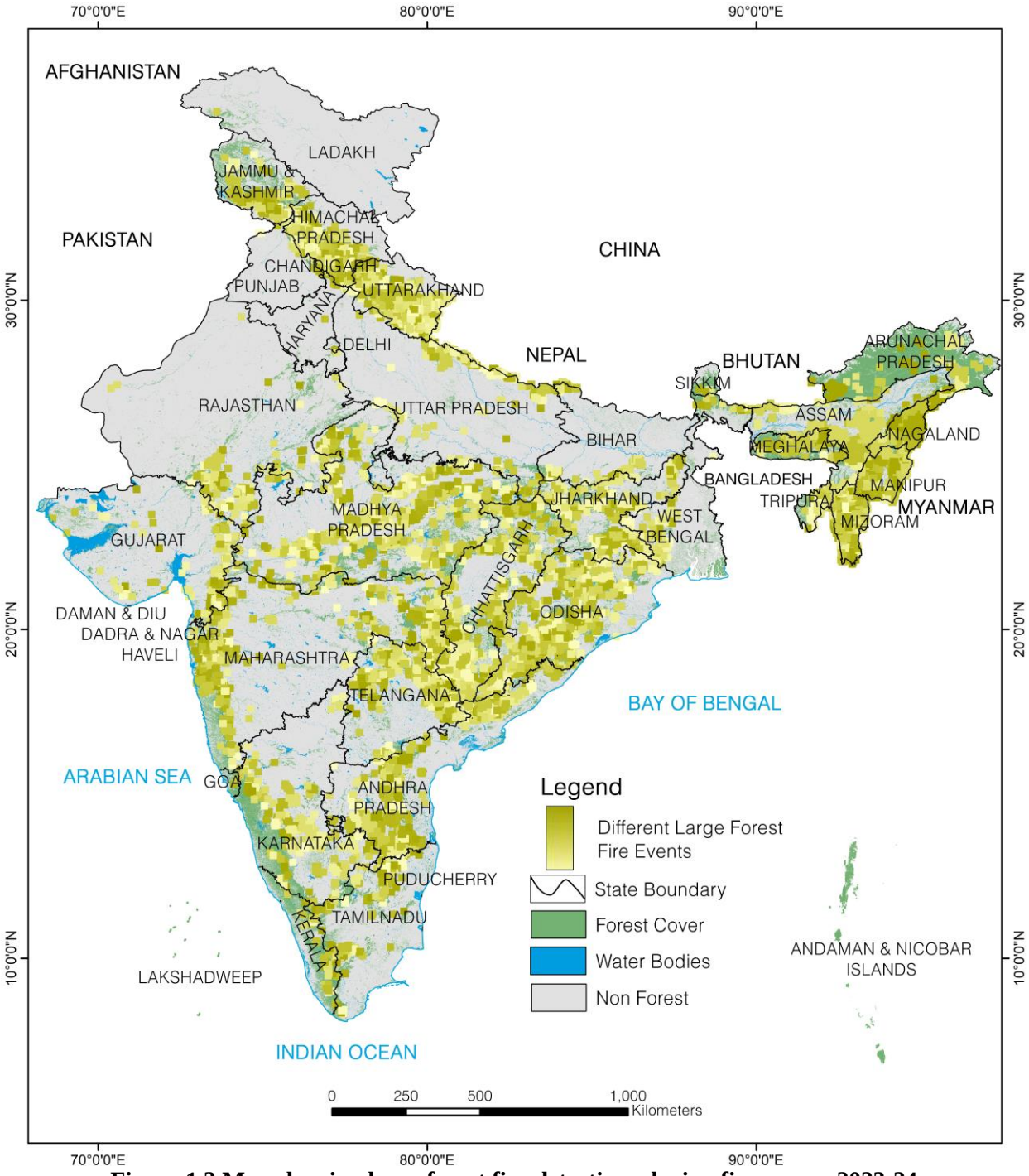


Figure 1.3 Map showing large forest fire detections during fire season 2023-24

1.4.2.3 Recorded Forest Area/ Green Wash Area

The delineated burnt scar along with their severity classes are further masked out using the Recorded Forest Area boundary provided by the respective State Forest Department. Those

State/UTs whose RFA boundary is not available, Green Wash boundary has been used which is delineated from Survey of India toposheet. The details of the RFA/Green Wash boundary used for generation of area figures is shown in the Table 1.3

Table 1.3 State/UT-wise RFA/GW used in the analysis

Area in km^2

S.No.	State/UT	RFA/GW	RFA Area	Area (Digital Boundary)
1	Andhra Pradesh	RFA	37,258	37,095.46
2	Arunachal Pradesh	GW	51,540	63,752.00
3	Assam	GW	26,836	27,545.50
4	Bihar	RFA	7,442	6,378.06
5	Chhattisgarh	RFA	59,816	53,034.54
6	Delhi	RFA	104	96.97
7	Goa	RFA	1,271	1,326.48
8	Gujarat	RFA	21,870	30,354.00
9	Haryana	RFA	1,559	1,628.34
10	Himachal Pradesh	GW	37,948	14,024.98
11	Jharkhand	RFA	25,118	19,096.52
12	Karnataka	RFA	38,284	31,036.84
13	Kerala	RFA	11,522	11,554.99
14	Madhya Pradesh	RFA	94,689	92,769.42
15	Maharashtra	RFA	61,952	57,724.83
16	Manipur	GW	17,418	17,476.61
17	Meghalaya	GW	9,508	17,490.61
18	Mizoram	GW	7,479	20,570.21
19	Nagaland	GW	8,632	10,610.99
20	Odisha	RFA	61,204	42,430.62
21	Punjab	GW	3,084	924.03
22	Rajasthan	RFA	32,869	35,963.43
23	Sikkim	RFA	5,841	5,414.38
24	Tamil Nadu	RFA	23,188	21,585.02
25	Telangana	RFA	27,688	26,881.38
26	Tripura	RFA	6,295	5,955.00
27	Uttar Pradesh	GW	17,435	13,407.59
28	Uttarakhand	RFA	38,000	25,494.47
29	West Bengal	RFA	11,885	11,787.40
30	Andaman & Nicobar Islands	RFA	7,171	6,747.11
31	Chandigarh	RFA	35	11.32
32	Dadra & Nagar Haveli & Daman & Diu	RFA	217	196.95
33	Jammu & Kashmir	RFA	20,199	27,702.46
34	Ladakh	GW	7	3,184.79
35	Lakshadweep	-	-	0
36	Puducherry	RFA	13	9.51
	TOTAL		**7,75,377.00**	**7,41,262.81**

1.4.2.4 Ground Truthing

Ground truthing is one of the important component for validation of the resultant product based on remote sensing based digital image processing. It helps the analyst to relate the processed information and identified classes to the ground reality. After the burnt scars are delineated, the delineated burnt scars polygons having low confidence are selected for further validation on the basis of developed criteria that involves resolving mixing of signature of burnt scars and shadows, signatures of different severity classes, dark feature identification and its separation.

During fire season 2023-24, extensive ground truthing has been carried out by the across the country along with the officials from respective State Forest Departments. A total of 674 burnt patches have been visited by the team across the country. Figure 1.4 shows the locations of the ground truth points. Of the 674 ground truth visited on the ground, 668 points were found to be interpreted correctly.

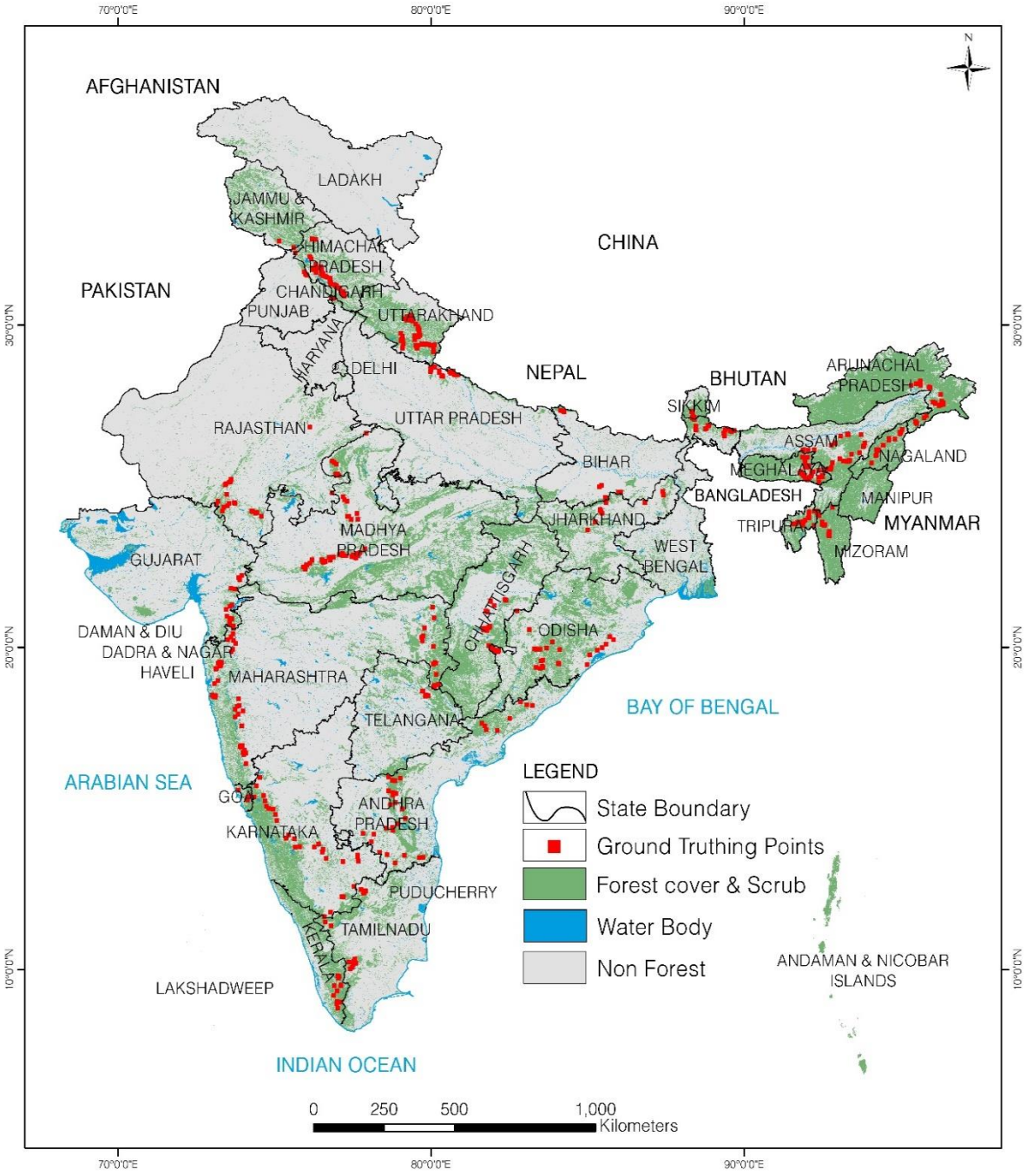


Figure 1.4 Locations of the ground truth points visited in the country

1.5 Methodology

One of the precise methods of assessing change is Image Differencing[10] and Data Normalization which leads to higher accuracy[11]. Usually, Normalized Difference Vegetation Index (NDVI) is one of the most used technique in delineating burnt scars[12]. However, outcomes of NDVI is inaccurate where fires occur after vegetation has died[13] as well as in areas that have little vegetation before the disturbance[14]. Fire severity altogether integrates the physical, chemical, and biological changes on a site as a result of fire disturbance. Fire reduces absorption of visible wavelengths by leaf-chlorophylls, and the SWIR wavelengths by plant moisture. Several studies have concluded that using short-wave infrared bands to analyze burn severity provides highest accuracy[15]. Of the studied approaches on burnt area assessment, It has been found that the difference normalized burnt ratio method provide accurate results for regions receiving forest fires between moderate to severe fires. In case of low severity fires, there could be a chance of signatures of unburnt area getting mixed with those of burnt. For such regions careful selection of dNBR ranges is a requirement and has been adopted in the present methodology.

In this study, identification of burnt areas and their severity has been carried out using difference Normalized Burn Ratio (dNBR) using pre-fire and post-fire images of Sentinel-2 satellite data. To differentiate between burnt and unburnt areas, dNBR have been examined and found to have the highest distinguishable index values using Sentinel-2 satellite data. The flowchart of the methodology developed for the study is shown in Figure 1.5. Following's indices have been calculated to delineate burnt scar.

Index Formula:

$$NBR = (NIR - SWIR) / (NIR + SWIR)$$

$$dNBR = (NBR_{Pre\text{-}fire}) - (NBR_{Post\text{-}fire})$$

[10] Kushla, J.D., Ripple, W.J., 1998. Assessing wildfire affects with Landsat thematic mapper data. *International Journal of Remote Sensing*. 19,2493-2507.
[11] Bertolette, D., Spotskey, D., 2001. Remotely sensed burn severity mapping. In 'Crossing boundaries in park management: Proceedings of 11th conference on research and resource management in parks and on public lands". 45-51.
[12] Salvador, R., Valeriano, J., Pons, X., Diaz-Delgado, R., 2002. A semi-autpmatic methodology to detect fire scars in shrubs and evergreen forests with Landsat MSS time series. *International Journal of Remote Sensing.* 21, 655-671.
[13] Eva, H., Lambin, E.F., 1998. Burnt area mapping in Central Africa using ATSR data. *International Journal of Remote Sensing.* 19, 3473-3497.
[14] Rogan, J., Yool, S.R., 2001 Mapping fire-induced vegetation depletion in the Peloncillo Mountains: Arizona and New Mexico. *International Journal of Remote Sensing.* 22, 3101-3121.
[15] Citation is same as 10.

where,

NBR	=	Normalized Burnt Ratio
dNBR	=	Difference Normalized Burnt Ratio
NIR	=	Near Infra-Red band
SWIR	=	Short-Wave Infra-Red band

- **Normalized Burnt Ratio (NBR):** This index highlights burnt areas by using NIR and SWIR bands. The NBR values ranges from -1 to 1. A high NBR value indicates healthy vegetation while a low value indicates burnt areas. Non-burnt areas are normally attributed to values close to zero.
- **Difference Normalized Burnt Ratio (dNBR):** The difference between the pre-fire and post-fire NBR are used to calculate the dNBR, which then can be used to estimate the burn severity.

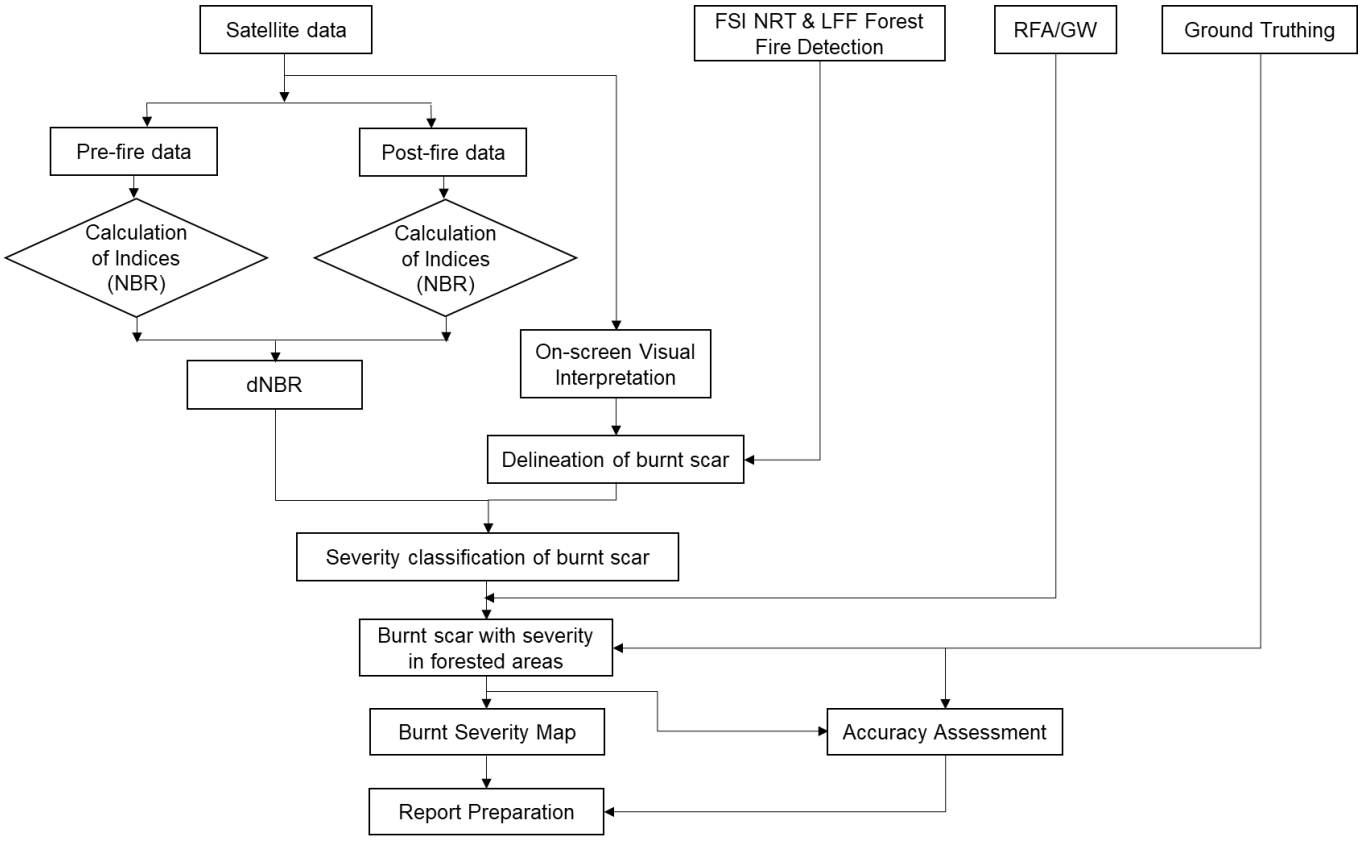


Figure 1.5 Methodology of forest fire burnt area assessment

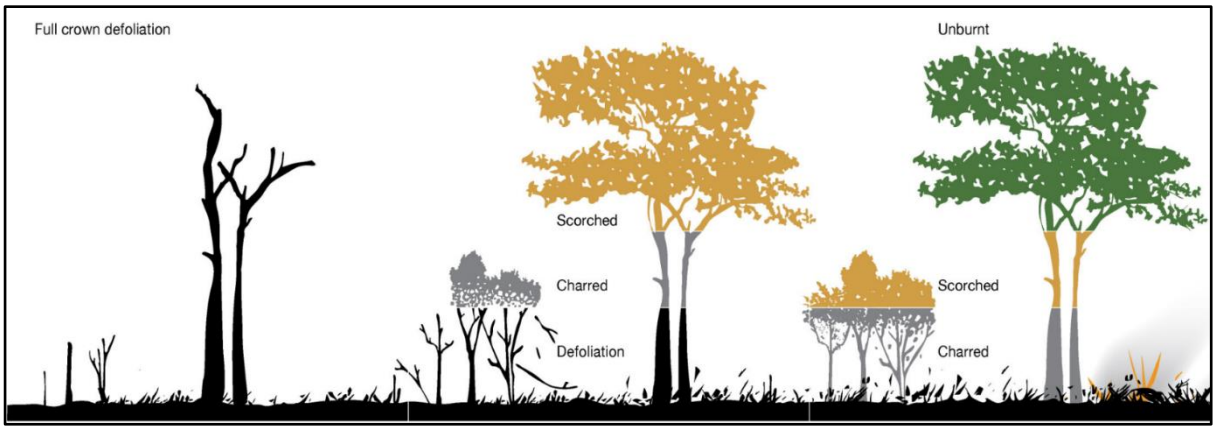
1.6 Results and analysis

In this study, the forest fire detections in the country during November 2023 to June 2024 have been used to identify forest fire affected area in the Sentinel-2 satellite images. dNBR has been used to identify burnt area and assessment of burnt severity. The burnt severity levels have been determined through an approach developed taking into reference the past study for Manipur on burnt area assessment, United States Geological Survey (USGS) classification scheme (Table 1.4) and the local field observations. In this study, three levels of burnt severity have been estimated namely - low, moderately and severely burnt. The severity has been analyzed based on the following parameters:

If the scar is clearly visible, the different grey values in the black shade, have been analysed for the range under burnt class. On ground, it is presumed that in case the surface, trunk and the leaves have been affected due to fire, the area is classified as **severely burnt**. However, in case only the surface and some part of trunk has been burnt, it is classified as **moderately burnt**. Low burnt area experiences minimal damage to trees and understory vegetation. In **low burnt** areas, only the forest floor is burnt. The low burnt class categorized in the present classification scheme represents low severity area based on the above assumption but is representing the largest forest fire affected area on ground; contrary to USGS classification scheme where crown fires leading to severe fires have the largest area affected due to fires. Pictorial view of different severity class is shown in Figure 1.6.

Table 1.4 Burnt severity classes according to USGS classification scheme

Severity Classes	dNBR Range (scaled by 10^3)
Low Burnt	+100 to +269
Moderately Burnt	+270 to +659
Severely Burnt	>660



Severely Burnt Moderately Burnt Low Burnt

Source: https://www.grida.no/resources/15589

Figure 1.6 Pictorial view of different severity classes

1.6.1 Crucial period of fire season

Month-wise number of forest fire detections during fire season 2023-2024 is shown in Figure 1.7, which depicts that the number of detections increases from November until April and then decreases until the end of the fire season. The highest number of detections has been observed in the month of April (86,689) followed by March (53,996) and May (27,678). The lowest number of detections has been observed in the month of November (1,684) followed by December (3,612) and January (6,937). The large forest fire incidences are mainly attributed to climatic factors resulting in fuel load accumulation. Different regions in the country have varied reasons causing fire incidences like Jhum Cultivation in the North-Eastern region, Mahua flower & Tendu leaves collection in the Central region, clearing of forest floor for getting new grass for fodder in the Northern Region etc.

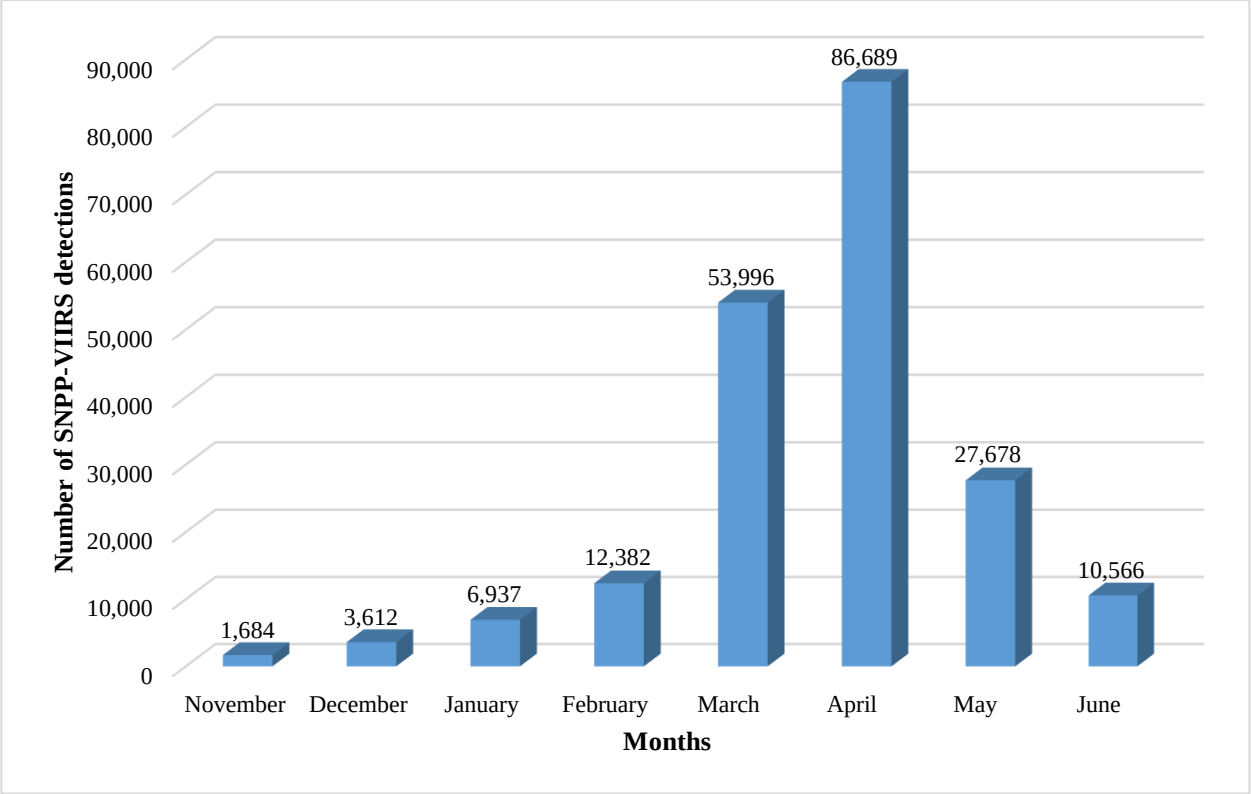


Figure 1.7 Month-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2023-24

The duration for the maximum forest fire detections over the years could provide the information for crucial period of fire occurrences. Such periods of fire occurrences has been studied for the intervals when the frequency of forest fire detections have been maximum. The estimation of the crucial time period have been carried out by averaging out the day-wise frequency of total forest fire detections of last eight years. Scatter plot of the average forest fire frequencies have been generated as shown in Figure 1.8. After the generation of the scatter plot, 1/3rd from the peak value has been calculated to get the crucial period of forest fires in the country. From the figure, it can be depicted that the crucial period of forest fire detections in the country is between 1st week of March to last week of April.

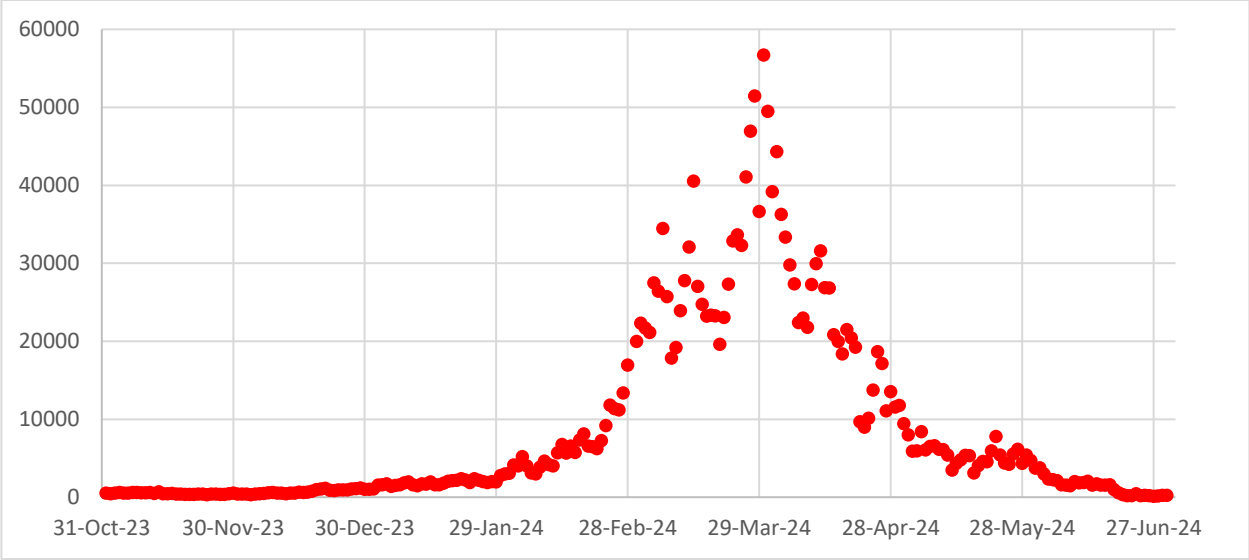


Figure 1.8 Scatter-plot of average number of forest fire detections for the last eight years

1.5.2 State/UT-wise analysis of burnt scar

State/UT-wise burnt severity findings based on the digital image analysis of the satellite data are given in Table 1.5. From the table, it can be inferred that Andhra Pradesh, Maharashtra and Telangana are the most fire affected States during fire season 2023-24. In addition, maximum area falling under severely burnt and moderately burnt severity class has been recorded in Chhattisgarh followed by Karnataka and Andhra Pradesh. A total of 34,562.33 km^2 fire affected forest area has been reported in the country. The burnt scar map of India is shown in Figure 1.9.

Table 1.5 State/UT-wise burnt area estimated during fire season 2023-24

Area in km^2

S.No.	State/UT	Severely Burnt	Moderately Burnt	Low Burnt	Total Burnt
1	Andhra Pradesh	0.00	267.63	5,019.13	**5,286.76**
2	Arunachal Pradesh	0.02	13.15	112.86	**126.03**
3	Assam	0.03	20.47	398.70	**419.20**
4	Bihar	0.00	19.62	663.12	**682.74**
5	Chhattisgarh	0.01	438.68	3,373.59	**3,812.28**
6	Delhi	0.00	0.00	0.00	**0.00**
7	Goa	0.00	0.00	0.45	**0.45**
8	Gujarat	0.00	0.25	408.36	**408.61**
9	Haryana	0.23	4.32	40.08	**44.63**
10	Himachal Pradesh	0.76	152.26	630.09	**783.11**
11	Jharkhand	0.35	38.95	1,047.16	**1,086.46**
12	Karnataka	0.00	363.61	1,724.74	**2,088.35**

S.No.	State/UT	Severely Burnt	Moderately Burnt	Low Burnt	Total Burnt
13	Kerala	0.01	69.10	139.85	**208.96**
14	Madhya Pradesh	1.13	38.14	3,132.86	**3,172.13**
15	Maharashtra	6.36	10.24	4,078.44	**4,095.04**
16	Manipur	0.24	73.08	211.88	**285.20**
17	Meghalaya	0.12	65.27	398.56	**463.95**
18	Mizoram	3.98	42.77	197.01	**243.76**
19	Nagaland	0.48	35.83	125.46	**161.77**
20	Odisha	0.01	108.49	2,355.24	**2,463.74**
21	Punjab	0.01	6.36	34.18	**40.55**
22	Rajasthan	0.01	0.53	423.93	**424.47**
23	Sikkim	0.00	0.04	2.04	**2.08**
24	Tamil Nadu	0.00	183.48	1,139.26	**1,322.74**
25	Telangana	0.00	47.39	3,935.89	**3,983.28**
26	Tripura	0.35	45.04	145.08	**190.47**
27	Uttar Pradesh	0.15	0.74	256.99	**257.88**
28	Uttarakhand	1.02	177.97	1,629.91	**1,808.90**
29	West Bengal	0.09	23.22	236.62	**259.93**
30	Andaman and Nicobar Islands	0.00	0.00	0.00	**0.00**
31	Chandigarh	0.00	0.00	0.00	**0.00**
32	Dadra & Nagar Haveli & Daman & Diu	0.00	0.00	0.00	**0.00**
33	Jammu & Kashmir	0.19	22.45	416.22	**438.86**
34	Ladakh	0.00	0.00	0.00	**0.00**
35	Lakshadweep	0.00	0.00	0.00	**0.00**
36	Puducherry	0.00	0.00	0.00	**0.00**
	TOTAL	**15.55**	**2,269.08**	**32,277.70**	**34,562.33**

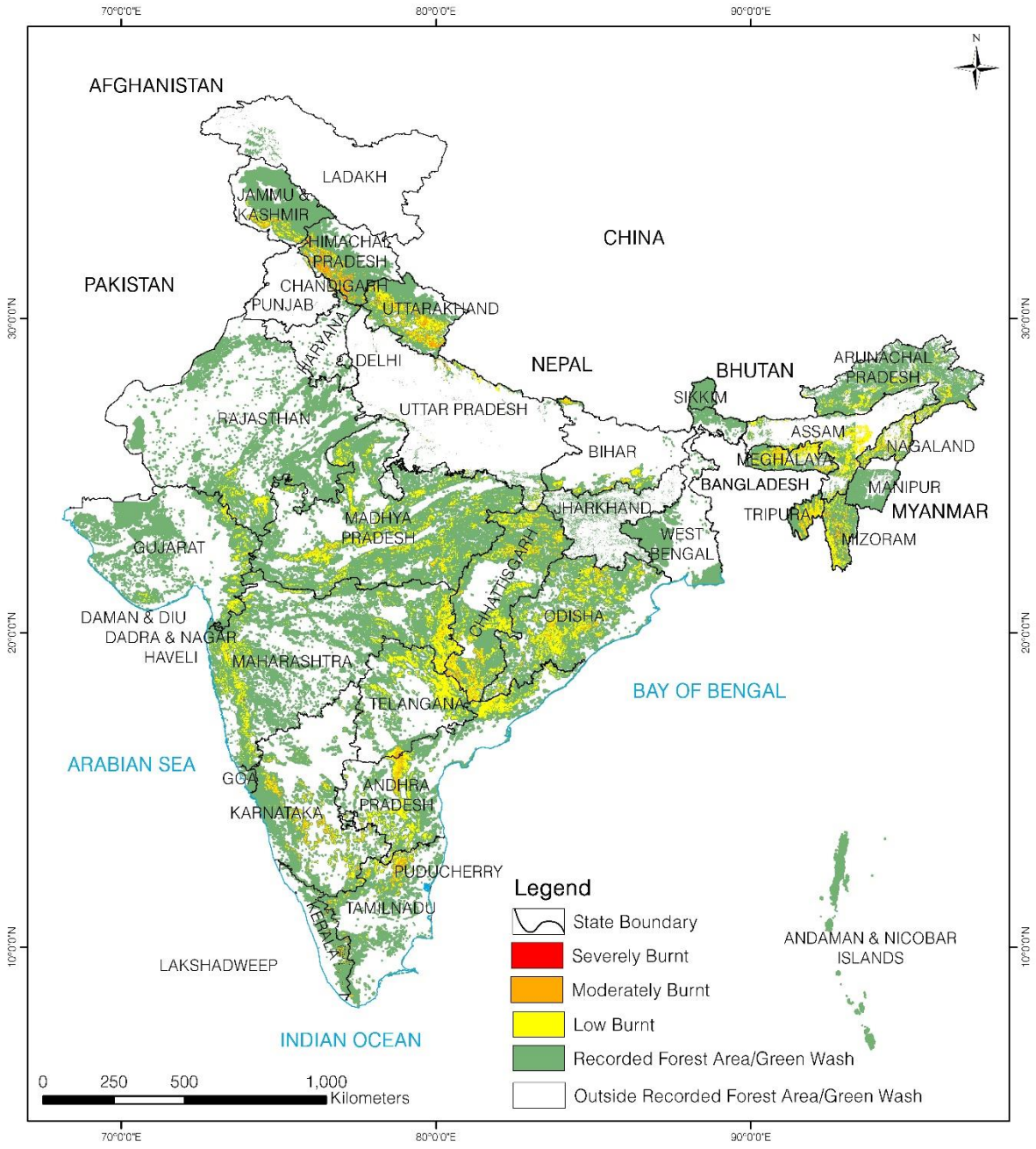


Figure 1.9 Forest fire burnt area map of India

1.6 Accuracy Assessment

Accuracy assessment is an integral component of mapping projects involving remotely sensed data. Classification accuracy is typically taken to mean the degree to which the derived image

classification agrees with reality or conforms to the 'truth'[16&17]. A total of 671 points were visited by the field teams for collection of ground truth and to assess the accuracy of the classified data at different points of time. The Overall objective of the ground truthing was to validate the burnt scars analyzed using remote sensing data with the fire affected area on the ground. In order to have a precise representation of all classes for estimation of overall, producers and users accuracy for the country level burnt scars estimates, a total of 13,365 sample points using Landsat-OLI satellite images of the nearby dates, representing different fire affected classes for burnt severity and unburnt class were used. The most common way to represent the classification accuracy of remotely sensed data is in the form of confusion or error matrix. It is cross-tabulation of the mapped class label against that observed in the ground or reference data for a sample of cases at specified locations[18]. An error matrix is a square array of numbers set out in rows/columns that express the number of sample units (pixels, clusters or polygons) assigned to a particular category in another classification[19]. Error matrix serves as a base for evaluating classification accuracy and identifying errors, which further helps in the improvement of the classification process.

Producer's accuracy and user's accuracy are ways of representing individual category accuracies instead of just the overall classification accuracy. Producer's accuracy measures how well a certain area has been classified. The user's accuracy is a measure of the reliability of the map. It provides information about how well the map represents as compared to the ground. The producer's accuracy is derived by dividing the number of correct classified units in one class by the total number of units as derived from reference data. User's accuracy is obtained by dividing the correct classified units in a class by the total number of units that were classified in that class. One class in the map can have two types of classes on the ground. The measure of overall accuracy in error matrix is calculated using

$$OA = \frac{\sum A}{\sum B}$$

Where,

[16] Campbell, J. B., 1996. Introduction to remote sensing (2nd ed.). London: Taylor and Francis

[17] Smits, P. C., Dellepiane, S. G., & Schowengerdt, R. A., 1999. Quality assessment of image classification algorithms for land-cover mapping: a review and proposal for a cost-based approach. International Journal of Remote Sensing, 20, 1461 – 1486.

[18] Canters, F., 1997. Evaluating the uncertainty of area estimates derived from fuzzy land-cover classification. Photogrammetric Engineering and Remote Sensing, 63, 403 – 414.

[19] Congalton, R. G., & Green, K., 1999. Assessing the accuracy of remotely sensed data: principles and practices. Boca Raton: Lewis Publishers.

OA = Overall accuracy in error matrix

A = Sum of no. of correctly classified site

B = Total no. of observations

A major problem for some users is that some cases may have been allocated to the correct class purely by chance[20]. To accommodate for the effects of chance agreement, Cohen's kappa coefficient has often been used adopted as a standard measure of classification accuracy[21]. The Kappa analysis is a discrete multivariate technique used in accuracy assessments for statistically determining if one error matrix is significantly different than another. Results of accuracy assessment are further authenticated by carrying out Kappa analysis providing a statistics known as K_{HAT}. This coefficient gives a measure of overall agreement of error matrix. In contrast to the overall accuracy - the ratio of the sum of diagonal values to total number of sampling points in the error matrix, the Kappa coefficient takes also non-diagonal elements into account. This statistic usually ranges between 0 and 1 and is used to indicate whether the correct values of the error matrix are due to true or chance agreement. Any classification having kappa coefficient more than 0.60 is considered as statistically sound.

$$K_{HAT} = \frac{Overall\ classification\ accuracy - expected\ classification\ accuracy}{1 - expected\ classification\ accuracy}$$

Table 1.6 Error Matrix

Severity Classes	Severely Burnt	Moderately Burnt	Low Burnt	Unburnt	Total	User Accuracy
Severely Burnt	11	3	1	0	15	**73.33**
Moderately Burnt	4	330	16	0	350	**94.29**
Low Burnt	0	49	4,889	62	5,000	**97.78**
Unburnt	0	0	12	7,988	8,000	**99.85**
Total	15	382	4,918	8,050	13,365	
Producer Accuracy	**73.33**	**86.39**	**99.41**	**99.23**		
Overall Accuracy	**98.90**					
Overall Kappa Statistics	**0.98**					

[20] Pontius, R. G., 2000. Quantification error versus location error in comparison of categorical maps. Photogrammetric Engineering and Remote Sensing, 66, 1011 – 1016

[21] Same as 17

An attempt has been made to estimate the accuracy of the classes under different burnt severity classes and unburnt areas. 15 severely burnt, 350 moderately burnt, 5000 low burnt and 8,000 unburnt random points have been used for assessment of accuracy. The error matrix of the burnt scar assessment is shown in Table 1.6. From the table it is observed that the producer's accuracy for Severely , Moderately, Low and Unburnt classes are 73.33%, 86.30%, 99.41% and 99.23% respectively. Similarly, user's accuracy for these classes are 73.33%, 94.29, 97.78% and 99.85% respectively.

The overall accuracy for the estimation has been observed to be around 98.90%. K_{HAT} calculated from the error matrix is equal to 0.98, which indicates that an observed classification is 98 percent better than one resulting from chance.

The errors in classification are largely attributed to the classification of the dark features in the image such as leaf shedding areas, shadow & marshy areas, hillshade and the areas dominated by the dark coloured soil and rocky outcrops.

From table 1.6, it could be inferred that the overall classification accuracy of 98.90% means a good agreement between the classification of burnt areas in the image and the ground and other reference datasets. The relatively low user's accuracy for severely burnt area may be attributed to fires although of low intensity resulting in leaf stress and yellowing causing poor reflectance in the satellite image.

Chapter 2

2.1 Andhra Pradesh

2.1.1 Introduction

The state lies between 12°37' N to 19°55' N latitude and 76°45' E to 84°46' E longitude. It shares border with Odisha & Chhattisgarh in the North, Telangana & Karnataka in the West and Tamil Nadu in the South. It has the second longest coastline among the other coastal states of India and is estimated to be around 974 km. The state comprises of three main physiographic regions: South Deccan, Eastern Ghats and East Coast. Geographical area of the state is 1,62,923 km^2, which is 4.95% of the geographical area of the country. Godavari and Krishna are the two major rivers of the state. The climate of the state is hot and humid with an intra-annual temperature variation from 15°C to 45°C. The rainfall in the state is influenced by both the South-West and North-East monsoons with annual rainfall ranging from 1,100 mm to 1,250 mm. The state has variety of vegetation types and is rich in flora and fauna. The vegetation is largely dry deciduous in nature with a mixture of teak and other species of the genera *Terminalia, Dalbergia, Pterocarpus, Anogeissus* etc. Red sanders (*Pterocarpus santalinus*) is endemic to Andhra Pradesh and is highly valued for its rich red colour and grain pattern. The forests in the state can broadly be divided into four major biotic provinces, which are Deccan Plateau, Central Plateau, Eastern Highland and East Coastal Plains. The Recorded Forest Area (RFA) of the state is 37,258 km^2, which is 22.87% of its geographical area.

Forest fires are quite frequent in the state during fire season and a considerable area under forest is affected due to the forest fires every year. There are many causative factors for initiation and spread of fires. In majority of the incidents, grazing, firewood collection, Addaku leaf collection, Nanare drink collection, tourist spot, honey collection are the major causes of fire incidents in the state. Ground truthing was carried out by a joint team of FSI and State Forest Department during May-June 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and valdation of layers in fire risk zonation. A total of 33 points were visited by the team.

2.1.2 Forest Cover and Forest Type Group

As per the ISFR 2023, forest cover in the state is 30,084.96 km^2, which constitutes 18.46% of the state's geographical area. In terms of forest canopy density classes, the state has 1,995.71 km^2

under Very Dense Forest (VDF), 13,725.75 km^2 under Moderately Dense Forest (MDF), 14,363.50 km^2 under Open Forest (OF) and 8,351.62 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Andhra Pradesh belong to six forest type groups, which are further categorized into 21 forest types. The major forest type groups comprise of Tropical Dry Deciduous Forests followed by Tropical Moist Deciduous Forests and Tropical Thorn Forests.

The most vulnerable forest types to fires in the state are Southern dry mixed deciduous forest followed by Southern moist mixed deciduous forest and Dry red sanders-bearing forest.

2.1.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.1.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.1.1. Table 2.1.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

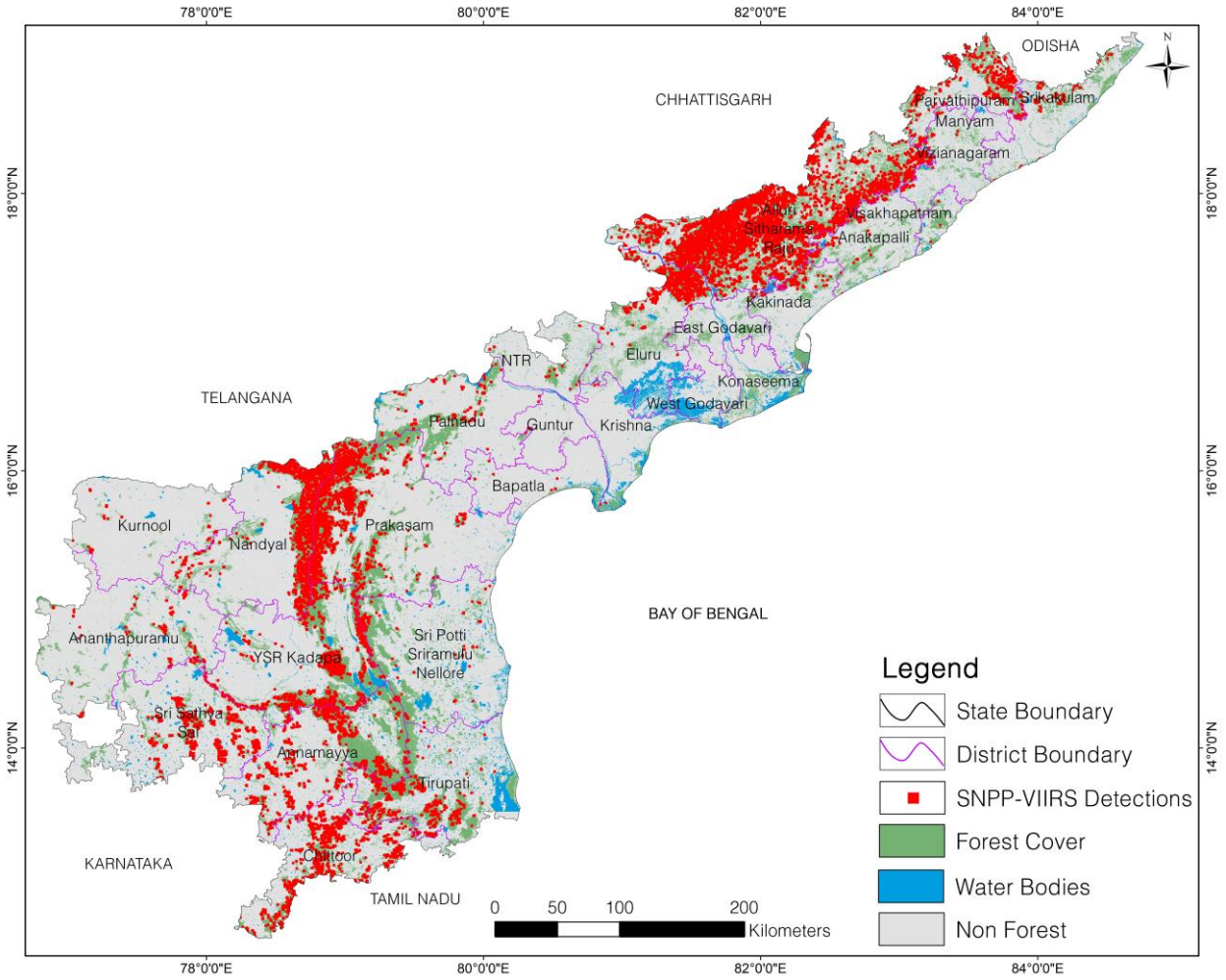


Figure 2.1.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.1.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Alluri Sitharama Raju	3,639	6,399
Anakapalli	194	126
Ananthapuramu	261	138
Annamayya	2,434	1,141
Bapatla	6	7
Chittoor	782	1,075
East Godavari	10	19
Eluru	256	834
Guntur	2	1
Kakinada	91	93
Konaseema	0	0

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Krishna	0	5
Kurnool	104	47
Nandyal	2,494	1,934
NTR	45	18
Palnadu	117	159
Parvathipuram Manyam	389	653
Prakasam	2,958	2,226
Sri Potti Sriramulu Nellore	449	211
Sri Sathya Sai	1,324	704
Srikakulam	181	102
Tirupati	570	760
Visakhapatnam	3	4
Vizianagaram	52	44
West Godavari	0	0
YSR Kadapa	3,006	1,474
Total	**19,367**	**18,174**

Based on the analysis of forest fire detections, the crucial period of forest fires in the state has been determined. The crucial period of forest fire detections in the state has been noticed to be tentatively between 16th February to 20th April, which is based on the forest fire detections of last eight years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years is shown in the Figure 2.1.2.

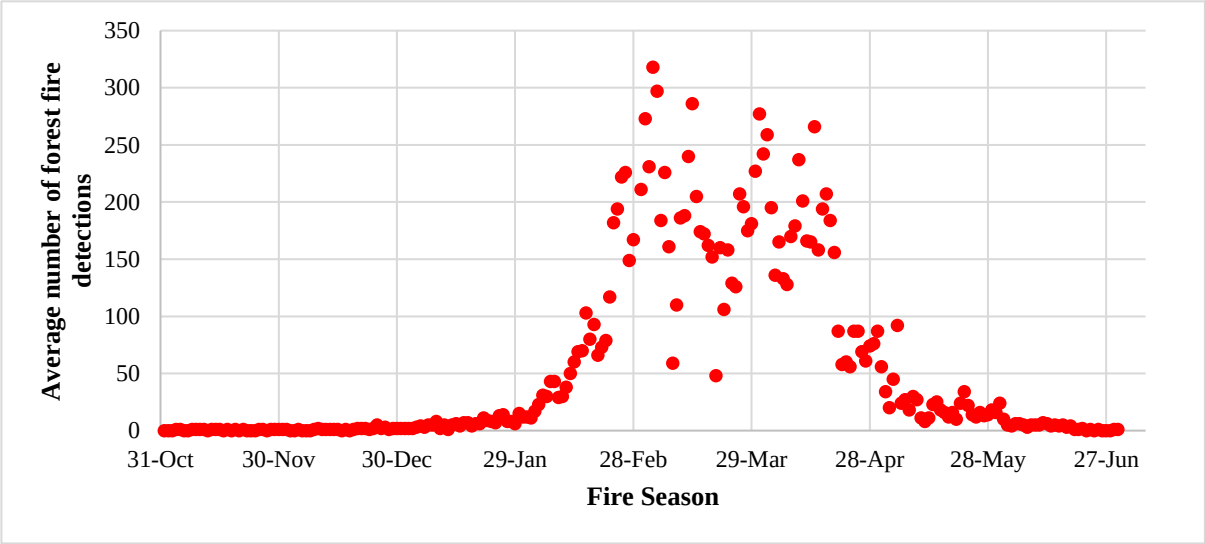


Figure 2.1.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.1.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.1.3. Table 2.1.2 shows the number of large forest fire detections during fire season 2022-23 and 2023-24.

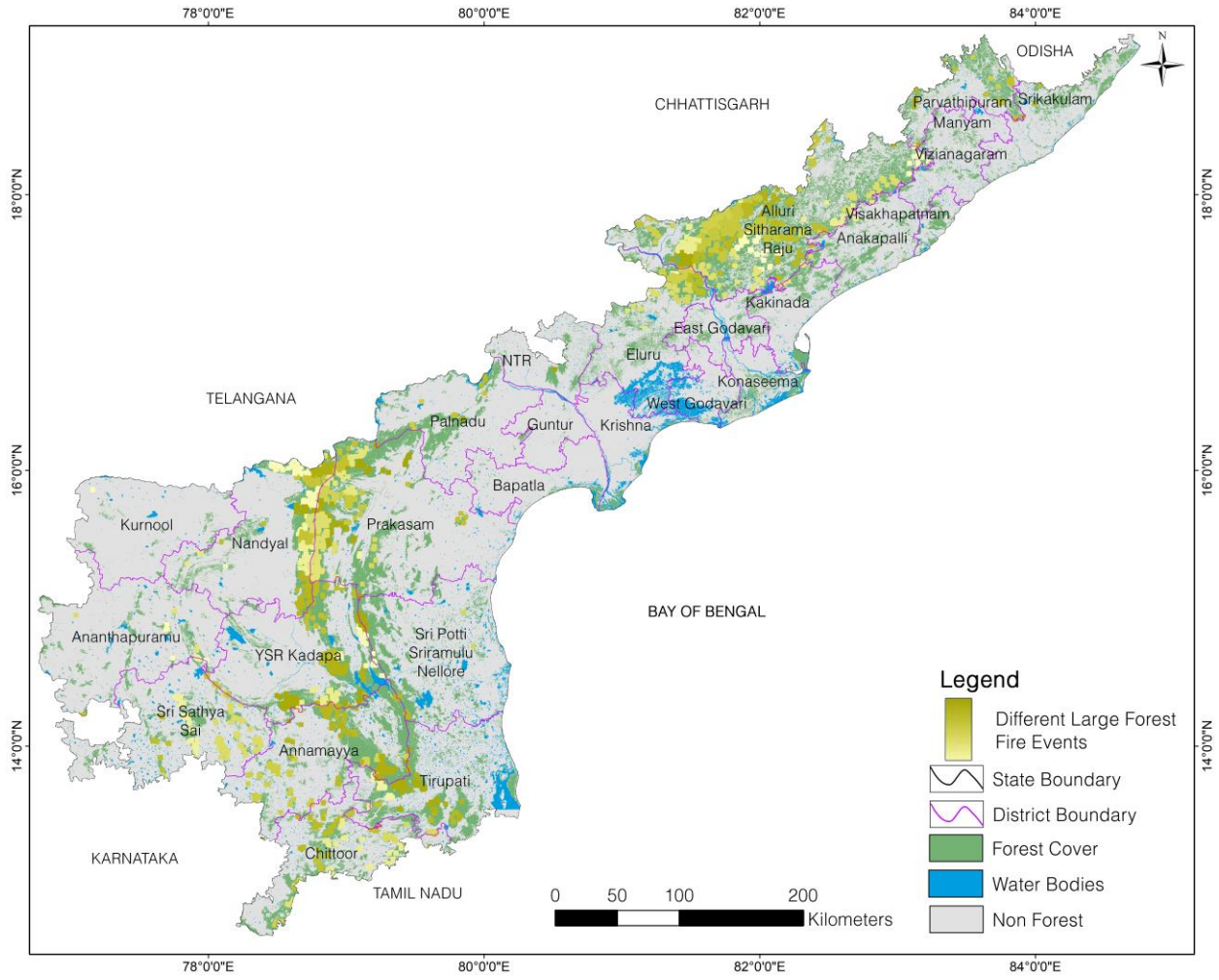


Figure 2.1.3 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.1.2 Number of large forest fire detections during fire season 2022-23 and 2023-24

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Andhra Pradesh	1,126	1,073

2.1.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.1.3. From the Figure 2.1.4, it can be inferred that 14.25% of the RFA has been affected by fires. A total of 13.53% of the RFA falls under the low burnt class and 0.72% under moderately burnt class. No area inside RFA have been classified under severely burnt class. The burnt area map of Andhra Pradesh is shown in Figure 2.1.5

Table 2.1.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
Alluri Sitharama Raju	0.00	0.60	1154.10	1154.70
Anakapalli	0.00	0.00	42.46	42.46
Ananthapuramu	0.00	0.71	29.37	30.08
Annamayya	0.00	0.00	438.18	438.18
Bapatla	0.00	0.00	0.00	0.00
Chittoor	0.00	0.00	263.11	263.11
East Godavari	0.00	0.00	0.01	0.01
Eluru	0.00	0.00	157.23	157.23
Guntur	0.00	0.00	0.00	0.00
Kakinada	0.00	0.00	13.60	13.60
Konaseema	0.00	0.00	0.00	0.00
Krishna	0.00	0.00	0.00	0.00
Kurnool	0.00	0.40	14.92	15.32
Nandyal	0.00	71.83	756.16	827.99
NTR	0.00	0.00	0.00	0.00
Palnadu	0.00	0.06	5.13	5.19
Parvathipuram Manyam	0.00	0.02	103.72	103.74
Prakasam	0.00	163.82	844.61	1008.43
Sri Potti Sriramulu Nellore	0.00	0.00	53.87	53.87
Sri Sathya Sai	0.00	4.85	286.18	291.03
Srikakulam	0.00	0.00	13.45	13.45
Tirupati	0.00	0.09	208.89	208.98
Visakhapatnam	0.00	0.00	0.00	0.00
Vizianagaram	0.00	0.00	35.68	35.68
West Godavari	0.00	0.00	0.00	0.00
YSR Kadapa	0.00	25.25	598.46	623.71
Total	**0.00**	**267.63**	**5,019.13**	**5,286.76**

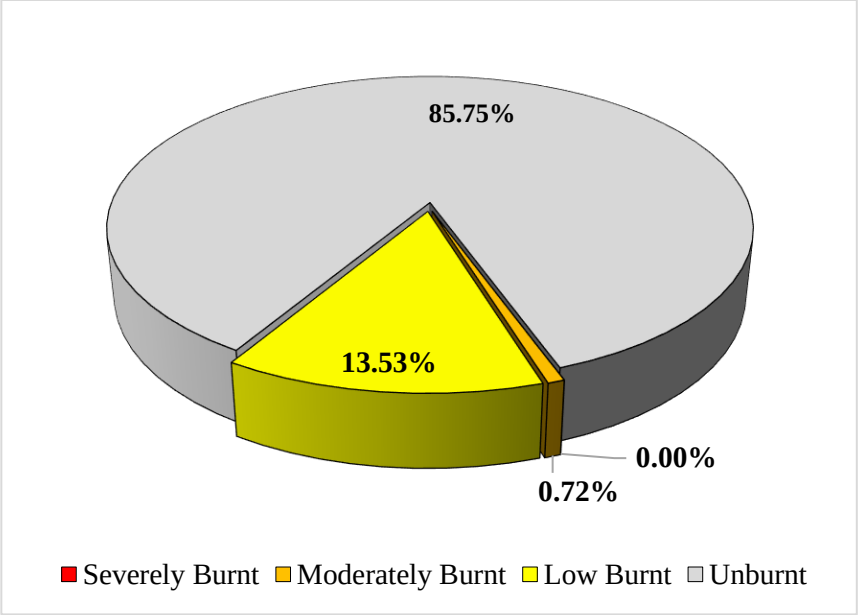


Figure 2.1.4 Distribution of burnt severity classes

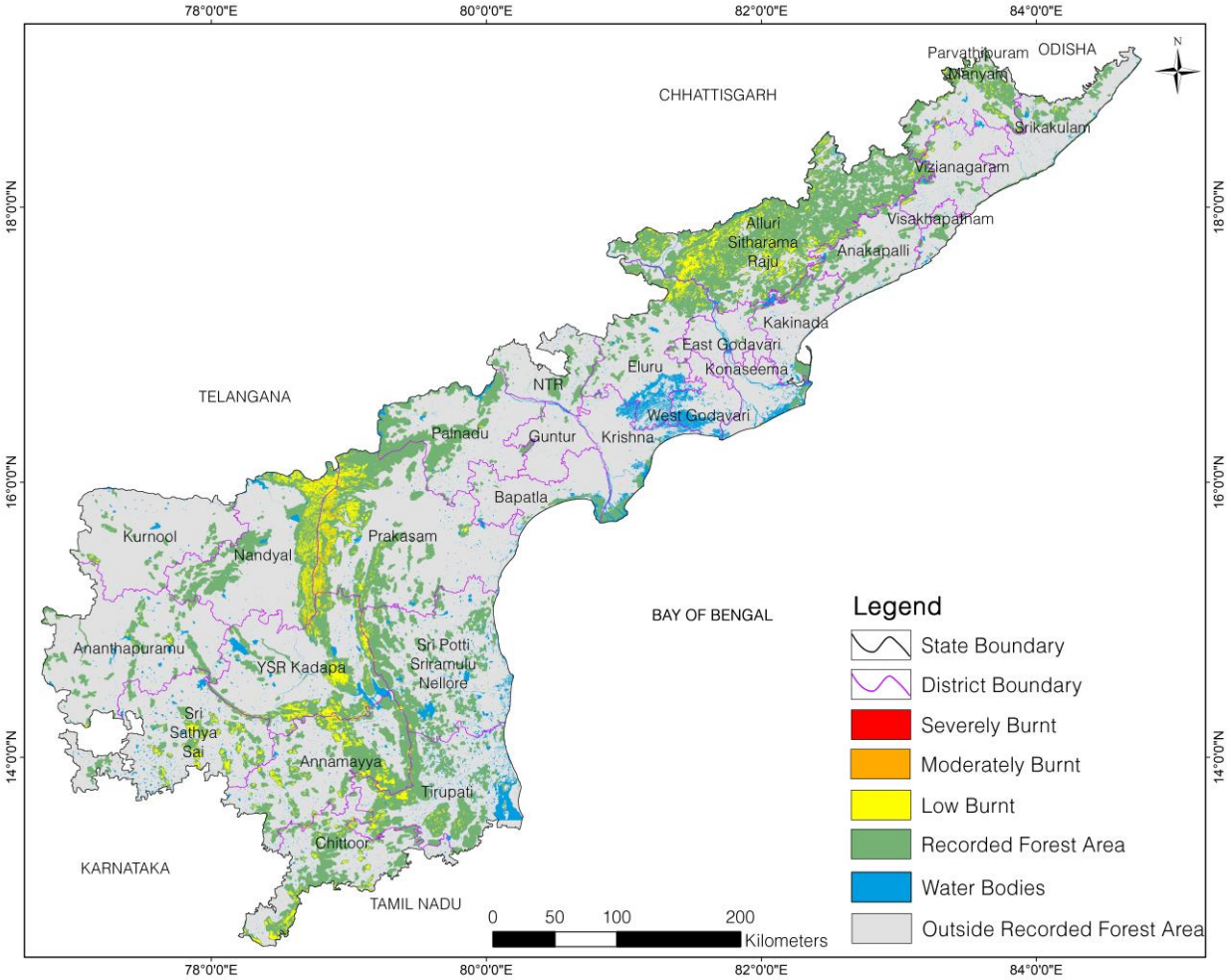


Figure 2.1.5 Map showing burnt area in Andhra Pradesh

2.1.5 Results and Analysis

Based on the analysis, it is observed that Alluri Sitharama Raju followed by Prakasam, Nandyal and YSR Kadapa are the most forest fire affected districts. The maximum affected area under moderately burnt severity class has been observed in Prakasam and Nandyal districts. Alluri Sitharama Raju district has reported the highest area under low burnt severity class. A total of 5,286.76 km^2 fire affected forest area has been reported in the state, which constitute 14.25% of the RFA.

2.2 Arunachal Pradesh

2.2.1 Introduction

The state lies between 26°28' N to 29°30' N latitude and 91°30' E to 97°30' E longitude. It shares border with Assam & Nagaland in the South and also shares international border with Bhutan in the West, China in the North & North-East and Myanmar in the East. It is situated in the North-Eastern part of the country with a geographical area of 83,743 km^2, which is 2.55% of the country's geographical area. Kameng, Subansiri, Siang, Lohit and Tirap are the major rivers of the state, which divide the state into five major valleys. The climate of the state varies with elevation and topography as it's temperate in the northern part to the warm and humid in the southern part. The average annual temperature of the state varies from below 0°C to 31°C.The rainfall in the state is mainly influenced by South-West monsoon with average annual rainfall varies from 2,000 mm to 8,000 mm. The state is one of the richest terrestrial biodiversity region in India with nearly 6,000 flowering plants, 400 species of pteridophytes, more than 50 species of bamboos, 23 species of conifers, 20 species of canes, 52 species of Rhododendron and more than 500 species of orchids. In this regard, Arunachal Pradesh is called the "Paradise of the Botanists". The Recorded Forest Area (RFA) of the state is 51,540 km^2, which is 61.55% of its geographical area.

Majority of the incidents responsible for initiation and spread of fires may be attributed to the practice of shifting cultivation commonly termed as *Jhum*. Ground truthing was carried out by a joint team of FSI and State Forest Department during May 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of 26 points were visited by the team.

2.2.2 Forest Cover and Forest Type Group

As per the ISFR 2023, forest cover in the state is 65,881.57 km^2, which constitute 78.67 % of the state's geographical area. In terms of forest canopy density classes, the state has 20,985.32 km^2 under Very Dense Forest (VDF), 29,615.09 km^2 under Moderately Dense Forest (MDF), 15,281.16 km^2 under Open Forest (OF) and 1,058.98 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Arunachal Pradesh belong to 12 forest type groups, which are further categorized into 25 forest types. The major forest type groups comprises of Subtropical Broadleaved Hill Forests followed by Montane Wet Temperate Forests and Tropical Semi-Evergreen Forests.

The most vulnerable forest types to fires in the state are Eastern alluvial secondary semi-evergreen forest followed by East Himalayan subtropical wet hill forest and Assam alluvial plains semi-evergreen forest.

2.2.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.2.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.2.1. Table 2.2.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

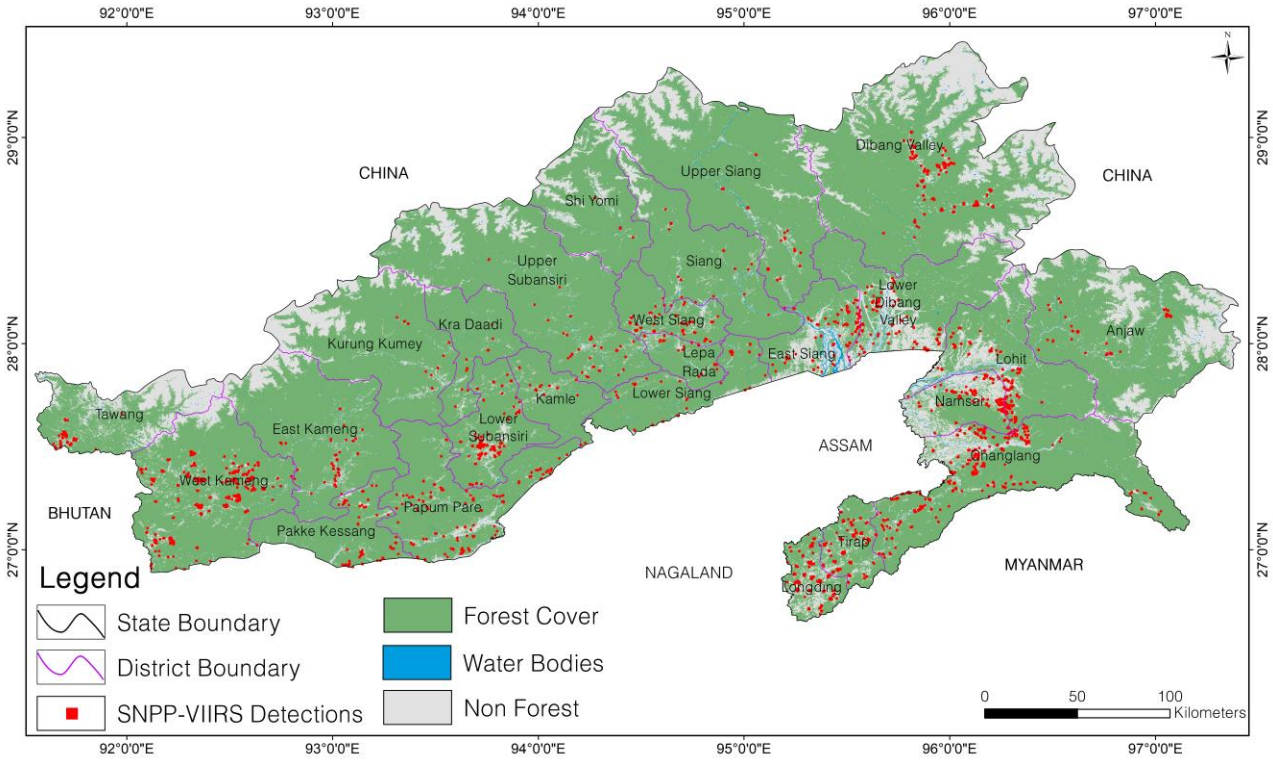


Figure 2.2.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.2.1 District-wise number of NRT detections using SNPP-VIIRS sensor during November 2023 to June 2024

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Anjaw	107	57
Changlang	426	290
Dibang Valley	79	137
East Kameng	90	42
East Siang	86	84
Kamle	13	16
Kra Daadi	17	12
Kurung Kumey	5	10
Lepa Rada	41	22
Lohit	153	130
Longding	250	132
Lower Dibang Valley	76	94
Lower Siang	29	32
Lower Subansiri	90	83
Namsai	211	120
Pakke Kessang	48	54
Papum Pare	141	116
Shi Yomi	16	6
Siang	23	19
Tawang	20	42
Tirap	88	105
Upper Siang	16	24
Upper Subansiri	27	32
West Kameng	317	337
West Siang	78	57
Total	**2,447**	**2,053**

Based on the analysis of forest fire detections, the crucial period of forest fires in the state has been determined. The crucial period of forest fire detections in the state has been noticed to be tentatively between 07th March to 26th April, which is based on the forest fire detections of last eight years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years is shown in the Figure 2.2.2.

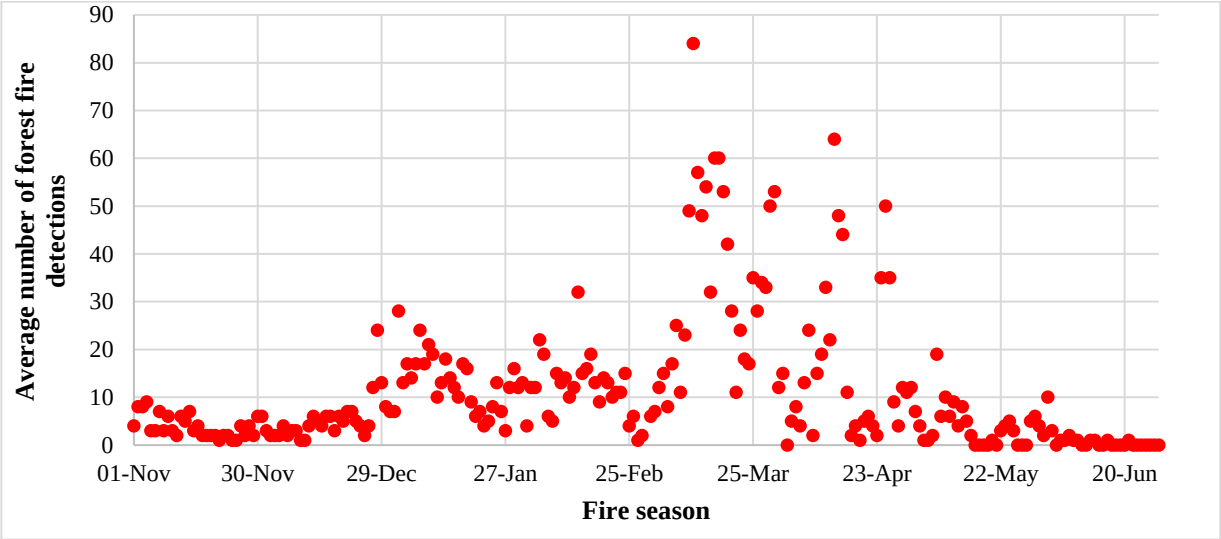


Figure 2.2.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.2.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.2.3. Table 2.2.2 shows the number of large forest fire detections during fire season 2022-23 and 2023-24.

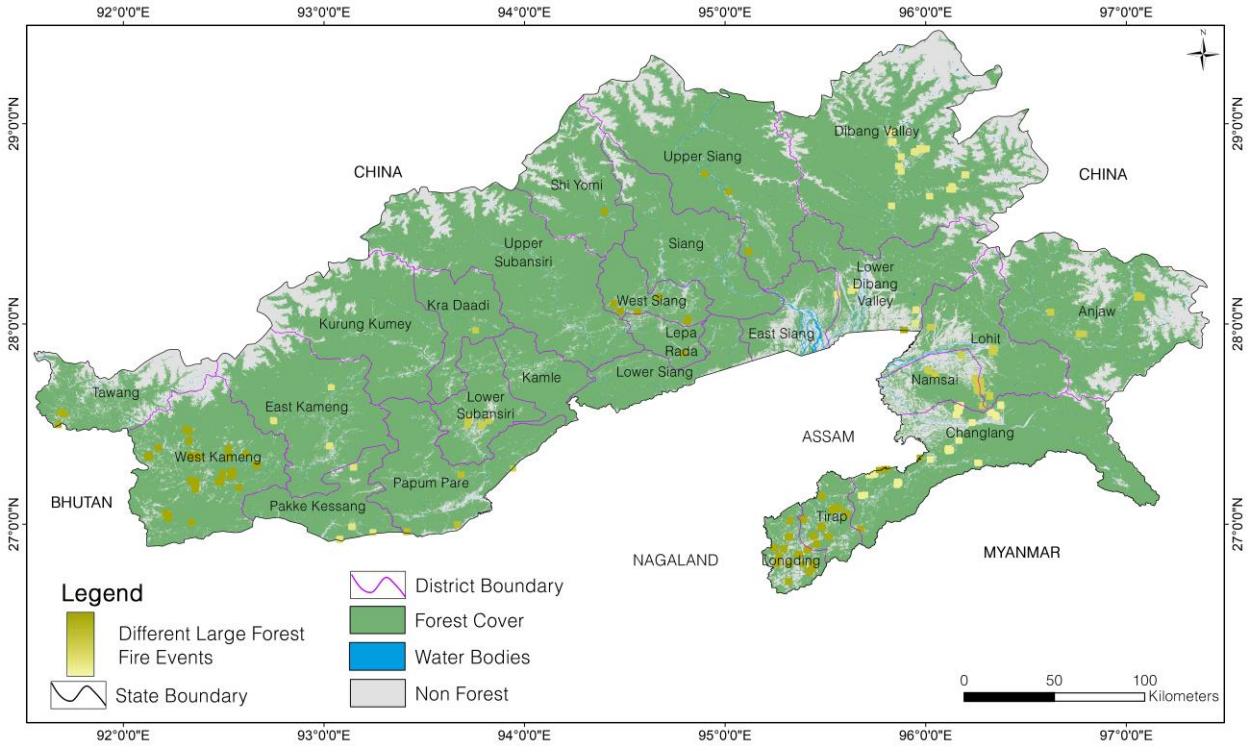


Figure 2.2.3 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.2.2 Number of large forest fire detections using SNPP-VIIRS sensor during November 2023

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Arunachal Pradesh	152	127

2.2.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.2.3. From the Figure 2.2.4, it can be inferred that 0.20% of the GW has been affected by fires. A total of 0.18% of the GW falls under the low burnt class and 0.02% under moderately burnt class. Only 0.02 km^2 of the GW have been classified under severely burnt class. The burnt area map of Arunachal Pradesh is shown in Figure 2.2.5

Table 2.2.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
Anjaw	0.00	0.00	1.79	1.79
Changlang	0.01	3.88	17.63	21.52
Dibang Valley	0.00	0.09	3.93	4.02
East Kameng	0.00	0.05	1.12	1.17
East Siang	0.00	0.13	1.67	1.80
Kamle	0.00	0.04	0.81	0.85
Kra Daadi	0.00	0.00	0.27	0.27
Kurung Kumey	0.00	0.00	0.71	0.71
Lepa Rada	0.00	0.01	3.20	3.21
Lohit	0.00	2.40	6.16	8.56
Longding	0.00	0.64	13.36	14.00
Lower Dibang Valley	0.00	0.08	2.84	2.92
Lower Siang	0.00	0.08	2.84	2.92
Lower Subansiri	0.00	0.21	4.12	4.33
Namsai	0.00	1.65	8.55	10.20
Pakke Kessang	0.00	0.20	2.41	2.61
Papum Pare	0.00	0.81	10.80	11.61
Shi Yomi	0.00	0.00	0.16	0.16
Siang	0.00	0.00	0.13	0.13
Tawang	0.00	0.56	4.16	4.72
Tirap	0.00	0.41	4.25	4.66
Upper Siang	0.00	0.02	1.49	1.51
Upper Subansiri	0.00	0.01	1.72	1.73
West Kameng	0.01	1.86	14.36	16.23
West Siang	0.00	0.02	4.38	4.40
Total	**0.02**	**13.15**	**112.86**	**126.03**

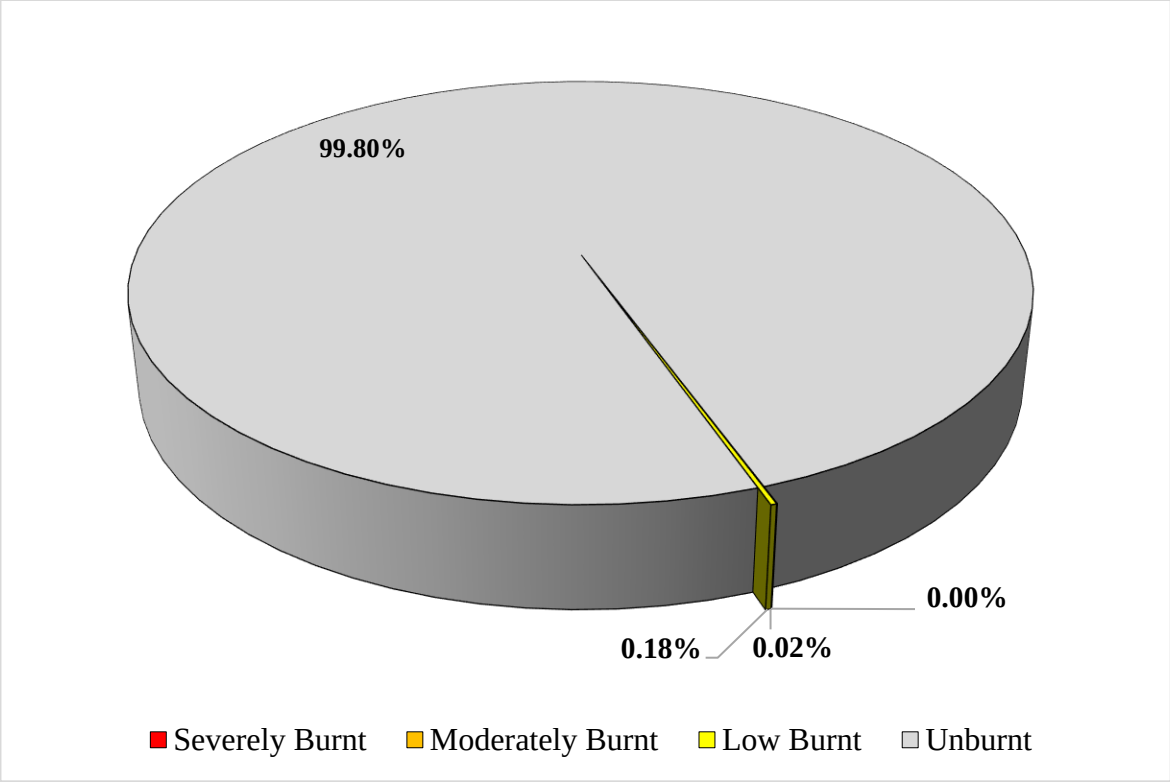


Figure 2.2.4 Distribution of burnt severity classes

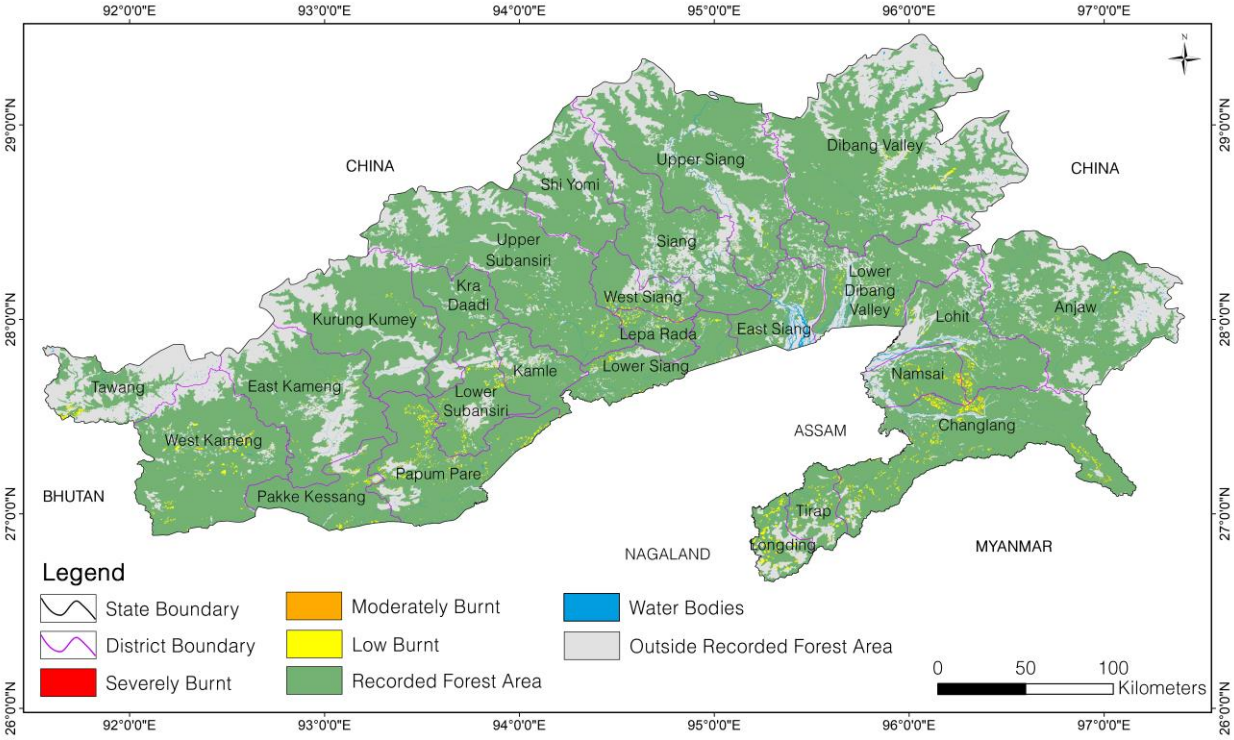


Figure 2.2.5 Map showing burnt area in Arunachal Pradesh

2.2.5 Results and Analysis

Based on the analysis, it is observed that Changlang followed by West Kameng, Longding and Papum Pare are the most fire affected districts. The maximum affected area under moderately burnt severity class has been observed in Changlang and Lohit districts. Changlang district has reported the highest area under low burnt severity class. A total of 126.03 km^2 fire affected forest area has been reported in the state, which constitute 0.20% of the GW.

2.3 Assam

2.3.1 Introduction

The state lies between 24°07' N to 28°00' N latitude and 89°42’ E to 96°02' E longitude. It shares border with Arunachal Pradesh in the North, Meghalaya, Tripura & Mizoram in the South, Nagaland & Manipur in the East and West Bengal in the West. It also shares international border with Bhutan in the North and Bangladesh in the South. The state comprises of three main physiographic regions: The Brahmaputra Valley, Central Assam Hills and Barak Valley. Geographical area of the state is 78,438 km^2, which is 2.39% of the geographical area of the country. Brahmaputra is the major river of the state. The climate of the state is sub-tropical with the average annual temperature varying from 5°C to 32°C. Whereas, the rainfall in the state is mainly influenced by South-West monsoon with average annual rainfall which ranges between 1,500 mm to 3,800 mm. The state is rich in diverse range of flora and fauna biodiversity. Assam is the land of enchanting beauty with lush green hills, pastures, tea gardens, river plains and wilderness. The Recorded Forest Area (RFA) of the state is 26,836 km^2, which is 34.21% of its geographical area.

Forest fires are quite frequent in the state during fire season and a considerable area under forest is affected due to the forest fires every year. There are many causative factors for initiation and spread of fires. In majority of the incidents, regeneration of grass and the practice of shifting cultivation commonly termed as *Jhum* cultivation are the major cause of fire incidents in the state. Ground truthing was carried out by a joint team of FSI and State Forest Department during March 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of 30 points were visited by the team.

2.3.2 Forest Cover and Forest Type Group

As per the ISFR 2023, forest cover in the state is 28,313.55 km^2, which constitute 36.10% of the state's geographical area. In terms of forest canopy density classes, the state has 3,189.71 km^2 under Very Dense Forest (VDF), 9,764.54 km^2 under Moderately Dense Forest (MDF), 15,359.30 km^2 under Open Forest (OF) and 240.93 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Assam belong to eight forest type groups, which are further categorized into 26 forest types. The major forest

type groups comprises of Tropical Semi-Evergreen Forests followed by Tropical Moist Deciduous Forests, Tropical Wet Evergreen Forest and Littoral & Swamp Forests.

The most vulnerable forest types to fires in the state are Cachar semi-evergreen forest followed by East Himalayan moist mixed deciduous forest and Secondary moist bamboo brakes.

2.3.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.3.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.3.1. Table 2.3.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

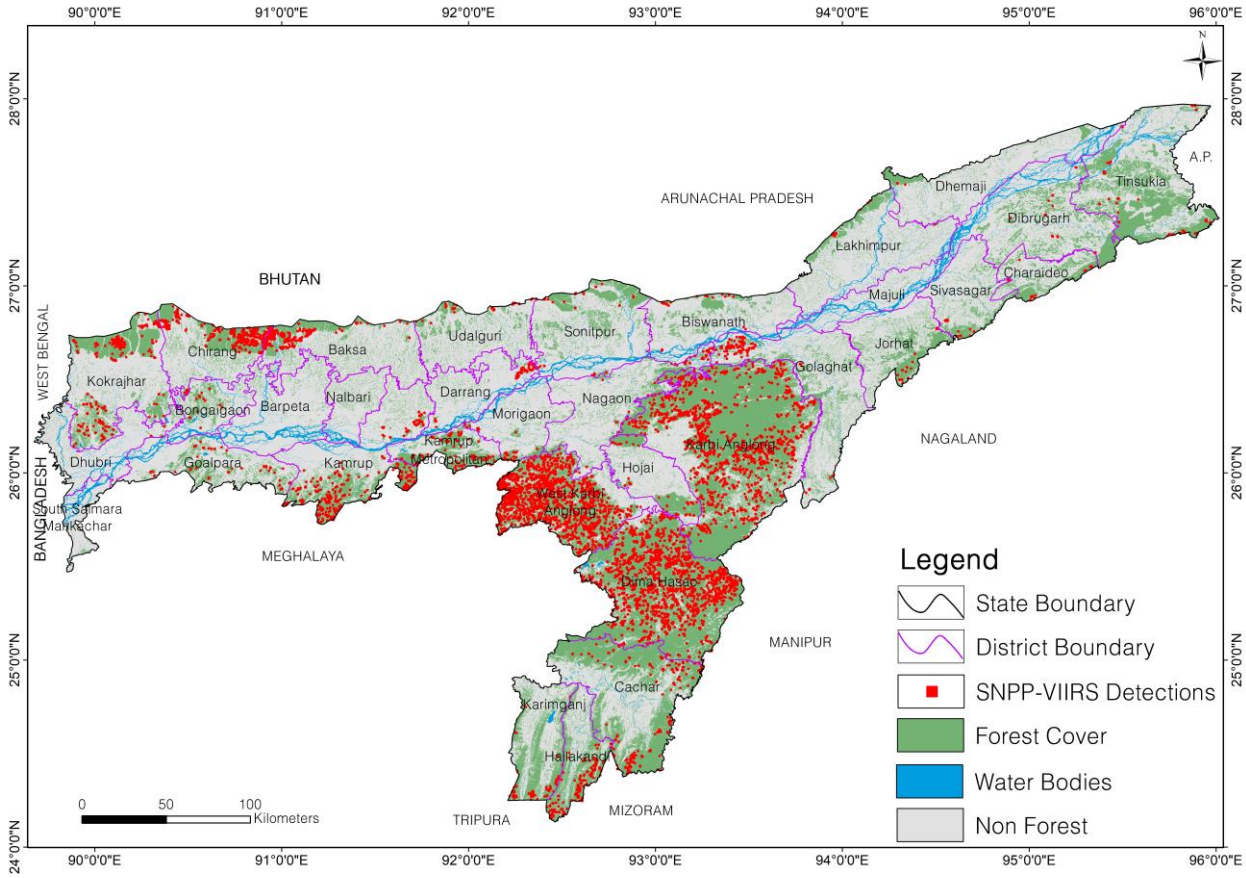


Figure 2.3.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.3.1 District-wise number of NRT detections using SNPP-VIIRS sensor during November 2023 to June 2024

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Baksa	131	252
Barpeta	0	0
Biswanath	38	32
Bongaigaon	4	15
Cachar	449	198
Charaideo	23	15
Chirang	227	376
Darrang	47	60
Dhemaji	1	2
Dhubri	4	3
Dibrugarh	48	38
Dima Hasao	2,315	1,843
Goalpara	36	43
Golaghat	144	143
Hailakandi	458	159
Hojai	38	43
Jorhat	43	53
Kamrup	381	316
Kamrup Metropolitan	126	95
Karbi Anglong	2,844	1,479
Karimganj	124	77
Kokrajhar	101	275
Lakhimpur	9	19
Majuli	0	0
Morigaon	8	36
Nagaon	33	51
Nalbari	0	0
Sivasagar	26	67
Sonitpur	41	25
South Salmara Mankachar	0	0
Tinsukia	130	125
Udalguri	31	33
West Karbi Anglong	1,970	1,766
Total	**9,830**	**7,639**

Based on the analysis of forest fire detections, the crucial period of forest fires in the state has been determined. The crucial period of forest fire detections in the state has been noticed to be tentatively between 11th March to 26th April, which is based on the forest fire detections of last eight years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years is shown in the Figure 2.3.2.

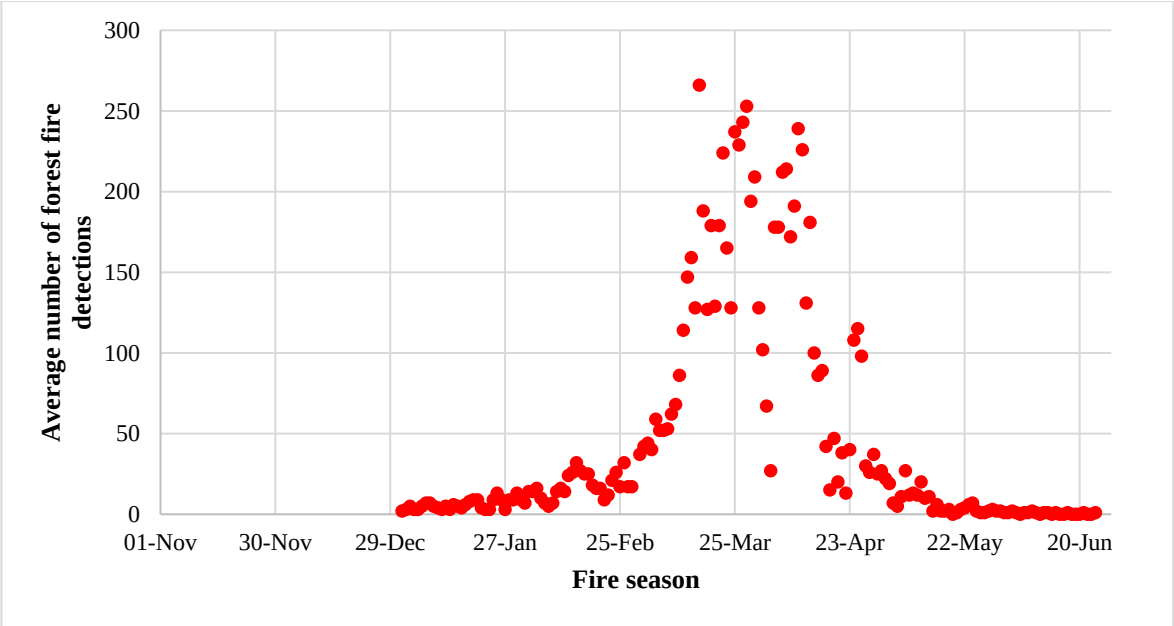


Figure 2.3.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.3.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.3.3. Table 2.3.2 shows the number of large forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

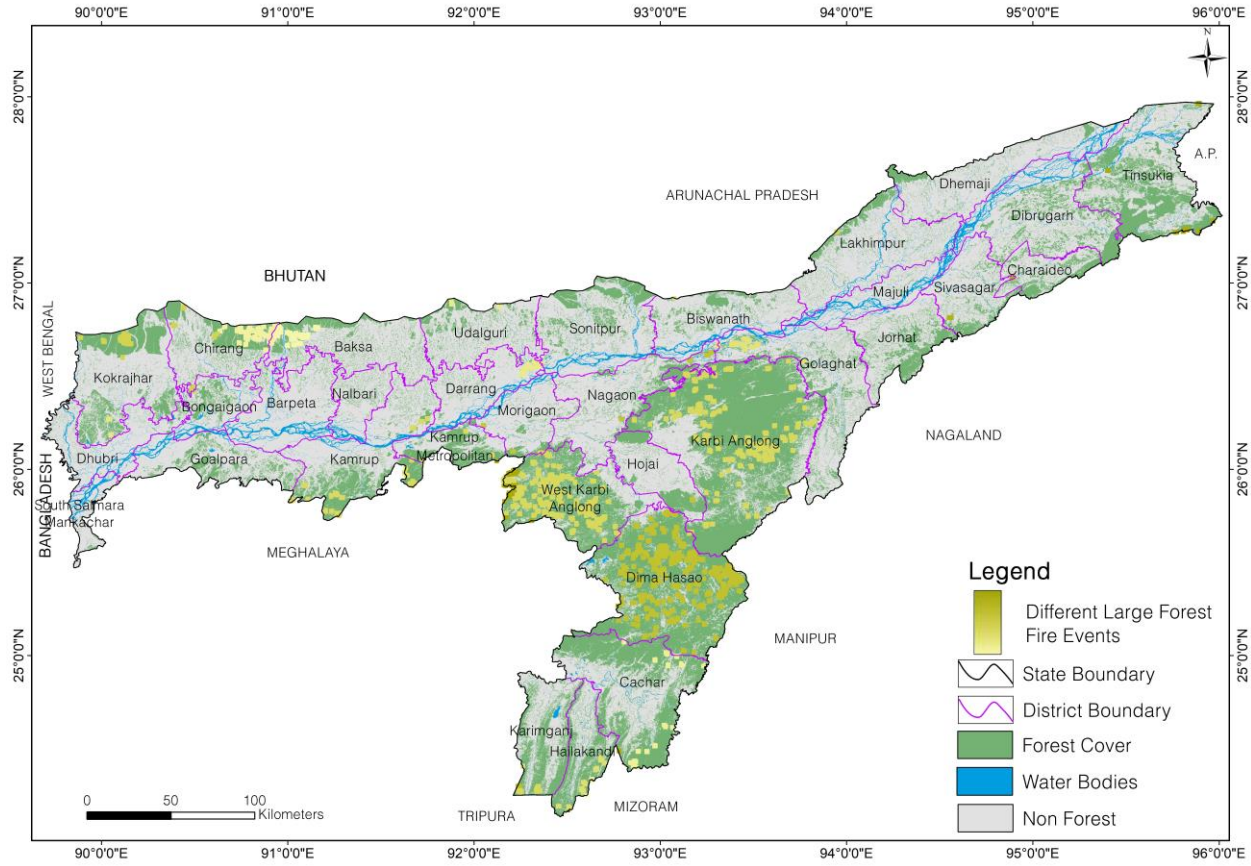


Figure 2.3.3 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.3.2 Number of large forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Assam	612	471

2.3.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.3.3. From the Figure 2.3.4, it can be inferred that 1.52% of the GW has been affected by fires. A total of 1.45% of the GW falls under the low burnt class and 0.07% under moderately burnt class. Only 0.03 km^2 of the GW have been classified under severely burnt class. The burnt area map of Assam is shown in Figure 2.3.5

Table 2.3.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
Baksa	0.00	0.01	0.90	0.91
Barpeta	0.00	0.00	0.00	0.00
Biswanath	0.00	0.14	2.57	2.71
Bongaigaon	0.00	0.00	0.35	0.35
Cachar	0.01	2.24	6.94	9.19
Charaideo	0.00	0.00	1.07	1.07
Chirang	0.00	0.02	6.42	6.44
Darrang	0.00	0.00	0.02	0.02
Dhemaji	0.00	0.00	0.11	0.11
Dhubri	0.00	0.00	0.00	0.00
Dibrugarh	0.00	0.00	0.00	0.00
Dima Hasao	0.01	8.06	77.64	85.71
Goalpara	0.00	0.01	0.26	0.27
Golaghat	0.00	0.00	0.38	0.38
Hailakandi	0.00	0.65	7.20	7.85
Hojai	0.00	0.01	5.71	5.72
Jorhat	0.00	0.04	1.09	1.13
Kamrup	0.00	0.45	20.38	20.83
Kamrup Metropolitan	0.00	0.14	6.06	6.20
Karbi Anglong	0.01	7.12	149.04	156.17
Karimganj	0.00	0.09	1.51	1.60
Kokrajhar	0.00	0.04	54.94	54.98
Lakhimpur	0.00	0.00	0.33	0.33
Majuli	0.00	0.00	0.00	0.00
Morigaon	0.00	0.01	1.90	1.91
Nagaon	0.00	0.00	0.76	0.76
Nalbari	0.00	0.00	0.00	0.00
Sivasagar	0.00	0.00	0.51	0.51
Sonitpur	0.00	0.00	0.54	0.54
South Salmara Mankachar	0.00	0.00	0.00	0.00
Tinsukia	0.00	0.00	0.26	0.26
Udalguri	0.00	0.02	0.41	0.43
West Karbi Anglong	0.00	1.42	51.40	52.82
Total	**0.03**	**20.47**	**398.70**	**419.20**

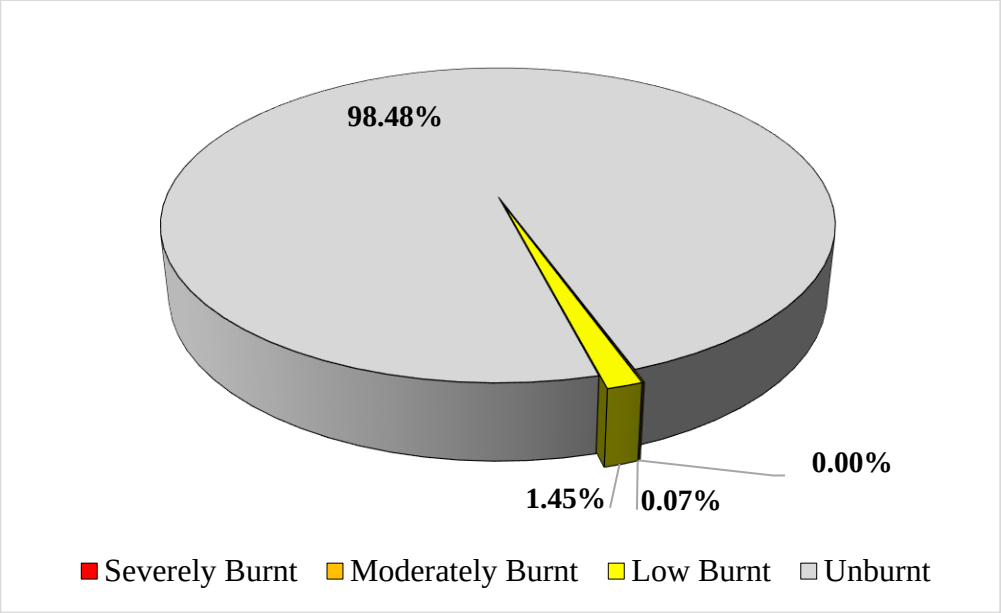


Figure 2.3.4 Distribution of burnt severity classes

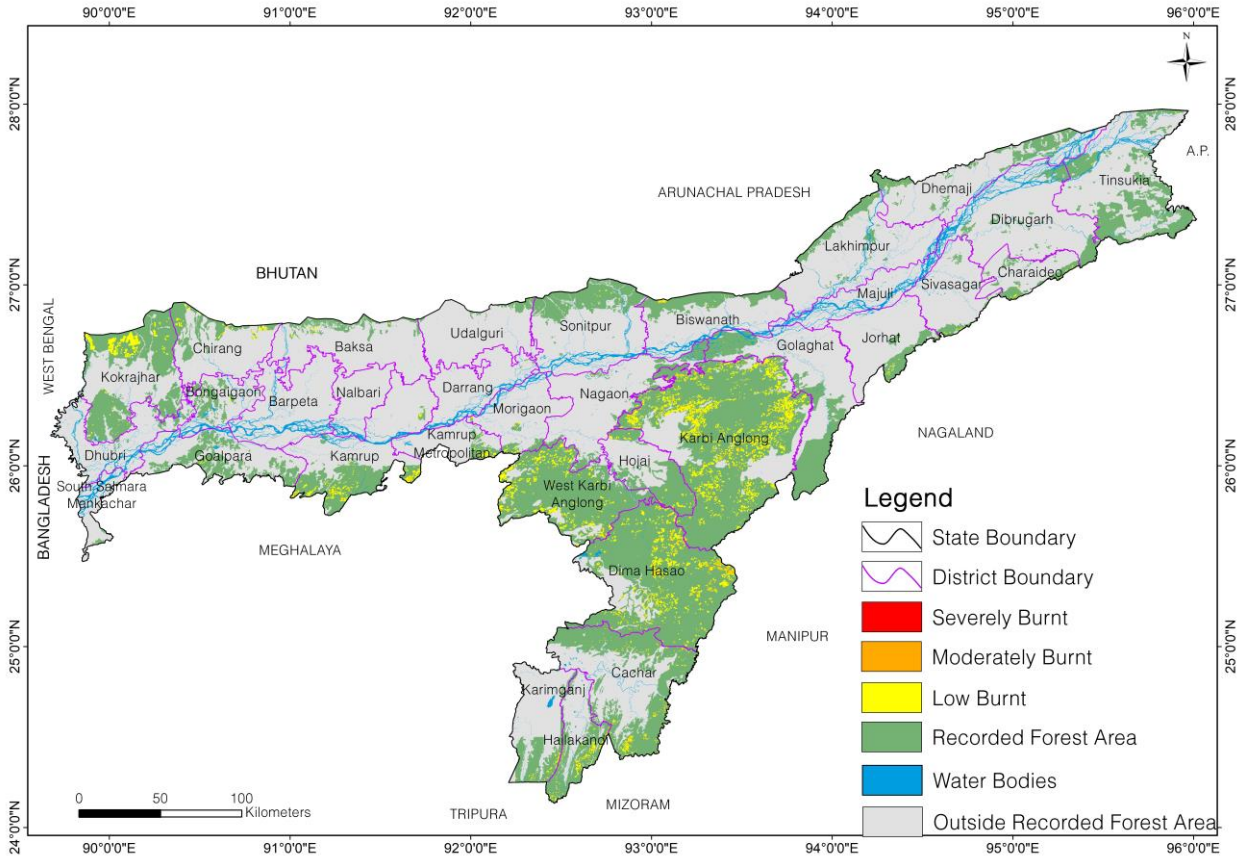


Figure 2.3.5 Map showing burnt area in Assam

2.3.5 Results and Analysis

Based on the analysis, it is observed that Karbi Anglong followed by Dima Hasao, Kokrajhar and West Karbi Anglong are the most fire affected districts. The maximum affected area under moderately burnt severity class has been observed in Dima Hasao and Karbi Anglong districts. Karbi Anglong district has reported the highest area under low burnt severity class followed by Dima Hasao and Kokrajhar. A total of 419.20 km^2 fire affected forest area has been reported in the state, which constitute 1.52% of the GW.

2.4 Bihar

2.4.1 Introduction

The state lies between 24°16' N to 27°45' N latitude and 83°16' E to 88°30' E longitude. It shares border with Uttar Pradesh in the West, Jharkhand in the South and West Bengal in the East. It also shares international borders with Nepal in the North. The state is divided into three parts: Southern Plateau, Shivalik Region and Bihar's Gangetic Plain. Geographical area of the state is 94,163 km^2, which is 2.86% of the geographical area of the country. Ganga is the major river of the state. The climate of the state is continental monsoon type with the average annual temperature of the state varies from 20°C to 28°C and average annual rainfall varies from 1,000 mm to 2,000 mm. The state is forest deficient and natural forests are found in limited areas. The Sub-Himalayan foothill of Someshwar and the Dun ranges in the Champaran district have belts of Moist Deciduous Forests, mixed with shrubs, grass and reeds. High rainfall above 1,600 mm promotes forests of Sal (*Shorea robusta*) in these areas. Other important trees are Cedrela toona, Khair, and Semal. The Recorded Forest Area (RFA) of the state is 7,442 km^2, which is 7.90% of its geographical area.

Majority of the incidents responsible for initiation and spread of fires may be attributed to human activities like the burning of agricultural residue, illegal forest clearing and carelessness by visitors. Ground truthing was carried out by a joint team of FSI and State Forest Department during June 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of 14 points were visited by the team.

2.4.2 Forest Cover and Forest Type Group

As per ISFR 2023, forest cover in the state is 7,532.45 km^2, which constitutes 8.00 % of the state's geographical area. In terms of forest canopy density classes, the state has 387.00 km^2 under Very Dense Forest (VDF), 3,284.21 km^2 under Moderately Dense Forest (MDF), 3,861.24 km^2 under Open Forest (OF) and 260.80 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Bihar belong to five forest type groups, which are further categorized into 14 forest types. The major forest type groups comprise of Tropical Dry Deciduous Forests and Tropical Moist Deciduous Forests.

The most vulnerable forest types to fires in the state are Dry peninsular sal forest followed by Northern dry mixed deciduous forest and Dry Siwalik sal forest.

2.4.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.4.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.4.1. Table 2.4.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

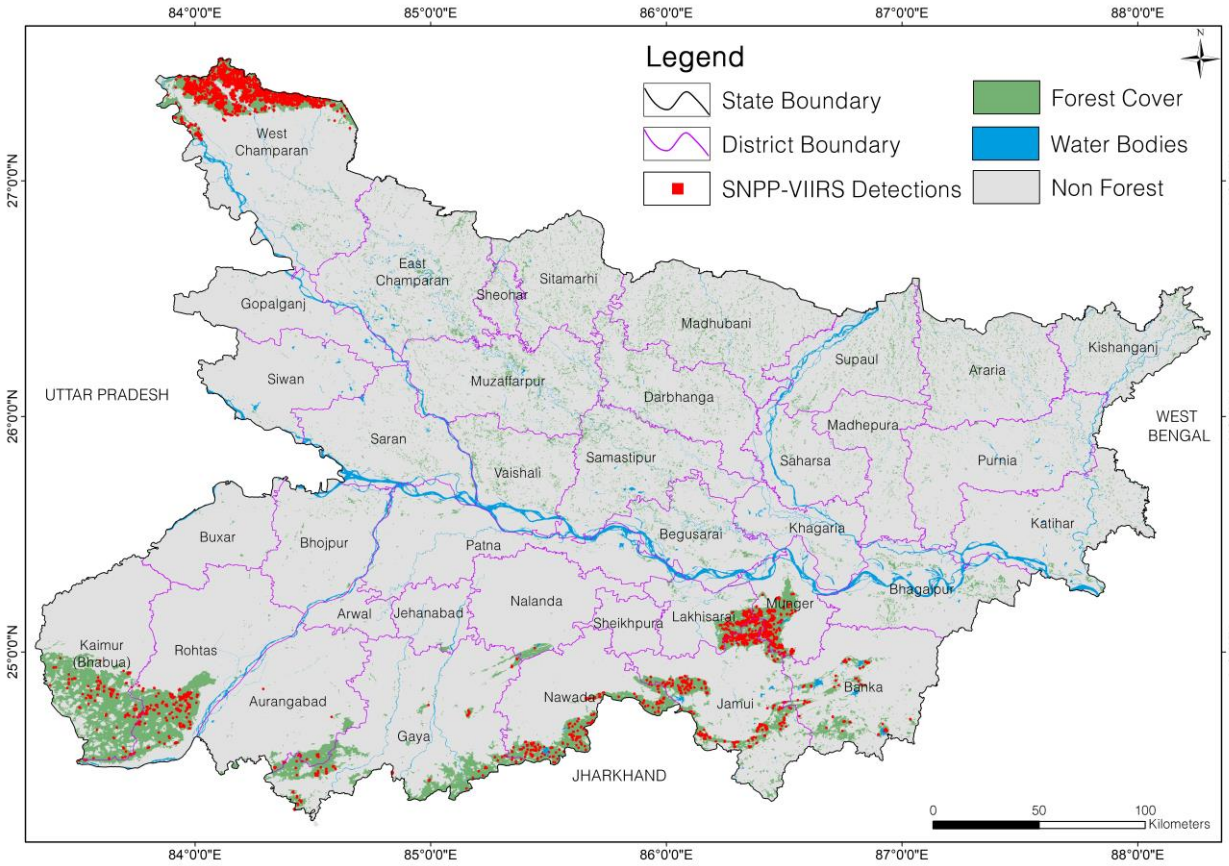


Figure 2.4.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.4.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Araria	0	0
Arwal	0	0
Aurangabad	53	89
Banka	165	50
Begusarai	0	0
Bhagalpur	0	0
Bhojpur	0	0
Buxar	2	0
Darbhanga	0	0
East Champaran	0	0
Gaya	178	69
Gopalganj	0	0
Jamui	531	354
Jehanabad	6	0
Kaimur	314	106
Katihar	0	0
Khagaria	0	0
Kishanganj	0	0
Lakhisarai	212	121
Madhepura	0	0
Madhubani	0	0
Munger	339	233
Muzaffarpur	0	0
Nalanda	19	1
Nawada	321	173
Patna	1	0
Purnia	1	0
Rohtas	155	164
Saharsa	0	0
Samastipur	0	0
Saran	0	0
Sheikhpura	0	0
Sheohar	0	0
Sitamarhi	0	0
Siwan	0	0
Supaul	0	0
Vaishali	0	0
West Champaran	1,496	1,403
Total	**3,793**	**2,763**

Based on the analysis of forest fire detections, the crucial period of forest fires in the state has been determined. The crucial period of forest fire detections in the state has been noticed to be tentatively between 22nd March to 14th April, which is based on the forest fire detections of last eight years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years is shown in the Figure 2.4.2.

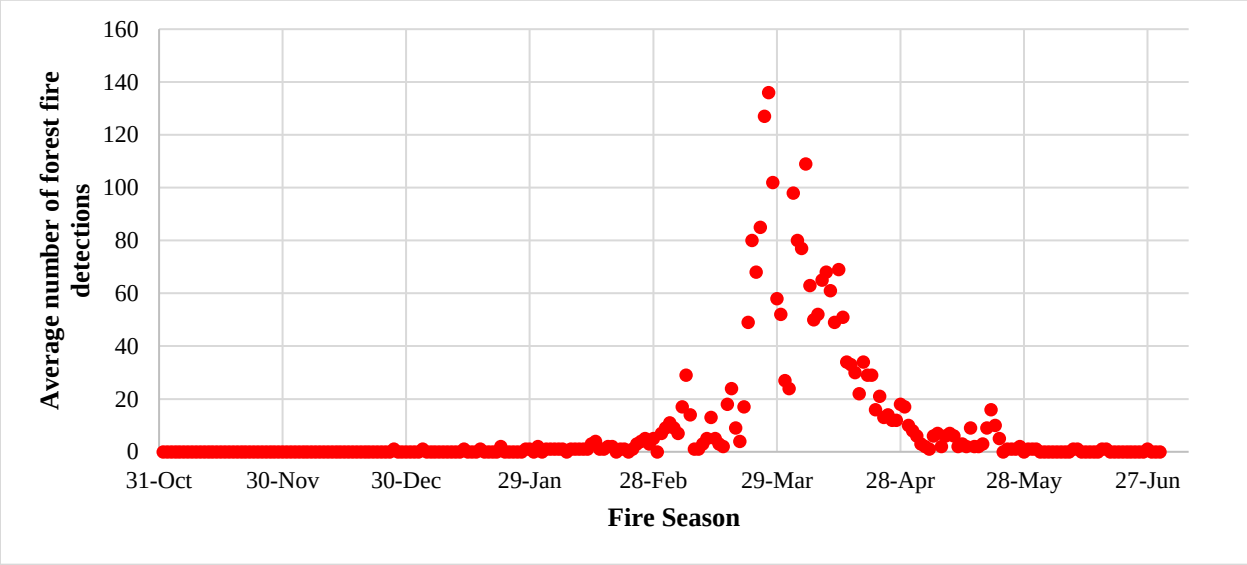


Figure 2.4.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.4.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.4.3. Table 2.4.2 shows the number of large forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

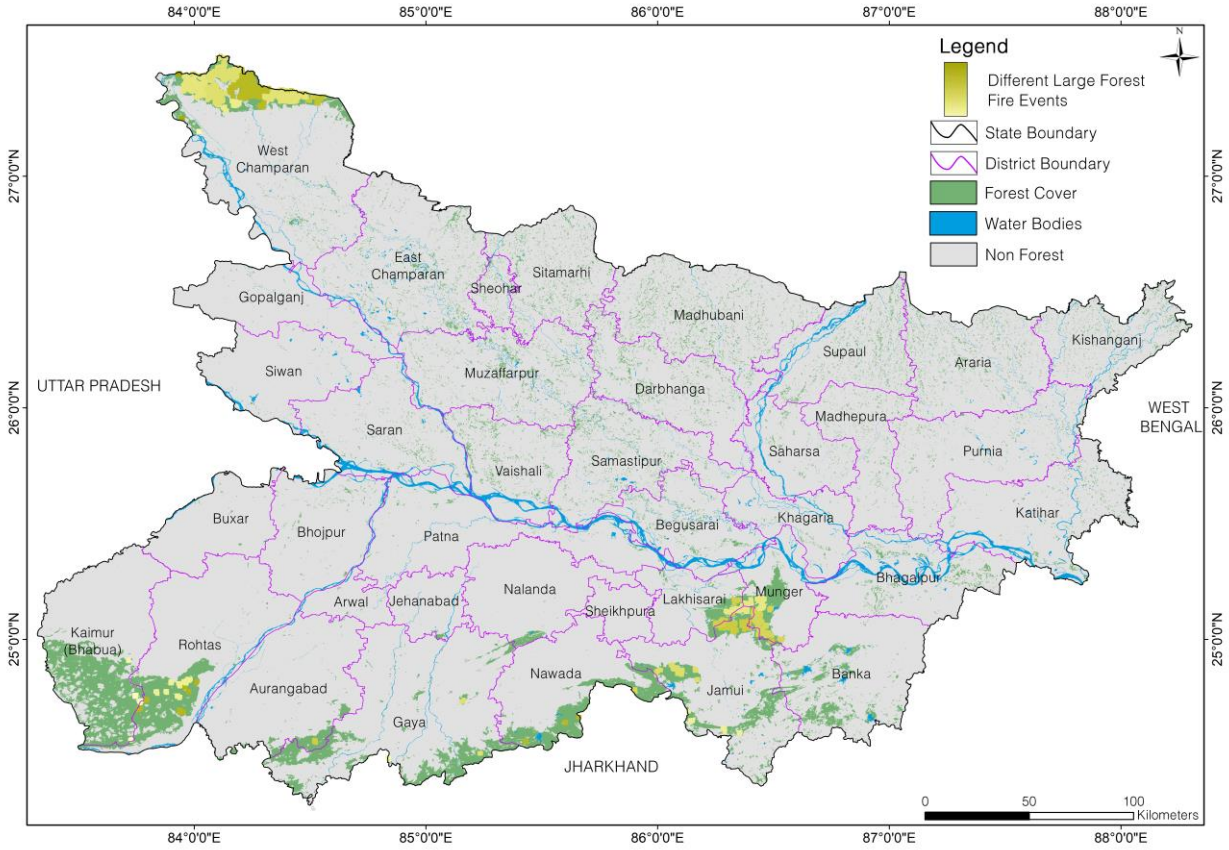


Figure 2.4.3 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.4.2 Number of large forest fire detections during fire season 2022-23 and 2023-24

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Bihar	194	124

2.4.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.4.3. From the Figure 2.4.4, it can be inferred that 10.71% of the RFA has been affected by fires. A total of 10.40% of the RFA falls under the low burnt class and 0.31% under moderately burnt class. No area inside RFA have been classified under severely burnt class. The burnt area map of Bihar is shown in Figure 2.4.5

Table 2.4.3 District-wise distribution of burnt severity classes

Area in km²

District	Affected Area			Total
	Severely	Moderately	Low	
Araria	0.00	0.00	0.00	0.00
Arwal	0.00	0.00	0.00	0.00
Aurangabad	0.00	0.15	9.81	9.96
Banka	0.00	0.09	11.55	11.64
Begusarai	0.00	0.00	0.00	0.00
Bhagalpur	0.00	0.00	0.00	0.00
Bhojpur	0.00	0.00	0.00	0.00
Buxar	0.00	0.00	0.00	0.00
Darbhanga	0.00	0.00	0.00	0.00
East Champaran	0.00	0.00	0.00	0.00
Gaya	0.00	0.40	36.87	37.27
Gopalganj	0.00	0.00	0.00	0.00
Jamui	0.00	0.60	158.22	158.82
Jehanabad	0.00	0.00	0.00	0.00
Kaimur	0.00	0.12	11.24	11.36
Katihar	0.00	0.00	0.00	0.00
Khagaria	0.00	0.00	0.00	0.00
Kishanganj	0.00	0.00	0.00	0.00
Lakhisarai	0.00	0.06	64.73	64.79
Madhepura	0.00	0.00	0.00	0.00
Madhubani	0.00	0.00	0.00	0.00
Munger	0.00	0.27	30.28	30.55
Muzaffarpur	0.00	0.00	0.00	0.00
Nalanda	0.00	0.01	8.82	8.83
Nawada	0.00	0.79	212.60	213.39
Patna	0.00	0.00	0.00	0.00
Purnia	0.00	0.00	0.00	0.00
Rohtas	0.00	0.75	52.15	52.90
Saharsa	0.00	0.00	0.00	0.00
Samastipur	0.00	0.00	0.00	0.00
Saran	0.00	0.00	0.00	0.00
Sheikhpura	0.00	0.00	0.00	0.00
Sheohar	0.00	0.00	0.00	0.00
Sitamarhi	0.00	0.00	0.00	0.00
Siwan	0.00	0.00	0.00	0.00
Supaul	0.00	0.00	0.00	0.00
Vaishali	0.00	0.00	0.00	0.00
West Champaran	0.00	16.37	66.86	83.23
Total	**0.00**	**19.62**	**663.12**	**682.74**

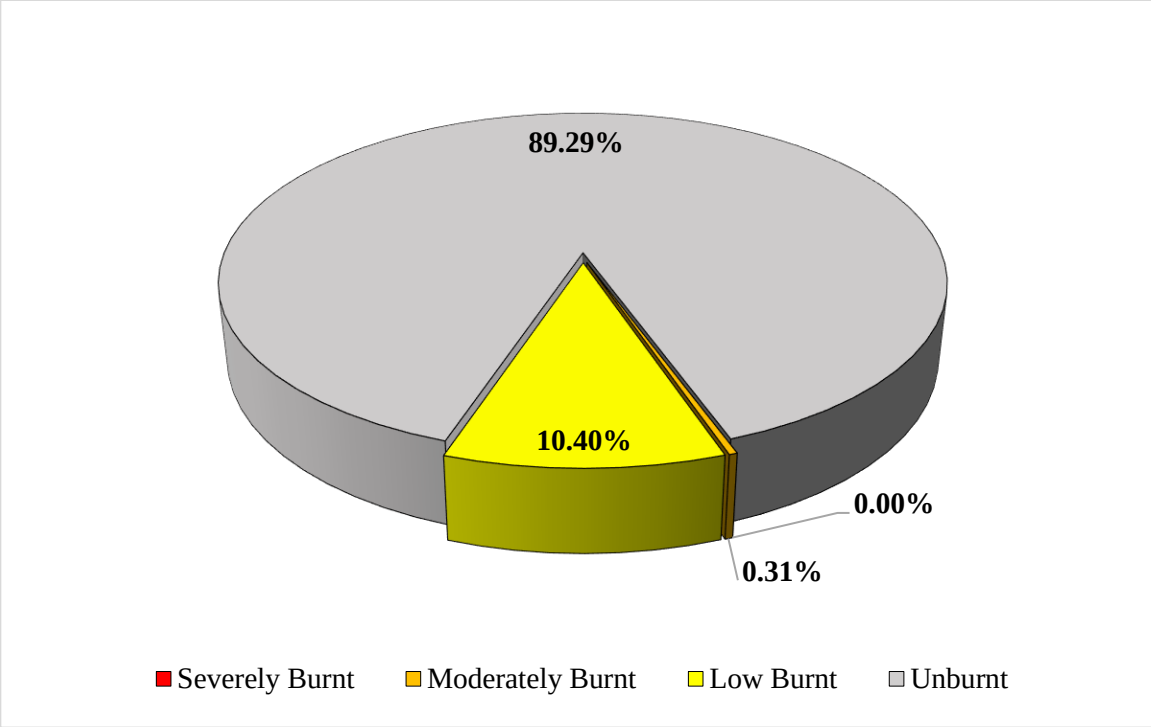


Figure 2.4.4 Distribution of burnt severity classes

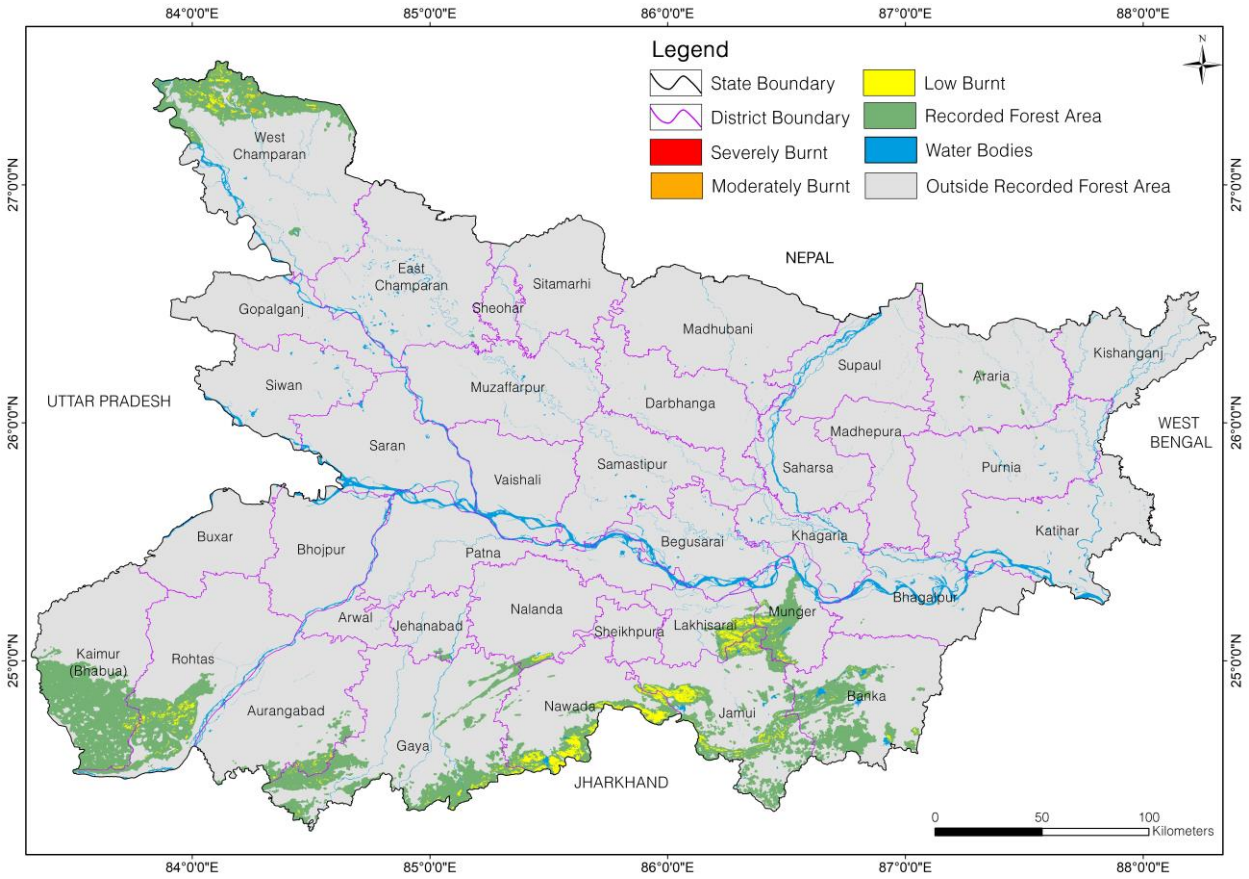


Figure 2.4.5 Map showing burnt area in Bihar

2.4.5 Results and Analysis

Based on the analysis, it is observed that Nawada followed by Jamui, West Champaran and Lakhisarai are the most affected districts. The maximum affected area under moderately burnt severity class has been observed in West Champaran and Nawada districts. Nawada district has reported the highest area under low burnt severity class. A total of 682.74 km^2 fire affected forest area has been reported in the state, which constitute 10.71% of the RFA.

2.5 Chhattisgarh

2.5.1 Introduction

The state lies between 17°47' N to 24°06' N latitude and 80°15' E to 84°24' E longitude. It shares border with Madhya Pradesh in the North-West, Uttar Pradesh in the North, Jharkhand in the North-East, Maharashtra in the West, Telangana in the South and Odisha in the South-East. The state lies in East Deccan physiographic zone and can be divided into three agro-climatic zones, viz. the Chhattisgarh Pains, the Northern Hills of Chhattisgarh and the Baster Plateau. Geographical area of the state is 1,35,192 km^2 which is 4.11% of the geographical area of the country. Rihad, Hasdo and Indravati are the major rivers of the state. The climate of the state is tropical hot and humid. The average annual temperature of the state varies from 11°C to 47°C. Whereas, the rainfall in the state is mainly influenced by South-West monsoons with average annual rainfall varies from 1,100 mm to 1,700 mm. The state is rich in flora and fauna biodiversity. The state's two main tree species are Sal (*Shorea robusta*) and Teak (*Tectona grandis*), other major species include Bija (*Pterocarpus marsupium*), Saja (*Terminalia elliptica*), Dhavdha (*Terminalia anogeissiana*), Mahua (*Madhuca longifolia*), Tendu (*Diospyros melanoxylon*) and Bamboo (*Dendrocalamus strictus*) etc. The Recorded Forest Area (RFA) of the state is 59,816 km^2, which is 44.25% of its geographical area.

Forest fires are quite frequent in the state during fire season and a considerable area under forest is affected due to the forest fires every year. There are many causative factors for initiation and spread of fires. In majority of the incidents, the practice of Tendu patta collection, fire wood collection and Mahua flower collection are the major causes of fire incidents in the state. Ground truthing was carried out by a joint team of FSI and State Forest Department during April 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of 29 points were visited by the team.

2.5.2 Forest Cover and Forest Type Group

As per the ISFR 2023, forest cover in the state is 55,811.75 km^2, which constitutes 41.28% of the state's geographical area. In terms of forest canopy density classes, the state has 7,416.57 km^2 under Very Dense Forest (VDF), 31,983.80 km^2 under Moderately Dense Forest (MDF), 16,411.38 km^2 under Open Forest (OF) and 610.41 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Chhattisgarh belong to three forest type groups which are further categorized into 13 forest types. The forest type groups comprises of Tropical Dry Deciduous Forests and Tropical Moist Deciduous Forests.

The most vulnerable forest types to fires in the state are Southern dry mixed deciduous forest followed by Dry peninsular Sal forest and Southern moist mixed deciduous forest.

2.5.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.5.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.5.1. Table 2.5.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

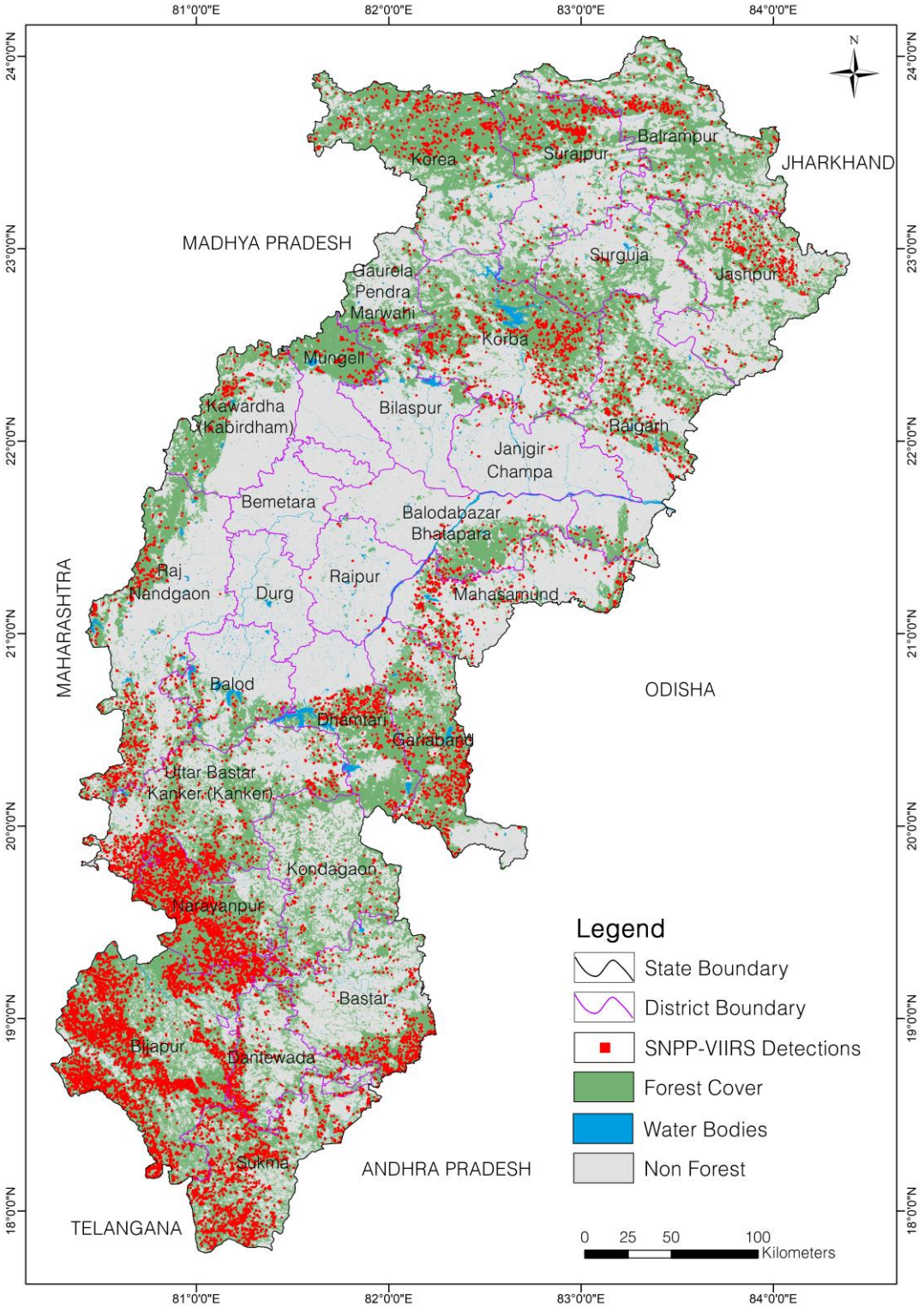


Figure 2.5.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.5.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Balod	99	119
Balodabazar Bhatapara	353	160
Balrampur	1,470	1,012
Bastar	426	683
Bemetara	0	0
Bijapur	2,940	5,018
Bilaspur	268	411
Dantewada	68	551
Dhamtari	511	463
Durg	0	0
Gariaband	1,233	699
Gaurela Pendra Marwahi	148	49
Janjgir Champa	228	80
Jashpur	1,111	405
Kawardha (Kabirdham)	449	180
Kondagaon	378	173
Korba	1,413	772
Korea	1,884	719
Mahasamund	830	428
Mungeli	158	136
Narayanpur	1,466	2,316
Raigarh	1,275	506
Raipur	28	17
Raj Nandgaon	901	623
Sukma	335	1,671
Surajpur	789	543
Surguja	408	110
Uttar Bastar Kanker (Kanker)	1,137	1,106
Total	**20,306**	**18,950**

Based on the analysis of forest fire detections, the crucial period of forest fires in the state has been determined. The crucial period of forest fire detections in the state has been noticed to be tentatively between 24th March to 20th April, which is based on the forest fire detections of last eight years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years is shown in the Figure 2.5.2.

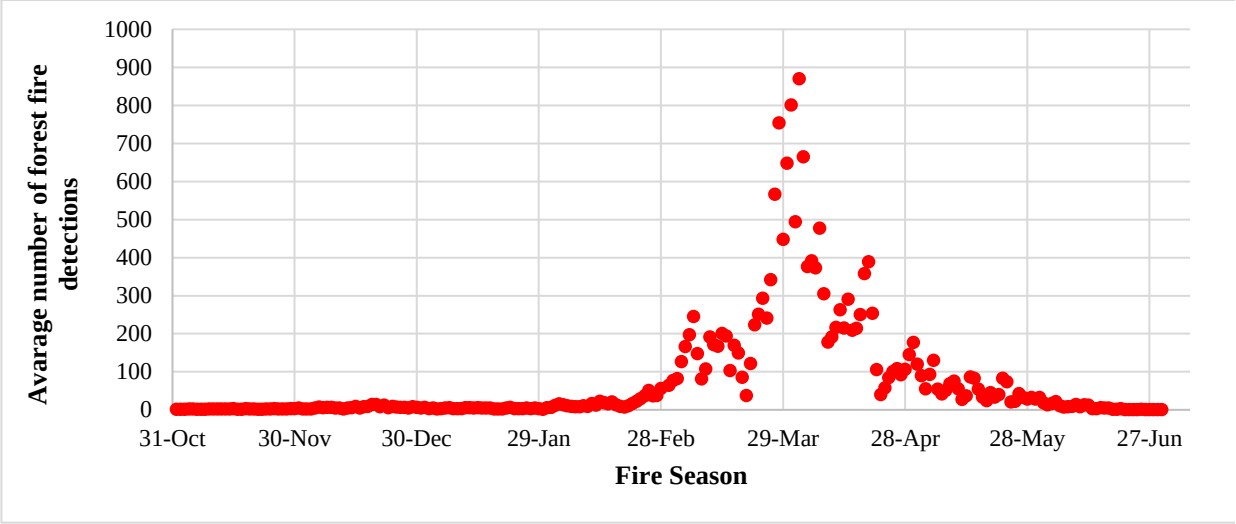


Figure 2.5.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.5.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.5.3. Table 2.5.2 shows the number of large forest fire detections during fire season 2022-23 and 2023-24.

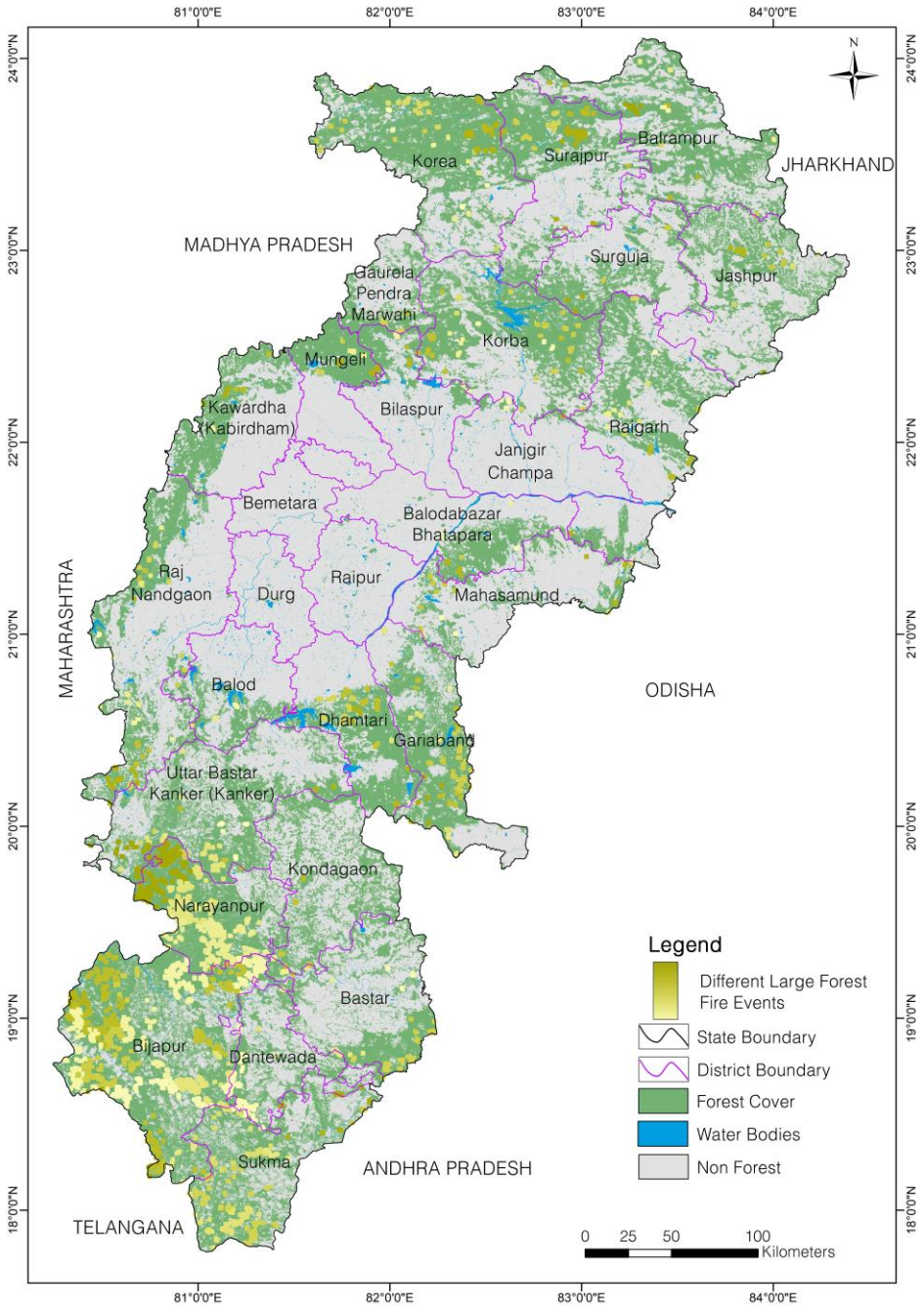


Figure 2.5.3 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.5.2 Number of large forest fire detections during fire season 2022-23 and 2023-24

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Chhattisgarh	1,115	928

2.5.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the satellite data is given in Table 2.5.3. From the Figure 2.5.4, it can be inferred that 7.20% of the RFA has been affected by fires. A total of 6.37% of the RFA falls under the low burnt class and 0.83% under moderately burnt class. Only 0.01 km^2 of the RFA have been classified under severely burnt class. The burnt scar map of Chhattisgarh is shown in Figure 2.5.5.

Table 2.5.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
Balod	0.00	0.08	21.01	21.09
Balodabazar Bhatapara	0.00	0.16	89.13	89.29
Balrampur	0.00	14.87	57.35	72.22
Bastar	0.00	9.91	119.97	129.88
Bemetara	0.00	0.00	0.00	0.00
Bijapur	0.00	245.29	868.12	1,113.41
Bilaspur	0.00	0.54	28.53	29.07
Dantewada	0.00	16.26	51.51	67.77
Dhamtari	0.00	0.19	320.21	320.40
Durg	0.00	0.00	0.00	0.00
Gariaband	0.00	0.15	255.63	255.78
Gaurela Pendra Marwahi	0.00	1.19	31.64	32.83
Janjgir Champa	0.00	0.06	6.68	6.74
Jashpur	0.00	22.71	62.81	85.52
Kawardha (Kabirdham)	0.00	0.18	14.46	14.64
Kondagaon	0.00	11.15	49.93	61.08
Korba	0.00	20.96	159.56	180.52
Korea	0.00	5.80	105.46	111.26
Mahasamund	0.00	0.08	35.65	35.73
Mungeli	0.00	0.26	29.76	30.02
Narayanpur	0.00	13.99	33.65	47.64
Raigarh	0.01	7.35	69.13	76.48
Raipur	0.00	0.00	0.03	0.03
Raj Nandgaon	0.00	10.62	66.12	76.74
Sukma	0.00	32.46	465.68	498.14
Surajpur	0.00	11.37	119.48	130.85
Surguja	0.00	7.05	23.81	30.86
Uttar Bastar Kanker (Kanker)	0.00	6.01	288.28	294.29
Total	**0.01**	**438.68**	**3,373.59**	**3,812.28**

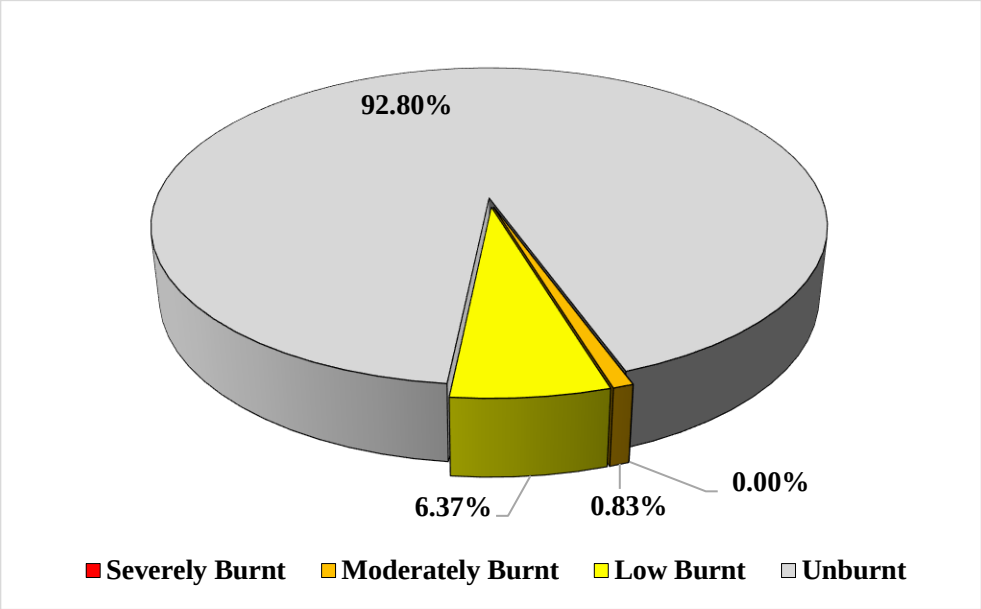


Figure 2.5.4 Distribution of burnt severity classes

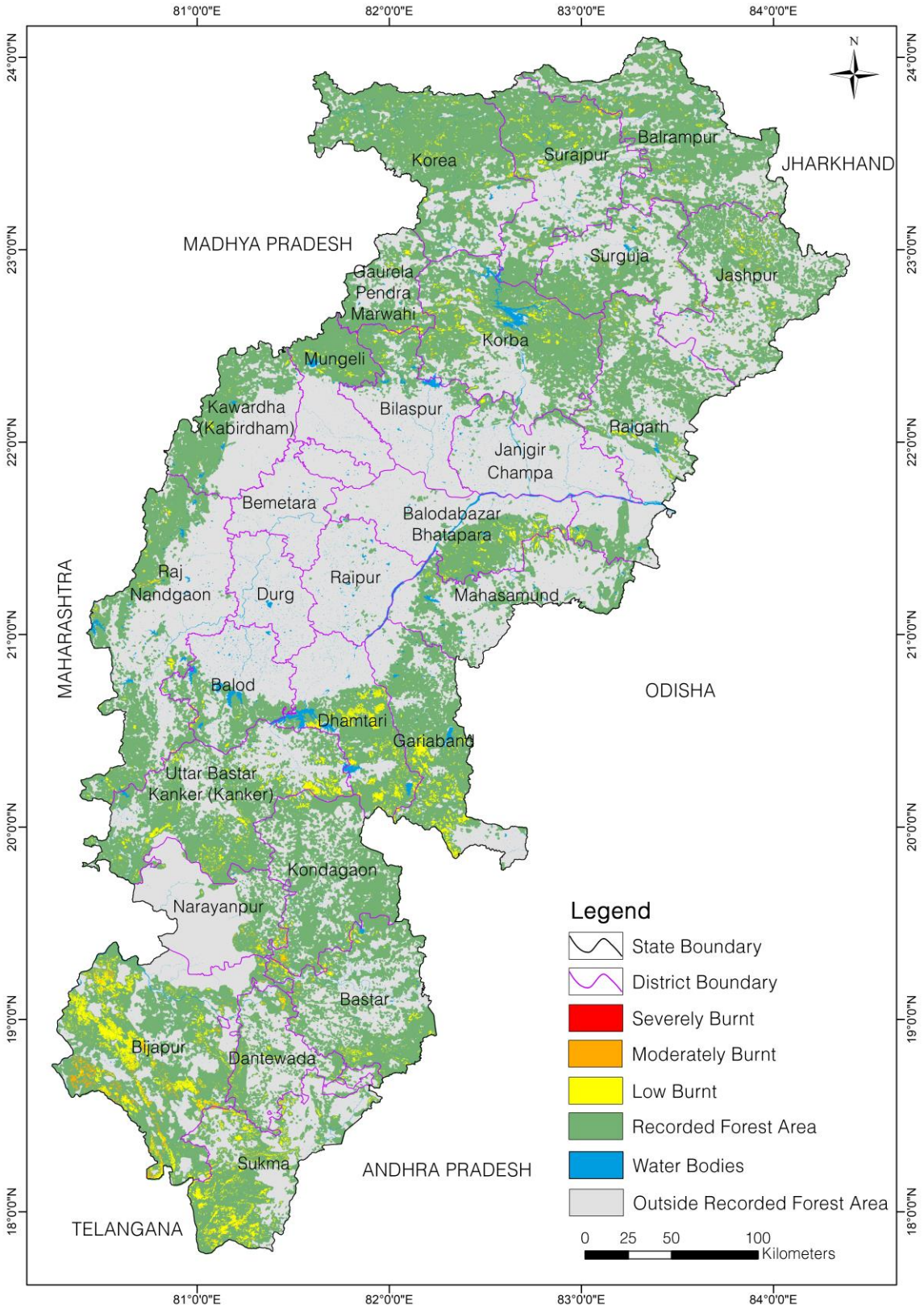


Figure 2.5.5 Map showing forest fire burnt area in Chhattisgarh

2.5.5 Results and Analysis

Based on the analysis, it is observed that Bijapur followed by Sukma, Dhamtari and Uttar Bastar Kanker (Kanker) are the most fire affected districts. The maximum affected area under moderately burnt severity class has been observed in Bijapur and Sukma districts. Bijapur district has reported the highest area under low burnt severity class followed by West Kameng and Longding. A total of 3,812.28 km^2 fire affected forest area has been reported in the state, which constitute 7.19 % of the RFA.

2.6 Delhi

2.6.1 Introduction

Delhi, the national capital of India lies between 28° 22' N to 28° 54' N latitude and 76°48' E to 77° 23' E longitude. It shares border with Haryana in the West, North & South and Uttar Pradesh in the East. Delhi is divided into three main regions: The low-lying Yamuna flood plains, the Aravalli Ridge and the Great Gangetic plain. Geographical area of the state is 1,483 km^2, which is 0.05% of the geographical area of the country. Yamuna is the major river of the state. The climate of the state is semi-arid climate in summer and dry winters. The average annual temperature of the state varies from 3°C to 45°C. Whereas, average annual rainfall varies from 400 mm to 600 mm. Delhi has six biodiversity parks which include Aravalli Biodiversity Park, Yamuna Biodiversity Park, Kamla Nehru Ridge, Tilpath Valley, Neela Hauz and Tughlaqabad. The Recorded Forest Area (RFA) of the state is 104 km^2, which is 7.01% of its geographical area.

2.6.2 Forest Cover and Forest Type Group

As per the ISFR 2023, forest cover in the state is 195.28 km^2, which constitutes 13.17% of the state's geographical area. In terms of forest canopy density classes, the state has 6.47 km^2 under Very Dense Forest (VDF), 53.55 km^2 under Moderately Dense Forest (MDF), 135.26 km^2 under Open Forest (OF) and 2.39 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Delhi belong to three forest type groups, which are further categorized into three forest types. The forest type groups comprises of Tropical Thorn Forests and Tropical Dry Deciduous Forests.

The most vulnerable forest types to fires in the state are Ravine thorn forest and Northern dry mixed deciduous forest.

2.6.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.6.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.6.1 Table 2.6.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

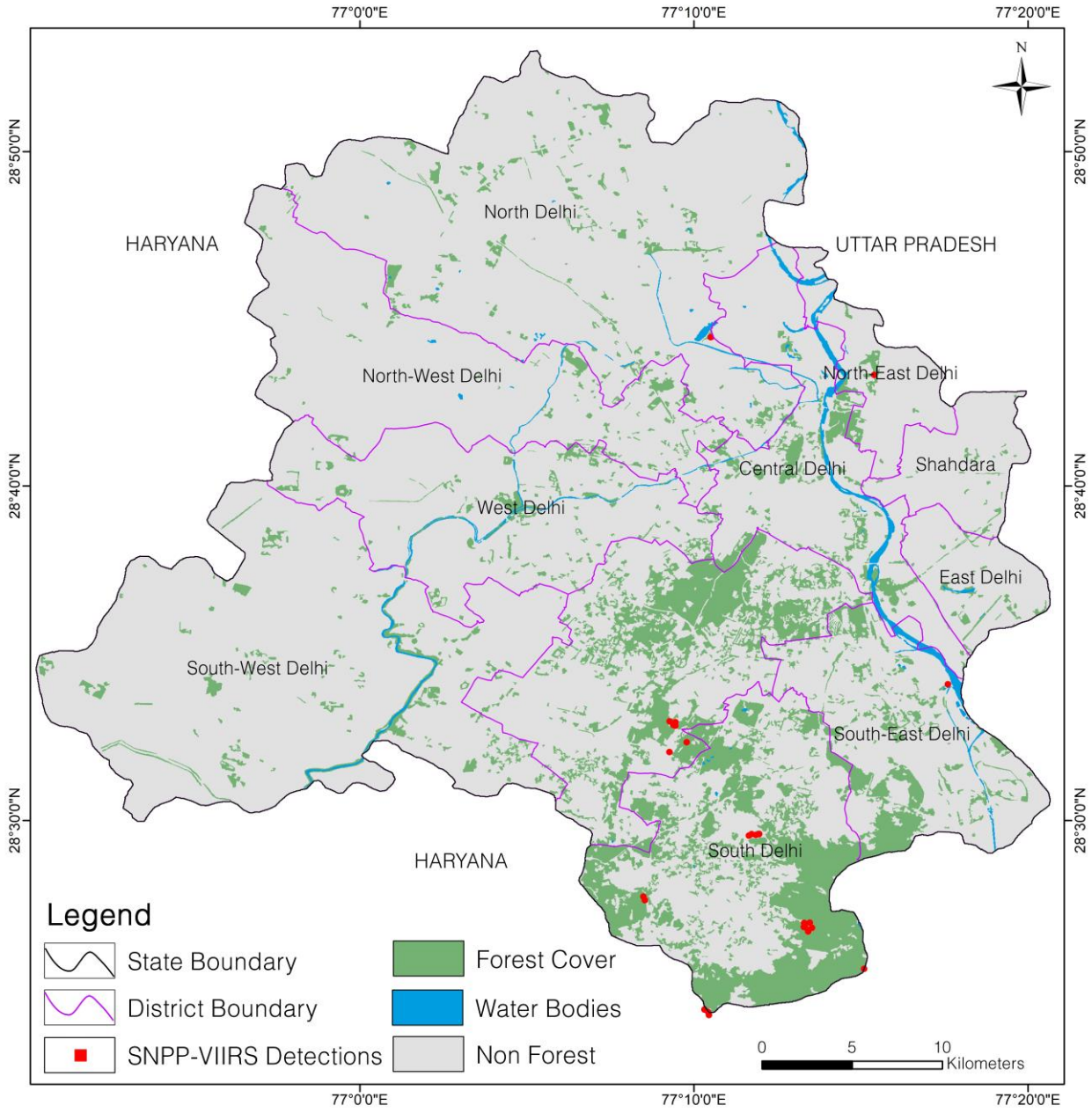


Figure 2.6.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.6.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Central Delhi	1	0
East Delhi	2	0
New Delhi	1	3
North Delhi	2	1
North-East Delhi	0	1
North-West Delhi	0	0
Shahadra	0	0
South Delhi	0	9
South-East Delhi	0	1
South-West Delhi	1	1
West Delhi	0	0
Total	**7**	**16**

Based on the analysis of forest fire detections of last eight years in the state, no clear correlation between year-wise forest fire detections appeared to determine the crucial period.

2.6.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.6.2. Table 2.6.2 shows the number of large forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

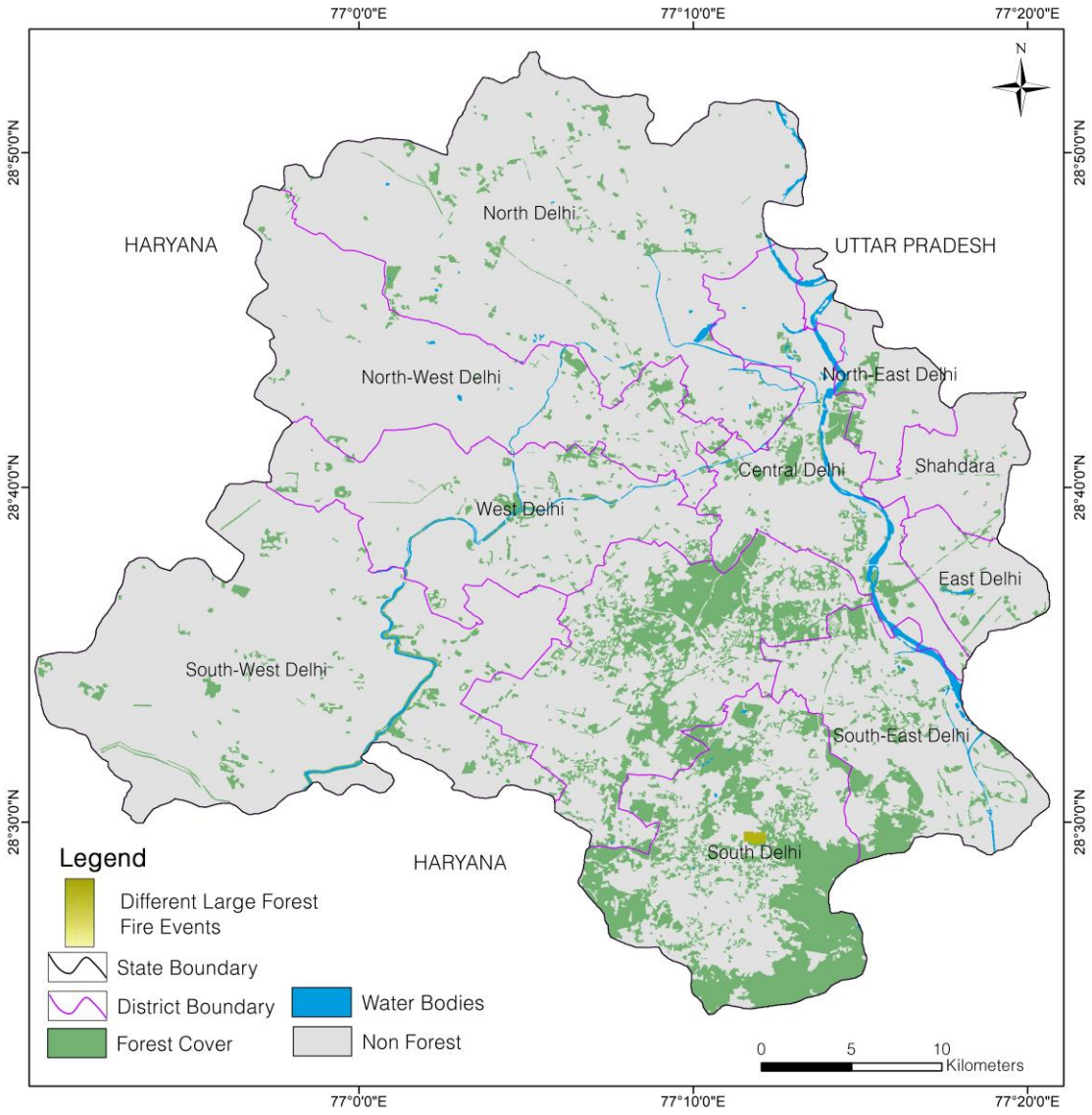


Figure 2.6.2 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.6.2 Number of large forest fire detections during fire season 2022-23 and 2023-24

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Delhi	0	1

2.6.4 Burnt Scar Assessment

No burnt scars have been observed in the state during fire season 2023-24.

2.6.5 Results and Analysis

No burnt scars have been observed in the state during fire season 2023-24.

2.7 Goa

2.7.1 Introduction

The state lies between 14°53' N to 15°40' N latitude and 73°40' E to 74°21' E longitudes. It shares border with Maharashtra in the North, Karnataka in the South & the East and Arabian Sea in the West. The state comprises of two main physiographic regions: Western Ghats and Coastal Plain. Geographical area of the state is 3,702 km^2, which is 0.11% of the geographical area of the country. Mandovi and Zuari are the two major rivers of the state. The state has tropical monsoon climate and is warm & humid throughout the year with an average annual temperature ranges between 16°C to 37°C. The rainfall in the state is influenced by South-West monsoon and an average annual rainfall is 3,800 mm. The state falls in Western Ghats, which is one among the 36 biodiversity hotspots in the world. Major portion of the vegetation in Goa belongs to plateau vegetation along undulating terrain and hills. The state can be broadly divided into four regions, viz. Eastern Hill Region, Central Valley Lands, Flood Plains and the Coastal Plains. The state has Recorded Forest Area (RFA) of 1,271 km^2, which is 34.33% of its geographical area.

Majority of the incidents responsible for initiation and spread of fires may be attributed to large influx of tourists and human influence in nearby forest areas of the state. Ground truthing was carried out by a joint team of FSI and State Forest Department during June 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of six points were visited by the team.

2.7.2 Forest Cover and Forest Type Group

As per ISFR 2023, forest cover in the state is 2,265.72 km^2, which constitutes 61.20 % of the state's geographical area. In terms of forest canopy density classes, the state has 555.46 km^2 under Very Dense Forest (VDF), 589.43 km^2 under Moderately Dense Forest (MDF) and 1,120.83 km^2 under Open Forest (OF) and 21.69 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Goa belong to six forest type groups, which are further categorized into six forest types. The major forest type groups comprises of Tropical Moist Deciduous Forests followed by Tropical Wet Evergreen Forests and Tropical Semi-Evergreen Forests.

The most vulnerable forest types to fires in the state are West Coast tropical evergreen forest followed by West Coast semi-evergreen forest and Southern moist mixed deciduous forest.

2.7.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.7.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.7.1. Table 2.7.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

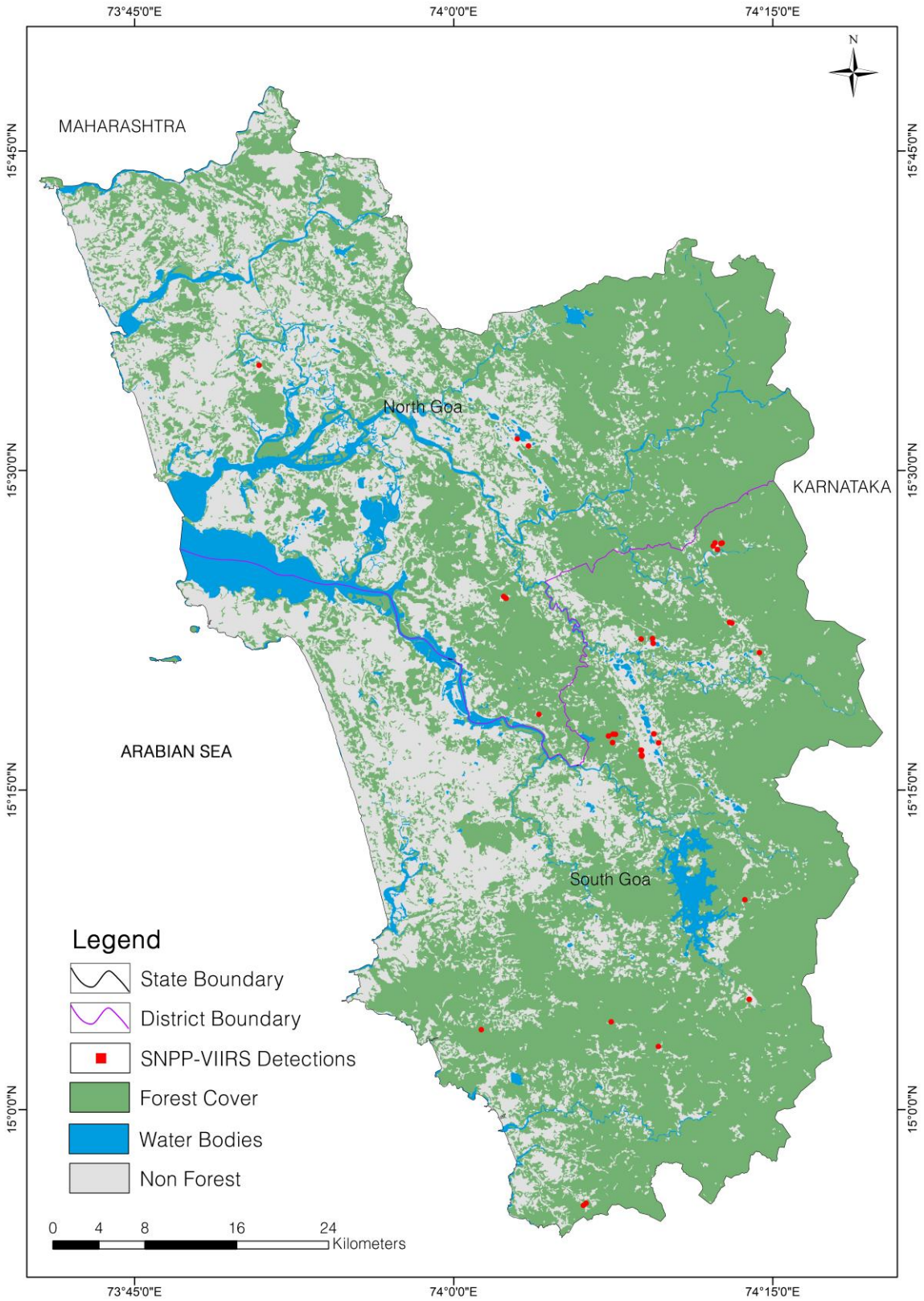


Figure 2.7.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.7.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
North Goa	24	5
South Goa	123	31
Total	**147**	**36**

Based on the analysis of forest fire detections of last eight years in the state, no clear correlation between year-wise forest fire detections appeared to determine the crucial period.

2.7.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.7.2. Table 2.7.2 shows the number of large forest fire detections during fire season 2022-23 and 2023-24.

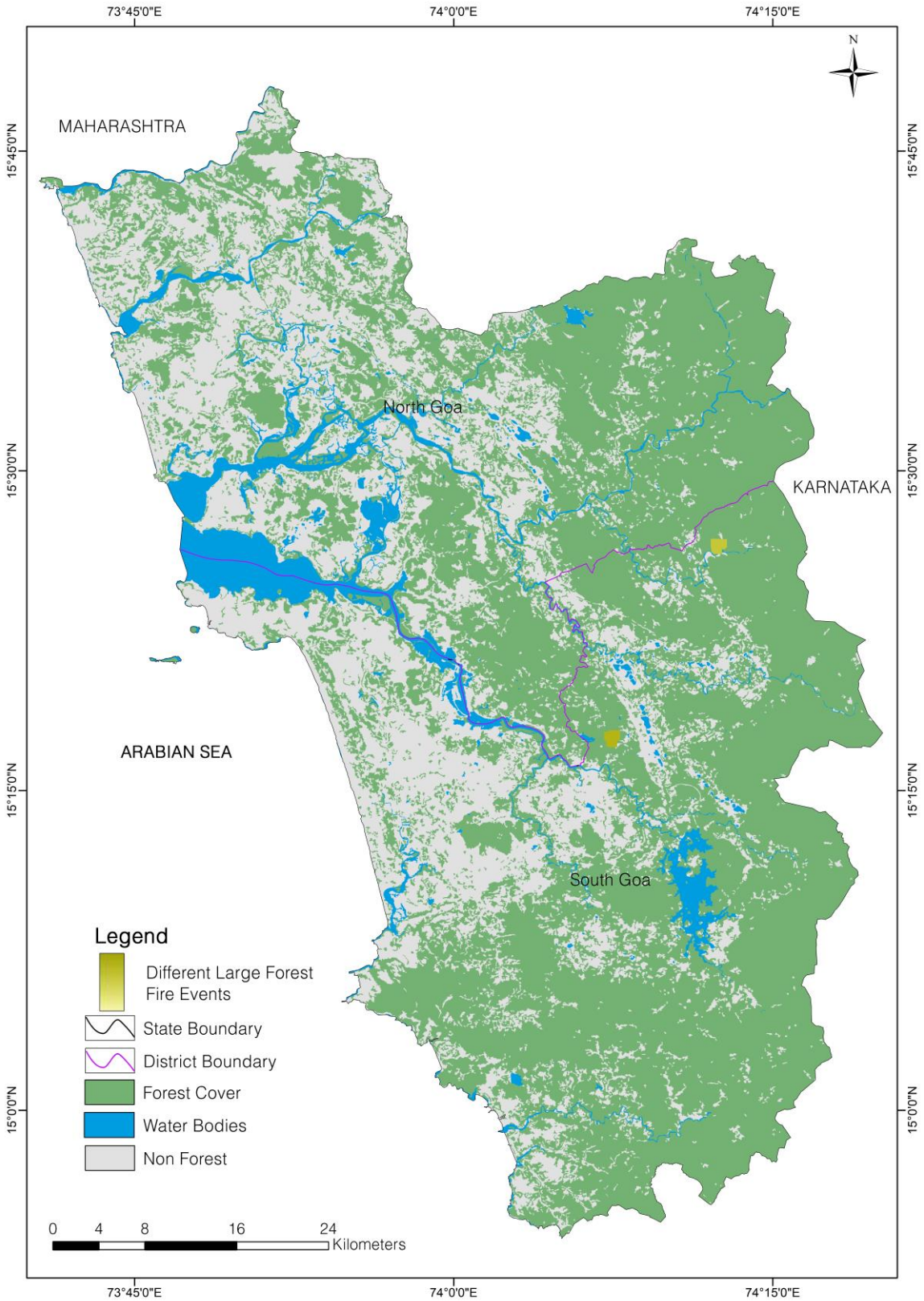


Figure 2.7.2 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.7.2 Number of large forest fire detections during fire season 2022-23 and 2023-24

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Goa	4	2

2.7.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.7.3. From the Figure 2.7.3, it can be inferred that 0.03% of the RFA has been affected by fires, which falls under the low-severity burnt class. No area inside RFA have been classified under severely burnt class and moderately burnt class. The burnt scar map of Goa is shown in Figure 2.7.4.

Table 2.7.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
North Goa	0.00	0.00	0.02	0.02
South Goa	0.00	0.00	0.43	0.43
Total	**0.00**	**0.00**	**0.45**	**0.45**

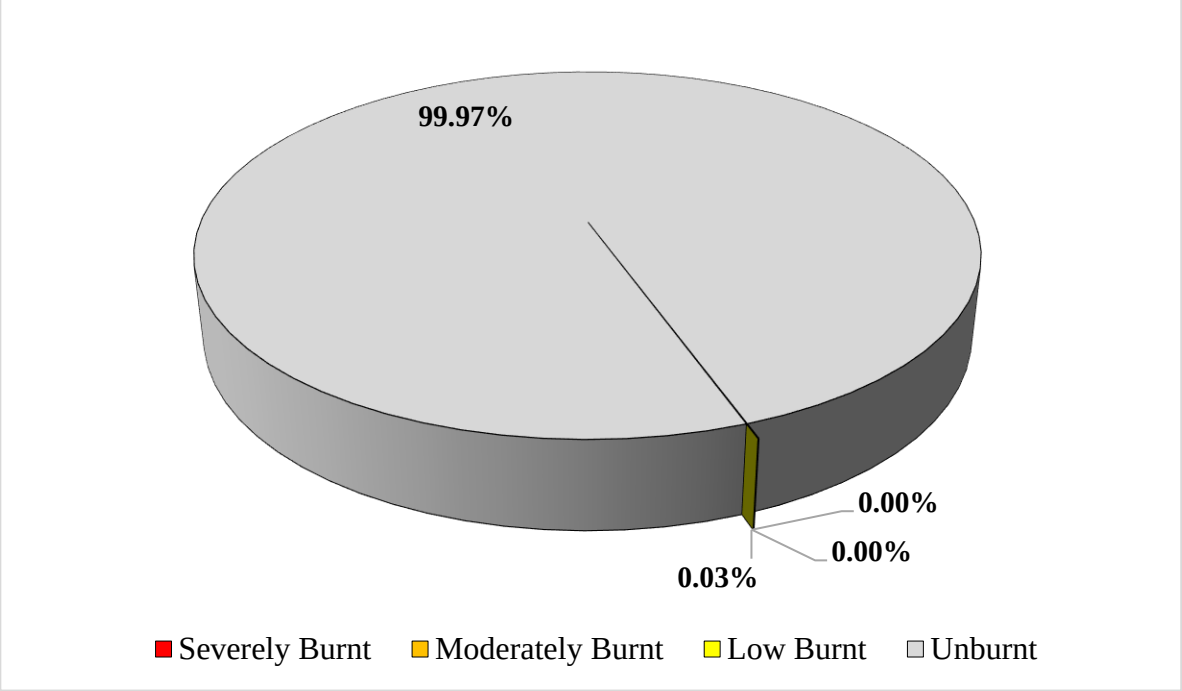


Figure 2.7.3 Distribution of burnt severity classes

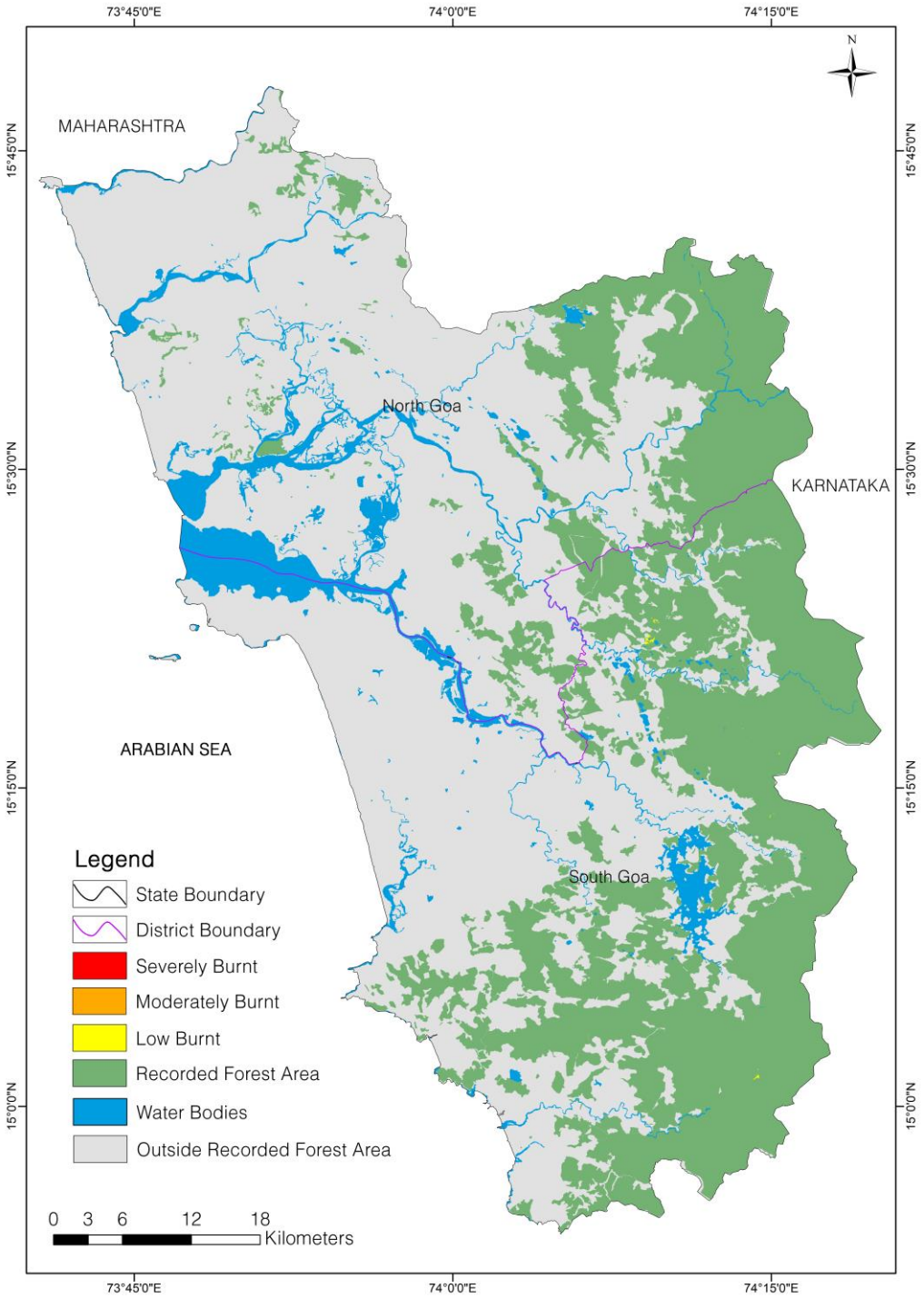


Figure 2.7.4 Map showing burnt area in Goa

2.7.5 Results and Analysis

Based on the analysis, it is observed that South Goa is the most affected district. A total of 0.45 km^2 fire affected forest area has been reported in the state, which constitute 0.03 % of the RFA.

2.8 Gujarat

2.8.1 Introduction

The state lies between 20°07' N to 24°43' N latitude and 68°10' E to 74°29' E longitude. It shares border with Arabian Sea in the West & South, Rajasthan in the North & North-East, Madhya Pradesh in the East and Maharashtra & Dadra & Nagar Haveli in the South-East. It also shares international border with Pakistan on the North-Western part. It has the longest coastline among the other coastal states of India and is estimated to be around 1,600 km. In addition, The Great Rann of Kutch is a salt marsh in Thar Desert in the Kutch district and is one of the largest salt deserts in the world. The state comprises of three main physiographic regions: The Peninsula, Kutch on the North-West and the Mainland. Geographical area of the state is 1,96,244 km^2, which is 5.97% of the geographical area of the country. Narmada, Tapi and Sabarmati are the major rivers of the state. The climate of the state is hot and dry in summers and mild, pleasant and dry in the winters. The average annual temperature of the state varies from 25°C to 28°C. Whereas, the rainfall in the state is mainly influenced by South-West monsoon with average annual rainfall varies from 800 mm to 1,000 mm. The state is rich in diverse range of flora and fauna biodiversity. The state has four national parks and 23 wildlife sanctuaries. The Recorded Forest Area (RFA) of the State is 21,870 km^2, which is 11.14% of its geographical area.

Majority of the incidents responsible for initiation and spread of fires may be attributed to Tendu and Mahua collection, settlement surrounding forest, stubble burning and agricultural practices. Ground truthing was carried out by a joint team of FSI and State Forest Department during June 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of 15 points were visited by the team.

2.8.2 Forest Cover and Forest Type Group

As per ISFR 2023, forest cover in the state is 15,016.64 km^2, which constitutes 7.65% of the state's geographical area. In terms of forest canopy density classes, the state has 419.71 km^2 under Very Dense Forest (VDF), 4,902.20 km^2 under Moderately Dense Forest (MDF), 9,694.73 km^2 under Open Forest (OF) and 2,029.95 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Gujarat belong to five forest type groups, which are further categorized into 26 forest types. The major forest type

groups comprises of Tropical Dry Deciduous Forests followed by Tropical Thorn Forests and Tropical Moist Deciduous Forests.

The most vulnerable forest types to fires in the state are Dry teak forest followed by Southern dry mixed deciduous forest and Slightly moist teak forest.

2.8.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.8.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.8.1. Table 2.8.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

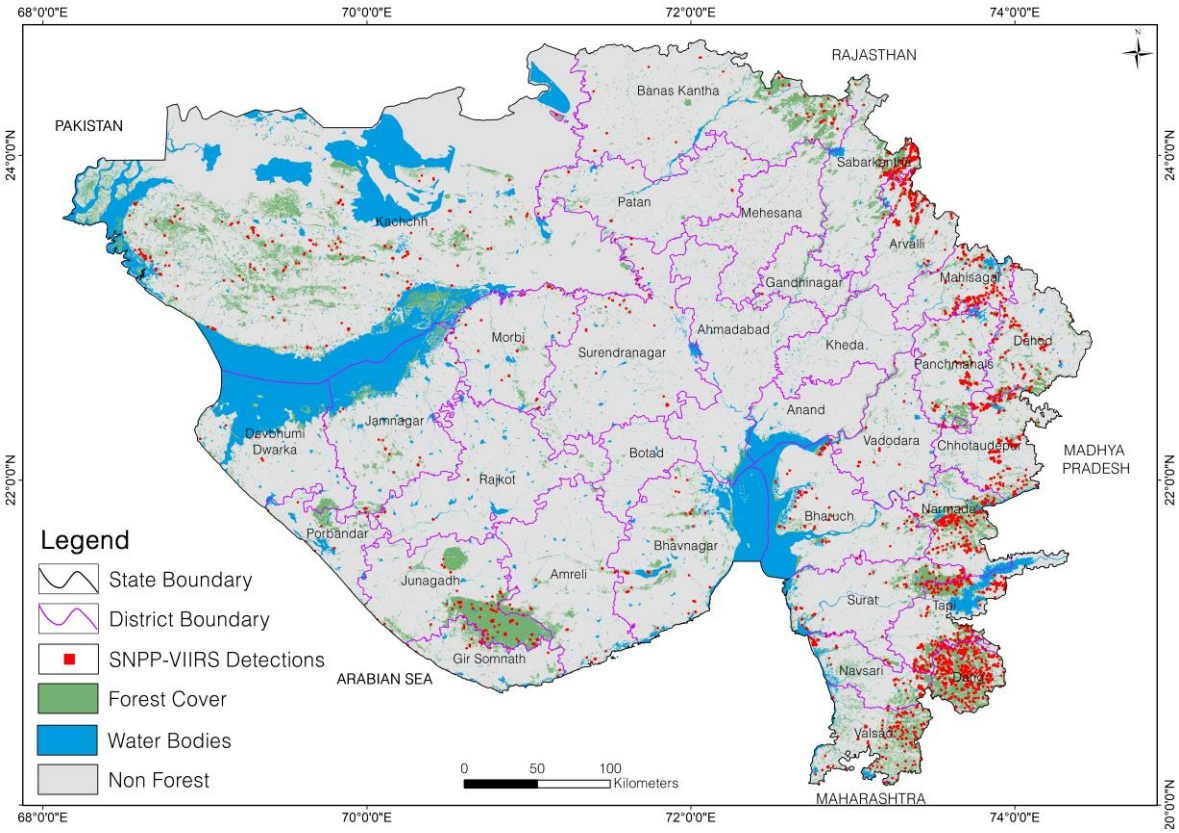


Figure 2.8.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.8.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Ahmadabad	0	0
Amreli	25	23
Anand	0	0
Arvalli	18	210
Banaskantha	23	65
Bharuch	110	82
Bhavnagar	68	44
Botad	2	0
Chhotaudepur	255	232
Dahod	122	135
Dang	417	478
Devbhumi Dwarka	31	8
Gandhinagar	2	2
Gir Somnath	30	25
Jamnagar	20	25
Junagadh	77	118
Kachchh	133	237
Kheda	0	0
Mahisagar	53	161
Mehesana	2	0
Morbi	6	29
Narmada	270	239
Navsari	67	98
Panchmahals	66	116
Patan	7	14
Porbandar	14	10
Rajkot	8	9
Sabarkantha	45	201
Surat	133	102
Surendranagar	22	33
Tapi	222	323
Vadodara	9	20
Valsad	85	143
Total	**2,342**	**3,182**

Based on the analysis of forest fire detections, the crucial period of forest fires in the state has been determined. The crucial period of forest fire detections in the state has been noticed to be tentatively between 25th February to 30th May, which is based on the forest fire detections of last eight years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years is shown in the Figure 2.8.2.

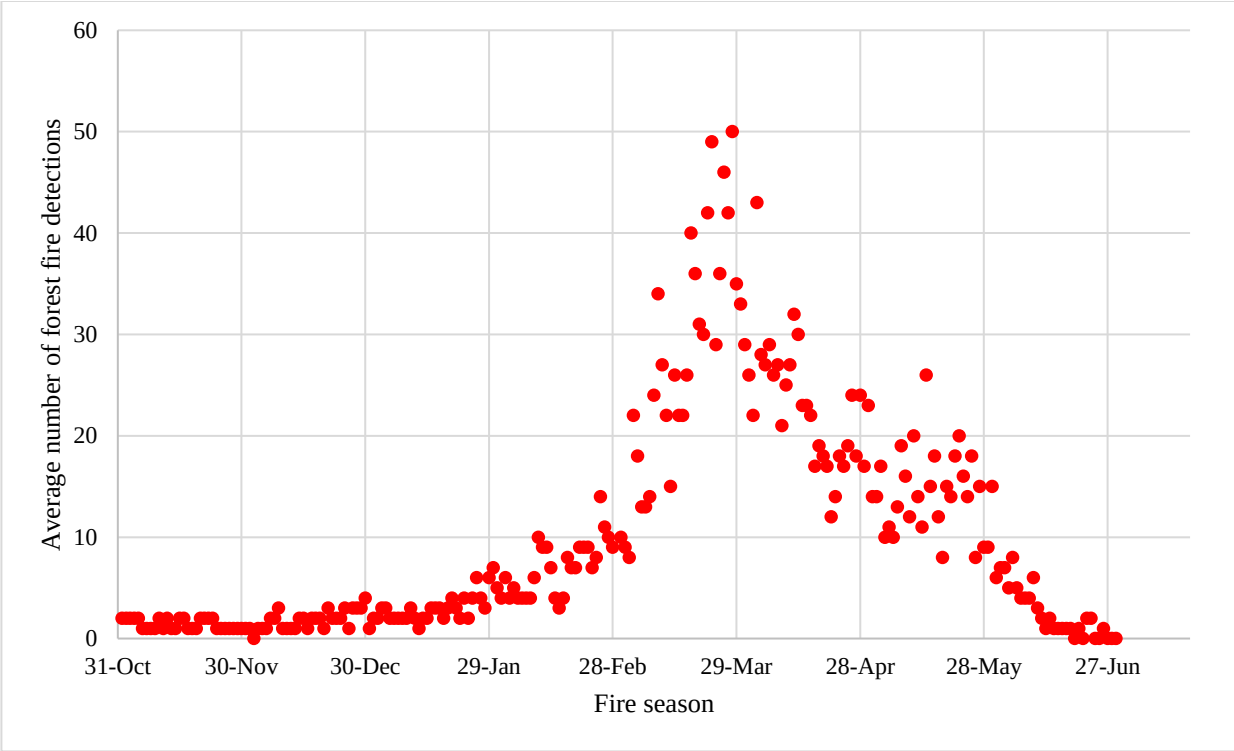


Figure 2.8.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.8.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.8.3. Table 2.8.2 shows the number of large forest fire detections during fire season 2022-23 and 2023-24.

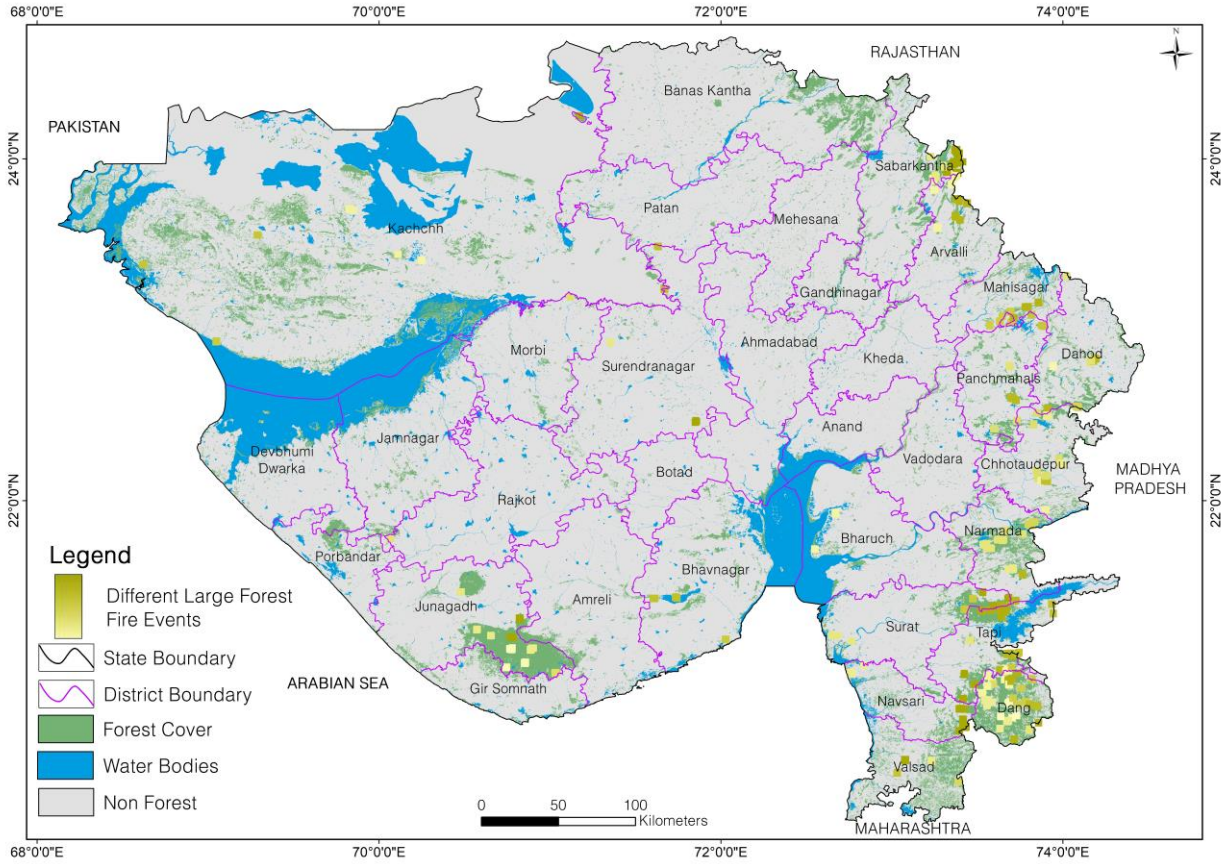


Figure 2.8.3 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.8.2 Number of large forest fire detections during November 2023 to June 2024

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Gujarat	108	167

2.8.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.8.3. From the Figure 2.8.4, it can be inferred that 1.35% of the RFA has been affected by fires. A total of 1.35% of the RFA falls under the low burnt class. Only 0.25 km^2 of the RFA has been classified under moderately burnt class and no area have been under severely under burnt class. The burnt area map of Gujarat is shown in Figure 2.8.5

Table 2.8.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
Ahmadabad	0.00	0.00	0.00	0.00
Amreli	0.00	0.00	0.71	0.71
Anand	0.00	0.00	0.00	0.00
Arvalli	0.00	0.04	46.05	46.09
Banaskantha	0.00	0.00	2.49	2.49
Bharuch	0.00	0.00	1.48	1.48
Bhavnagar	0.00	0.00	0.18	0.18
Botad	0.00	0.00	0.00	0.00
Chhotaudepur	0.00	0.03	45.08	45.11
Dahod	0.00	0.00	29.57	29.57
Dang	0.00	0.00	43.31	43.31
Devbhumi Dwarka	0.00	0.00	0.00	0.00
Gandhinagar	0.00	0.00	0.00	0.00
Gir Somnath	0.00	0.00	1.41	1.41
Jamnagar	0.00	0.00	0.07	0.07
Junagadh	0.00	0.00	15.86	15.86
Kachchh	0.00	0.00	0.00	0.00
Kheda	0.00	0.00	0.00	0.00
Mahisagar	0.00	0.01	16.86	16.87
Mehesana	0.00	0.00	0.00	0.00
Morbi	0.00	0.00	0.00	0.00
Narmada	0.00	0.01	37.18	37.19
Navsari	0.00	0.00	8.05	8.05
Panchmahals	0.00	0.01	34.28	34.29
Patan	0.00	0.00	0.00	0.00
Porbandar	0.00	0.00	0.04	0.04
Rajkot	0.00	0.00	0.00	0.00
Sabarkantha	0.00	0.12	49.24	49.36
Surat	0.00	0.00	4.75	4.75
Surendranagar	0.00	0.00	0.00	0.00
Tapi	0.00	0.03	67.34	67.37
Vadodara	0.00	0.00	0.60	0.60
Valsad	0.00	0.00	3.81	3.81
Total	**0.00**	**0.25**	**408.36**	**408.61**

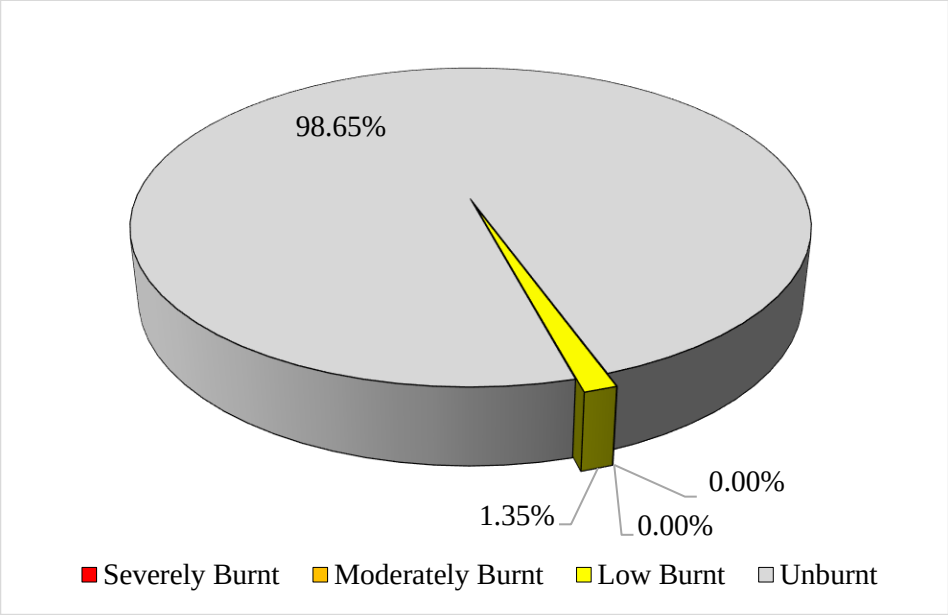


Figure 2.8.4 Distribution of burnt severity classes

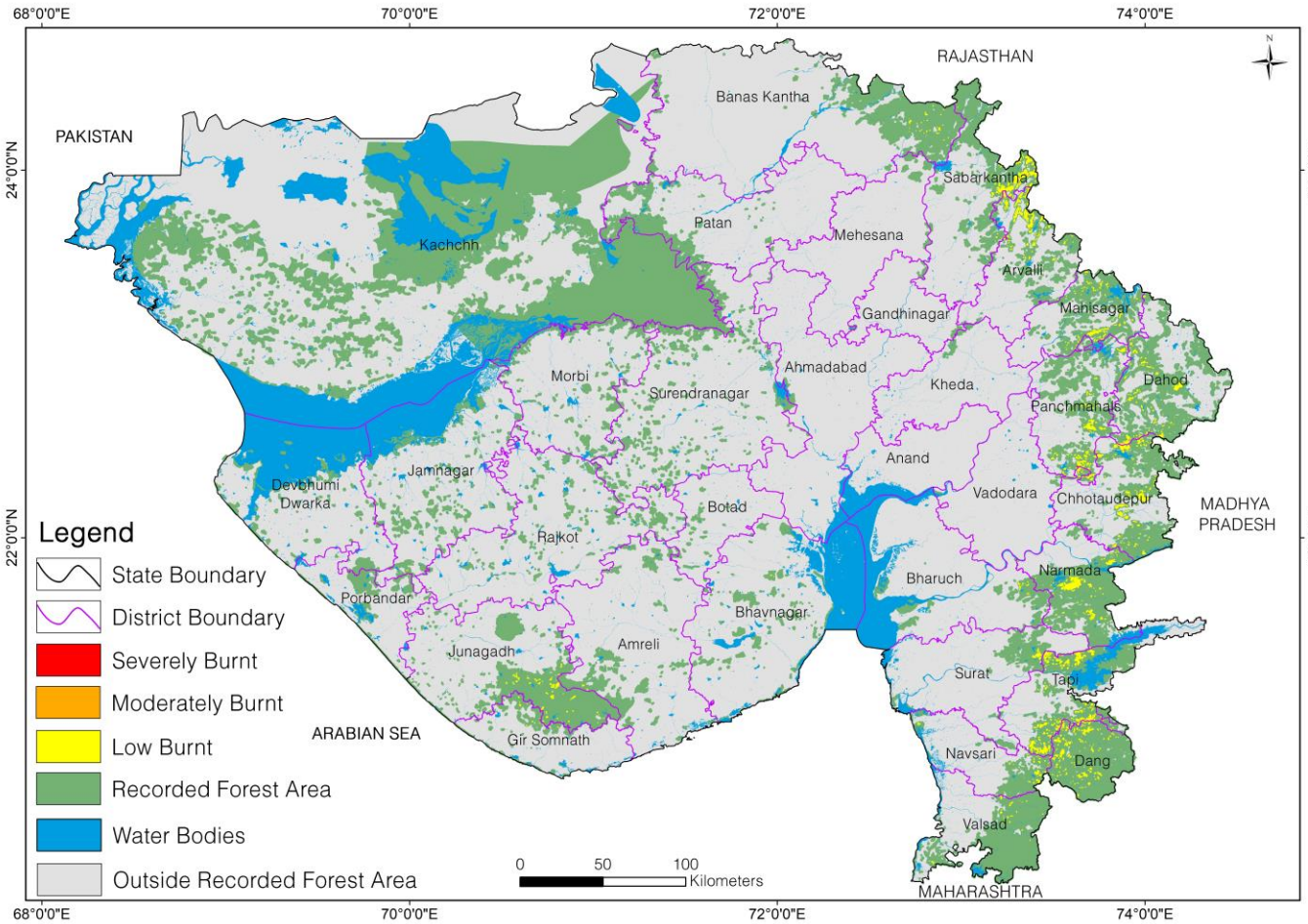


Figure 2.8.5 Map showing forest fire burnt area in Gujarat

2.8.5 Result and Analysis

Based on the analysis, it is observed that Tapi, Sabarkantha, Arvalli, Chhotaudepur are the most forest fire affected districts. A total of 408.61 km^2 fire affected forest area has been reported in the state, which constitute 1.35% of the RFA.

2.9 Haryana

2.9.1 Introduction

The State lies between 27° 39' N to 30° 55' N latitude and 74° 27' E to 77° 36' E longitude. It shares border with Uttarakhand, Delhi & Uttar Pradesh in the East, Himachal Pradesh & Punjab in the North and Rajasthan in the West & South. The State comprises of two main physiographic regions: The Indo Gangetic Plain and Shiwalik Hills. Geographical area of the State is 44,212 km^2, which is 1.34% of the geographical area of the country. Yamuna and Ghaggar are the major rivers of the State. Climate of the State is arid to semi-arid. The average annual temperature of the State varies from 1°C to 45°C whereas, the rainfall in the State is mainly influenced by South-West monsoon with average annual rainfall varies from 200 mm to 1,400 mm. Haryana is predominantly an agriculture State, with almost 80% of the geographical area under agriculture. Poplar and Eucalyptus are the major agroforestry species. The Recorded Forest Area (RFA) of the State is 1,559 km^2, which is 3.53% of its geographical area.

Majority of the incidents responsible for initiation and spread of fires may be attributed to influx of tourists and human influence in nearby forest areas. Ground truthing was carried out in the fire affected areas by a joint team of FSI and State Forest Department during May 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of five points were visited by the team.

2.9.2 Forest Cover and Forest Type Group

As per the ISFR 2023, forest cover in the State is 1,614.26 km^2, which constitutes 3.65% of the State's geographical area. In terms of forest canopy density classes, the State has 27.17 km^2 under Very Dense Forest (VDF), 441.18 km^2 under Moderately Dense Forest (MDF), 1,145.91 km^2 under Open Forest (OF) and 174.38 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Haryana belong to four forest type groups, which are further categorized into 11 forest types. The major forest type groups comprises of Tropical Dry Deciduous Forests followed by Tropical Thorn Forests and Subtropical Pine Forests.

The most vulnerable forest types to fires in the State are Northern dry mixed deciduous forest followed by Ravine thorn forest and Dry Siwalik sal forest.

2.9.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.9.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.9.1. Table 2.9.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

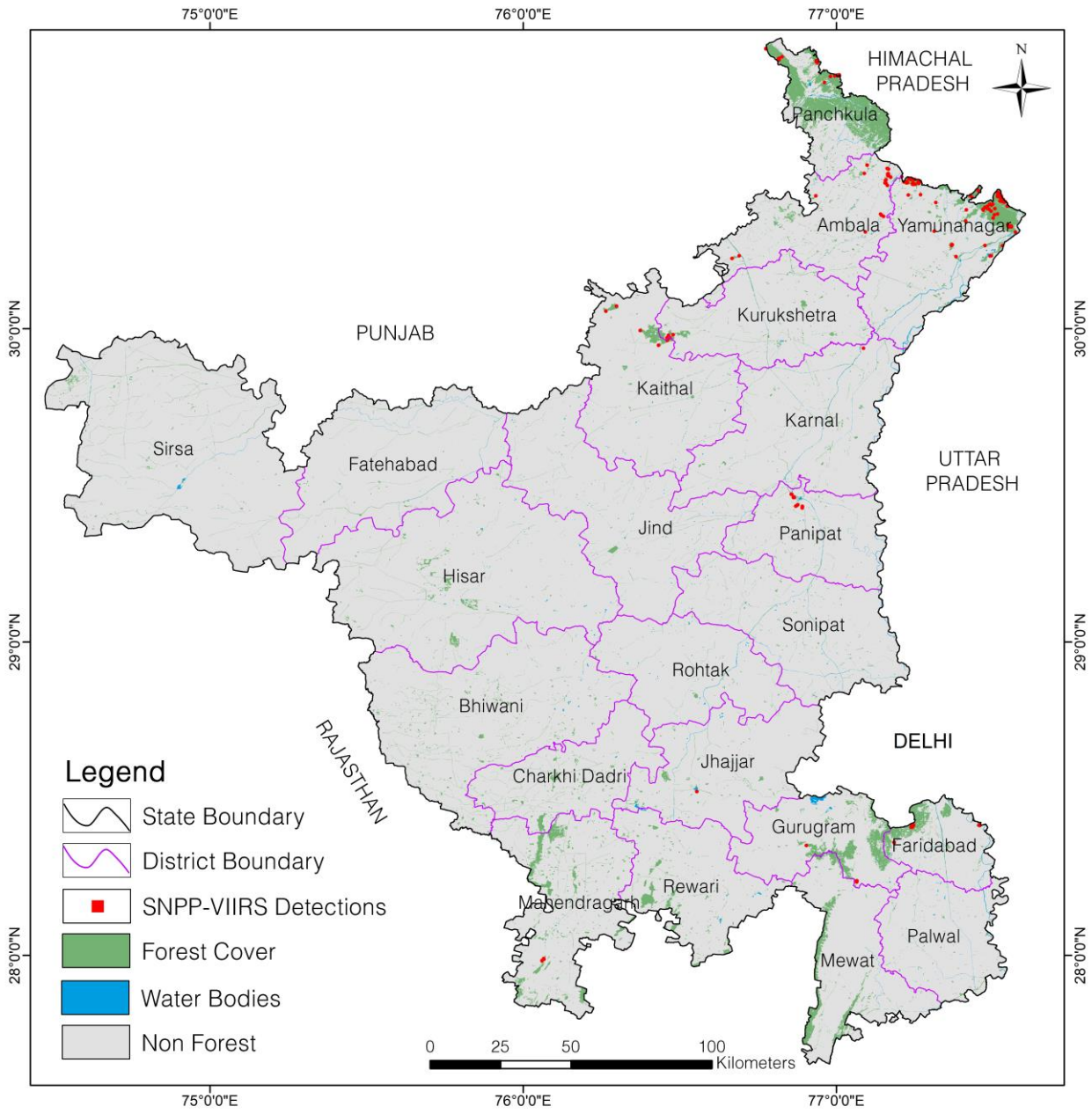


Figure 2.9.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.9.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Ambala	6	19
Bhiwani	0	0
Charkhi Dadri	0	0
Faridabad	0	12

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Fatehabad	4	0
Gurugram	0	4
Hisar	2	0
Jhajjar	0	1
Jind	0	0
Kaithal	8	5
Karnal	3	1
Kurukshetra	3	3
Mahendragarh	0	2
Mewat	0	0
Palwal	0	0
Panchkula	5	29
Panipat	32	16
Rewari	0	1
Rohtak	0	0
Sirsa	0	0
Sonipat	0	0
Yamunanagar	19	73
Total	**82**	**166**

Based on the analysis of forest fire detections of last eight years in the state, no clear correlation between year-wise forest fire detections appeared to determine the crucial period.

2.9.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.9.2. Table 2.9.2 shows the number of large forest fire detections during fire season 2022-23 and 2023-24.

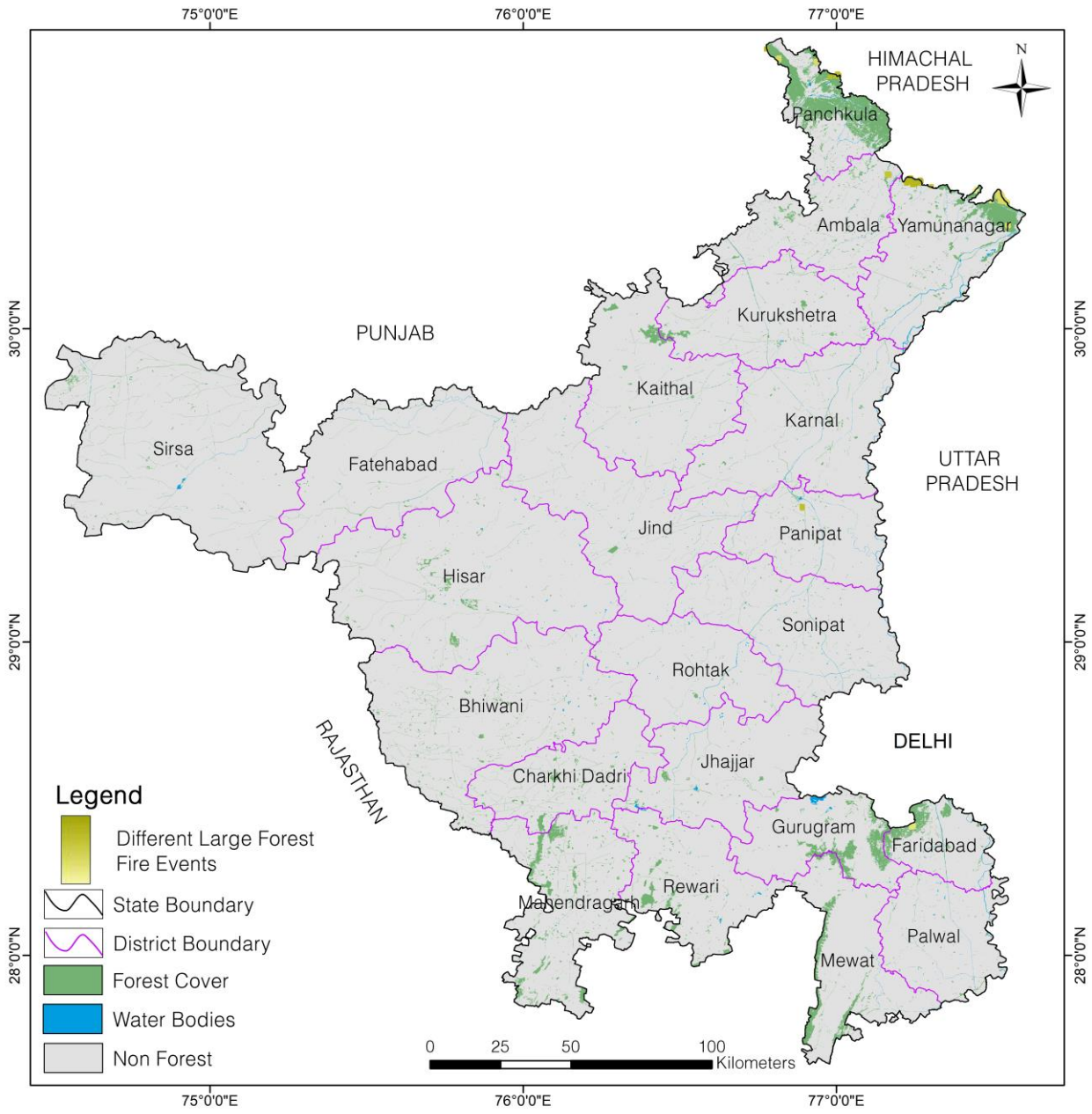


Figure 2.9.2 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.9.2 Number of large forest fire detections during November 2023 to June 2024

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Haryana	2	7

2.9.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.9.3. From the Figure 2.9.3, it can be inferred that 2.86% of the RFA has been affected by fires. A total of 2.57%

of the RFA falls under the low burnt class, 0.28% under moderately burnt class and 0.01% under severely burnt class. The burnt area map of Haryana is shown in Figure 2.9.4.

Table 2.9.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
Ambala	0.00	0.00	0.00	0.00
Bhiwani	0.00	0.00	0.00	0.00
Charkhi Dadri	0.00	0.00	0.00	0.00
Faridabad	0.00	0.00	0.00	0.00
Fatehabad	0.00	0.00	0.00	0.00
Gurugram	0.00	0.00	0.00	0.00
Hisar	0.00	0.00	0.00	0.00
Jhajjar	0.00	0.00	0.00	0.00
Jind	0.00	0.00	0.00	0.00
Kaithal	0.00	0.00	0.00	0.00
Karnal	0.00	0.00	0.00	0.00
Kurukshetra	0.00	0.00	0.00	0.00
Mahendragarh	0.00	0.00	0.00	0.00
Mewat	0.00	0.00	0.00	0.00
Palwal	0.00	0.00	0.00	0.00
Panchkula	0.14	3.86	24.40	28.40
Panipat	0.00	0.00	0.00	0.00
Rewari	0.00	0.00	0.00	0.00
Rohtak	0.00	0.00	0.00	0.00
Sirsa	0.00	0.00	0.00	0.00
Sonipat	0.00	0.00	0.00	0.00
Yamunanagar	0.09	0.46	15.68	16.23
Total	**0.23**	**4.32**	**40.08**	**44.63**

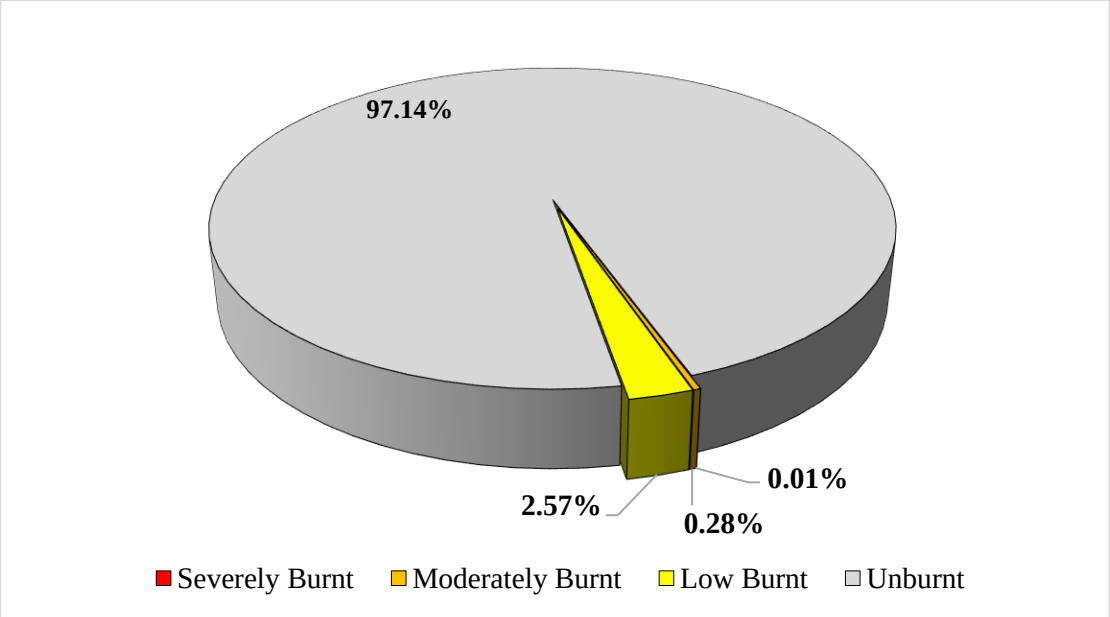


Figure 2.9.3 Distribution of burnt severity classes

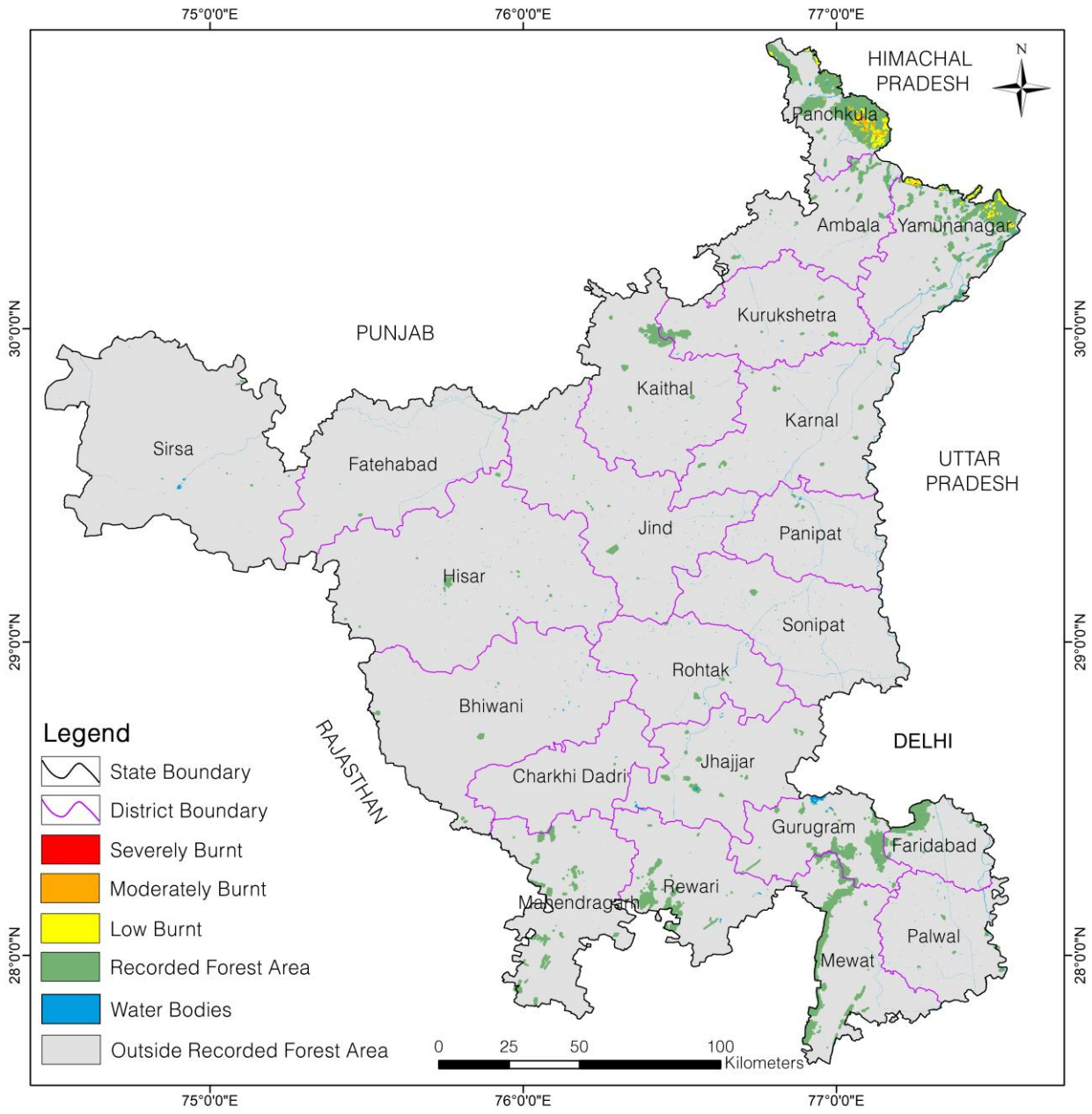


Figure 2.9.4 Map showing burnt area in Haryana

2.9.5 Results and Analysis

Based on the analysis, it is observed that Panchkula district has reported the highest fire affected forest area followed by Yamunanagar. A total of 44.63 km^2 fire affected forest area has been reported in the State, which constitute 2.86% of the RFA.

2.10 Himachal Pradesh

2.10.1 Introduction

The state lies between 30°22' N to 33°12' N latitude and 75°45' E to 79°04' E longitude. It shares border with Ladakh in the North, Jammu & Kashmir in the North-West, Punjab in the West & South-West, Haryana & Uttar Pradesh in South and Uttarakhand in the South-East. It also shares international border with China in the East. The state comprises of five main physiographic zones: Wet Sub-Temperate Zone, Humid Sub-Temperate Zone, Dry Temperate-Alpine High Lands, Humid Sub-Tropical Zone and Sub-Humid Tropical Zone. Geographical area of the state is 55,673 km^2, which is 1.69% of the geographical area of the country. Satluj, Beas, Parbati, Ravi, Chenab and Spiti are the major rivers of the state. The climate varies from hot and humid subtropical in the southern tracts to cold, alpine and glacial in the Northern and Eastern mountain ranges at high elevations. The average annual temperature varies from sub-zero to 35°C. The state receives average annual rainfall of about 1,800 mm. Forests of Himachal Pradesh are home to a variety of flora and fauna. A part of the Himalayan subtropical forest is dominated by Sal, Shisham and Chir Pine. The temperate region has Oak, Deodar, Blue Pine, Fir and Spruce. The Recorded Forest Area (RFA) of the state is 37,948 km^2, which is 68.16 % of its geographical area.

Forest fires are quite frequent in the state during fire season and a considerable area under forest is affected due to the forest fires every year. There are many causative factors for initiation and spread of fires. In majority of the incidents, regeneration of new grasslands and tourism activities are the major causes of fire incidents in the state. Ground truthing was carried out by a joint team of FSI and State Forest Department during June 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of 52 points were visited by the team.

2.10.2 Forest Cover and Forest Type Group

As per the ISFR 2023, forest cover in the state is 15,580.35 km^2, which constitutes 27.99% of the state's geographical area. In terms of forest canopy density classes, the state has 3,117.60 km^2 under Very Dense Forest (VDF), 7,280.29 km^2 under Moderately Dense Forest (MDF), 5,182.46 km^2 under Open Forest (OF) and 308.69 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Himachal Pradesh belong to nine forest type groups which are further categorized into 40 forest types. The major forest type groups comprise Himalayan Moist Temperate Forests followed by Moist Alpine Scrub, Tropical Dry Deciduous Forests and Subtropical Pine Forests.

The most vulnerable forest types to fires in the state are Northern dry mixed deciduous forest followed by Lower or Siwalik chir pine forest and Upper or Himalayan chir pine forest.

2.10.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.10.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.10.1. Table 2.10.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

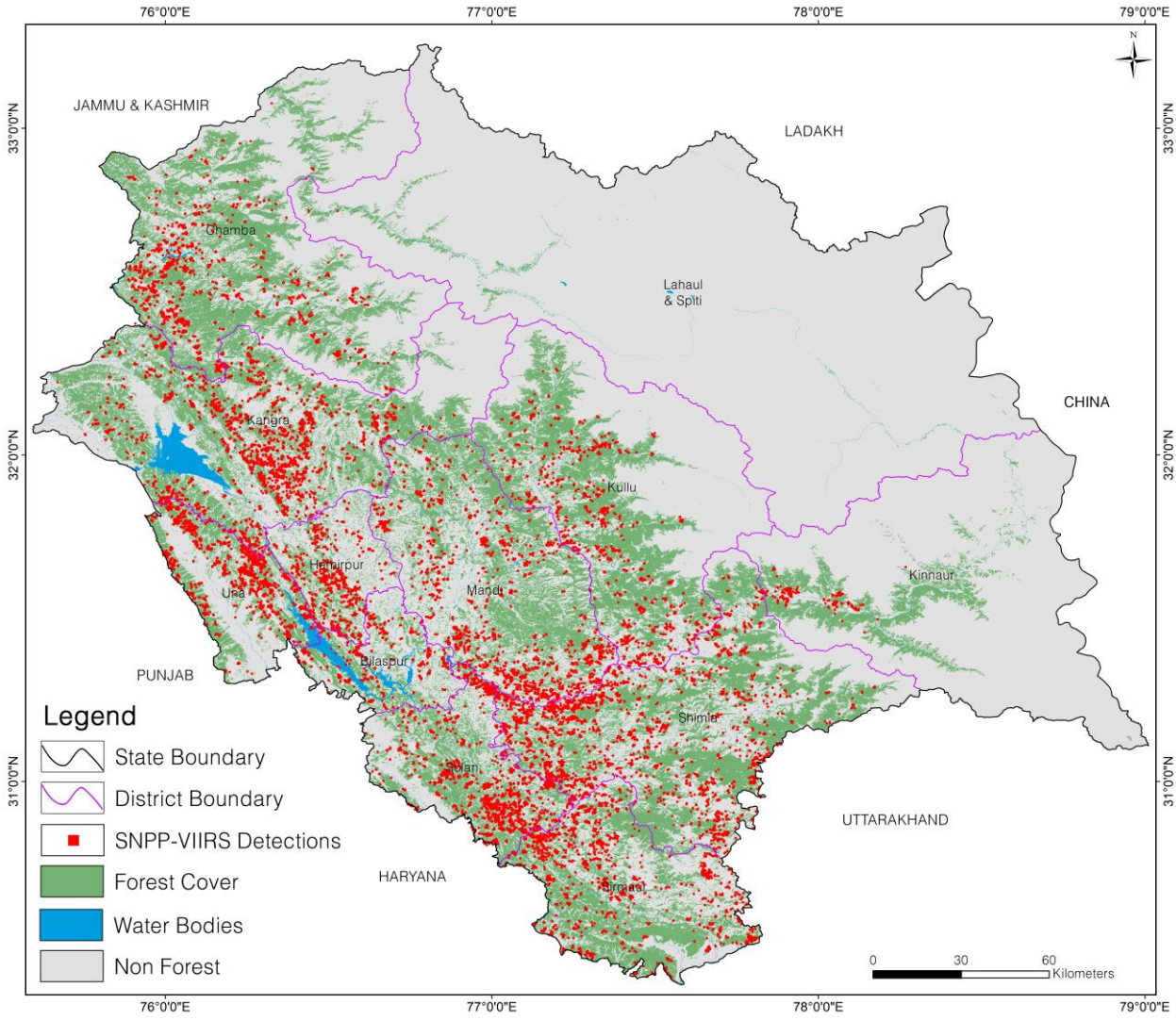


Figure 2.10.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.10.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Bilaspur	10	428
Chamba	31	784
Hamirpur	23	507
Kangra	32	1,547
Kinnaur	23	121
Kullu	147	764
Lahaul & Spiti	0	4
Mandi	128	1,167

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Shimla	199	1,823
Sirmaur	45	1,055
Solan	19	1,078
Una	47	858
Total	**704**	**10,136**

Based on the analysis of forest fire detections, the crucial period of forest fires in the state has been determined. The crucial period of forest fire detections in the state has been noticed to be tentatively between 02nd April to 18th June, which is based on the forest fire detections of last eight years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years is shown in the Figure 2.10.2.

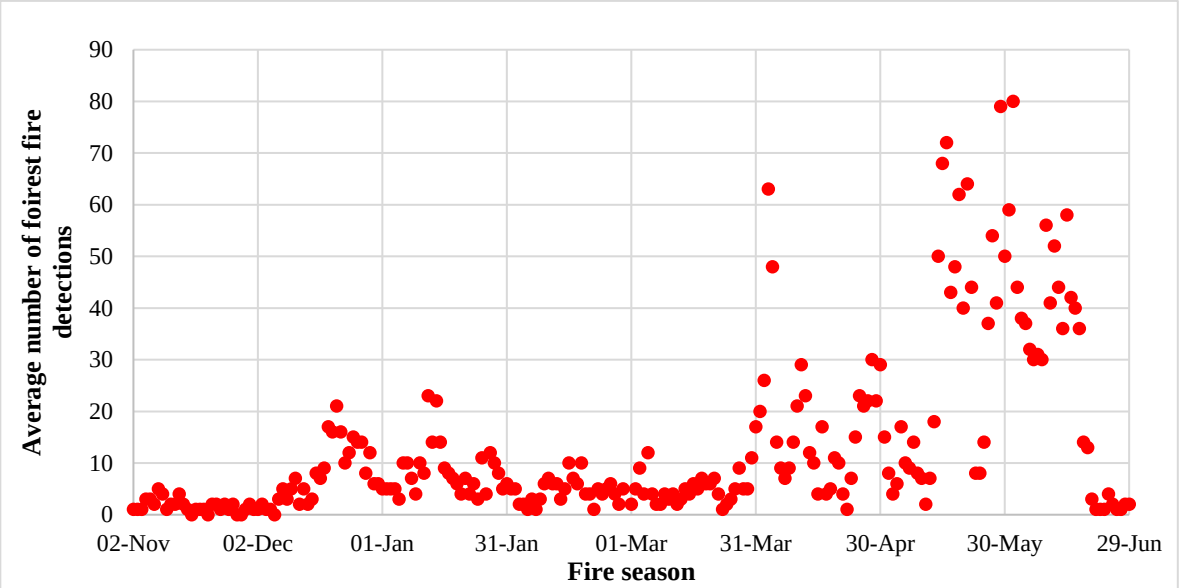


Figure 2.10.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.10.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.10.3. Table 2.10.2 shows the number of large forest fire detections during fire season 2022-23 and 2023-24.

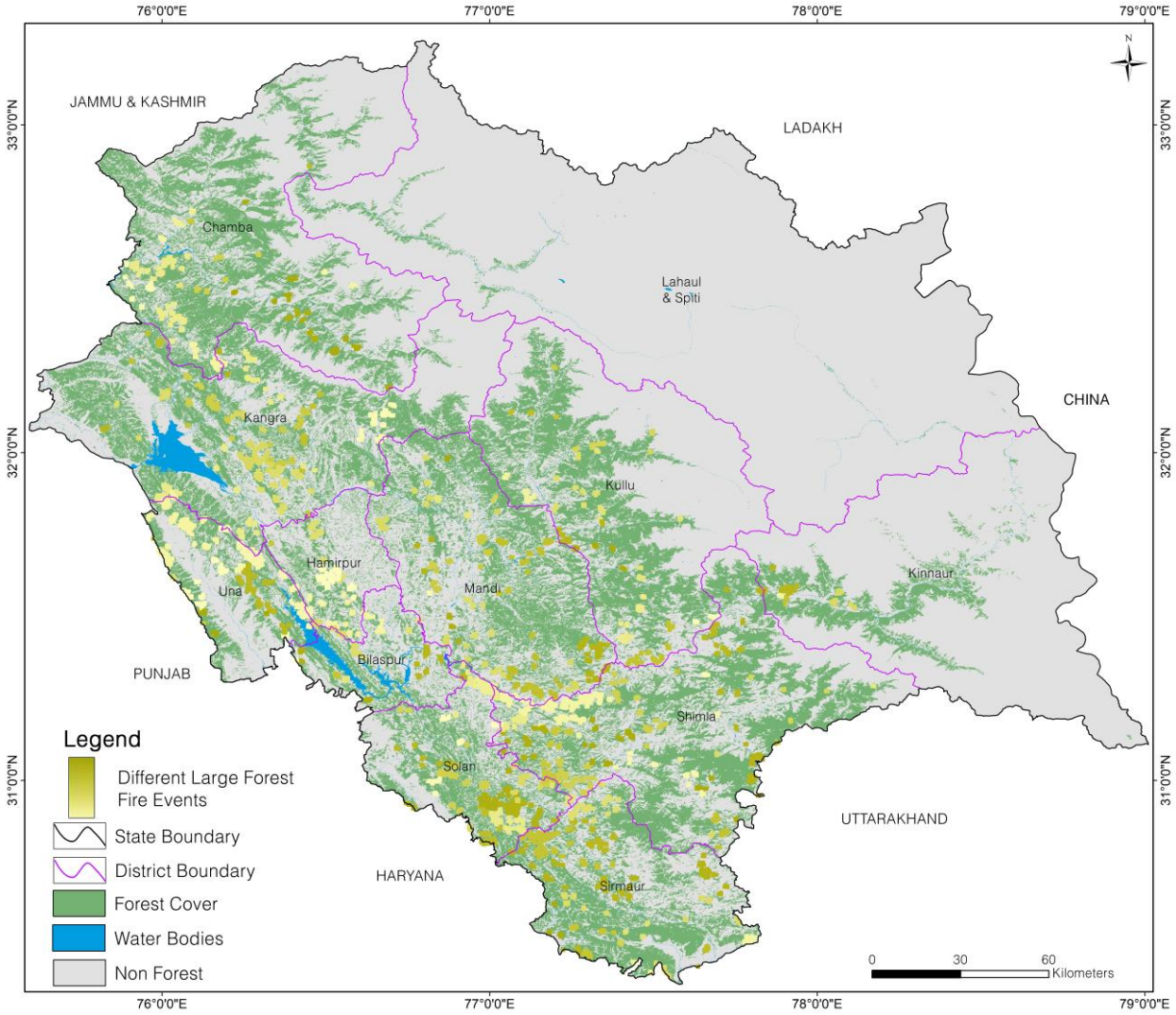


Figure 2.10.3 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.10.2 Number of large forest fire detections during fire season 2022-23 and 2023-24

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Himachal Pradesh	45	732

2.10.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.10.3. From the Figure 2.10.4, it can be inferred that 5.59% of the GW has been affected by fires. A total of

4.49% of the GW falls under the low burnt class, 1.09% under moderately burnt class and 0.01% under severely burnt class. The burnt area map of Himachal Pradesh is shown in Figure 2.10.5

Table 2.10.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
Bilaspur	0.00	8.98	38.36	47.34
Chamba	0.02	2.34	31.56	33.92
Hamirpur	0.15	26.25	83.85	110.25
Kangra	0.26	23.88	149.90	174.04
Kinnaur	0.00	0.00	0.00	0.00
Kullu	0.00	0.00	0.32	0.32
Lahaul & Spiti	0.00	0.00	0.00	0.00
Mandi	0.05	14.65	58.17	72.87
Shimla	0.02	12.31	35.23	47.56
Sirmaur	0.09	10.08	42.22	52.39
Solan	0.06	31.62	81.25	112.93
Una	0.11	22.15	109.23	131.49
Total	**0.76**	**152.26**	**630.09**	**783.11**

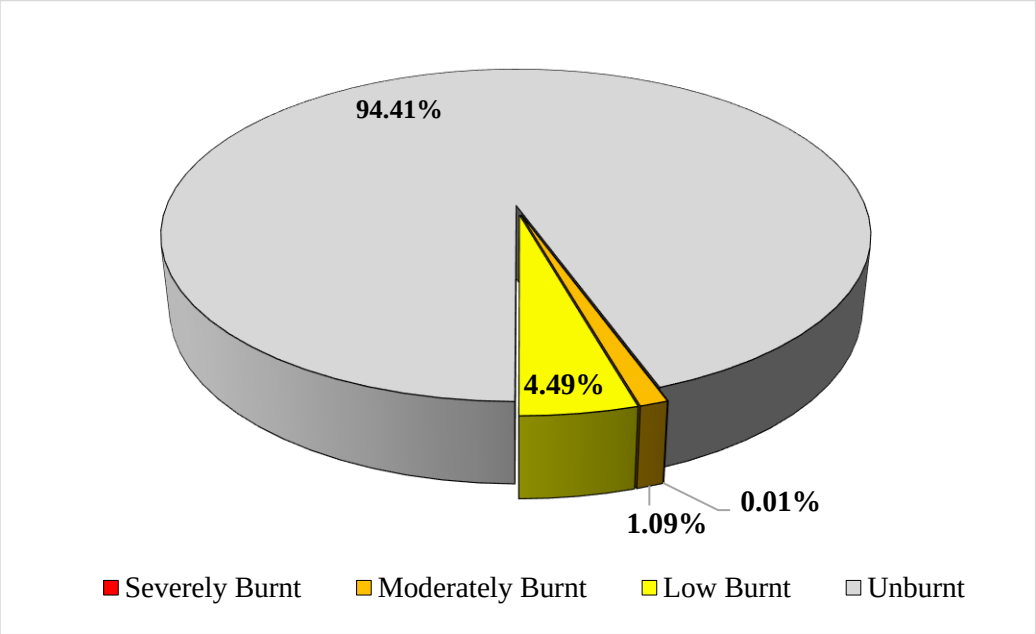


Figure 2.10.4 Distribution of burnt severity classes

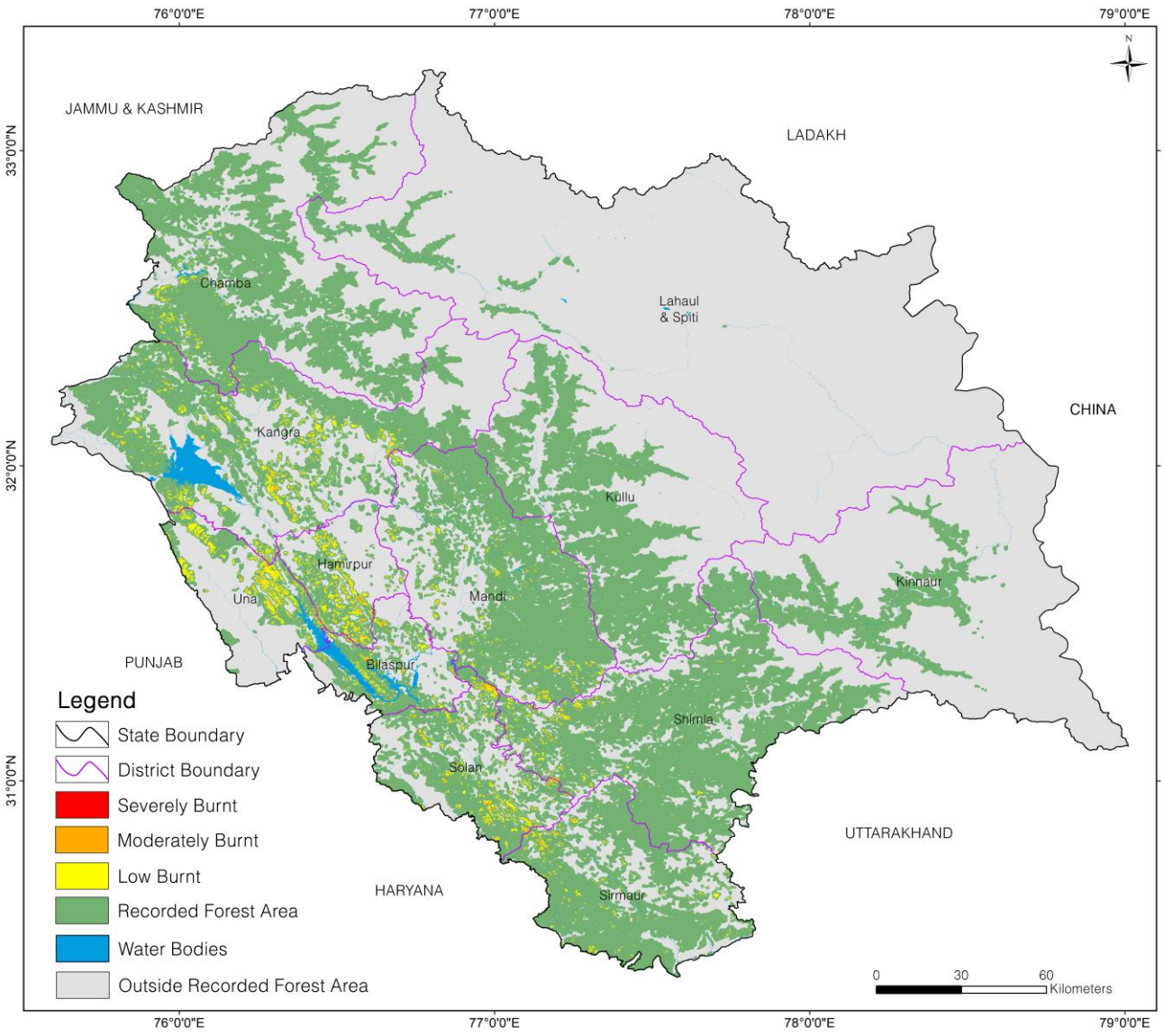


Figure 2.10.5 Map showing burnt area in Himachal Pradesh

2.10.5 Results and Analysis

Based on the analysis, it is observed that Kangra, Una, Solan and Hamirpur are the most forest fire affected districts. The maximum affected area under moderately burnt severity class has been observed in Solan followed Hamirpur and Kangra districts. Kangra district has reported the highest area under low burnt severity class. A total of 783.11 km^2 fire affected forest area has been reported in the state, which constitute 5.59% of the GW.

2.11 Jharkhand

2.11.1 Introduction

The state lies between 22° 00' N to 24° 37' N latitude and 83° 15' E to 87° 01' E longitude. It shares border with Bihar in the North, Uttar Pradesh in the North-West, Chhattisgarh in the West, Odisha in the South and West Bengal in the East. Physiographically, the state is prominently bounded by the Chotta Nagpur Plateau. Geographical area of the state is 79,716 km^2, which is 2.42% of the geographical area of the country. Ganga, Son, South Koel, Baitarni and Damodar are the major rivers of the state. The climate of the state is sub-tropical with the average annual temperature of the state varies from 4°C to 47°C. Whereas, the rainfall in the state is mainly influenced by South-West monsoon with average annual rainfall varies from 1,000 mm to 1,550 mm. The state is rich in flora and fauna biodiversity. Chhota Nagpur is rich in Sal (*Shorea robusta*), a valuable hardwood. Other trees include the Asan (*Terminalia tomentosa*). Among the other common trees, most of which are found in the plain, are the Banyan (*Ficus benghalensis*), Pipal (*Ficus religiosa*) and Palmyra palm (*Borassus flabellifer*). The Recorded Forest Area (RFA) of the state is 25,118 km^2, which is 31.51 % of its geographical area.

Forest fires are quite frequent in the state during fire season and a considerable area under forest is affected due to the forest fires every year. There are many causative factors for initiation and spread of fires. In majority of the incidents, human activities such as agricultural residue burning, collection of Mahua (*Madhuca indica*) flowers, and clearing of forest areas are the major causes of fire incidents in the state. Ground truthing was carried out by a joint team of FSI and State Forest Department during June 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of 15 points were visited by the team.

2.11.2 Forest Cover and Forest Type Group

As per ISFR 2023, forest cover in the state is 23,765.78 km^2, which constitutes 29.81% of the state's geographical area. In terms of forest canopy density classes, the state has 2,635.35 km^2 under Very Dense Forest (VDF), 9,640.99 km^2 under Moderately Dense Forest (MDF), 11,489.44 km^2 under Open Forest (OF) and 558.32 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Jharkhand belong to three forest type groups, which are further categorized into nine forest types. The forest type groups comprise of Tropical Dry Deciduous Forests and Tropical Moist Deciduous Forests.
The most vulnerable forest types to fires in the state are Dry peninsular sal forest followed by Northern dry mixed deciduous forest and Dry deciduous scrub.

2.11.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.11.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.11.1. Table 2.11.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

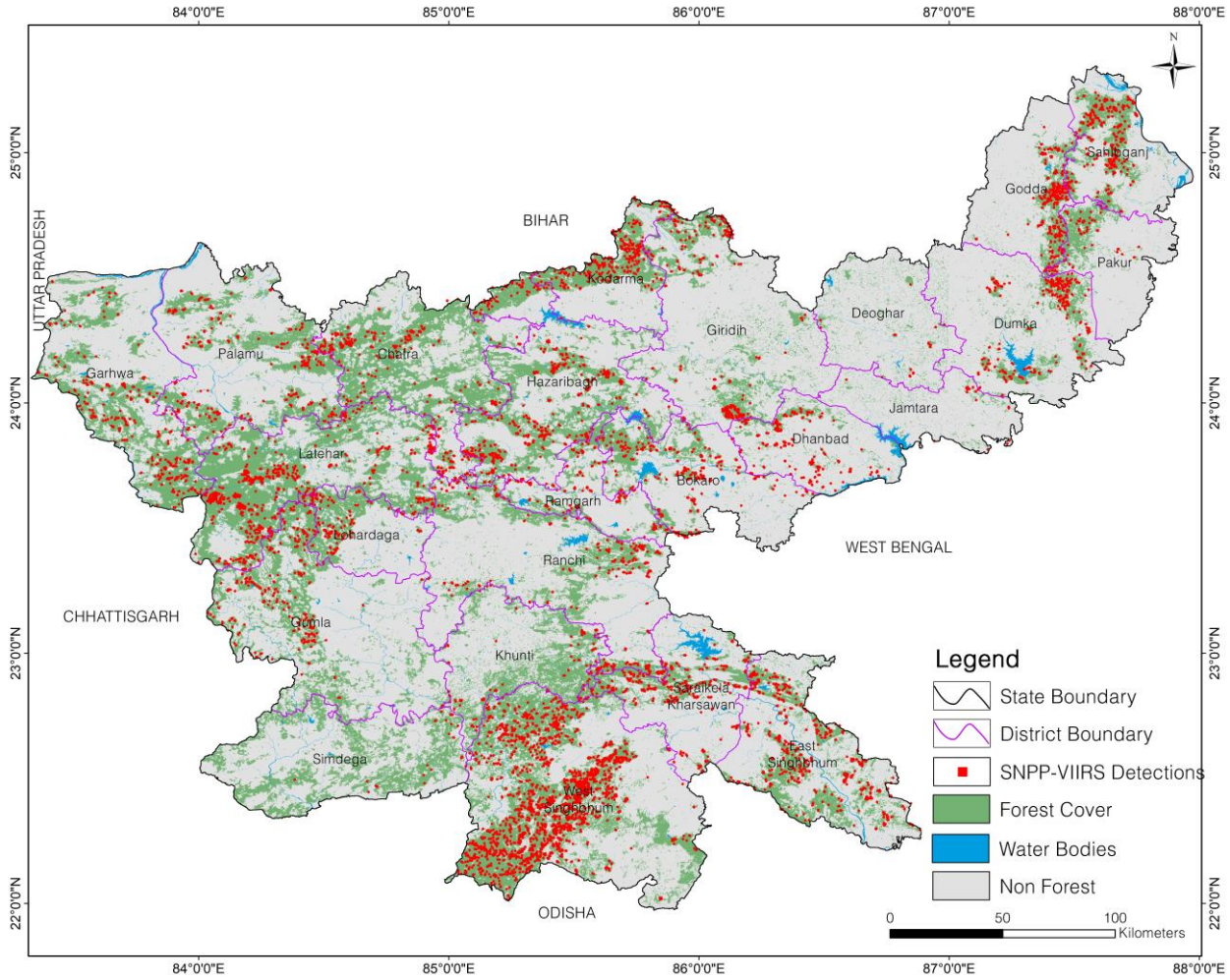


Figure 2.11.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.11.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Bokaro	458	242
Chatra	489	329
Deoghar	28	31
Dhanbad	204	176
Dumka	420	246
East Singhbhum	977	407
Garhwa	225	284
Giridih	361	231
Godda	451	306
Gumla	468	260
Hazaribagh	682	513
Jamtara	32	22

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Khunti	198	73
Kodarma	407	278
Latehar	802	710
Lohardaga	281	135
Pakur	180	63
Palamu	305	271
Ramgarh	320	238
Ranchi	480	252
Sahibganj	468	278
Saraikela Kharsawan	287	318
Simdega	542	27
West Singhbhum	2,858	1,835
Total	**11,923**	**7,525**

Based on the analysis of forest fire detections, the crucial period of forest fires in the state has been determined. The crucial period of forest fire detections in the state has been noticed to be tentatively between 02nd March to 18th April, which is based on the forest fire detections of last eight years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years is shown in the Figure 2.11.2.

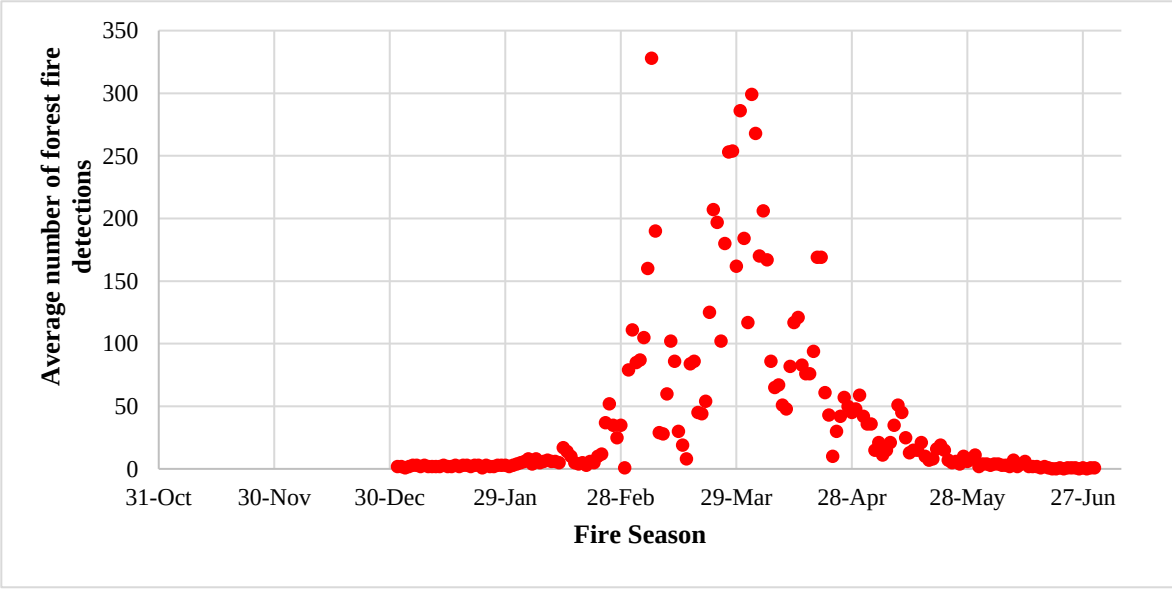


Figure 2.11.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.11.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.11.3. Table 2.11.2 shows the number of large forest fire detections during fire season 2022-23 and 2023-24.

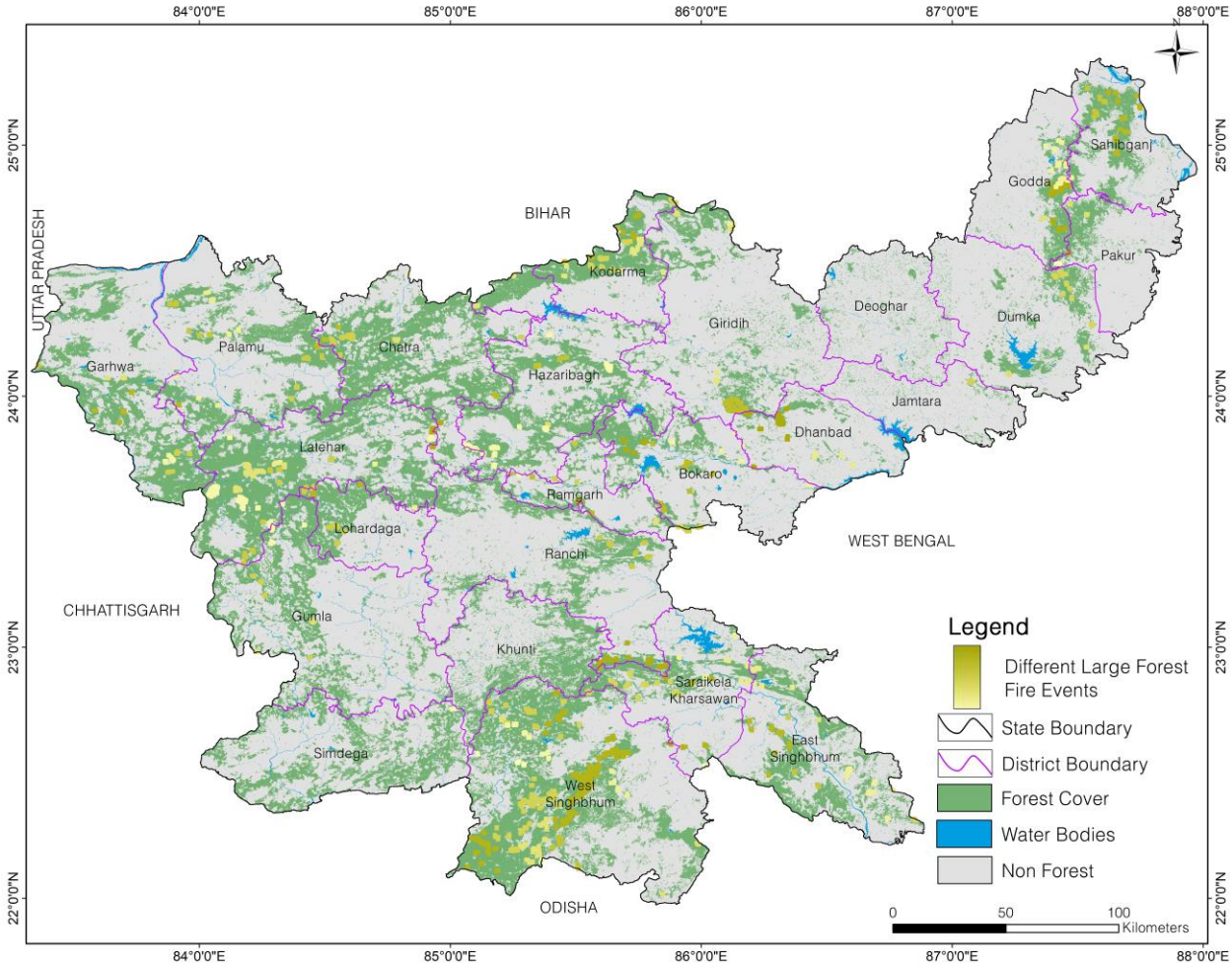


Figure 2.11.3 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.11.2 Number of large forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Jharkhand	555	385

2.11.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.11.3. From the Figure 2.11.4, it can be inferred that 5.69% of the RFA has been affected by fires. A total of 5.49% of the RFA falls under the low burnt class and 0.20% under moderately burnt class. Only 0.35 km^2 of the RFA have been classified under severely burnt class. The burnt area map of Jharkhand is shown in Figure 2.11.5.

Table 2.11.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
Bokaro	0.00	0.66	22.89	23.55
Chatra	0.00	0.74	82.16	82.90
Deoghar	0.00	0.10	7.71	7.81
Dhanbad	0.00	2.25	32.58	34.83
Dumka	0.00	1.43	42.43	43.86
East Singhbhum	0.00	3.70	146.04	149.74
Garhwa	0.19	0.54	20.65	21.38
Giridih	0.00	2.08	41.07	43.15
Godda	0.00	0.00	2.61	2.61
Gumla	0.00	6.30	74.39	80.69
Hazaribagh	0.00	3.71	172.40	176.11
Jamtara	0.00	0.00	0.01	0.01
Khunti	0.00	0.51	18.71	19.22
Kodarma	0.00	1.75	58.63	60.38
Latehar	0.00	3.52	51.29	54.81
Lohardaga	0.00	3.19	29.06	32.25
Pakur	0.00	0.00	0.99	0.99
Palamu	0.15	0.77	20.89	21.81
Ramgarh	0.00	0.65	12.78	13.43
Ranchi	0.00	3.70	56.64	60.34
Sahibganj	0.00	0.00	0.67	0.67
Saraikela Kharsawan	0.00	1.46	41.87	43.33
Simdega	0.00	0.00	3.17	3.17
West Singhbhum	0.00	1.86	107.51	109.37
Total	**0.35**	**38.95**	**1,047.16**	**1,086.46**

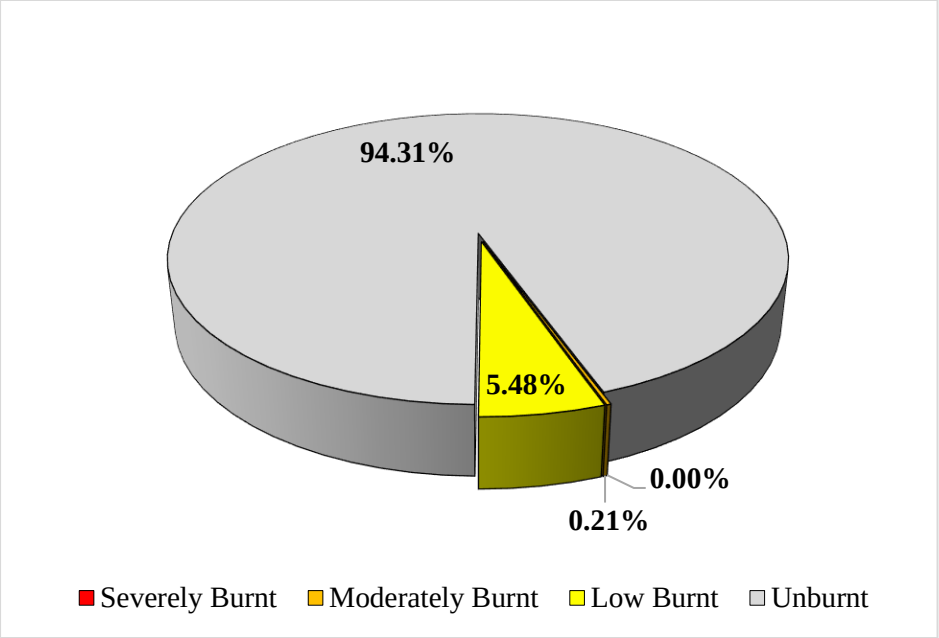


Figure 2.11.4 Distribution of burnt severity classes

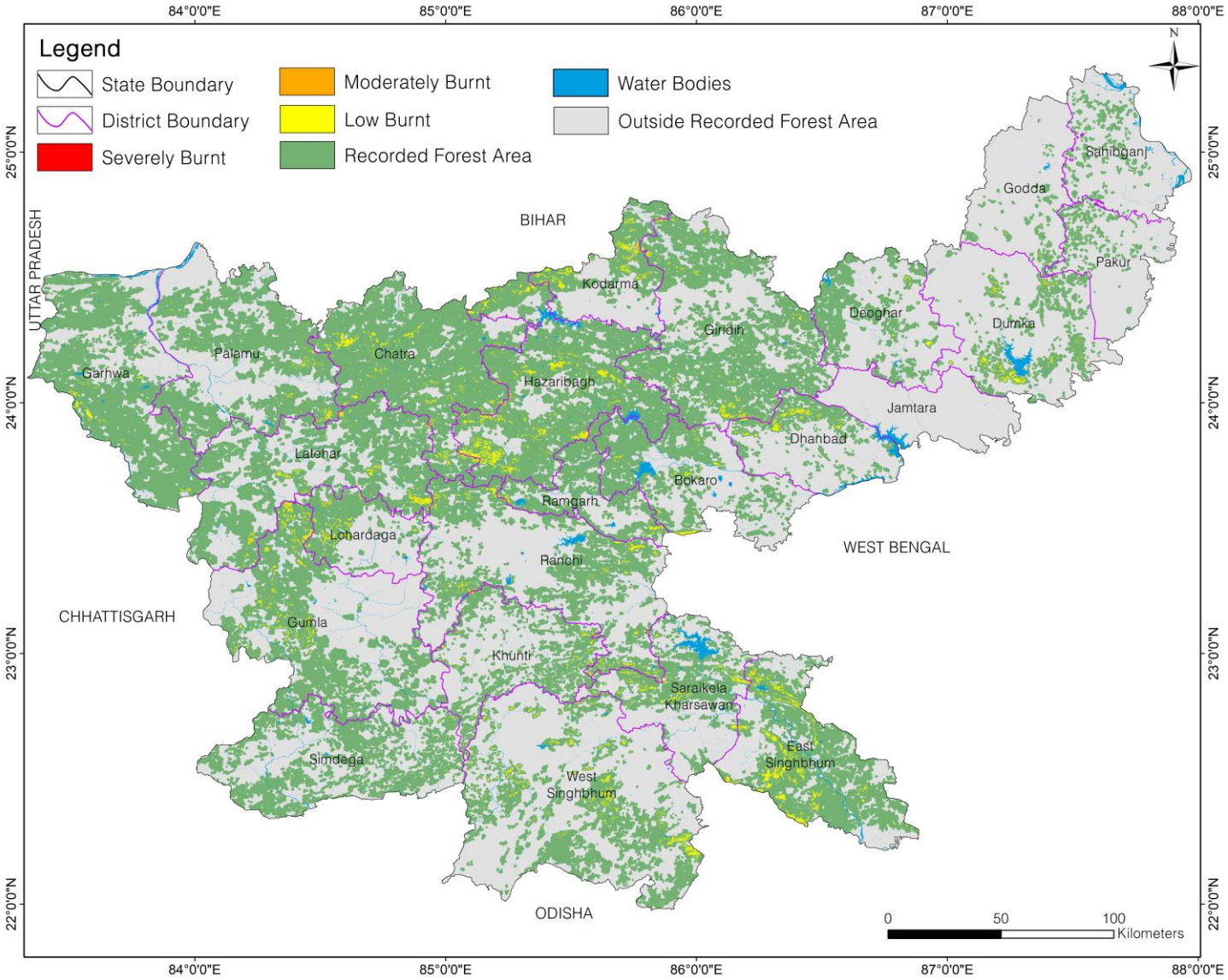


Figure 2.11.5 Map showing burnt area in Jharkhand

2.11.5 Results and Analysis

Based on the analysis, it is observed that Hazaribagh, East Singhbhum, West Singhbhum and Chatra are the most affected districts. The maximum affected area under moderately burnt severity class has been observed in Gumla and Hazaribagh districts. Hazaribagh district has also reported the highest area under low burnt severity class. A total of 1,086.46 km^2 fire affected forest area has been reported in the state, which constitute 5.69 % of the RFA.

2.12 Karnataka

2.12.1 Introduction

The state lies between 11°30' N to 18°30' N latitude and 74°00' E to 78°30' E longitude. It shares border with Maharashtra & Goa in the North & the North-West, Telangana & Andhra Pradesh in the East & the North-East, Kerala & Tamil Nadu in the South and Arabian Sea in the West. It has coastline to be around 400 km along the Arabian Sea. The state comprises of two main physiographic regions: The "Malnad" or hilly region comprising Western Ghats and "Maidan" or plain region comprising the inland plateau of varying heights. Geographical area of the state is 1,91,791 km^2, which is 5.83% of the geographical area of the country. East flowing rivers are Cauvery & Krishna and West flowing rivers mainly are Sharavati & Kali. The state has diverse climatic condition i.e. hot and moist summers and cool and dry winters with average temperature ranges from 25°C to 35°C. The rainfall in the state is mainly influenced by the South-West monsoon with average annual rainfall ranges from 2,000 mm to 3,200 mm. The state has variety of vegetation types and is rich in flora and fauna. The Recorded Forest Area (RFA) of the state is 38,284 km^2, which is 19.96 % of its geographical area.

Forest fires are quite frequent in the state during fire season and a considerable area under forest is affected due to the forest fires every year. There are many causative factors for initiation and spread of fires. In majority of the incidents, grazing, firewood collection, tourist spot, honey collection, hunting and for threatening wild animals from agricultural fields & habitation are the major causes of fire incidents in the state. Ground truthing was carried out by a joint team of FSI and State Forest Department during May 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of 30 points were visited by the team.

2.12.2 Forest Cover and Forest Type Group

As per ISFR 2023 forest cover in the state is 39,254.27 km^2, which constitutes 20.47% of the state's geographical area. In terms of forest canopy density classes, the state has 4,537.79 km^2 under Very Dense Forest (VDF), 21,151.75 km^2 under Moderately Dense Forest (MDF), 13,564.73 km^2 under Open Forest (OF) and 4,513.15 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Karnataka belong to eight forest type groups, which are further categorized into 24 forest types. The major forest type groups comprises of Tropical Dry Deciduous Forests followed by Tropical Moist Deciduous Forests, Tropical Wet Evergreen Forests and Tropical Thorn Forests.

The most vulnerable forest types to fires in the state are Dry deciduous scrub followed by Southern thorn scrub and Southern thorn forest.

2.12.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.12.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.12.1. Table 2.12.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

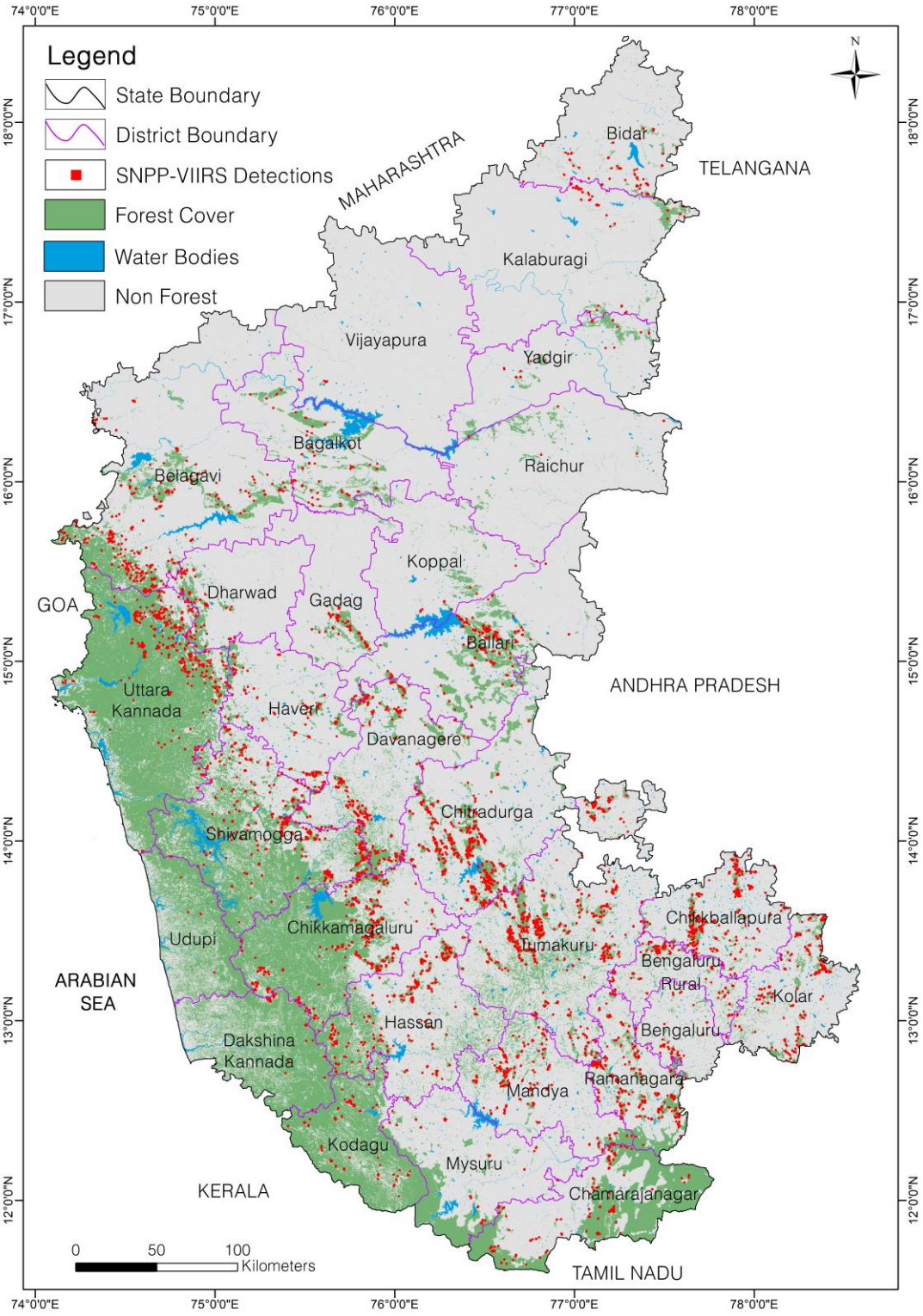


Figure 2.12.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.12.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Bagalkot	211	65
Ballari	778	273
Belagavi	1,033	318
Bengaluru	44	51
Bengaluru Rural	169	124
Bidar	63	66
Chamarajanagar	196	140
Chikkamagaluru	1,187	336
Chikkballapura	415	300
Chitradurga	927	494
Dakshina Kannada	322	33
Davanagere	613	298
Dharwad	267	90
Gadag	249	69
Hassan	518	278
Haveri	384	147
Kalaburagi	58	50
Kodagu	195	77
Kolar	193	230
Koppal	27	17
Mandya	302	212
Mysuru	50	30
Raichur	10	5
Ramanagara	365	258
Shivamogga	1,356	436
Tumakuru	933	631
Udupi	24	11
Uttara Kannada	2,162	436
Vijayapura	8	4
Yadgir	15	21
Total	**13,074**	**5,500**

Based on the analysis of forest fire detections, the crucial period of forest fires in the state has been determined. The crucial period of forest fire detections in the state has been noticed to be tentatively between 14th February to 31st March, which is based on the forest fire detections of last

eight years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years is shown in the Figure 2.12.2.

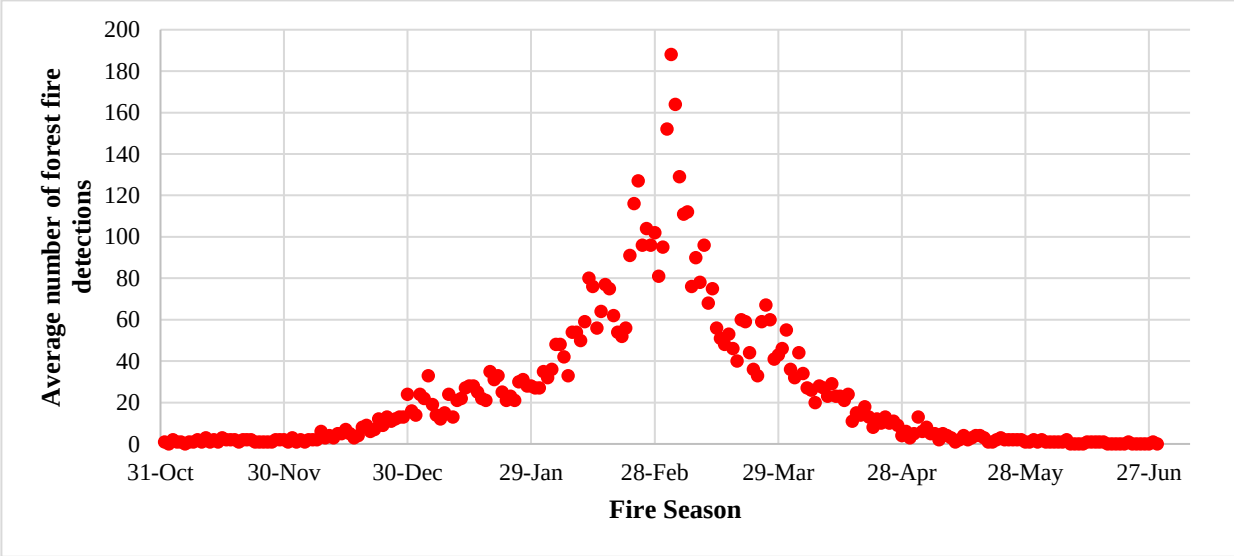


Figure 2.12.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.12.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.12.3. Table 2.12.2 shows the number of large forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

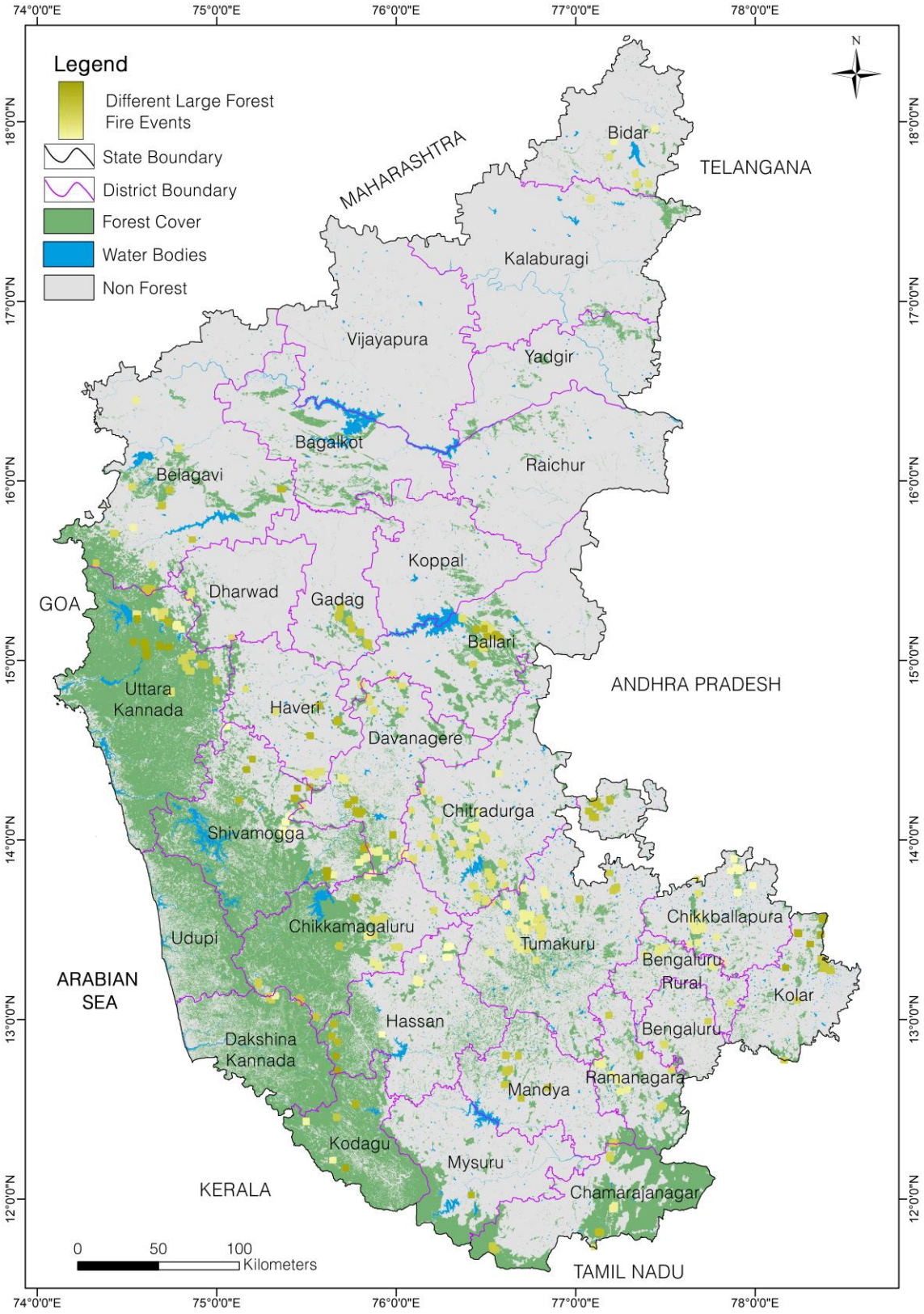


Figure 2.12.3 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.12.2 Number of large forest fire detections during fire season 2022-23 and 2023-24

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Karnataka	868	311

2.12.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.12.3. From the Figure 2.12.4, it can be inferred that 6.73% of the RFA has been affected by fires. A total of 5.56% of the RFA falls under the low burnt class and 1.17% under moderately burnt class. No areas have been classified under severely burnt class. The burnt scar map of Karnataka is shown in Figure 2.12.5.

Table 2.12.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
Bagalkot	0.00	0.02	7.95	7.97
Ballari	0.00	2.99	107.20	110.19
Belagavi	0.00	24.71	39.40	64.11
Bengaluru	0.00	0.51	31.51	32.02
Bengaluru Rural	0.00	0.03	4.98	5.01
Bidar	0.00	0.58	3.79	4.37
Chamarajanagar	0.00	4.97	155.37	160.34
Chikkamagaluru	0.00	13.27	112.32	125.59
Chikkballapura	0.00	49.63	84.74	134.37
Chitradurga	0.00	36.54	234.85	271.39
Dakshina Kannada	0.00	2.79	2.17	4.96
Davanagere	0.00	18.70	144.62	163.32
Dharwad	0.00	16.60	11.66	28.26
Gadag	0.00	2.85	19.55	22.40
Hassan	0.00	9.34	107.82	117.16
Haveri	0.00	5.41	36.50	41.91
Kalaburagi	0.00	0.36	1.54	1.91
Kodagu	0.00	1.30	6.03	7.34
Kolar	0.00	4.52	17.09	21.60
Koppal	0.00	0.00	0.00	0.00

District	Affected Area			Total
	Severely	Moderately	Low	
Mandya	0.00	1.16	44.46	45.62
Mysuru	0.00	0.02	2.54	2.56
Raichur	0.00	0.00	0.00	0.00
Ramanagara	0.00	11.81	164.65	176.46
Shivamogga	0.00	47.90	88.93	136.83
Tumakuru	0.00	7.97	237.45	245.42
Udupi	0.00	0.00	0.09	0.09
Uttara Kannada	0.00	99.46	56.61	156.07
Vijayapura	0.00	0.14	0.13	0.27
Yadgir	0.00	0.04	0.78	0.81
Total	**0.00**	**363.61**	**1,724.74**	**2,088.35**

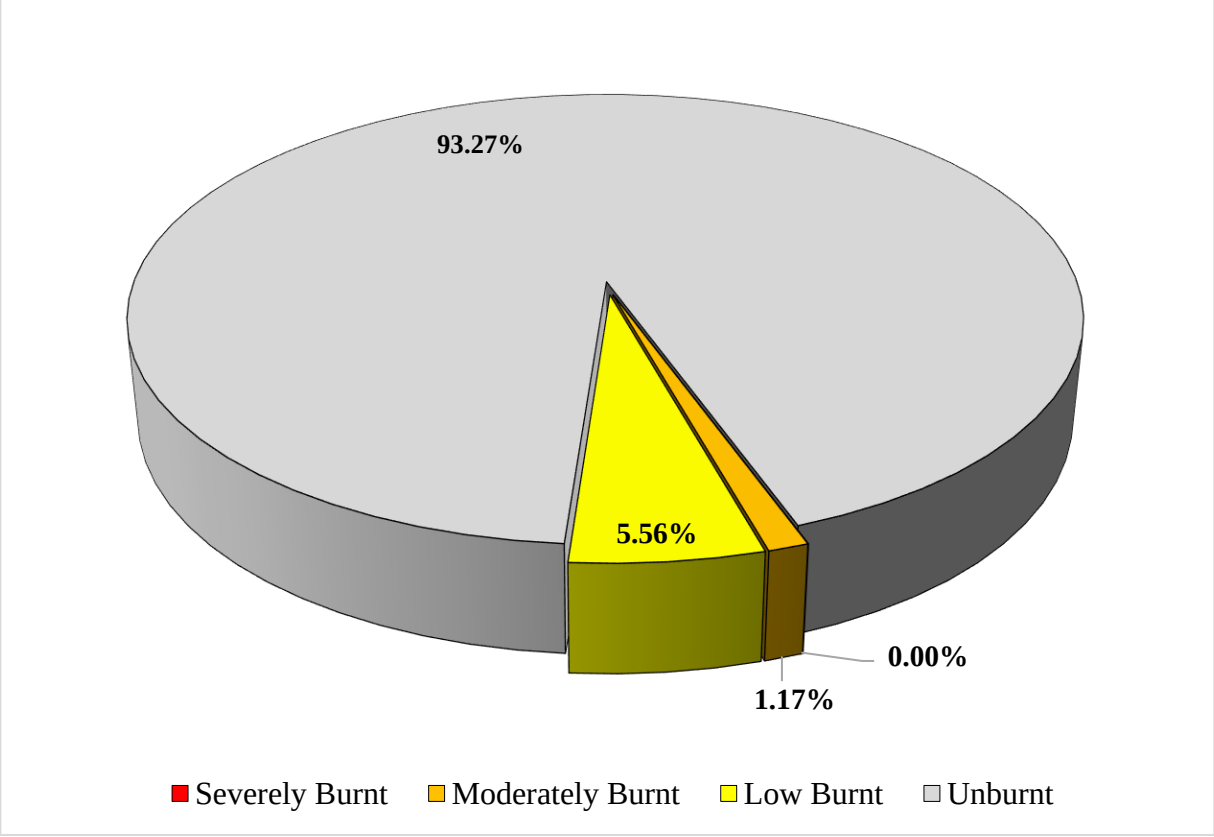


Figure 2.12.4 Distribution of burnt severity classes

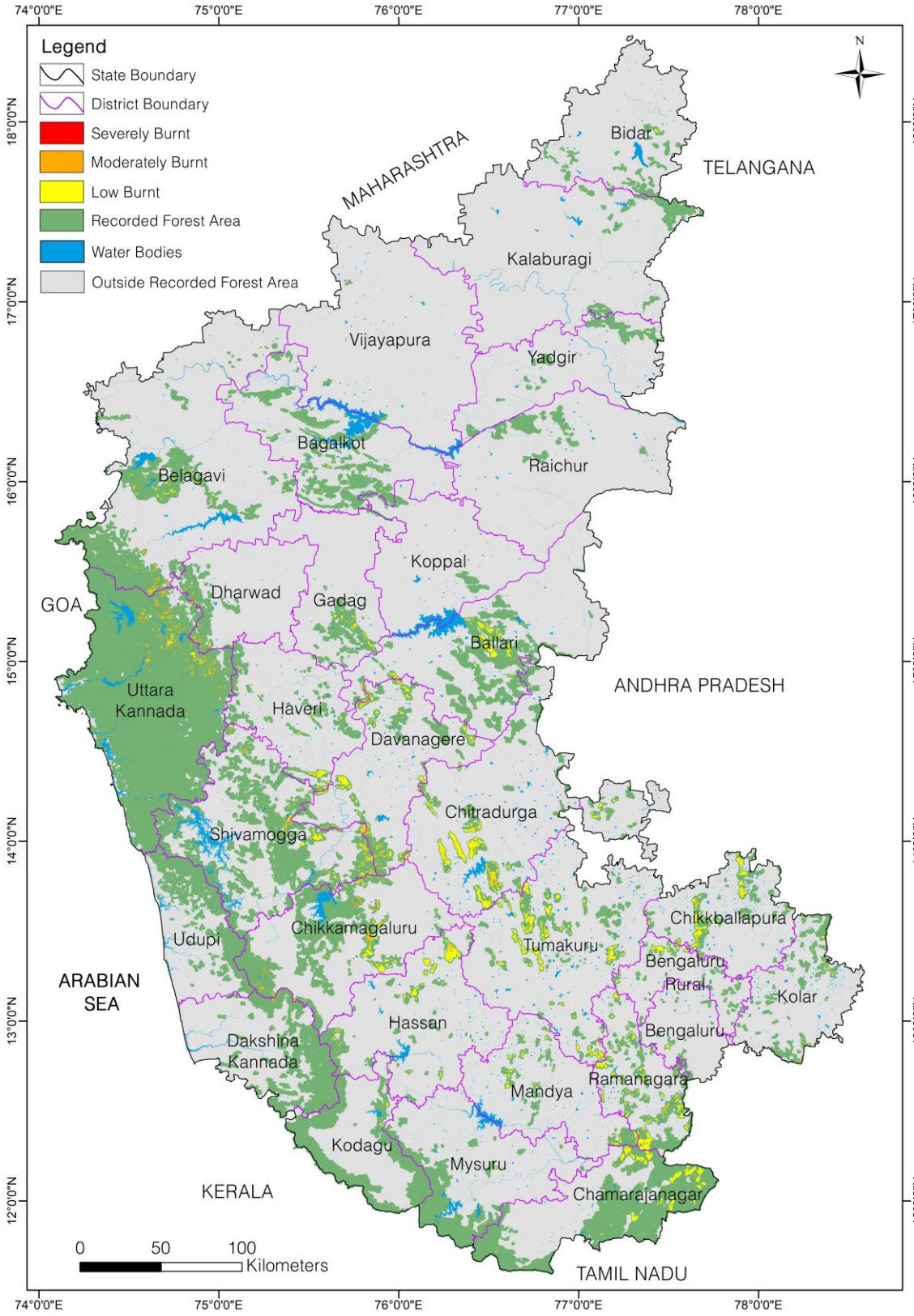


Figure 2.12.5 Map showing burnt area in Karnataka

2.12.5 Results and Analysis

Based on the analysis, it is observed that Chitradurga, Tumakuru and Ramanagara are the most affected districts. The maximum affected area under moderately burnt severity class has been observed in Uttara Kannada followed by Chikkballapura and Shivamoga districts. Tumakuru district has reported the highest area under low burnt severity class followed by Chitradurg and Ramanagara. A total of 2,088.35 km^2 fire affected forest area has been reported in the state, which constitute 6.73 % of the RFA.

2.13 Kerala

2.13.1 Introduction

The state lies between 8°17' N to 12°47' N latitude and 74°52' E to 77°24' E longitude. It shares border with Tamil Nadu in the East & South-East, Karnataka in the North & North-East and Lakshadweep Sea in the West. It has the coastline of around 580 km. The state comprises of three main physiographic regions: The Coastal Plains, Central Midland and Eastern Highland. Geographical area of the state is 38,852 km^2, which is 1.18% of the geographical area of the country. Periyar, Bharathapuzha, Pampa and Neyyar are the important rivers of the state. The climate of the state is humid with the average annual temperature of the state varying from 19.8°C to 36.7°C. The rainfall in the state is mainly influenced by South-West monsoon and North-East monsoon with average annual rainfall varies from 1,520 mm to 4,075 mm. The state is rich in diverse range of flora and fauna biodiversity. The Recorded Forest Area (RFA) of the state is 11,522 km^2, which is 29.66% of its geographical area.

Majority of the incidents responsible for initiation and spread of fires may be attributed to grazing and firewood collection. Ground truthing was carried out by a joint team of FSI and State Forest Department during May 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of 16 points were visited by the team.

2.13.2 Forest Cover and Forest Type Group

As per the ISFR 2023, forest cover in the state is 22,059.36 km^2, which constitutes 56.78% of the state's geographical area. In terms of forest canopy density classes, the state has 2,041.17 km^2 under Very Dense Forest (VDF), 9,321.82 km^2 under Moderately Dense Forest (MDF), 10,696.37 km^2 under Open Forest (OF) and 21.88 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Kerala belong to eight forest type groups which are further categorized into 17 forest types. The major forest type groups comprises of Tropical Wet Evergreen Forests followed by Tropical Semi-Evergreen Forests and Tropical Moist Deciduous Forests.

The most vulnerable forest types to fires in the Southern moist mixed deciduous forest followed by West Coast semi-evergreen forest and West Coast tropical evergreen forest.

2.13.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.13.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.13.1. Table 2.13.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

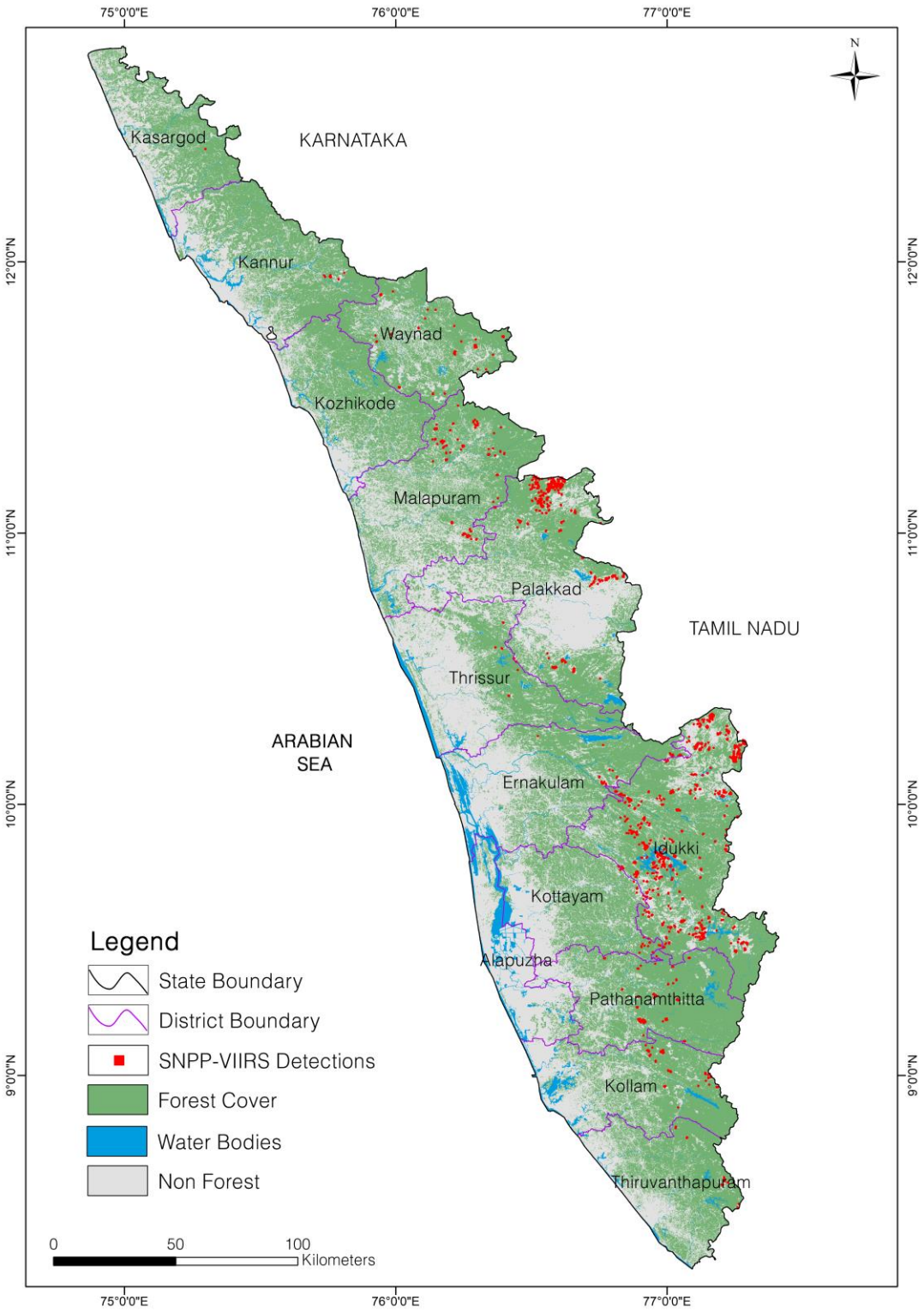


Figure 2.13.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.13.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Alappuzha	0	0
Ernakulam	16	25
Idukki	449	570
Kannur	14	9
Kasargod	3	1
Kollam	37	47
Kottayam	52	21
Kozhikode	6	0
Malapuram	95	74
Palakkad	544	250
Pathanamthitta	54	58
Thiruvanthapuram	14	12
Thrissur	182	6
Waynad	84	37
Total	**1,550**	**1,110**

Based on the analysis of forest fire detections, the crucial period of forest fires in the state has been determined. The crucial period of forest fire detections in the state has been noticed to be tentatively between 28th January to 29th March, which is based on the forest fire detections of last eight years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years is shown in the Figure 2.13.2.

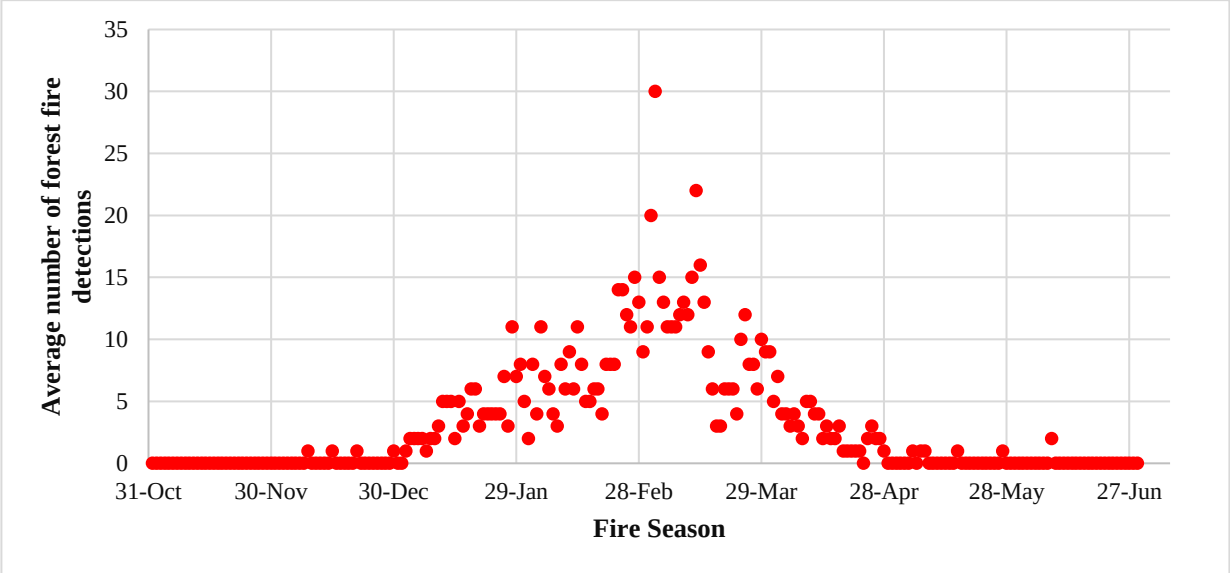


Figure 2.13.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.13.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.13.3. Table 2.13.2 shows the number of large forest fire detections during fire season 2022-23 and 2023-24.

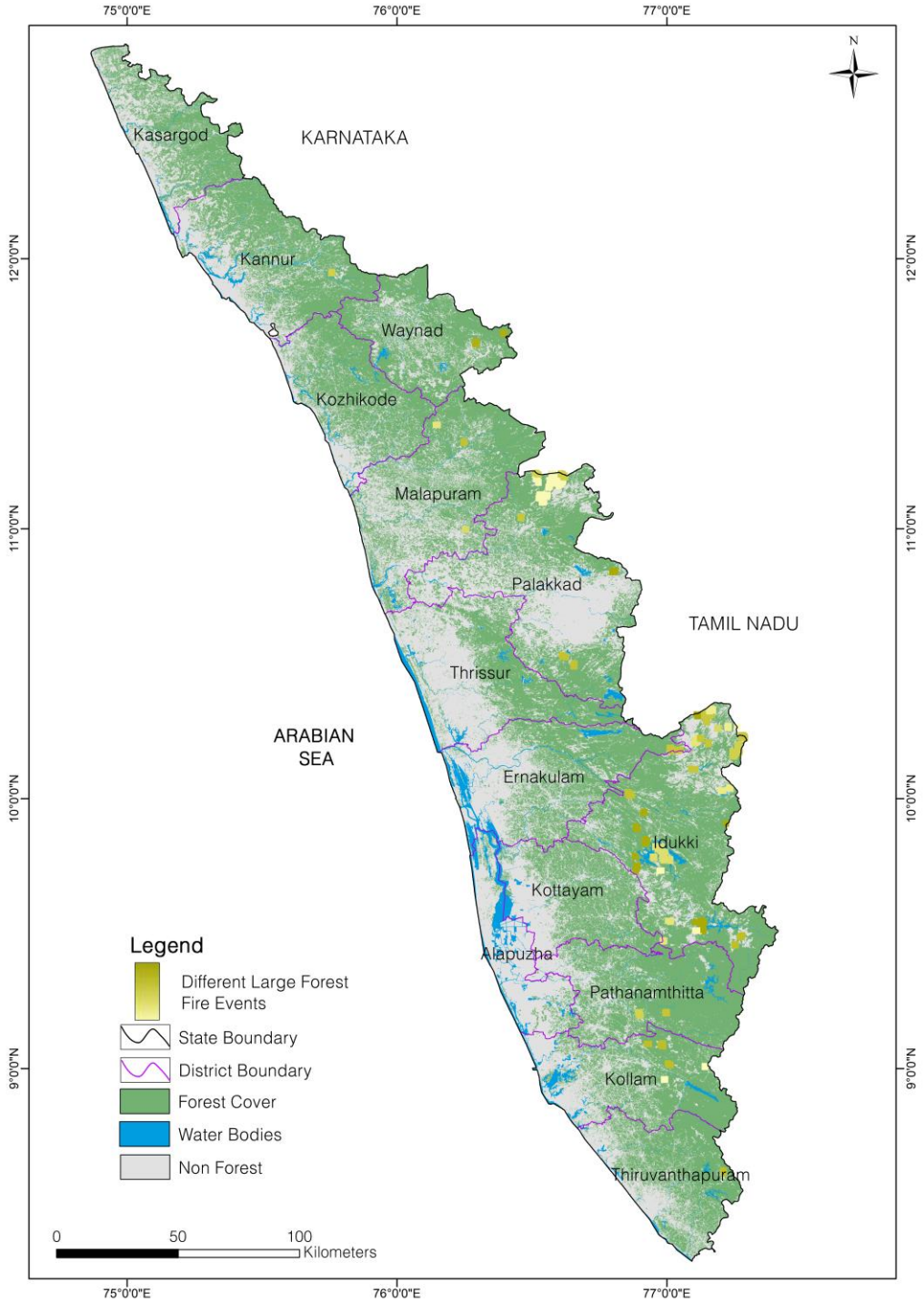


Figure 2.13.3 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.13.2 Number of large forest fire detections during fire season 2022-23 and 2023-24

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Kerala	89	70

2.13.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.13.3. From the Figure 2.13.4, it can be inferred that 1.81% of the RFA has been affected by fires. A total of 1.21% of the RFA falls under the low burnt class and 0.60% under moderately burnt class. Only 0.01 km^2 of the RFA have been classified under severely burnt class. The burnt scar map of Kerala is shown in Figure 2.13.5.

Table 2.13.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
Alappuzha	0.00	0.00	0.00	0.00
Ernakulam	0.00	0.16	2.24	2.40
Idukki	0.00	45.01	88.86	133.87
Kannur	0.00	0.00	0.00	0.00
Kasargod	0.00	0.00	0.00	0.00
Kollam	0.00	0.19	0.73	0.92
Kottayam	0.00	0.87	2.17	3.04
Kozhikode	0.00	0.00	0.01	0.01
Malapuram	0.00	0.32	0.42	0.74
Palakkad	0.01	20.01	36.15	56.18
Pathanamthitta	0.00	1.90	3.04	4.94
Thiruvanthapuram	0.00	0.12	0.30	0.42
Thrissur	0.00	0.05	0.37	0.42
Waynad	0.00	0.47	5.56	6.03
Total	**0.01**	**69.10**	**139.85**	**208.96**

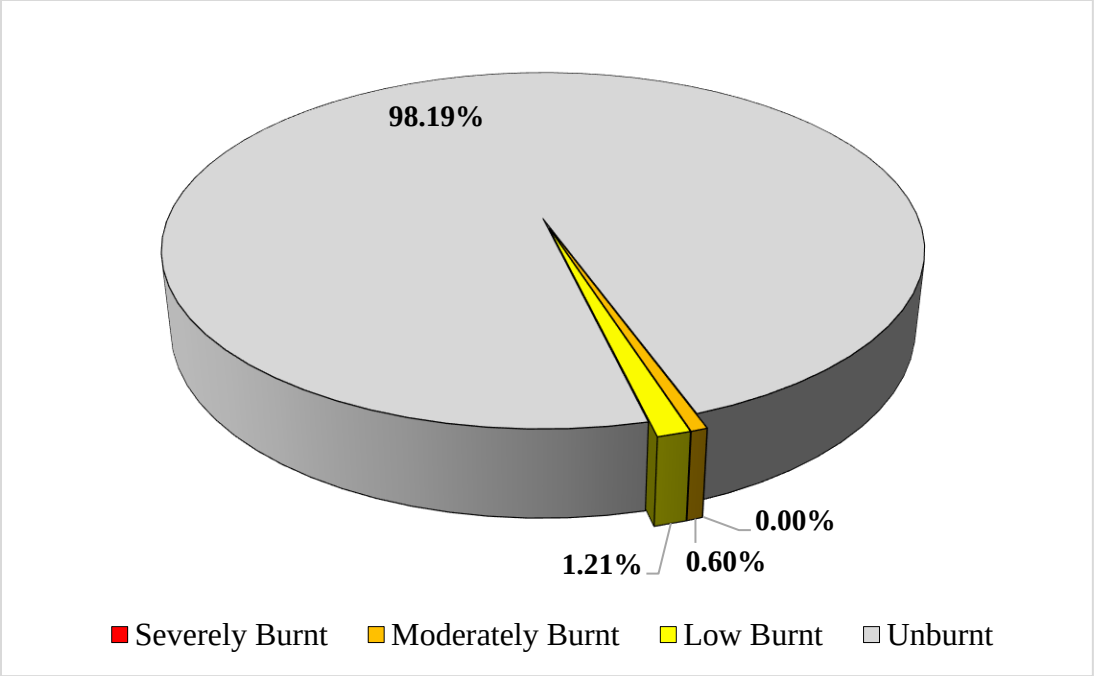


Figure 2.13.4 Distribution of burnt severity classes

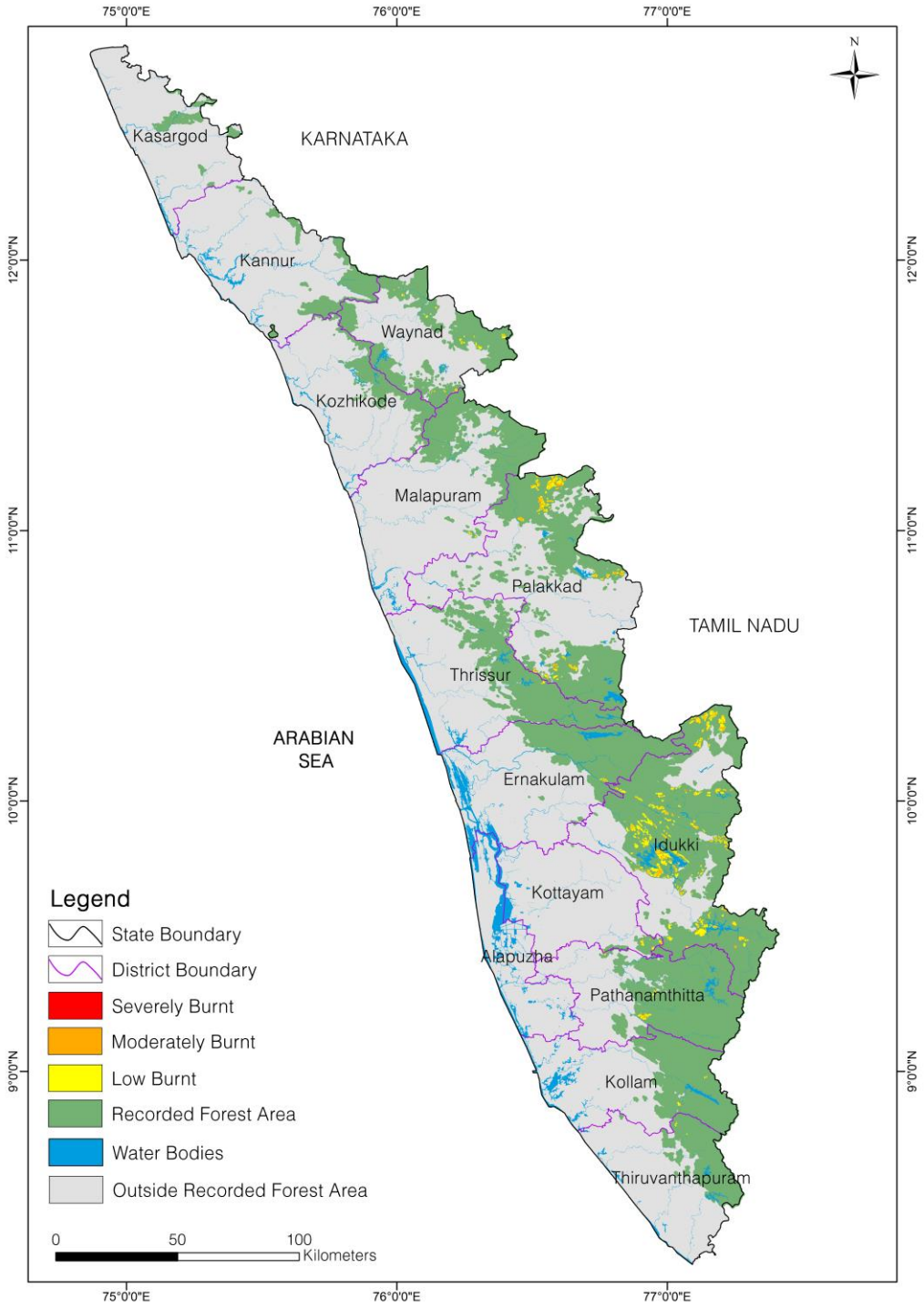


Figure 2.13.5 Map showing burnt area in Kerala

2.13.5 Results and Analysis

Based on the analysis, it is observed that Idukki and Palakkad are the most affected districts. A total of 208.96 km^2 fire affected forest area has been reported in the state, which constitutes 1.81% of the RFA.

2.14 Madhya Pradesh

2.14.1 Introduction

The state lies between 21°17' N to 26°52' N latitude and 74°08' E to 82°49' E longitude. It shares border with Gujarat in the West, Rajasthan in the North-West, Uttar Pradesh in the North-East, Chhattisgarh in the East and Maharashtra in the South. The state comprises of four main physiographic zones: the low lying areas in the North & North-West of Gwalior, Malwa Plateau, Satpuda and Vindhyan Ranges. Geographical area of the state is 3,08,252 km^2, which is 9.38% of the geographical area of the country. Chambal, Betwa, Son and Narmada are the major rivers of the state. The state experienced sub-tropical climatic condition with average annual temperature of the state varies from 22° to 25°C. Whereas, the rainfall in the state is mainly influenced by South-West monsoon with average annual rainfall ranges from 800 mm to 1,800 mm. The state is rich in diverse range of flora and fauna biodiversity. Teak and Sal forests are pride of the state. Bamboo bearing areas are also widely distributed. The Recorded Forest Area (RFA) of the state is 94,689 km^2, which is 30.72% of its geographical area.

Forest fires are quite frequent in the state during fire season and a considerable area under forest is affected due to the forest fires every year. There are many causative factors for initiation and spread of fires. In majority of the incidents, agriculture practices, Mahua (*Madhuca indica*) flower collection, Tendu (*Diospyros melanoxylon*) patta collection and encroachment are the major cause of fire incidents in the state. Ground truthing was carried out by a joint team of FSI and State Forest Department during April 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of 50 points were visited by the team.

2.14.2 Forest Cover and Forest Type Group

As per ISFR 2023, forest cover in the state is 77,073.44 km^2, which constitutes 25.00% of the state's geographical area. In terms of forest canopy density classes, the state has 7,021.31 km^2 under Very Dense Forest (VDF), 33,508.64 km^2 under Moderately Dense Forest (MDF), 36,543.49 km^2 under Open Forest (OF) and 3,124.20 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Madhya Pradesh belong to six forest type groups, which are further categorized into 22 forest types. The major

forest type groups comprise of Tropical Dry Deciduous Forests followed by Tropical Moist Deciduous Forests and Tropical Thorn Forests.

The most vulnerable forest types to fires in the state are Dry teak forest followed by Southern dry mixed deciduous forest and Northern dry mixed deciduous forest.

2.14.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.14.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.14.1. Table 2.14.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

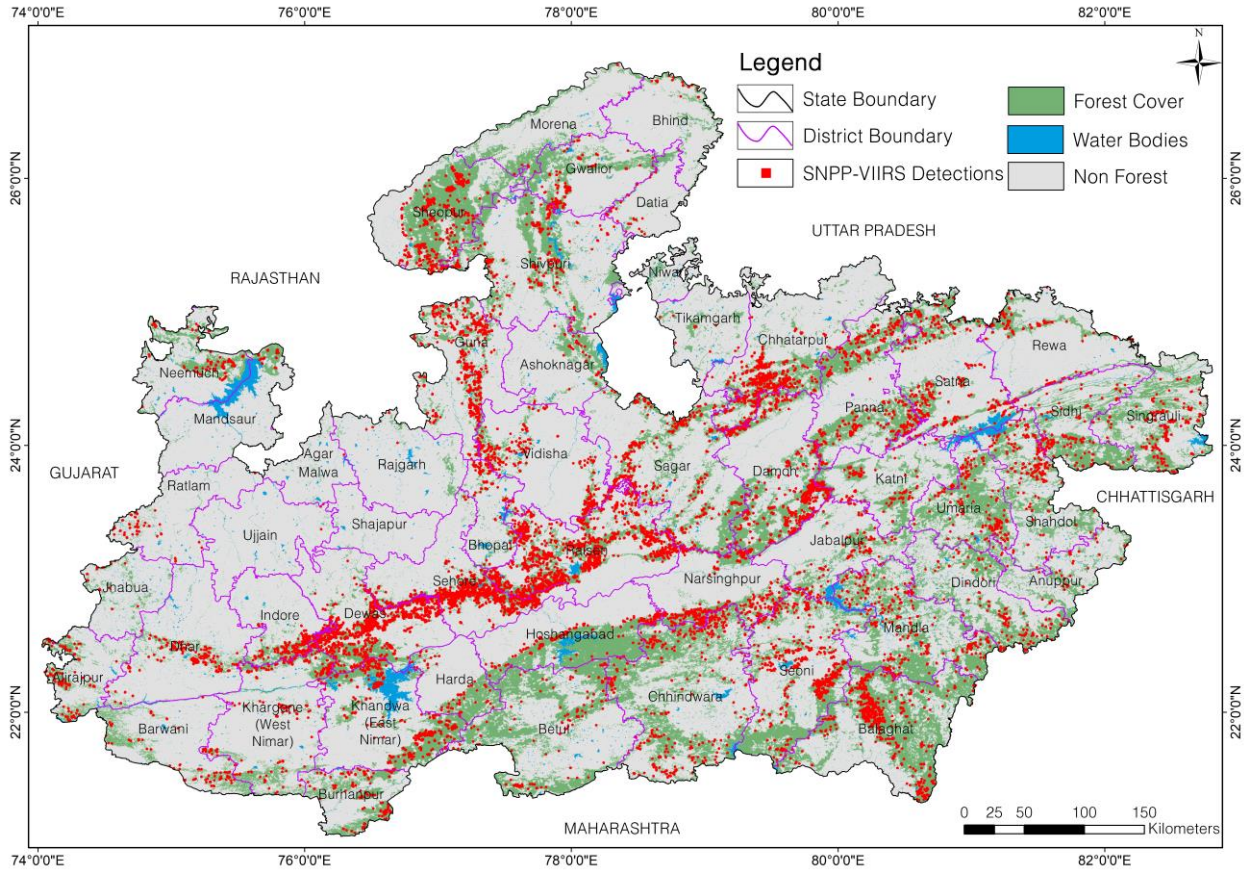


Figure 2.14.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.14.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Agar Malwa	7	5
Alirajpur	110	119
Anuppur	109	48
Ashoknagar	33	43
Balaghat	1,098	681
Barwani	73	84
Betul	527	173
Bhind	1	24
Bhopal	98	123
Burhanpur	378	139
Chhatarpur	192	732
Chhindwara	1,405	431
Damoh	991	817
Datia	31	33

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Dewas	981	1,265
Dhar	202	183
Dindori	312	151
Guna	467	604
Gwalior	38	124
Harda	121	67
Hoshangabad	280	235
Indore	219	291
Jabalpur	397	140
Jhabua	29	26
Katni	242	201
Khandwa (East Nimar)	539	457
Khargone (West Nimar)	347	303
Mandla	479	323
Mandsaur	17	35
Morena	0	10
Narsinghpur	438	426
Neemuch	56	121
Niwari	5	0
Panna	422	563
Raisen	1,352	1,696
Rajgarh	8	6
Ratlam	72	55
Rewa	107	182
Sagar	465	511
Satna	292	430
Sehore	632	1,136
Seoni	749	595
Shahdol	580	238
Shajapur	0	0
Sheopur	217	641
Shivpuri	171	333
Sidhi	544	242
Singrauli	300	214
Tikamgarh	12	13
Ujjain	6	3
Umaria	671	212
Vidisha	320	394
Total	**17,142**	**15,878**

Based on the analysis of forest fire detections, the crucial period of forest fires in the state has been determined. The crucial period of forest fire detections in the state has been noticed to be tentatively between 25th March to 18th April, which is based on the forest fire detections of last

eight years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season is shown in the Figure 2.14.2.

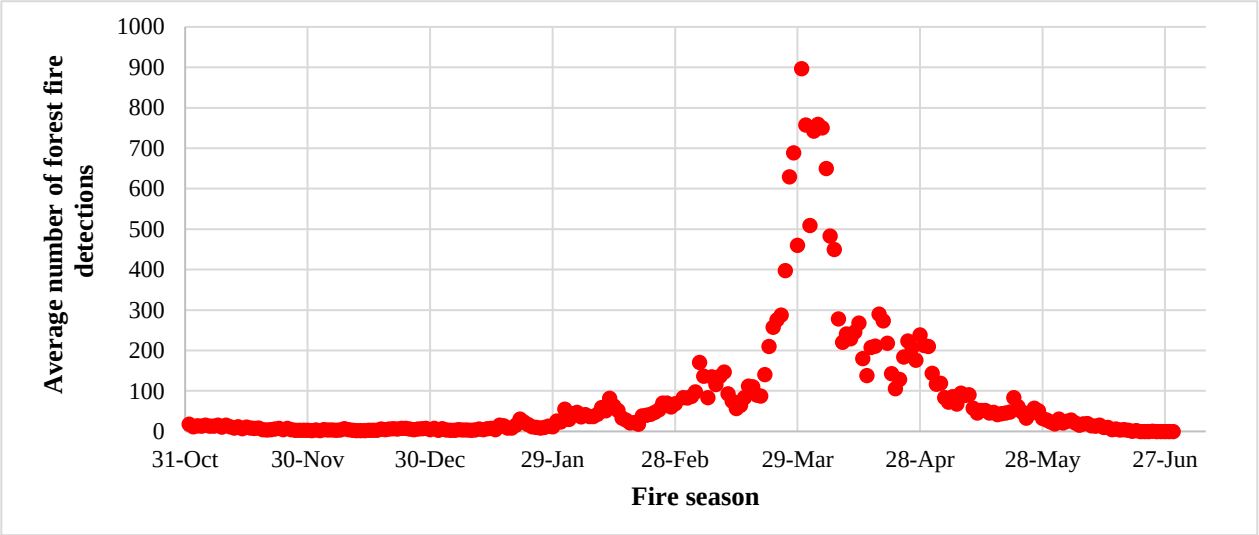


Figure 2.14.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.14.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.14.3. Table 2.14.2 shows the number of large forest fire detections during fire season 2022-23 and 2023-24.

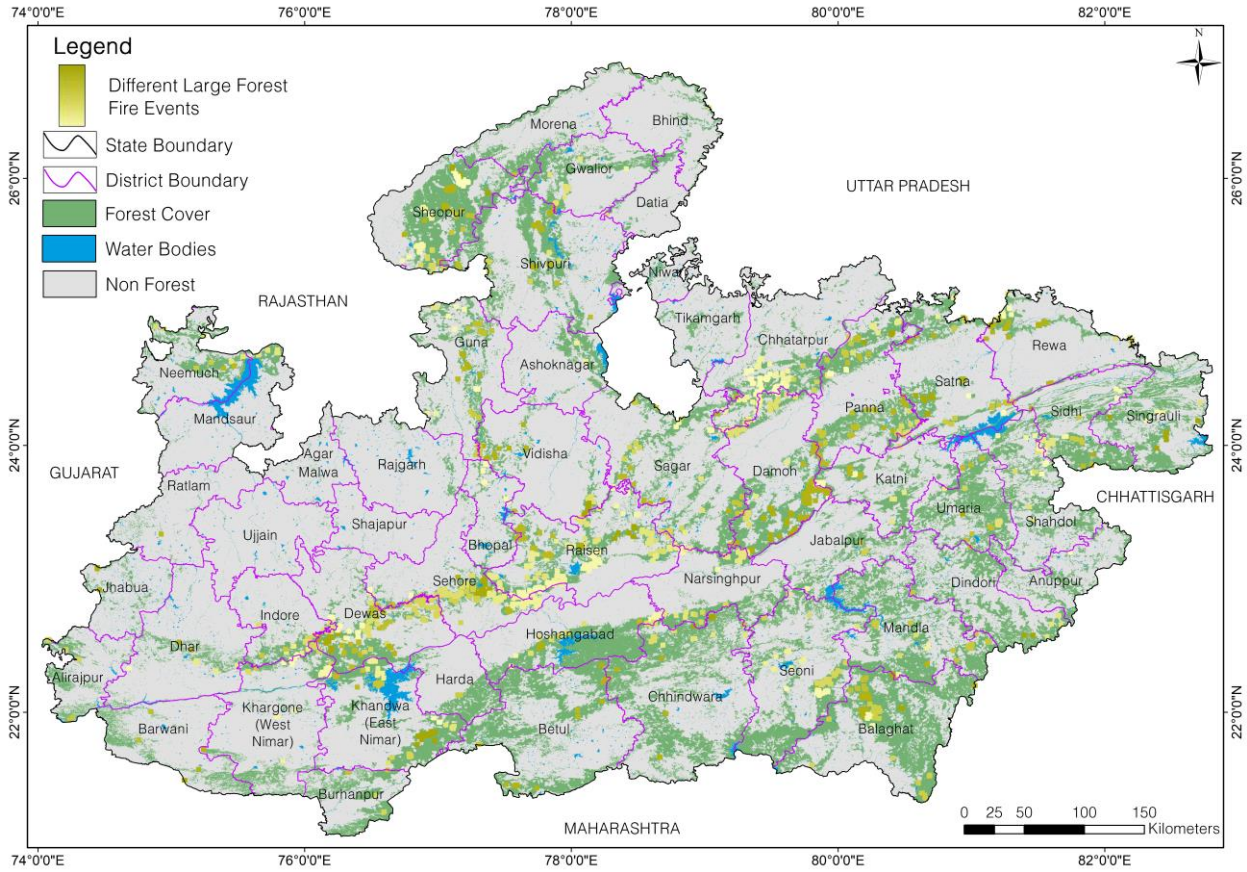


Figure 2.14.3 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.14.2 Number of large forest fire detections during November 2023 to June 2024

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Madhya Pradesh	1,130	962

2.14.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.14.3. From the Figure 2.14.4, it can be inferred that 3.42% of the RFA has been affected by fires. A total of 3.38% of the RFA falls under the low burnt class and 0.04% under moderately burnt class. Only 1.13 km^2 of the RFA have been classified under severely burnt class. The burnt area map of Madhya Pradesh is shown in Figure 2.14.5

Table 2.14.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
Agar Malwa	0.00	0.00	0.00	0.00
Alirajpur	0.00	0.00	0.97	0.97
Anuppur	0.00	0.00	2.39	2.39
Ashoknagar	0.00	0.00	3.31	3.31
Balaghat	0.00	1.27	182.95	184.22
Barwani	0.00	0.00	6.14	6.14
Betul	0.00	0.00	55.80	55.80
Bhind	0.00	0.00	0.72	0.72
Bhopal	0.00	1.71	21.92	23.63
Burhanpur	0.00	0.00	31.15	31.15
Chhatarpur	0.00	0.07	140.22	140.29
Chhindwara	0.00	0.50	63.02	63.52
Damoh	0.01	1.29	143.07	144.37
Datia	0.00	0.00	0.00	0.00
Dewas	0.00	12.66	249.27	261.93
Dhar	0.00	0.00	26.80	26.80
Dindori	0.00	0.00	8.67	8.67
Guna	0.00	0.90	106.30	107.20
Gwalior	0.00	0.01	22.62	22.63
Harda	0.00	0.01	12.27	12.28
Hoshangabad	0.11	3.40	70.98	74.49
Indore	0.05	2.02	106.05	108.12
Jabalpur	0.00	0.05	42.40	42.45
Jhabua	0.00	0.00	2.56	2.56
Katni	0.00	0.00	53.64	53.64
Khandwa (East Nimar)	0.33	0.13	163.07	163.53
Khargone (West Nimar)	0.00	0.29	71.10	71.39
Mandla	0.13	0.37	103.76	104.26
Mandsaur	0.00	0.00	3.30	3.30
Morena	0.00	0.00	0.35	0.35
Narsinghpur	0.00	1.98	92.67	94.65
Neemuch	0.00	0.01	24.84	24.85
Niwari	0.00	0.00	0.00	0.00
Panna	0.00	0.45	87.44	87.89
Raisen	0.00	1.27	259.85	261.12
Rajgarh	0.00	0.00	0.00	0.00
Ratlam	0.00	0.01	3.44	3.45
Rewa	0.00	0.00	48.89	48.89
Sagar	0.13	0.01	98.11	98.25

District	Affected Area			Total
	Severely	Moderately	Low	
Satna	0.00	0.04	49.73	49.77
Sehore	0.02	2.41	120.27	122.70
Seoni	0.35	5.71	136.50	142.56
Shahdol	0.00	0.04	57.19	57.23
Shajapur	0.00	0.00	0.00	0.00
Sheopur	0.00	0.14	231.27	231.41
Shivpuri	0.00	0.35	61.10	61.45
Sidhi	0.00	0.03	12.57	12.60
Singrauli	0.00	0.09	32.32	32.41
Tikamgarh	0.00	0.00	0.28	0.28
Ujjain	0.00	0.00	0.00	0.00
Umaria	0.00	0.02	41.77	41.79
Vidisha	0.00	0.90	79.82	80.72
Total	**1.13**	**38.14**	**3,132.86**	**3,172.13**

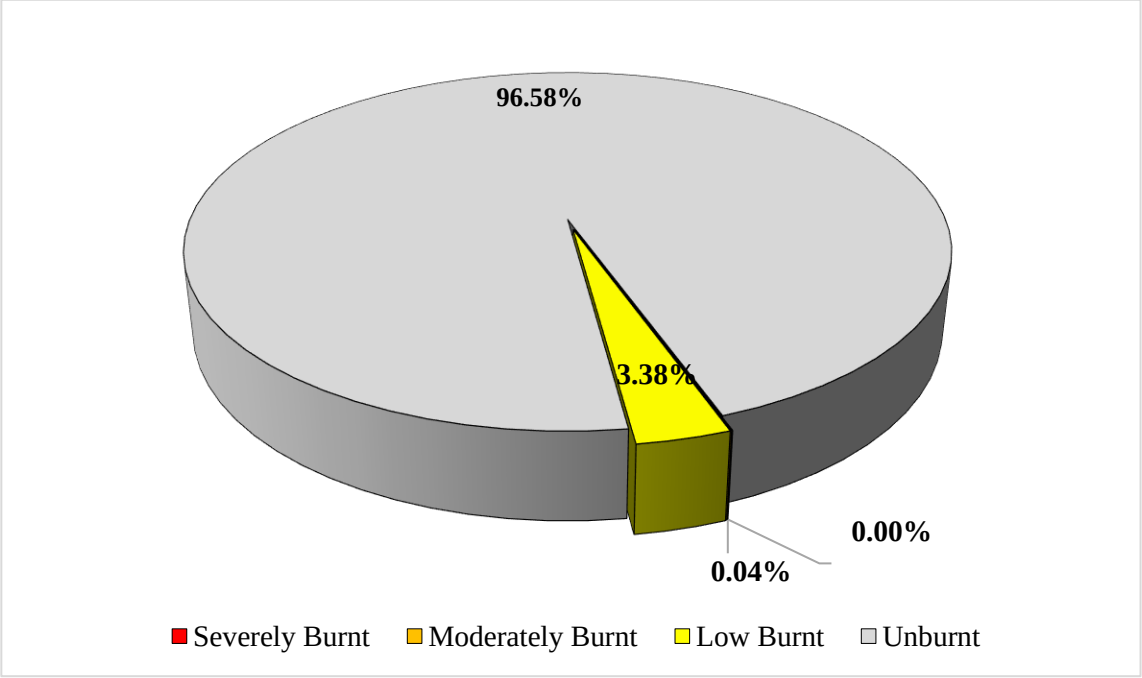


Figure 2.14.4 Distribution of burnt severity classes

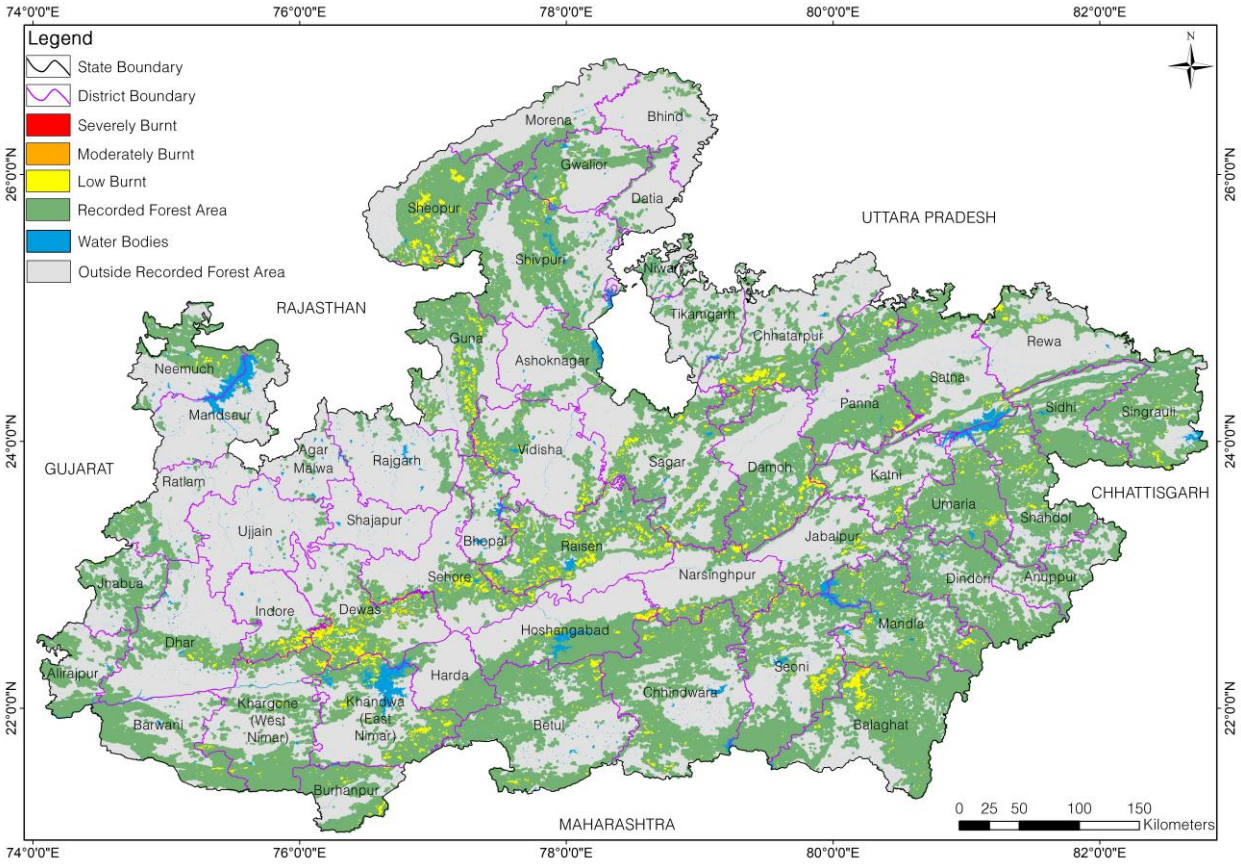


Figure 2.14.5 Map showing burnt area in Madhya Pradesh

2.14.5 Result and Analysis

Based on the analysis of the results, it is observed that Dewas followed by Raisen, Sheopur, and Balaghat are the most forest fire affected districts. The maximum affected area under severely and moderately burnt severity class has been observed in Dewas and Seoni districts. Raisen district has reported the highest area under low burnt severity class. A total of 3,172.13 km^2 fire affected forest area has been reported in the state, which constitutes 3.42% of the RFA.

2.15 Maharashtra

2.15.1 Introduction

The state lies between 15° 35' N to 22° 02' N latitude and 72° 36' E to 80° 54' E longitude. It shares border with Gujarat and Madhya Pradesh in the North Chhattisgarh in the East, Telangana, Karnataka & Goa in the South and Arabian Sea in the West. It has the long coastline, which is estimated to be around 720 km. The state comprises of three main physiographic regions: North Deccan, Western Ghats and West Coast. Geographical area of the state is 3,07,713 km^2, which is 9.36% of the geographical area of the country. Godavari, Bhima, Narmada, Tapti, Koyna and Krishna are the major rivers of the state. The climate of the state is tropical monsoon climate with average annual temperature of the state varies from 25°C to 28°C. Whereas, the rainfall in the state is mainly influenced by South-West monsoon with average annual rainfall ranges from 400 mm to 6,000 mm. Babul, Bor, and Palas are some of the major tree species found in the state and mangrove vegetation occurs in marshes & estuaries along the coast. The Recorded Forest Area (RFA) of the state is 61,952 km^2, which is 20.13% of its geographical area.

Forest fires are quite frequent in the state during fire season and a considerable area under forest is affected due to the forest fires every year. There are many causative factors for initiation and spread of fires. In majority of the incidents, practice of regeneration of floor grass and for threatening wild animals from agricultural fields & habitation. Ground truthing was carried out by a joint team of FSI and State Forest Department during June 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of 57 points were visited by the team.

2.15.2 Forest Cover and Forest Type Group

As per ISFR 2023, forest cover in the state is 50,858.53 km^2, which constitutes 16.53% of the state's geographical area. In terms of forest canopy density classes, the state has 9,865.62 km^2 under Very Dense Forest (VDF), 21,577.79 km^2 under Moderately Dense Forest (MDF), 19,415.12 km^2 under Open Forest (OF) and 3,645.67 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Maharashtra belong to seven forest type groups, which are further categorized into 18 forest types. The major

forest type groups comprise of Tropical Dry Deciduous Forests followed by Tropical Moist Deciduous Forests, Tropical Semi-Evergreen Forests and Subtropical Broadleaved Hill Forests.

The most vulnerable forest types to fires in the state are Southern moist mixed deciduous forest followed by Southern dry mixed deciduous forest and Moist teak forest.

2.15.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.15.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.15.1 Table 2.15.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

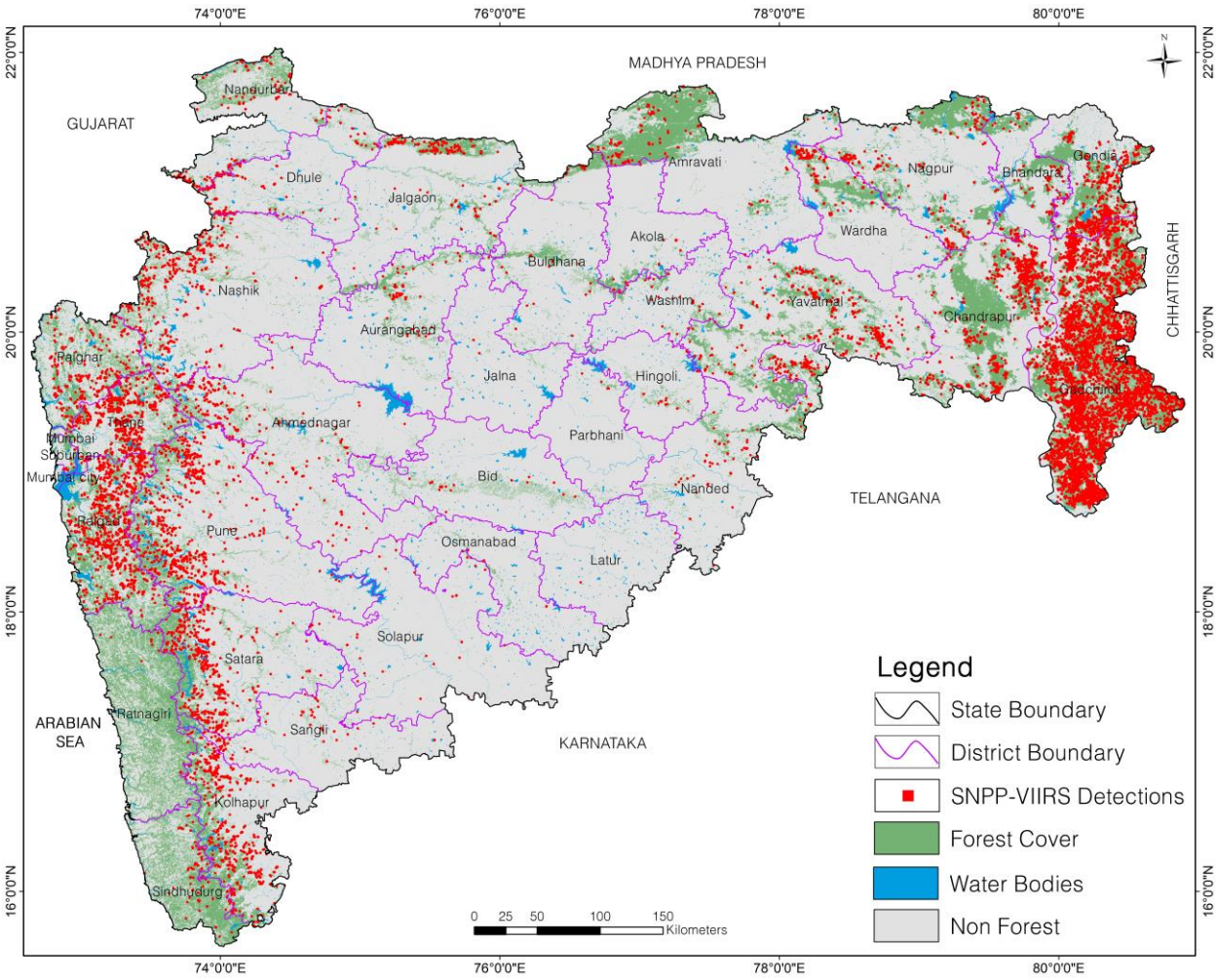


Figure 2.15.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.15.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Ahmednagar	273	255
Akola	44	17
Amravati	482	152
Aurangabad	85	92
Beed	48	19
Bhandara	93	147
Buldhana	130	36
Chandrapur	1,246	965
Dhule	165	148
Gadchiroli	6,093	7,042
Gondia	605	644
Hingoli	16	21

District	No. of Forest Fire Detections	
	Season 2022-23	**Season 2023-24**
Jalgaon	413	207
Jalna	13	4
Kolhapur	618	523
Latur	9	2
Mumbai city	0	1
Mumbai Suburban	48	31
Nagpur	238	255
Nanded	361	179
Nandurbar	109	183
Nashik	414	542
Osmanabad	10	5
Palghar	371	331
Parbhani	5	4
Pune	759	911
Raigad	1,005	1,128
Ratnagiri	7	19
Sangli	158	83
Satara	574	621
Sindhudurg	275	97
Solapur	58	42
Thane	725	717
Wardha	120	141
Washim	82	32
Yavatmal	467	412
Total	**16,119**	**16,008**

Based on the analysis of forest fire detections, the crucial period of forest fires in the state has been determined. The crucial period of forest fire detections in the state has been noticed to be tentatively between 28th March to 28th April, which is based on the forest fire detections of last eight years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years is shown in the Figure 2.15.2.

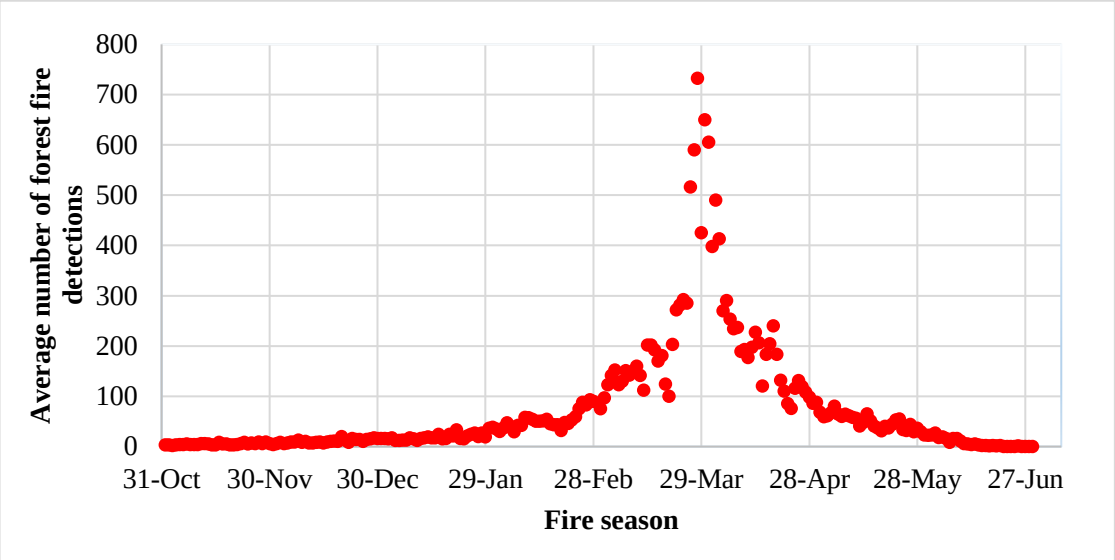


Figure 2.15.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.15.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.15.3. Table 2.15.2 shows the number of large forest fire detections during fire season 2022-23 and 2023-24.

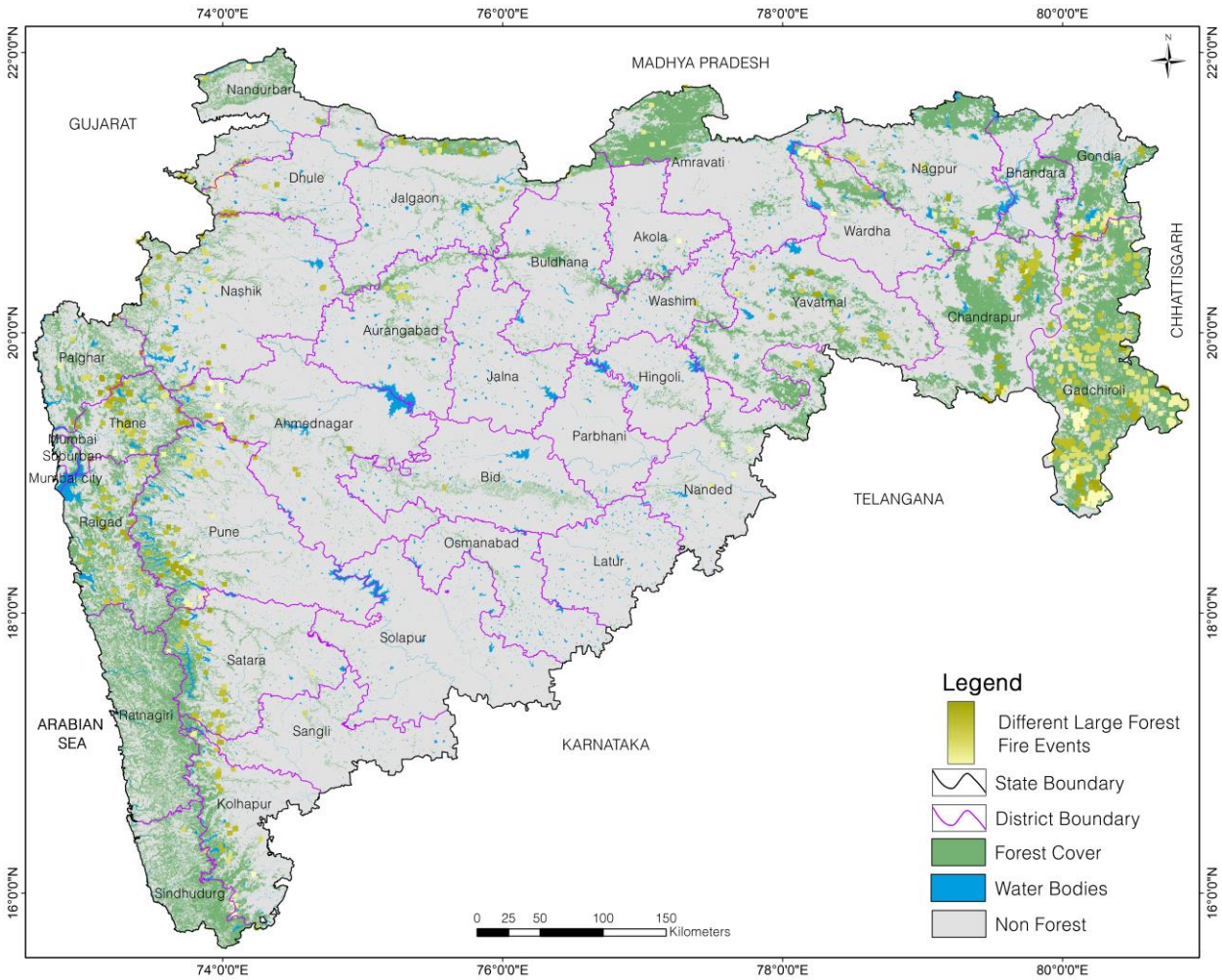


Figure 2.15.3 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.15.2 Number of large forest fire detections during fire season 2022-23 and 2023-24

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Maharashtra	853	668

2.15.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.15.3. From the Figure 2.15.4, it can be inferred that 7.09% of the RFA has been affected by fires. A total of 0.01% of the RFA falls under the severely burnt class, 0.02% under moderately burnt class and 7.06% under the low burnt class. The burnt area map of Maharashtra is shown in Figure 5.15.5

Table 2.15.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
Ahmednagar	0.00	0.02	25.54	25.56
Akola	0.00	0.00	0.35	0.35
Amravati	0.00	0.00	14.37	14.37
Aurangabad	0.00	0.00	1.42	1.42
Beed	0.00	0.00	0.22	0.22
Bhandara	0.10	0.05	13.33	13.48
Buldhana	0.00	0.00	3.81	3.81
Chandrapur	0.06	0.13	165.46	165.65
Dhule	0.01	0.00	43.47	43.48
Gadchiroli	0.07	7.66	2673.36	2681.09
Gondia	0.25	1.99	216.30	218.54
Hingoli	0.00	0.00	1.60	1.60
Jalgaon	0.93	0.00	57.12	58.05
Jalna	0.00	0.00	0.00	0.00
Kolhapur	0.97	0.00	52.02	52.99
Latur	0.00	0.00	0.00	0.00
Mumbai City	0.00	0.00	0.00	0.00
Mumbai Suburban	0.00	0.00	0.00	0.00
Nagpur	0.27	0.00	32.48	32.75
Nanded	0.00	0.01	34.78	34.79
Nandurbar	0.00	0.00	49.42	49.42
Nashik	0.00	0.00	47.17	47.17
Osmanabad	0.00	0.00	0.03	0.03
Palghar	0.26	0.02	28.84	29.12
Parbhani	0.00	0.00	0.19	0.19
Pune	0.02	0.11	156.75	156.88
Raigad	0.37	0.08	75.52	75.97
Ratnagiri	0.00	0.00	0.01	0.01
Sangli	0.00	0.00	6.99	6.99
Satara	0.37	0.00	81.55	81.92
Sindhudurg	0.00	0.00	3.97	3.97
Solapur	0.00	0.00	0.00	0.00
Thane	2.45	0.16	175.26	177.87
Wardha	0.23	0.00	33.83	34.06
Washim	0.00	0.00	1.33	1.33
Yavatmal	0.00	0.01	81.95	81.96
Total	**6.36**	**10.24**	**4,078.44**	**4,095.04**

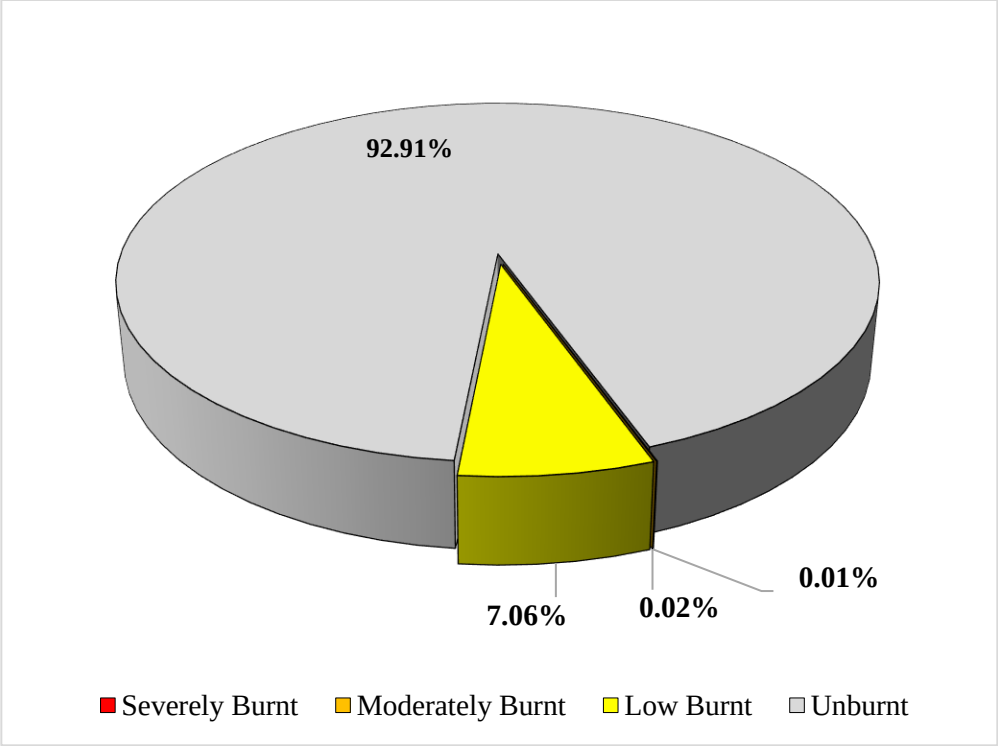


Figure 2.15.4 Distribution of burnt severity classes

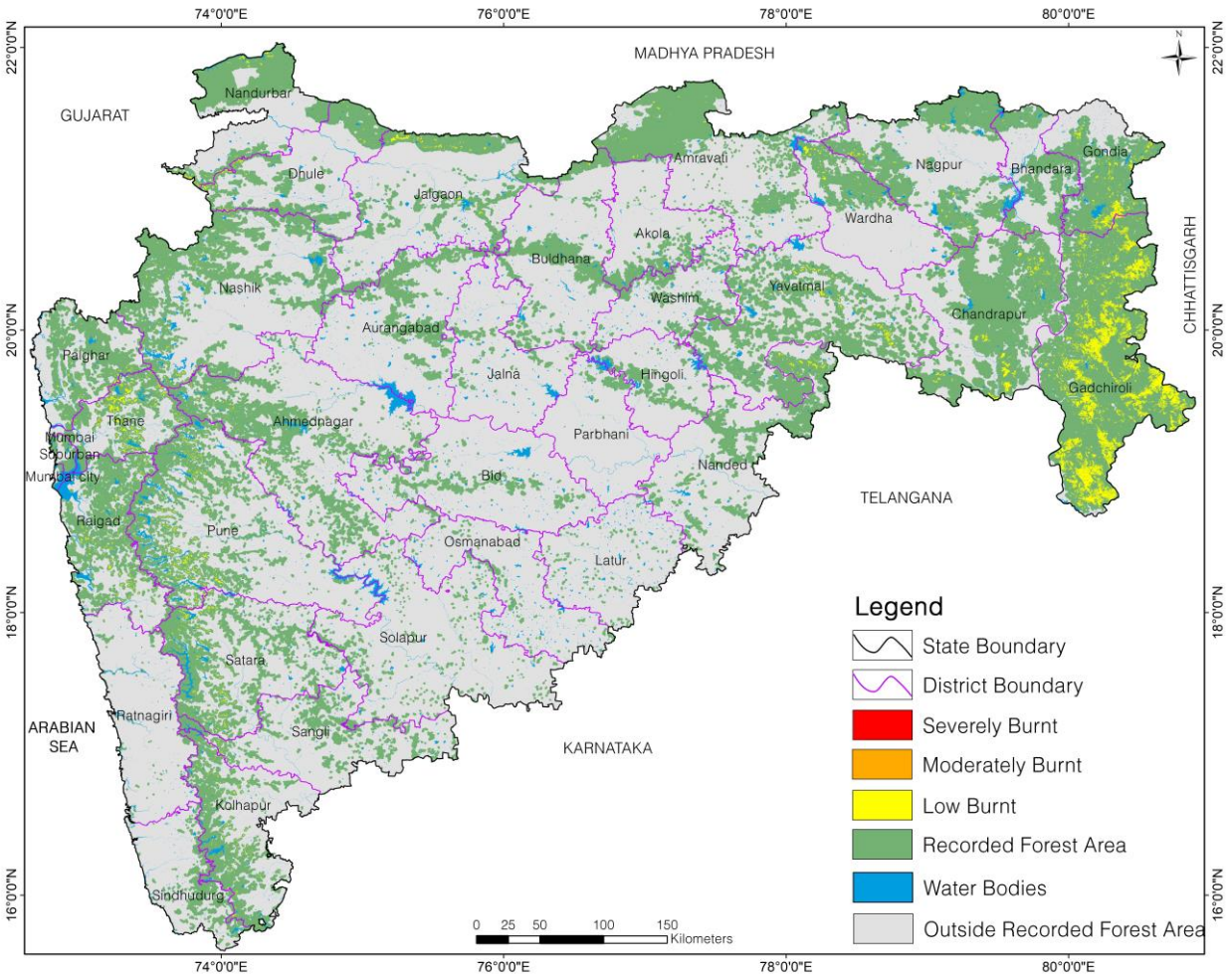


Figure 2.15.5 Map showing forest fire burnt area in Maharashtra

2.15.5 Results and Analysis

Based on the analysis, it is observed that Gadchiroli followed by Gondia, Thane, Chandrapur are the most affected districts. The maximum affected area under moderately burnt severity class has been observed in Gadchiroli and Gondia districts. A total of 4,095.04 km^2 fire affected forest area has been reported in the state, which constitute 7.09% of the RFA.

2.16 Manipur

2.16.1 Introduction

The state lies between 23°50' N to 25°42' N latitude and 92°59' E to 94°46' E longitude. It shares border with Nagaland in the North, Mizoram in the South and Assam in the West. It also shares international border with Myanmar in the East. The state comprises of two main physiographic regions: An outlying area of rugged hills & narrow valleys and the inner area of the flat plain, with associated landforms. Geographical area of the state is 22,327 km^2, which is 0.68% of the geographical area of the country. Barak river basin, Manipur river basin, Yu river basin and Lanye river basin are the four major rivers basins in the state. Imphal and Bara are the main rivers of the state. The state has tropical climate with average annual temperature varies from 14.5°C to 38°C. Whereas, the rainfall in the state is mainly influenced by South-West monsoon with average annual rainfall ranges from 1,250 mm of 2,700 mm and it varies from place to place due to its rugged topography. The state is rich in diverse range of flora and fauna biodiversity. The hills of the state densely covered with bamboos and teaks. Teak, Pine, Oak, Uningthou (Phoebe spp.), Leihao (Michelia spp.) are the major tree species of the state. The Recorded Forest Area (RFA) of the state is 17,418 km^2, which is 78.01% of its geographical area.

Forest fires are quite frequent in the state during fire season and a considerable area under forest is affected due to the forest fires every year. There are many causative factors for initiation and spread of fires. In majority of the incidents, practice of shifting cultivation commonly termed as Jhum cultivation is the major cause of fire incidents in the state.

2.16.2 Forest Cover and Forest Type Group

As per the ISFR 2023, forest cover in the state is 16,585.46 km^2, which constitutes 74.29% of the state's geographical area. In terms of forest canopy density classes, the state has 904.05 km^2 under Very Dense Forest (VDF), 6,217.55 km^2 under Moderately Dense Forest (MDF), 9,463.86 km^2 under Open Forest (OF) and 973.65 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Manipur belong to eight forest type groups, which are further categorized into 13 Forest Types. The major forest type groups comprise of Subtropical Broadleaved Hill Forests followed by Tropical Semi-Evergreen Forests and Tropical Moist Deciduous Forests.

The most vulnerable forest types to fire in the state are East Himalayan subtropical wet hill forest followed by East Himalayan moist mixed deciduous forest and Cachar semi-evergreen forest.

2.16.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.16.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.16.1. Table 2.16.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

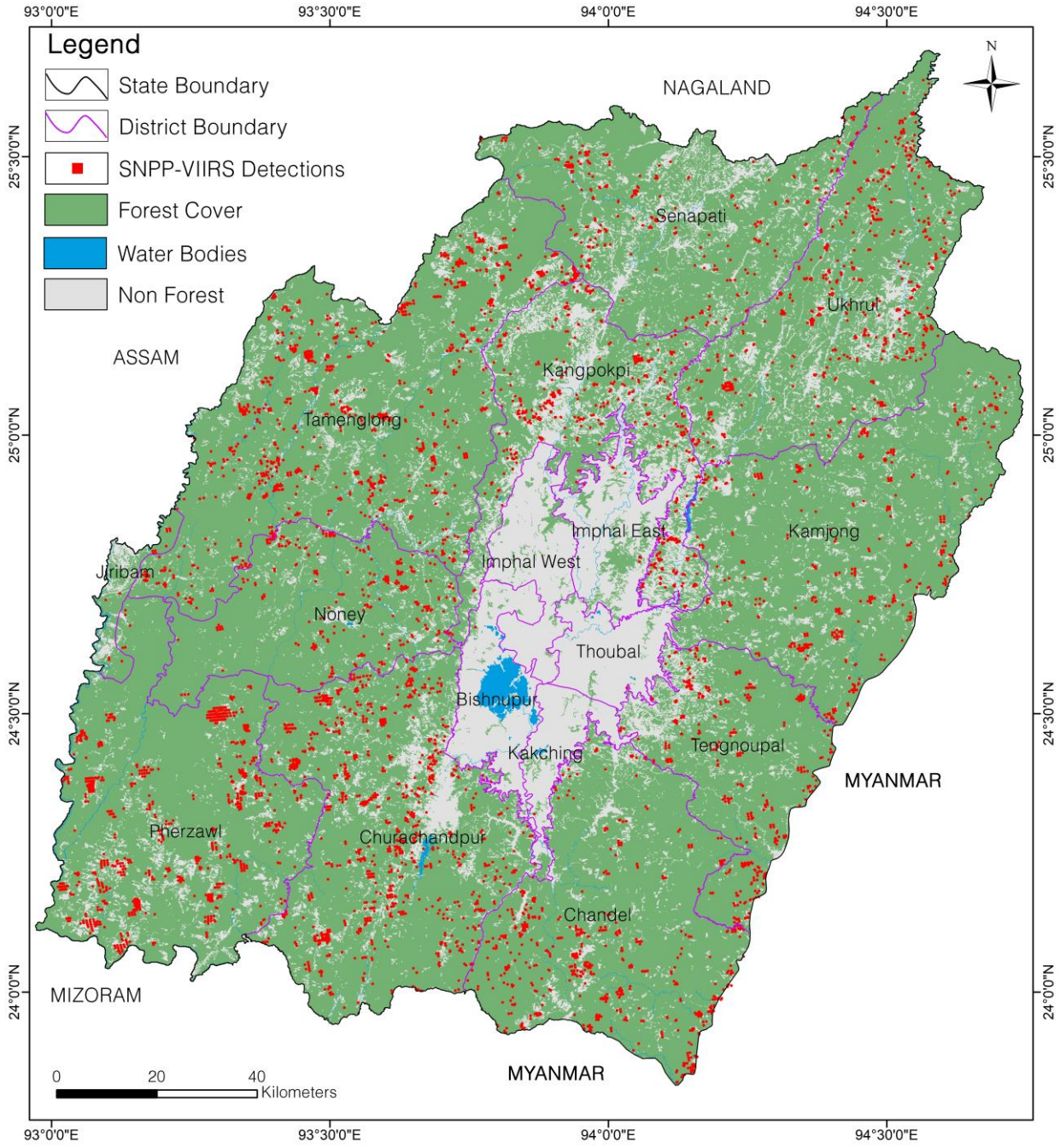


Figure 2.16.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.16.1. District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Bishnupur	5	1
Chandel	1,120	461
Churachandpur	1,738	767
Imphal East	99	4
Imphal West	7	0
Jiribam	30	14
Kakching	20	1
Kamjong	862	346
Kangpokpi	1,085	317
Noney	558	232
Pherzawl	696	647
Senapati	810	199
Tamenglong	1,326	819
Tengnoupal	596	266
Thoubal	7	1
Ukhrul	1,168	423
Total	**10,127**	**4,498**

Based on the analysis of forest fire detections, the crucial period of forest fires in the state has been determined. The crucial period of forest fire detections in the state has been noticed to be tentatively between 08th March to 15th April, which is based on the forest fire detections of last eight years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years is shown in the Figure 2.16.2.

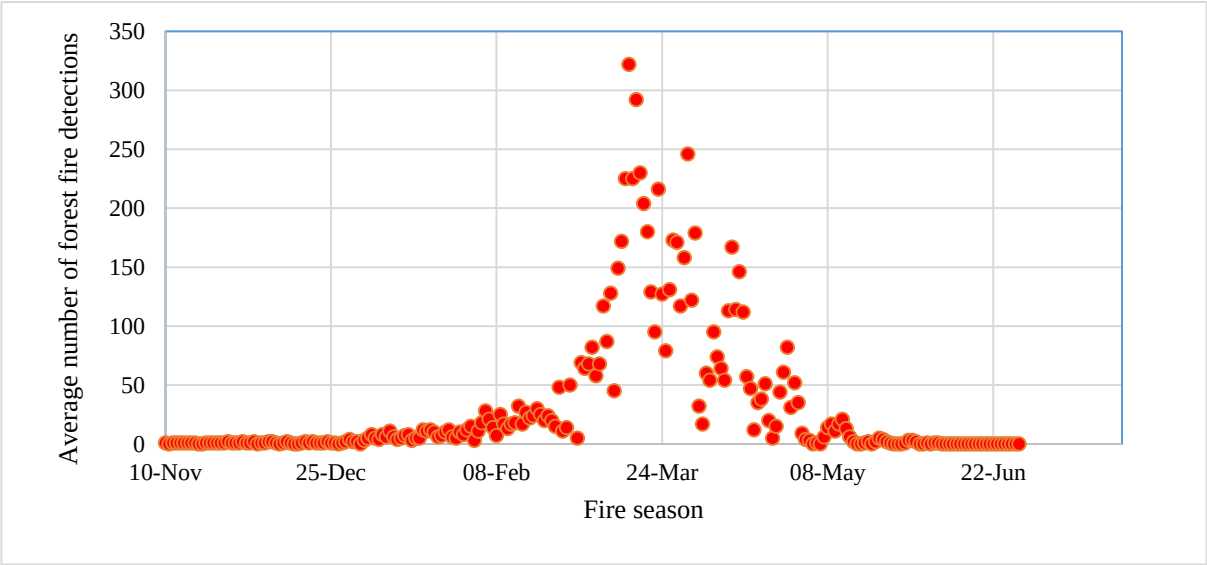


Figure 2.16.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.16.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.16.3. Table 2.16.2 shows the number of large forest fire detections during fire season 2022-23 and 2023-24.

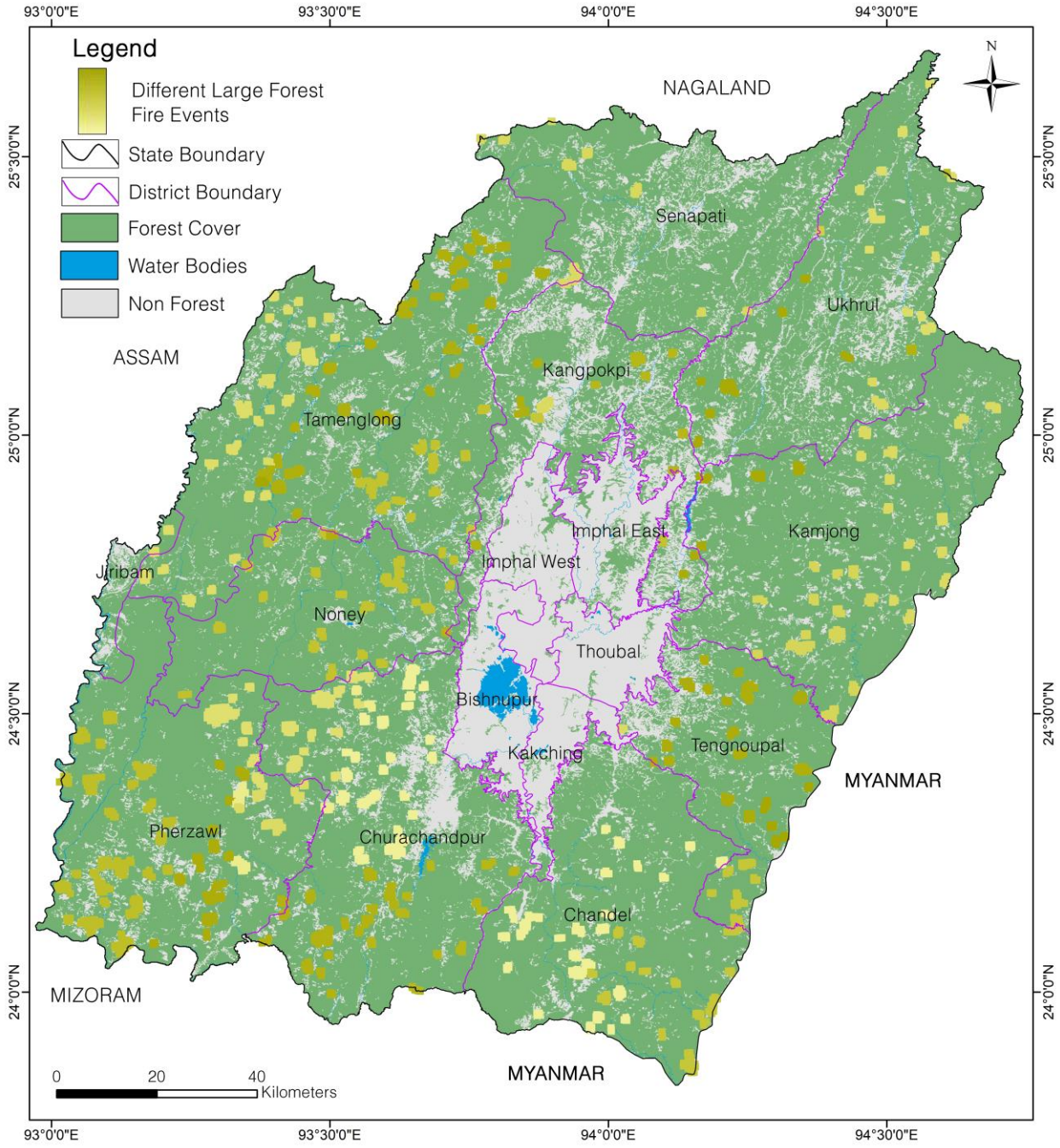


Figure 2.16.3 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.16.2 Number of large forest fire detections during fire season 2022-23 and 2023-24

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Manipur	701	372

2.16.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.16.3. From the Figure 2.16.4, it can be inferred that 1.63% of the GW has been affected by fires. A total of 0.42% of the GW falls under moderately burnt class and 1.21% under the low burnt class. Only 0.24 km^2 of the GW have been classified under severely burnt class. The burnt area map of Manipur is shown in Figure 2.16.5.

Table 2.16.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
Bishnupur	0.00	0.00	0.01	0.01
Chandel	0.04	17.21	27.59	44.84
Churachandpur	0.00	13.30	43.69	56.99
Imphal East	0.00	0.00	0.00	0.00
Imphal West	0.00	0.00	0.00	0.00
Jiribam	0.00	0.08	0.09	0.17
Kakching	0.00	0.00	0.00	0.00
Kamjong	0.00	6.58	20.96	27.54
Kangpokpi	0.02	0.71	4.02	4.75
Noney	0.00	3.52	12.55	16.07
Pherzawl	0.08	13.58	28.59	42.25
Senapati	0.00	0.43	5.16	5.59
Tamenglong	0.10	11.26	44.19	55.55
Tengnoupal	0.00	4.76	14.55	19.31
Thoubal	0.00	0.00	0.00	0.00
Ukhrul	0.00	1.65	10.48	12.13
Total	**0.24**	**73.08**	**211.88**	**285.20**

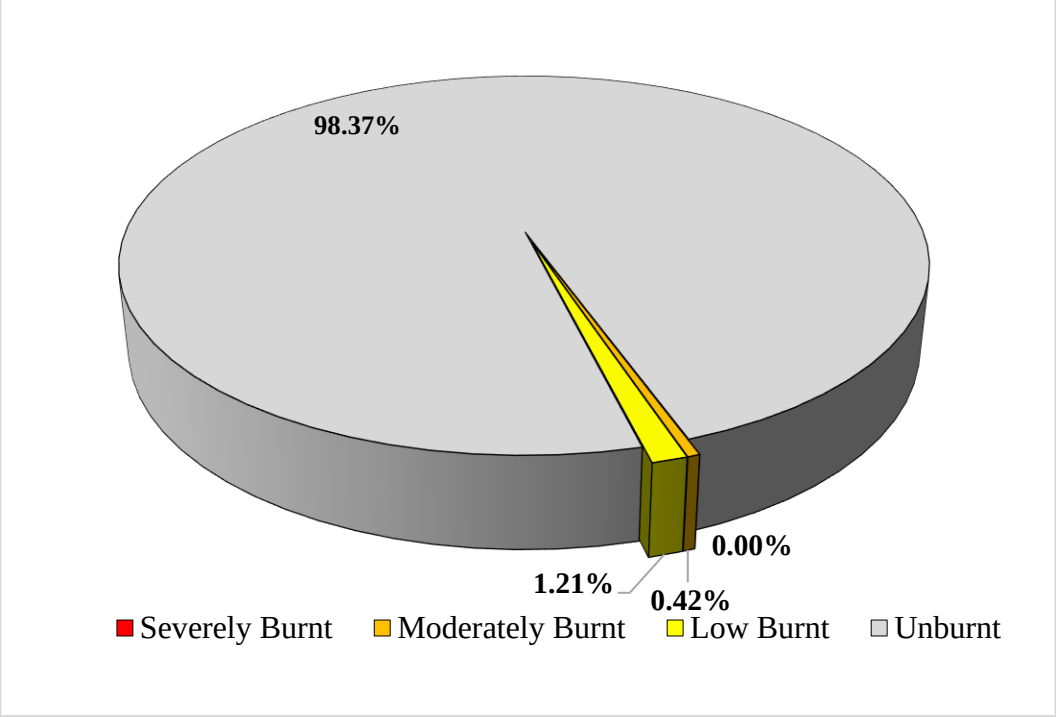


Figure 2.16.4 Distribution of burnt severity classes

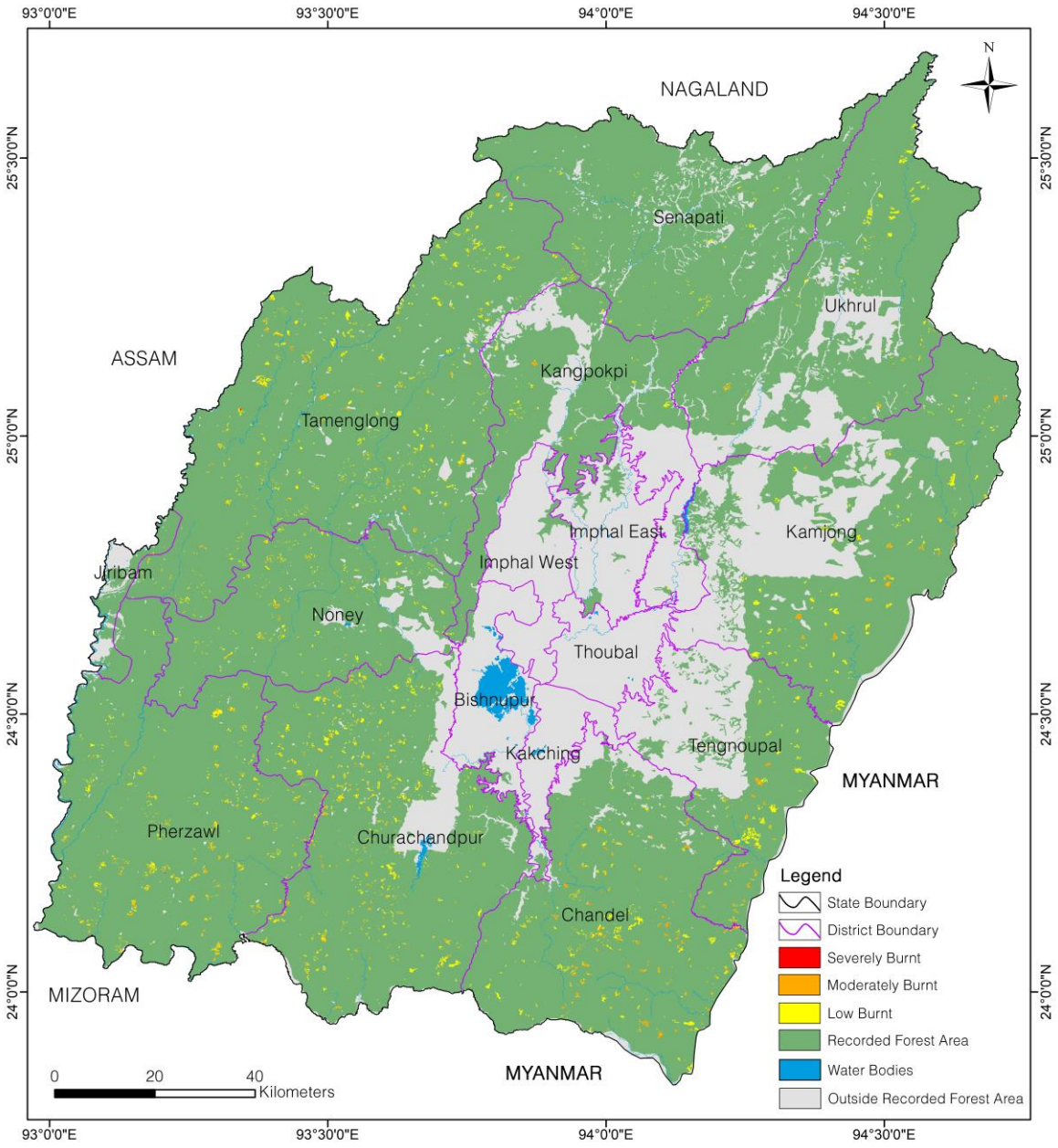


Figure 2.16.5 Map showing burnt area in Manipur

2.16.5 Results and Analysis

Based on the analysis, it is observed Churachandpur followed by Tamenglong, Chandel and Pherzawl are the most fire affected districts. The maximum affected area under moderately burnt severity class has been observed in Chandel and Pherzawl districts. Tamenglong district has reported the highest area under low burnt severity class followed by Churachandpur and Pherzawl. A total of 285.20 km^2 fire affected forest area has been reported in the state, which constitutes 1.63% of the GW.

2.17 Meghalaya

2.17.1 Introduction

The state lies between 24°58' N to 26°07' N latitude and 89°48' E to 92°51' E longitude. It shares border with Assam in the North & East. It also shares international border with Bangladesh in the South and West. The state comprises of three main distinct regions: Garo hills, Khasi hills and Jaintia hills. Geographical area of the state is 22,429 km^2, which is 0.68% of the geographical area of the country. Mawsynram, the wettest place on the earth located in this state. Sanda, Simsang, Umngot and Myntdu are the major rivers of the state. The climate of the state is moderate but humid with average annual temperature of the state varies from 2°C to 34°C. Whereas, the rainfall in the state is mainly influenced by South-West monsoon and North-East winder winds with average annual rainfall ranges from 4,000 mm to 11,500 mm. The State is rich in diverse range of flora and fauna biodiversity. Meghalaya forests support a vast floral diversity, including a large variety of parasites, epiphytes, succulent plants and shrubs. The Recorded Forest Area (RFA) of the state is 9,508 km^2 which is 42.39% of its geographical area.

Forest fires are quite frequent in the state during fire season and a considerable area under forest is affected due to the forest fires every year. There are many causative factors for initiation and spread of fires. In majority of the incidents, practice of shifting cultivation commonly termed as Jhum cultivation is the major cause of fire incidents in the state. Ground truthing was carried out by a joint team of FSI and State Forest Department during March 2024 for the analysis of the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of 35 points were visited by the team.

2.17.2 Forest Cover and Forest Type Group

As per the ISFR 2023, forest cover in the state is 16,966.84 km^2, which constitutes 75.65% of the state's geographical area. In terms of forest canopy density classes, the state has 594.84 km^2 under Very Dense Forest (VDF), 9,023.81 km^2 under Moderately Dense Forest (MDF), 7,348.19 km^2 under Open Forest (OF) and 620.41 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Meghalaya belong to six forest type groups, which are further categorized into 10 forest types. The major

forest type groups comprises of Tropical Moist Deciduous Forests followed by Subtropical Broadleaved Hill Forests and Tropical Wet Evergreen Forests.

The most vulnerable forest types to fires in the state are East Himalayan moist mixed deciduous forest followed by Khasi subtropical wet hill forest and Assam subtropical pine forest.

2.17.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.17.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.17.1. Table 2.17.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

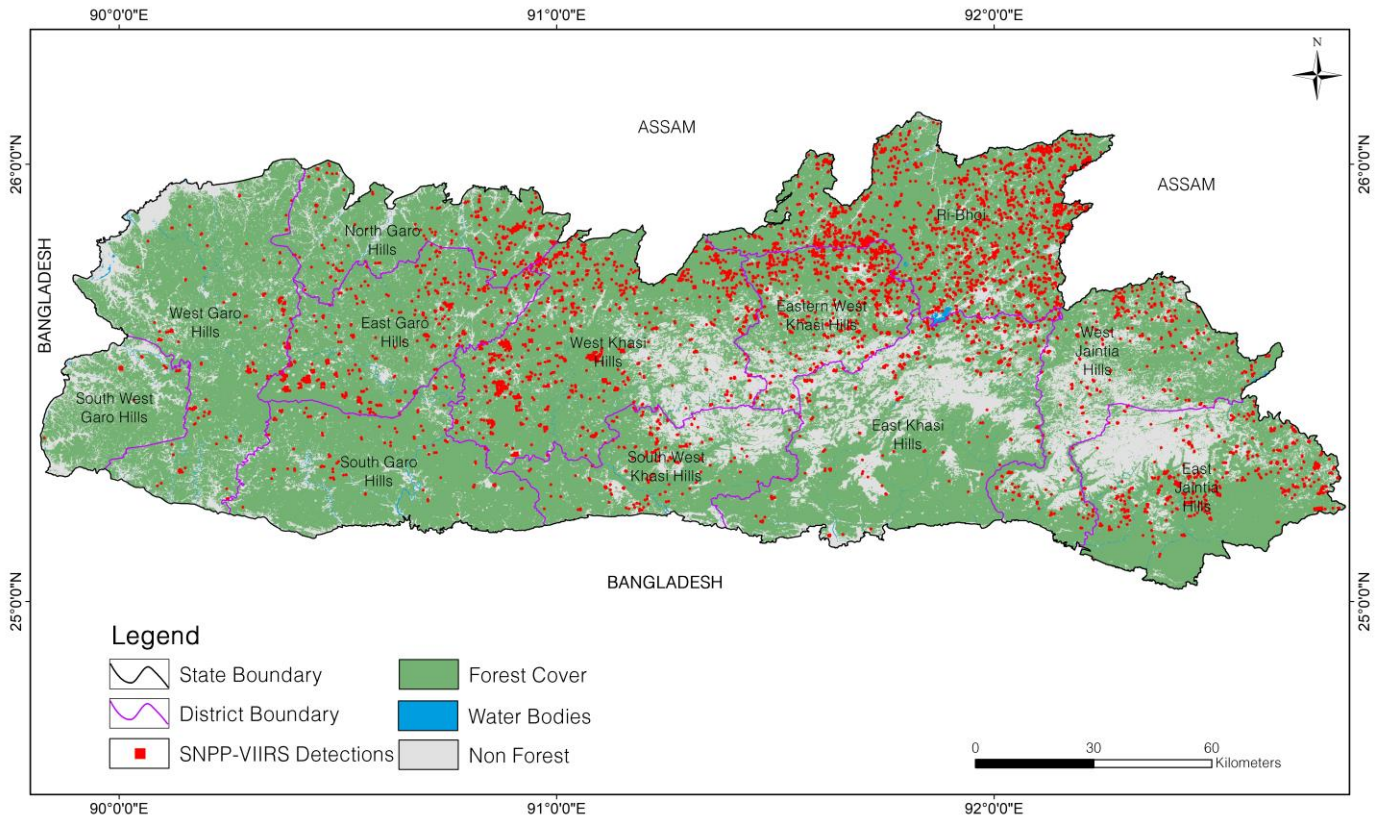


Figure 2.17.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.17.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
East Garo Hills	571	331
East Jaintia Hills	766	348
East Khasi Hills	380	226
Eastern West Khasi Hills	342	493
North Garo Hills	356	213
Ri-Bhoi	1,559	1,377
South Garo Hills	130	90
South West Garo Hills	14	15
South West Khasi Hills	589	119
West Garo Hills	164	114
West Jaintia Hills	391	243
West Khasi Hills	1,342	750
Total	**6,604**	**4,319**

Based on the analysis of forest fire detections, the crucial period of forest fires in the state has been determined. The crucial period of forest fire detections in the state has been noticed to be tentatively between 12th March to 08th April, which is based on the forest fire detections of last eight years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years is shown in the Figure 2.17.2

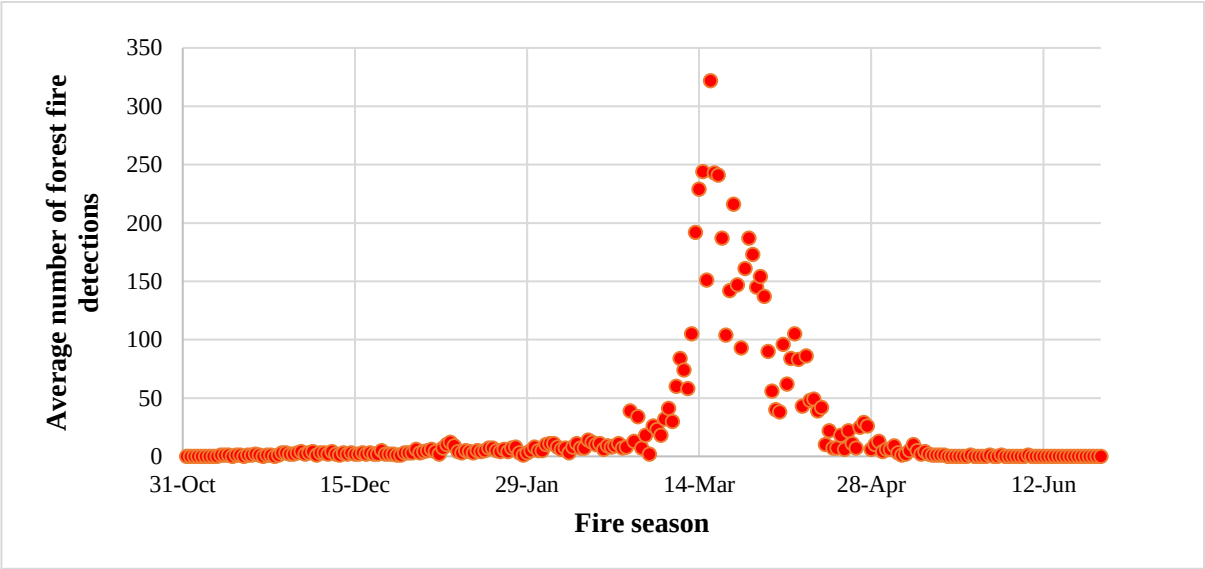


Figure 2.17.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.17.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.17.3. Table 2.17.2 shows the number of large forest fire detections during fire season 2022-23 and 2023-24.

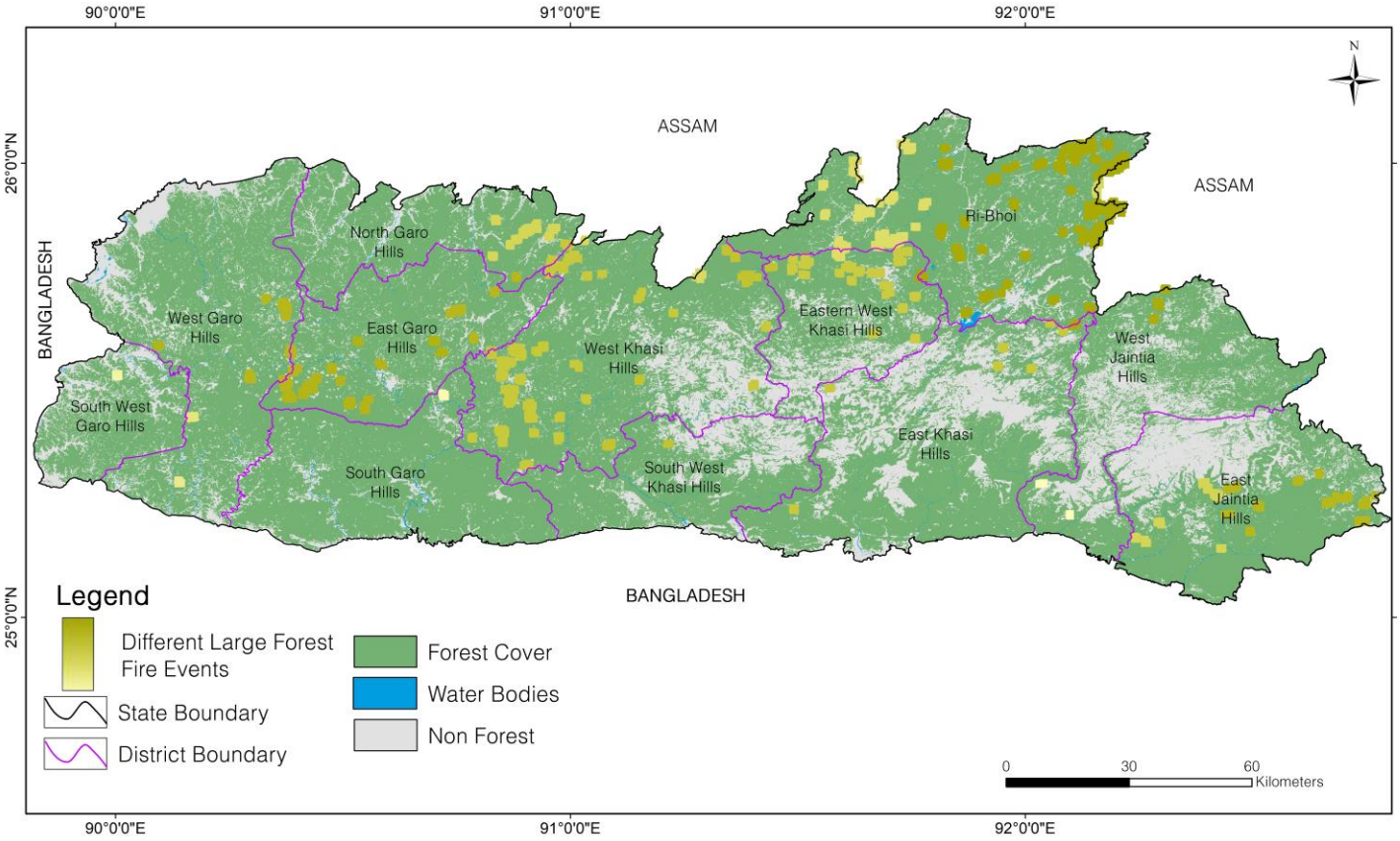


Figure 2.17.3 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.17.2 Number of large forest fire detections during fire season 2022-23 and 2023-24

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Meghalaya	352	191

2.17.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.17.3. From the Figure 2.17.4, it can be inferred that 2.65% of the GW has been affected by fires. A total of 2.28% of the GW falls under the low burnt class and 0.37% under moderately burnt class. Only 0.12 km^2 of the GW have been classified under severely burnt class. The burnt area map of Meghalaya is shown in Figure 2.17.5

Table 2.17.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
East Garo Hills	0.00	8.96	50.90	59.86
East Jaintia Hills	0.01	6.93	14.77	21.71
East Khasi Hills	0.00	0.36	8.64	9.00
Eastern West Khasi Hills	0.00	3.46	16.37	19.83
North Garo Hills	0.01	9.09	45.07	54.17
Ri-Bhoi	0.09	13.5	113.69	127.28
South Garo Hills	0.00	1.44	6.75	8.19
South West Garo Hills	0.00	0.02	8.91	8.93
South West Khasi Hills	0.00	0.10	10.49	10.59
West Garo Hills	0.00	2.59	19.72	22.31
West Jaintia Hills	0.00	2.88	11.64	14.52
West Khasi Hills	0.01	15.94	91.61	107.56
Total	**0.12**	**65.27**	**398.56**	**463.95**

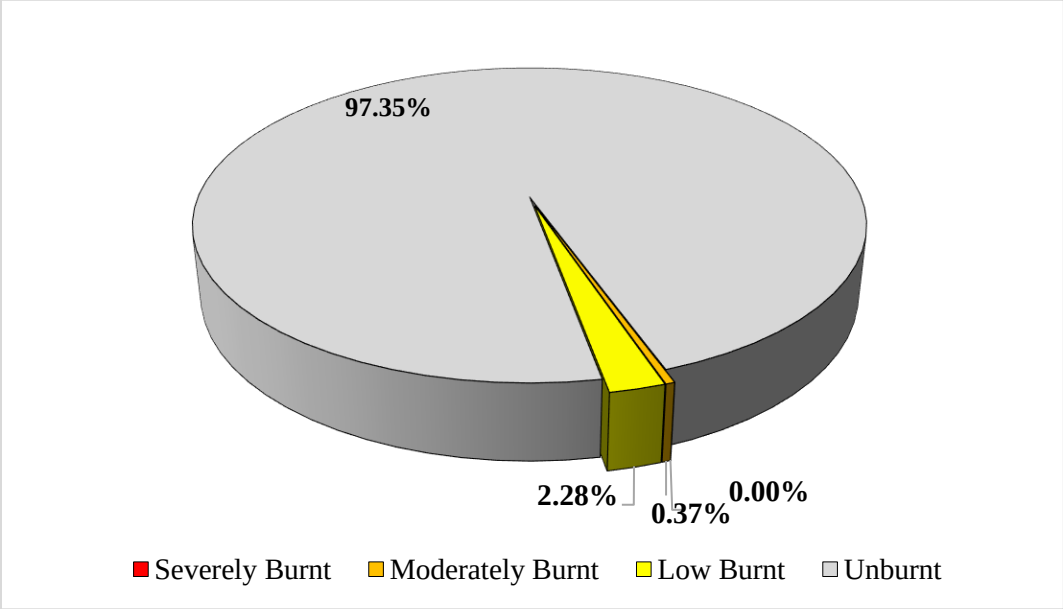


Figure 2.17.4 Distribution of burnt severity classes

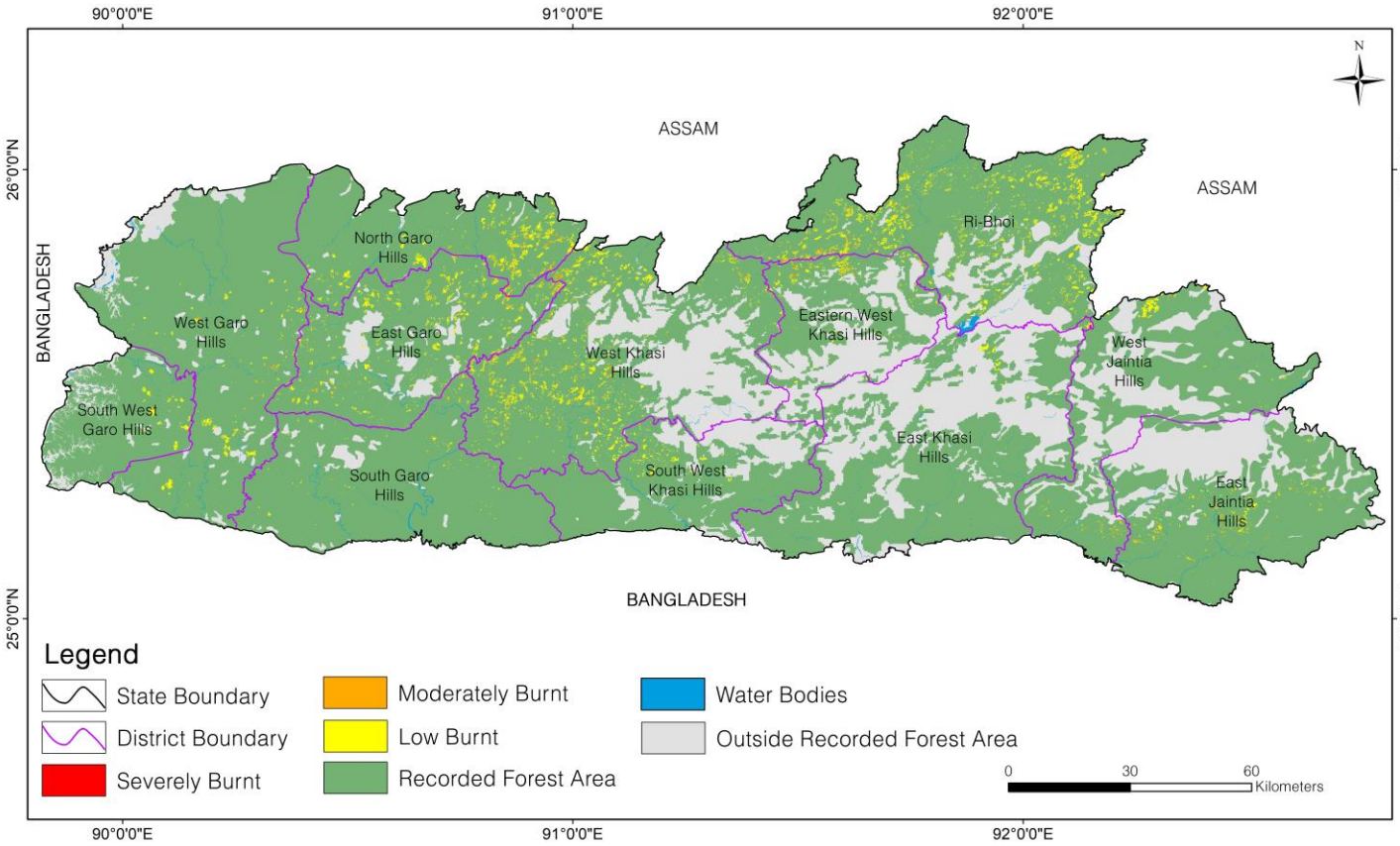


Figure 2.17.5 Map showing burnt area in Meghalaya

2.17.5 Results and Analysis

Based on the analysis, it is observed that Ri-Bhoi, West Khasi Hills, East Garo Hills, North Garo Hills are the most fire affected districts. The maximum affected area under moderately burnt severity class has been observed in West Khasi Hills and Ri-Bhoi districts. Ri-Bhoi district has reported the highest area under low burnt severity class followed by West Khasi Hills and East Garo Hills. A total of 463.95 km^2 fire affected forest area has been reported in the state, which constitutes 2.65 % of the GW.

2.18 Mizoram

2.18.1 Introduction

The state lies between 21°56' N to 24°31' N latitude and 92°16 E to 93°26' E longitude. It shares border with Tripura in the West and Assam & Manipur in the North. It also shares international border with Bangladesh in the West & South and Myanmar in the East. Physiographically, the state comprises rugged, steep hill ranges and interspersed valleys. Geographical area of the state is 21,081 km^2, which is 0.64% of the geographical area of the country. Chhimuipui, Tlawng (Dhaleswar or katakhal), Tut (Gutur), Tuirial (Sonai) and Tuivawl are the major rivers of the state. The state has moderate climate with average annual temperature varies from 11°C to 29°C. Whereas, the rainfall in the state is mainly influenced by South-West monsoon with average annual rainfall ranges between 2,100 mm to 3,500 mm. The state is rich in diverse range of flora and fauna biodiversity. Amongst all the States, Mizoram has the highest area under forest cover in terms of percentage of geographical area. The Recorded Forest Area (RFA) of the state is 7,479 km^2, which is 35.48% of its geographical area.

Forest fires are quite frequent in the state during fire season and a considerable area under forest is affected due to the forest fires every year. There are many causative factors for initiation and spread of fires. In majority of the incidents- practice of shifting cultivation commonly termed as *Jhum* cultivation is the major cause of fire incidents in the state. Ground truthing was carried out by a joint team of FSI and State Forest Department during May 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of 21 points were visited by the team.

2.18.2 Forest Cover and Forest Type Group

As per ISFR 2023, forest cover in the state is 17,990.46 km^2, which constitutes 85.34% of the state's geographical area. In terms of forest canopy density classes, the state has 261.52 km^2 under Very Dense Forest (VDF), 8,635.76 km^2 under Moderately Dense Forest (MDF), 9,093.18 km^2 under Open Forest (OF) and 314.54 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Mizoram belong to five forest type groups, which are further categorized into seven forest types. The major forest

type groups comprise of Tropical Semi-Evergreen Forests followed by Tropical Moist Deciduous Forests and Sub-Tropical Pine Forests.

The most vulnerable forest types to fires in the state are Secondary moist bamboo brakes followed by Cachar semi-evergreen forest and East Himalayan moist mixed deciduous forest.

2.18.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.18.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.18.1. Table 2.18.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

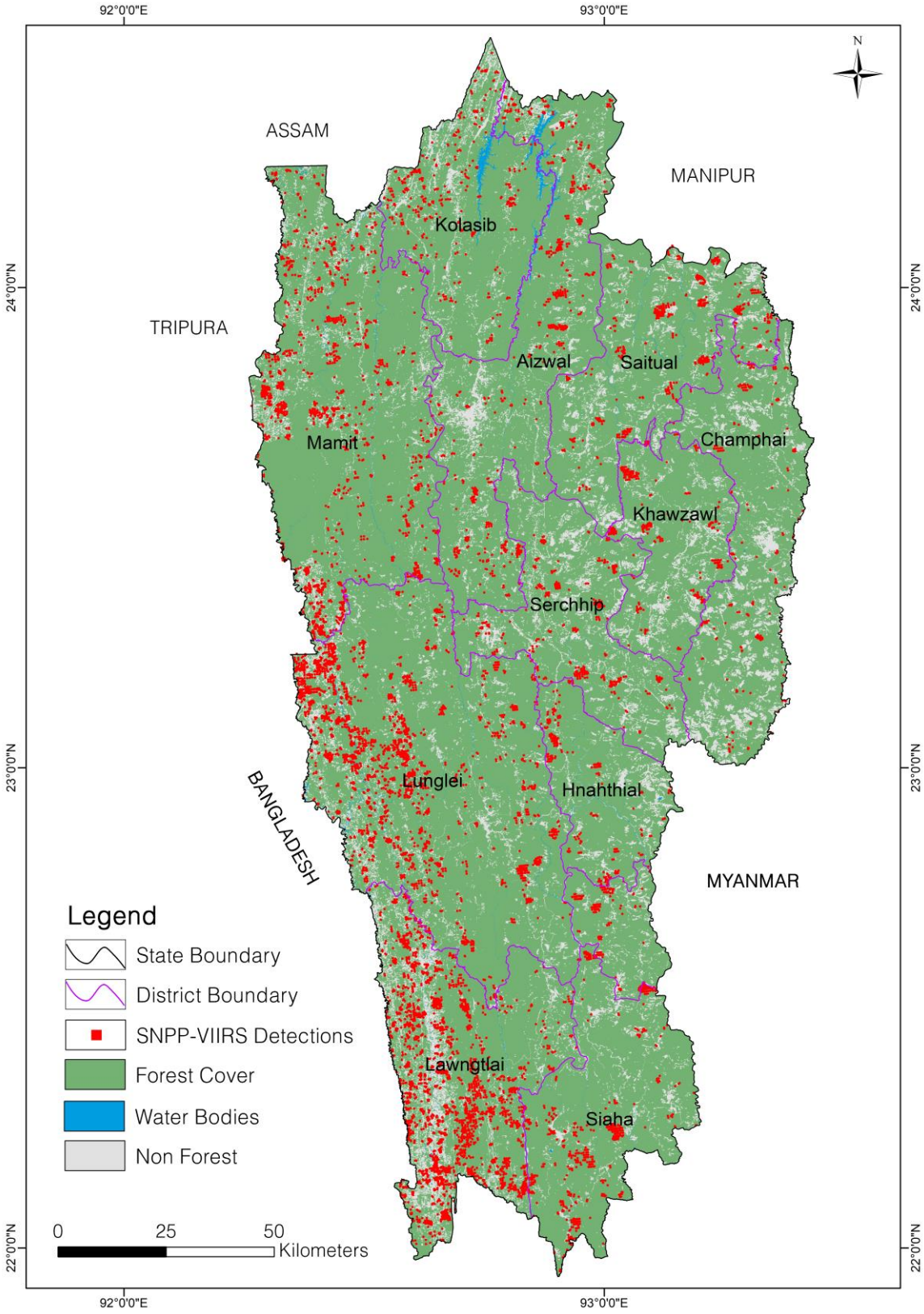


Figure 2.18.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.18.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Aizawl	446	442
Champhai	581	140
Hnahthial	70	178
Khawzawl	127	198
Kolasib	245	284
Lawngtlai	1,385	1811
Lunglei	1,045	1558
Mamit	814	994
Saitual	316	340
Serchhip	381	245
Siaha	388	437
Total	**5,798**	**6,627**

Based on the analysis of forest fire detections, the crucial period of forest fires in the state has been determined. The crucial period of forest fire detections in the state has been noticed to be tentatively between 14th March to 26th April, which is based on the forest fire detections of last eight years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years is shown in the Figure 2.18.2.

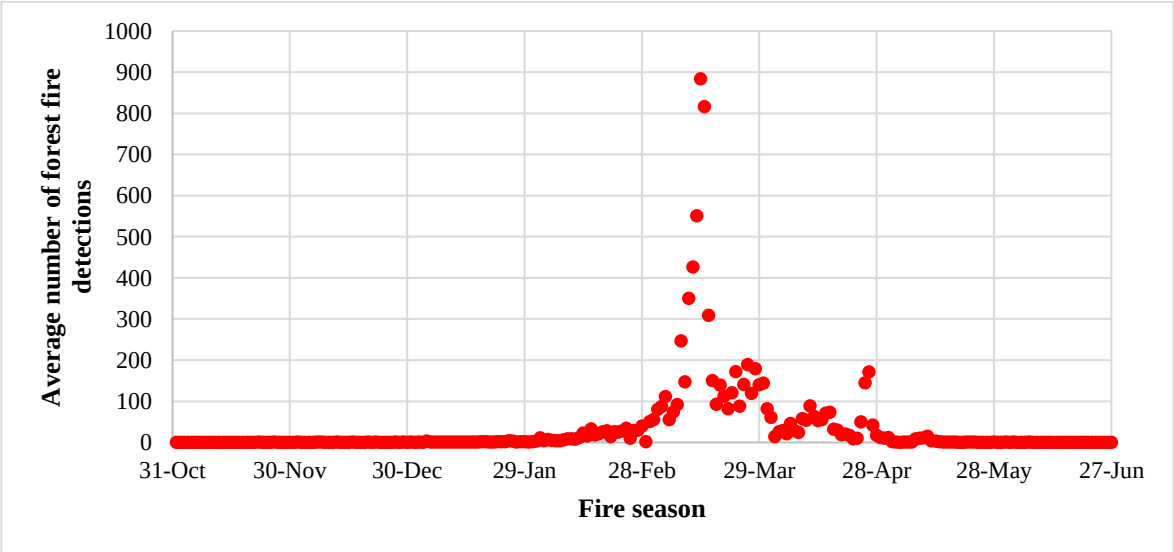


Figure 2.18.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.18.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.18.3. Table 2.18.2 shows the number of large forest fire detections during fire season 2022-23 and 2023-24.

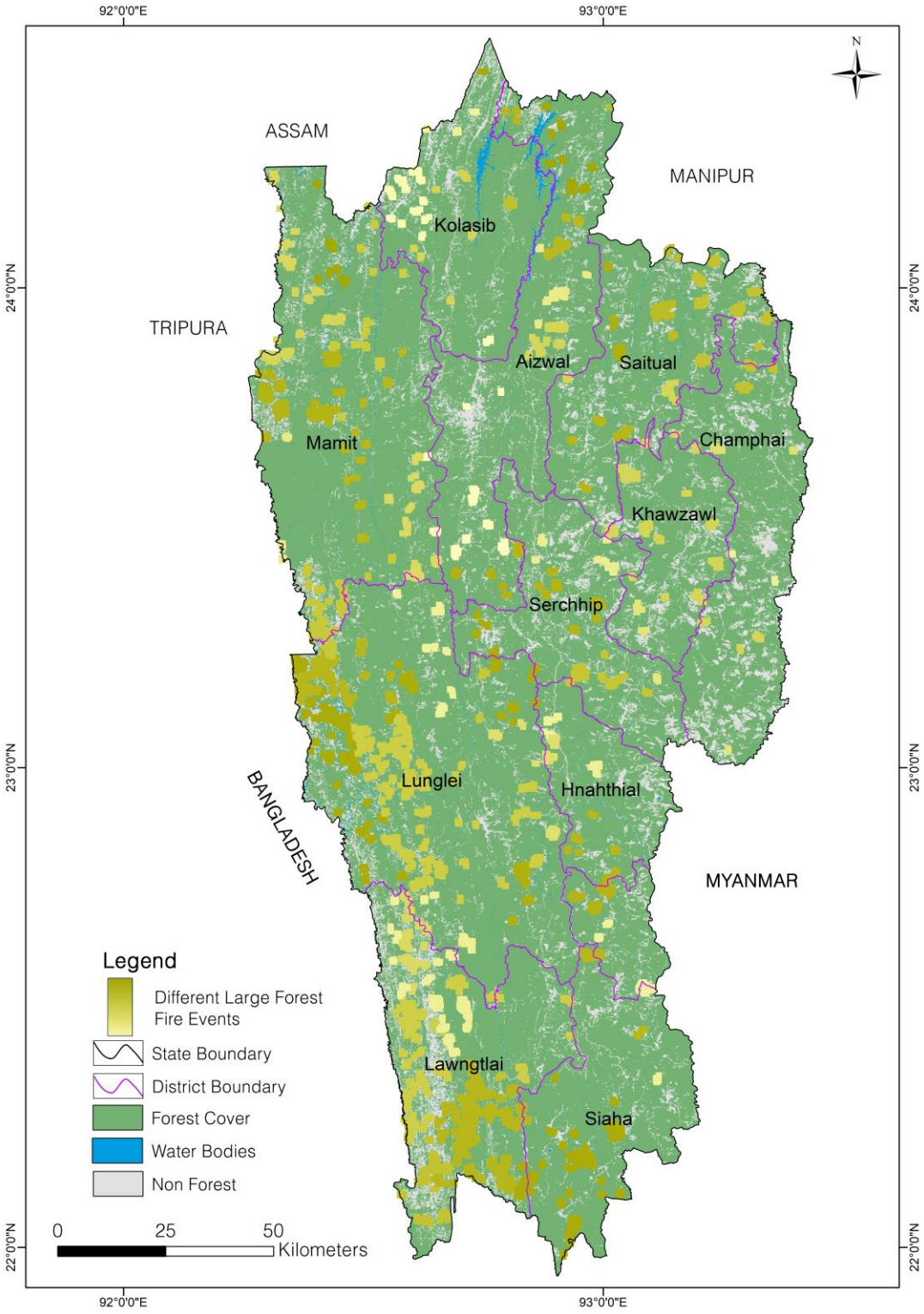


Figure 2.18.3 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.18.2 Number of large forest fire detections during fire season 2022-23 and 2023-24

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Mizoram	430	501

2.18.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.18.3. From the Figure 2.18.4, it can be inferred that 1.19% of the GW has been affected by fires. A total of 0.96% of the GW falls under the low burnt class, 0.21% under moderately burnt class and 0.02% under severely burnt class. The burnt scar map of Mizoram is shown in Figure 2.18.5.

Table 2.18.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
Aizawl	0.21	4.36	8.67	**13.24**
Champhai	0.10	0.88	3.69	**4.67**
Hnahthial	0.49	1.21	5.08	**6.78**
Khawzawl	0.77	3.00	6.70	**10.47**
Kolasib	0.00	0.03	4.92	**4.95**
Lawngtlai	0.22	6.20	49.64	**56.06**
Lunglei	0.88	10.42	47.77	**59.07**
Mamit	0.36	5.69	29.19	**35.24**
Saitual	0.25	3.80	13.19	**17.24**
Serchhip	0.53	5.66	17.19	**23.38**
Siaha	0.17	1.52	10.97	**12.66**
Total	**3.98**	**42.77**	**197.01**	**243.76**

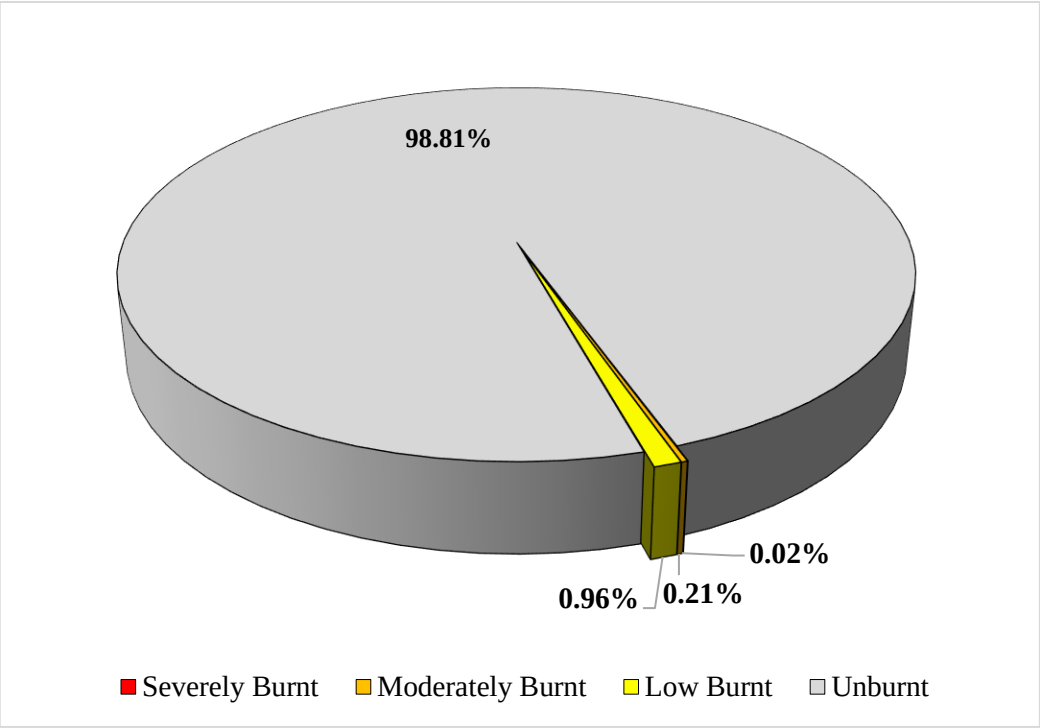


Figure 2.18.4 Distribution of burnt severity classes

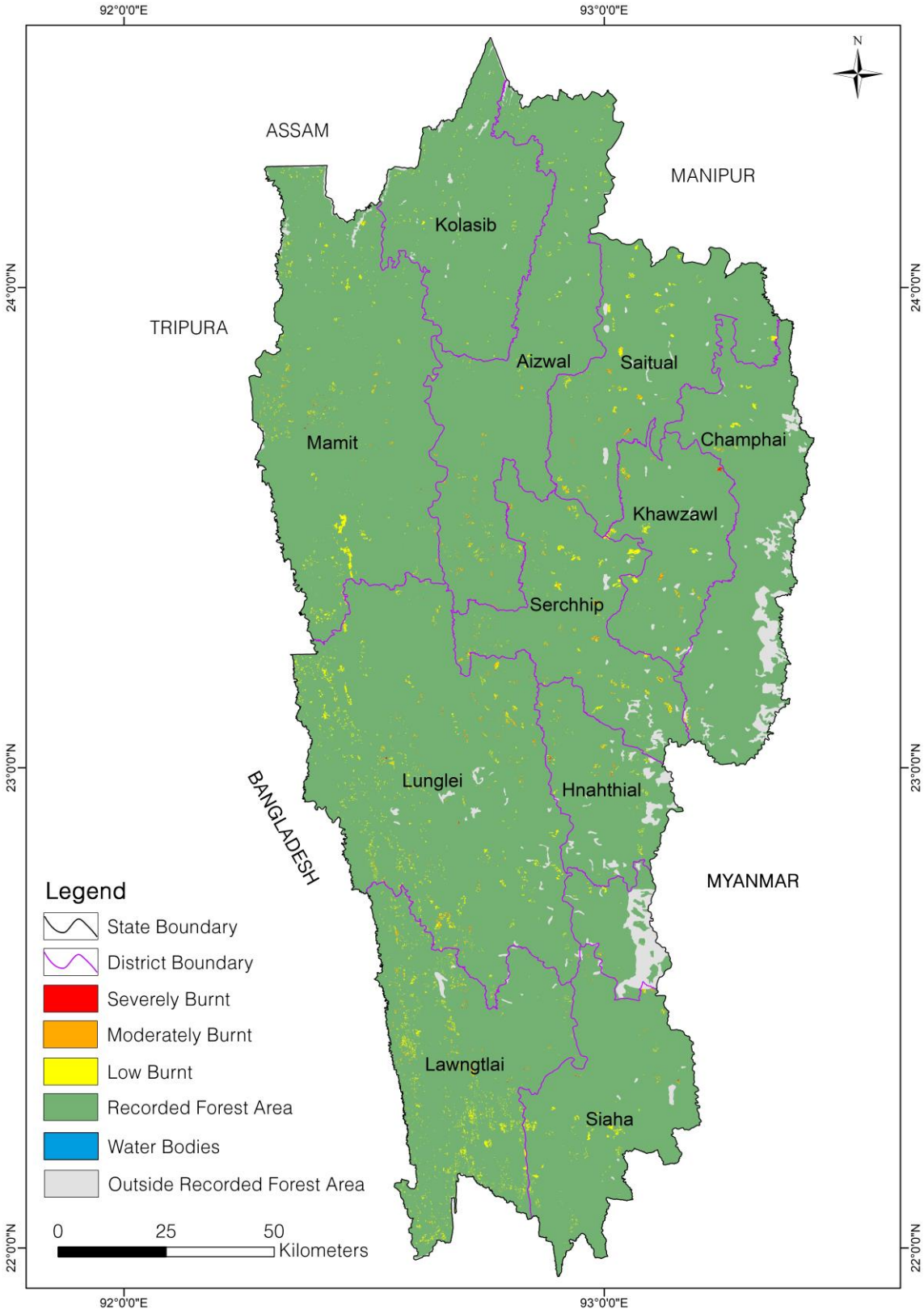


Figure 2.18.5 Map showing burnt area in Mizoram

2.18.5 Results and Analysis

Based on the analysis, it is observed that Lunglei, Lawngtlai, Mamit are the most affected districts. The maximum affected area under severely and moderately burnt severity class has been observed in Lunglei and Nainital districts. Lawngtlai district has reported the highest area under low burnt severity class. A total of 243.76 km^2 fire affected forest area has been reported in the state, which constitutes 1.19% of the GW.

2.19 Nagaland

2.19.1 Introduction

The state lies between 25°10' N to 27°04' N latitude and 93°15' E to 95°06' E longitude. It shares border with Assam and Arunachal Pradesh in the North, Manipur in the South and Assam in the West. It also shares international border with Myanmar in the East. Physiographically, state consists of a narrow strip of hilly region running North-East to South-West and facing the Assam plains to its North and North-West. Geographical area of the state is 16,579 km^2, which is 0.50% of the geographical area of the country. Dhansiri, Dhinku, Doyang and Tizu are the major rivers of the state. The climate of the state is Monsoonal climate with an average annual temperature of the state varies from 21°C to 40°C. Whereas, the rainfall in the state is mainly influenced by South-West monsoon with average annual rainfall ranges between 1,800 m to 2,500 mm. The state is rich in diverse range of flora and fauna biodiversity. About one-sixth of Nagaland is covered by tropical and sub-tropical evergreen forests including palms, bamboo and rattan as well as timber and mahogany forests. The Recorded Forest Area (RFA) of the state is 8,632 km^2 which is 52.07% of its geographical area.

Forest fires are quite frequent in the state during fire season and a considerable area under forest is affected due to the forest fires every year. There are many causative factors for initiation and spread of fires. In majority of the incidents, the practice of shifting cultivation commonly termed as Jhum cultivation is the major cause of fire incidents in the state. Ground truthing was carried out by a joint team of FSI and State Forest Department during May 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of 16 points were visited by the team.

2.19.2 Forest Cover and Forest Type Group

As per the ISFR 2023, forest cover in the state is 12,222.47 km^2, which constitutes 73.72% of the state's geographical area. In terms of forest canopy density classes, the state has 1,256.38 km^2 under Very Dense Forest (VDF), 4,461.81 km^2 under Moderately Dense Forest (MDF), 6,504.28 km^2 under Open Forest (OF) and 667.27 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Nagaland belong to eight forest type groups, which are further categorized into 11 forest types. The major forest

type groups comprises of Tropical Moist-Deciduous Forests followed by Tropical Semi-evergreen Forests, Subtropical Broadleaved Hill Forests and Montane Wet Temperate Forests.

The most vulnerable forest types to fires in the state are East Himalayan moist mixed deciduous forest followed by Khasi subtropical wet hill forest and Eastern alluvial secondary semi-evergreen forest.

2.19.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.19.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.19.1. Table 2.19.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

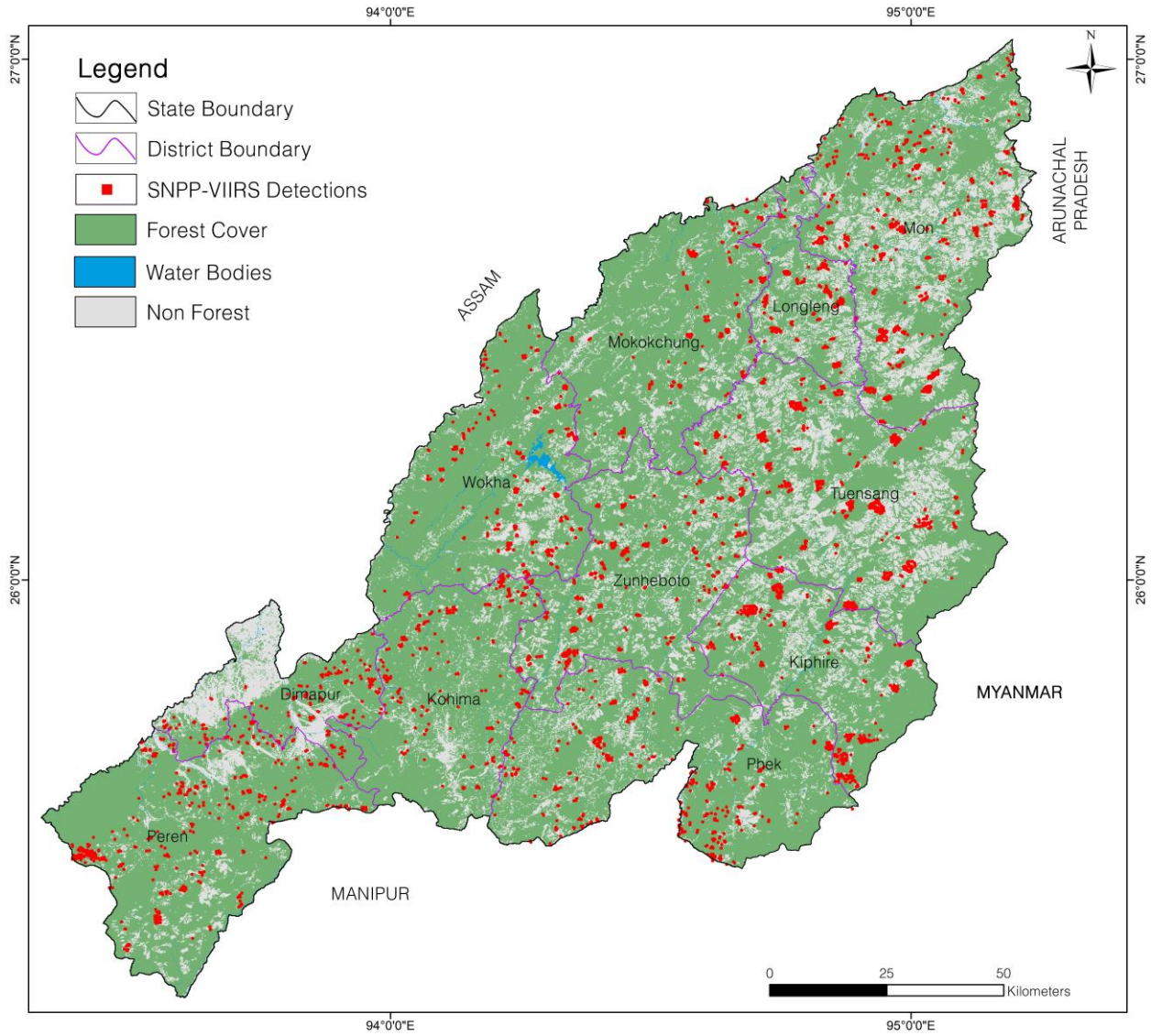


Figure 2.19.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.19.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Dimapur	5	1
Kiphire	1,120	461
Kohima	1,738	767
Longleng	99	4
Mokokchung	7	0
Mon	30	14
Peren	20	1
Phek	862	346

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Tuensang	1,085	317
Wokha	558	232
Zunheboto	696	647
Total	**3,882**	**2,609**

Based on the analysis of forest fire detections, the crucial period of forest fires in the state has been determined. The crucial period of forest fire detections in the state has been noticed to be tentatively between 14th February to 14th April, which is based on the forest fire detections of last eight years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years is shown in the Figure 2.19.2

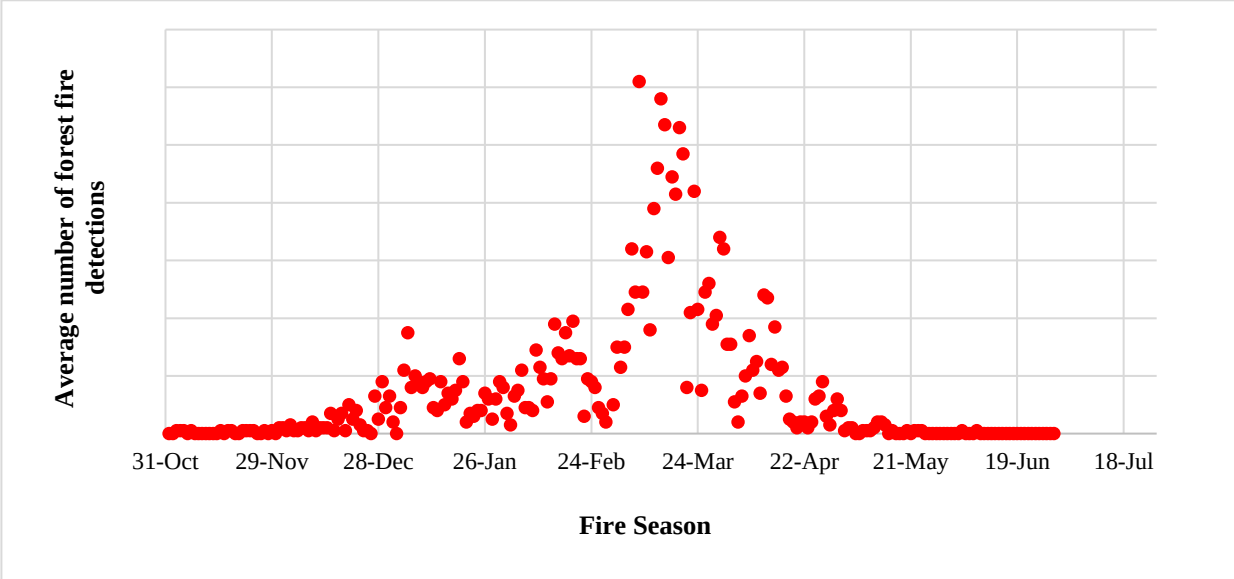


Figure 2.19.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.19.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.19.3. Table 2.19.2 shows the number of large forest fire detections during fire season 2022-23 and 2023-24.

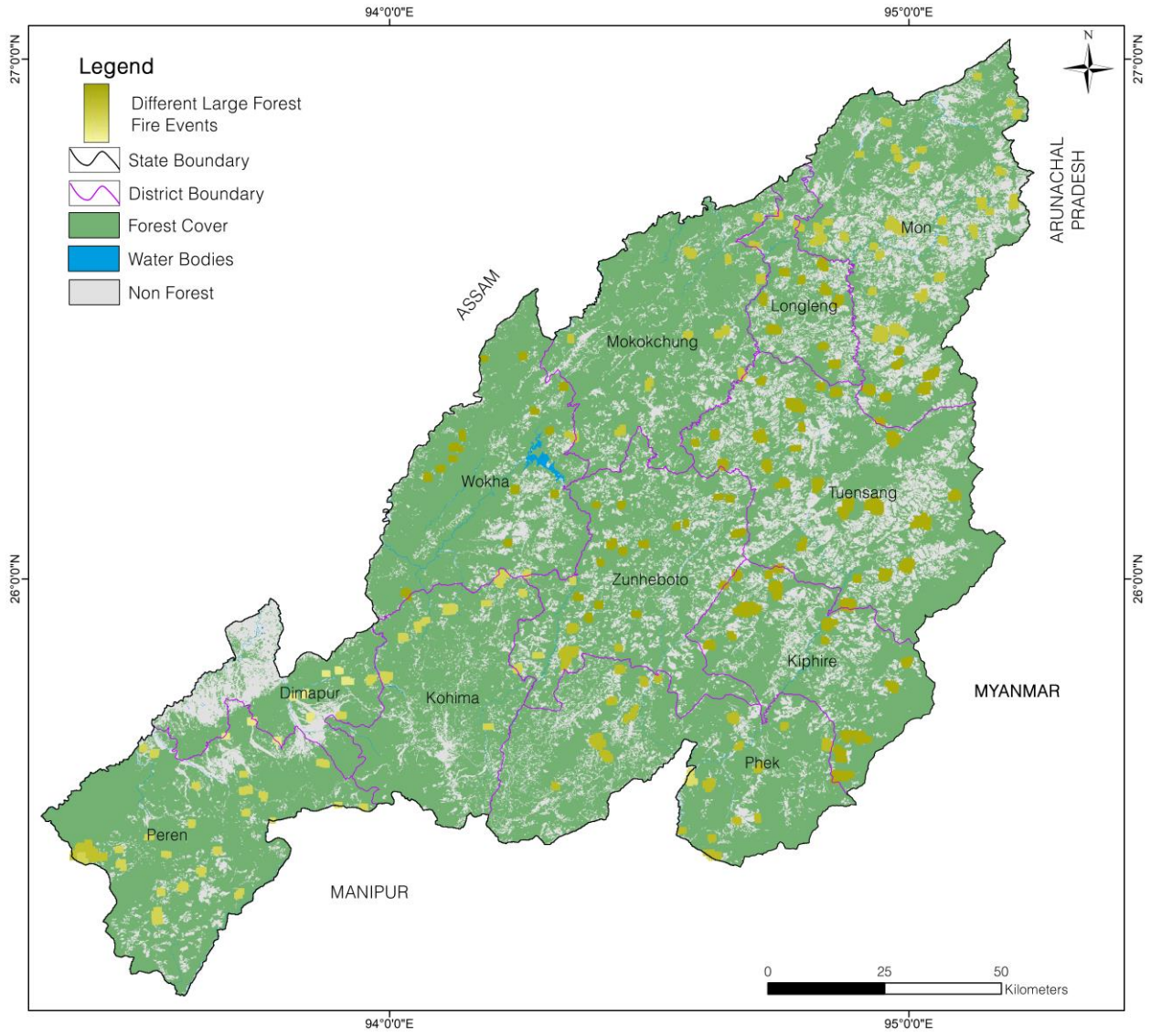


Figure 2.19.3 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.19.2 Number of large forest fire detections during fire season 2022-23 and 2023-24

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Nagaland	311	209

2.19.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the satellite data is given in Table 2.19.3. The burnt scar map of Nagaland is shown in Figure 2.19.4, it can be inferred that 1.52% of the GW has been affected by fires. A total of 1.18% of the GW falls under the low burnt class, 0.34%

under moderately burnt. Only 0.48 km^2 of the GW have been classified under severely burnt class. The burnt area map of Nagaland is shown in Figure 2.19.5

Table 2.19.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
Dimapur	0.00	0.99	11.59	12.58
Kiphire	0.06	1.04	2.73	3.83
Kohima	0.11	4.21	11.67	15.99
Longleng	0.00	0.50	5.17	5.67
Mokokchung	0.00	0.12	2.00	2.12
Mon	0.00	0.68	20.80	21.48
Peren	0.07	8.92	31.04	40.03
Phek	0.03	5.32	14.96	20.31
Tuensang	0.09	5.22	9.80	15.11
Wokha	0.03	2.89	7.89	10.81
Zunheboto	0.09	5.94	7.81	13.84
Total	**0.48**	**35.83**	**125.46**	**161.77**

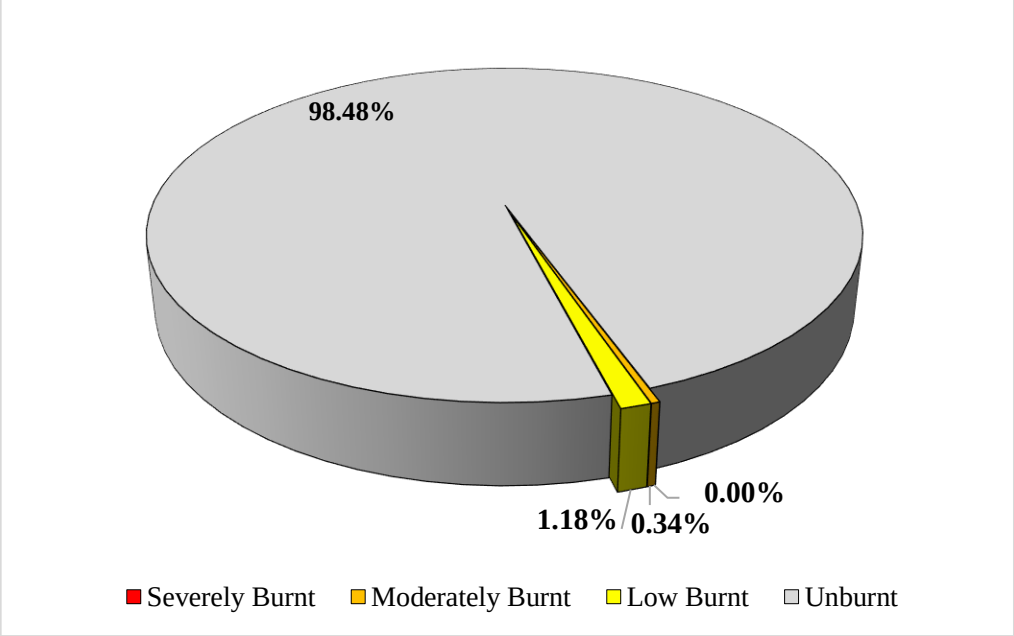


Figure 2.19.4 Distribution of burnt severity classes

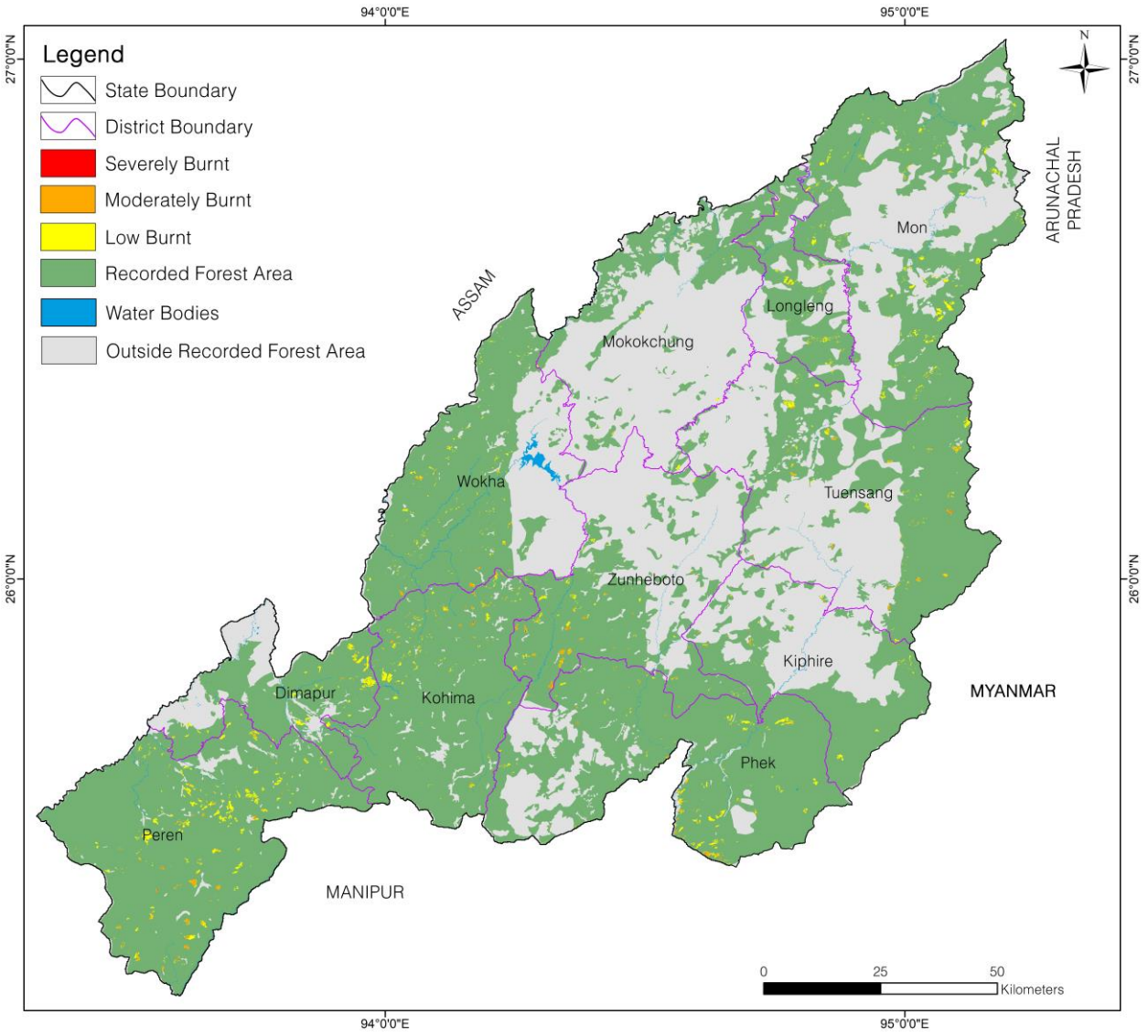


Figure 2.19.5 Map showing burnt area in Nagaland

2.19.5 Results and Analysis

Based on the analysis, it is observed that Peren, Mon, Phek, and Kohima are the most fire affected districts. The maximum affected area under moderately burnt severity class has been observed in Peren and Zunheboto districts. Peren district has reported the highest area under low burnt severity class followed by Mon and Phek. A total of 161.77 km^2 fire affected forest area has been reported in the state, which constitute 1.52% of the GW.

2.20 Odisha

2.20.1 Introduction

The state lies between 17°47' N to 22°34' N latitude and 81°22' E to 87°29' E longitude. It shares border with West Bengal & Jharkhand in the North, Bay of Bengal in the East, Andhra Pradesh & Telangana in the South and Chhattisgarh in the West. It has a coastline which is estimated to be around 450 km. The state comprises of four main physiographic regions: the Northern Plateau, the Eastern Ghats, the Central Tract and the Coastal Plains. Geographical area of the state is 1,55,707 km^2, which is 4.74% of the geographical area of the country. Mahanadi, Brahamani and Baitarni are the major rivers of the state. The state has a tropical wet-dry climate with average annual temperature varies from 25°C to 28°C. Whereas, the rainfall in the state is mainly influenced by South-West monsoon with average annual rainfall ranges between 1,200 mm to 1,600 mm. The state is rich in diverse range of flora and fauna biodiversity. Bamboo, Teak, Rosewood and Padauk are the major tree species of the state. The Recorded Forest Area (RFA) of the state is 61,204 km^2, which is 39.31% of its geographical area.

Forest fires are quite frequent in the state during fire season and a considerable area under forest is affected due to the forest fires every year. There are many causative factors for initiation and spread of fires. In majority of the incidents, Tendu patta and Mahua collection often involve unsustainable practices like clearing undergrowth and setting fires to facilitate collection. It has been observed that the majority of fires in Baliguda Divison, Daringbari Beat have been observed in regions dominated by pure Chir-Pine (*Pinus roxburghii*) species or regions with dominance of pine and Sal. Ground truthing was carried out by a joint team of FSI and State Forest Department during April 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of 35 points were visited by the team.

2.20.2 Forest Cover and Forest Type Group

As per the ISFR 2023, forest cover in the state is 52,433.56 km^2, which constitute 33.67% of the state's geographical area. In terms of forest canopy density classes, the state has 7,224.42 km^2 under Very Dense Forest (VDF), 21,065.55 km^2 under Moderately Dense Forest (MDF), 24,143.59 km^2 under Open Forest (OF) and 4,632.68 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Odisha belong to five forest type groups, which are further categorized into 20 forest types. The forest type groups comprises of Tropical Dry Deciduous Forests followed by Tropical Moist Deciduous Forests, Littoral & Swamp Forests & Tropical Semi-Evergreen Forests.

The most vulnerable forest types to fires in the state are Northern dry mixed deciduous forest followed by Moist Peninsular Low-level Sal and Dry Peninsular Sal forest.

2.20.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.20.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.20.1. Table 2.20.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

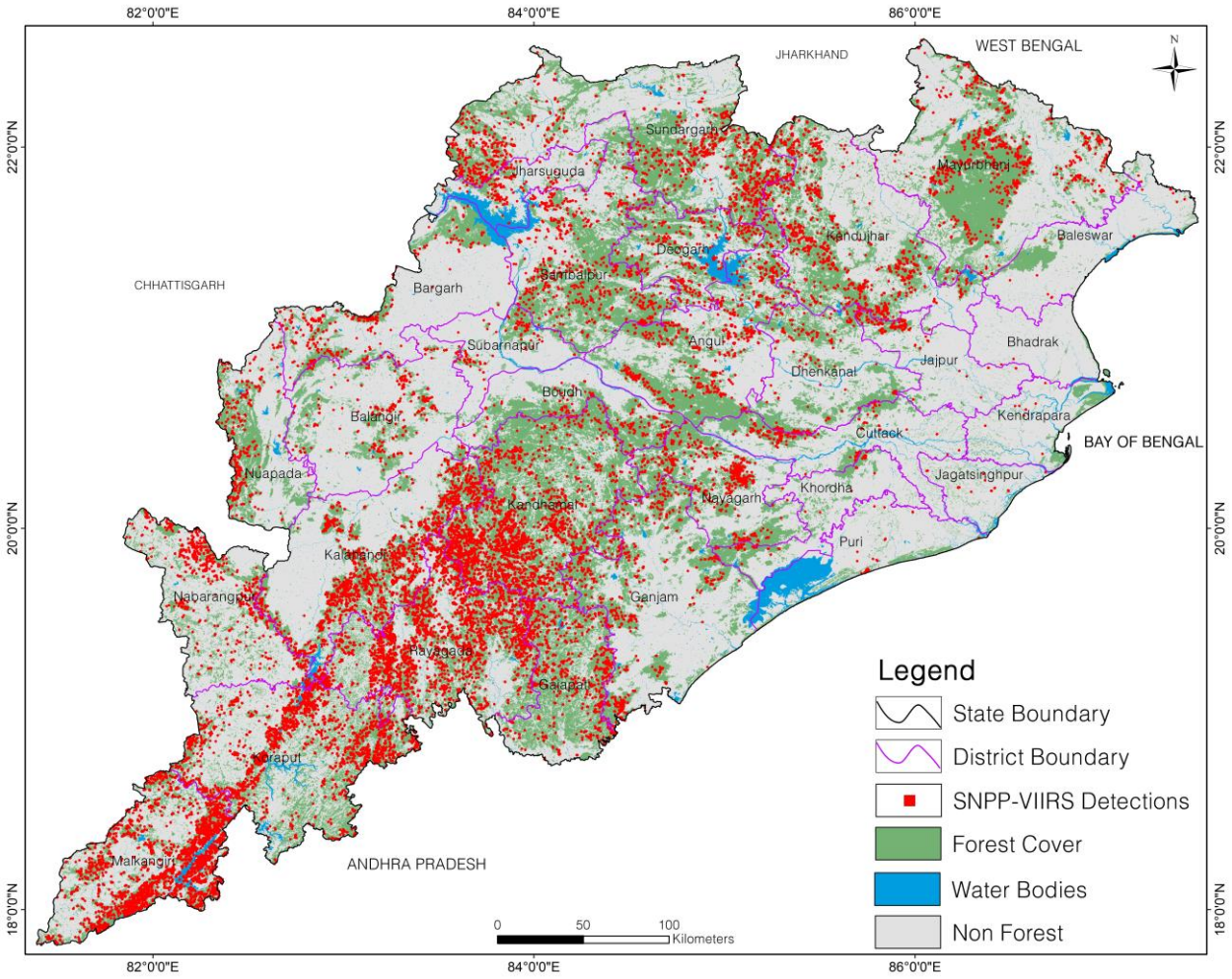


Figure 2.20.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.20.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Angul	1,471	833
Balangir	468	286
Baleswar	116	19
Bargarh	743	316
Bhadrak	36	3
Boudh	675	189
Cuttack	256	166
Deogarh	1,145	329
Dhenkanal	663	201
Gajapati	1,498	814
Ganjam	1,499	593
Jagatsinghpur	4	13
Jajpur	120	127

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Jharsuguda	468	157
Kalahandi	1,889	1,768
Kandhamal	3,090	2,591
Kendrapara	17	8
Kendujhar	2,204	926
Khordha	256	63
Koraput	1,447	1,994
Malkangiri	1,107	2,582
Mayurbhanj	2,698	800
Nabarangpur	1,232	656
Nayagarh	847	509
Nuapada	1,303	328
Puri	22	27
Rayagada	2,541	2,646
Sambalpur	2,248	692
Subarnapur	294	106
Sundargarh	3,104	1,231
Total	**33,461**	**20,973**

Based on the analysis of forest fire detections, the crucial period of forest fires in the state has been determined. The crucial period of forest fire detections in the state has been noticed to be tentatively between 03rd March to 20th April, which is based on the forest fire detections of last eight years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years is shown in the Figure 2.20.2.

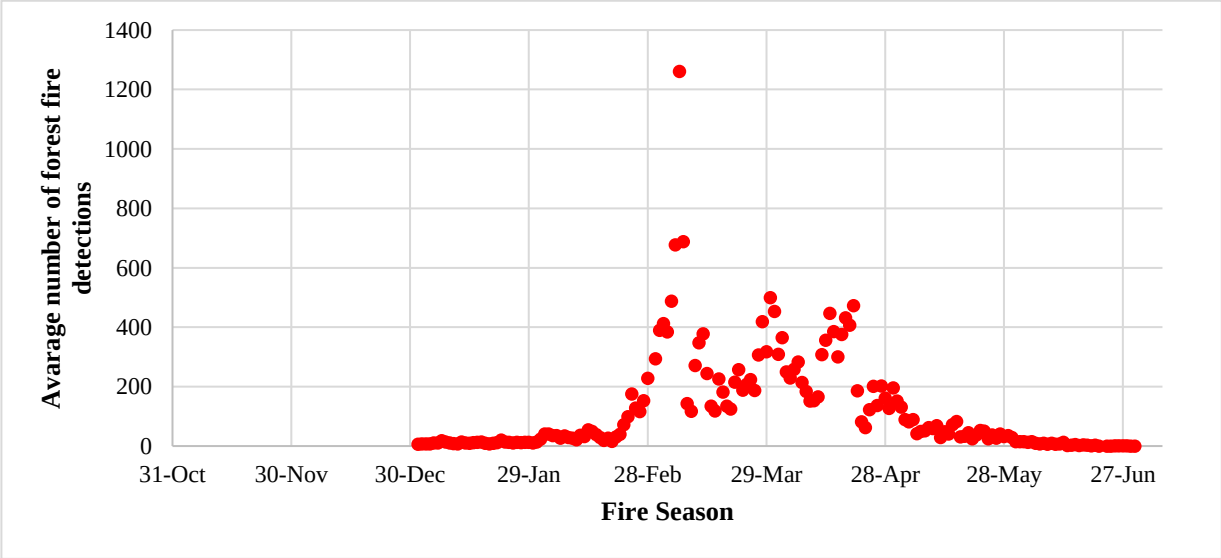


Figure 2.20.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.20.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.20.3. Table 2.20.2 shows the number of large forest fire detections during fire season 2022-23 and 2023-24.

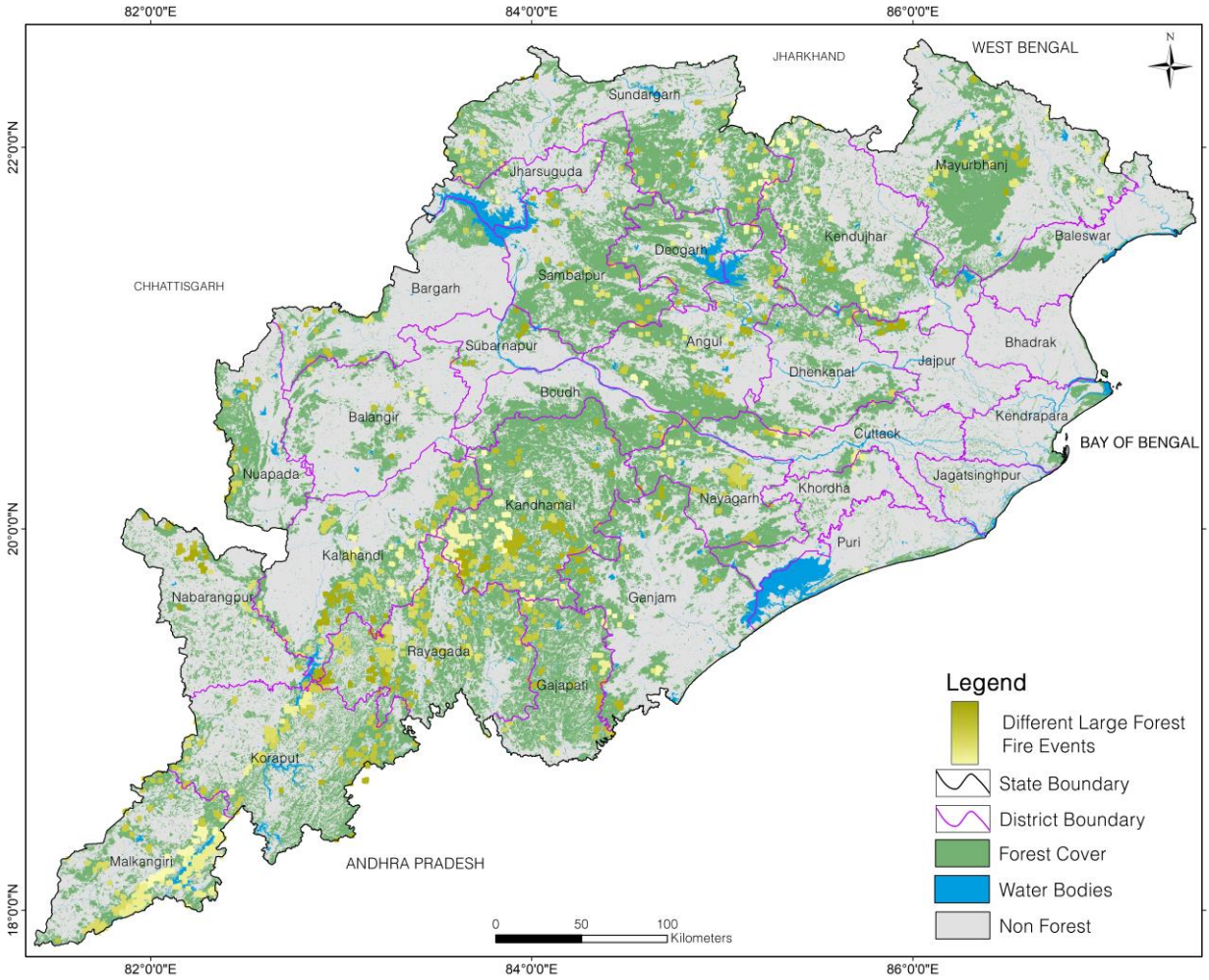


Figure 2.20.3 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.20.2 Number of large forest fire detections during fire season 2022-23 and 2023-24

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Odisha	1,905	1,131

2.20.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the satellite data is given in Table 2.20.3. From the Figure 2.20.4, it can be inferred that 5.81% of the RFA has been affected by fires. A total of 5.55% of the RFA falls under the low burnt class and 0.26% under moderately burnt class. Only 0.01 km^2 of the RFA have been classified under severely burnt class. The burnt scar map of Odisha is shown in Figure 2.20.5.

Table 2.20.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
Angul	0.00	1.30	125.51	126.81
Balangir	0.00	0.63	90.80	91.43
Baleswar	0.00	0.00	0.00	0.00
Bargarh	0.00	0.03	5.13	5.16
Bhadrak	0.00	0.00	0.00	0.00
Boudh	0.00	3.61	134.89	138.50
Cuttack	0.00	0.94	34.47	35.41
Deogarh	0.00	0.70	73.12	73.82
Dhenkanal	0.00	0.25	18.27	18.52
Gajapati	0.00	1.10	22.75	23.85
Ganjam	0.00	3.54	164.58	168.12
Jagatsinghpur	0.00	0.00	0.00	0.00
Jajpur	0.00	0.00	25.51	25.51
Jharsuguda	0.00	0.00	1.41	1.41
Kalahandi	0.00	8.99	247.68	256.67
Kandhamal	0.00	20.81	297.54	318.35
Kendrapara	0.00	0.00	0.00	0.00
Kendujhar	0.00	14.00	112.91	126.91
Khordha	0.00	0.48	5.93	6.41
Koraput	0.01	1.89	43.97	45.86
Malkangiri	0.00	4.22	74.28	78.50
Mayurbhanj	0.00	3.56	117.12	120.68
Nabarangpur	0.00	0.98	55.72	56.70
Nayagarh	0.00	10.95	167.84	178.79
Nuapada	0.00	1.47	41.27	42.74
Puri	0.00	0.00	0.00	0.00
Rayagada	0.00	2.04	217.00	219.04
Sambalpur	0.00	1.68	100.69	102.37
Subarnapur	0.00	0.48	7.59	8.07
Sundargarh	0.00	24.84	169.26	194.10
Total	**0.01**	**108.49**	**2,355.24**	**2,463.74**

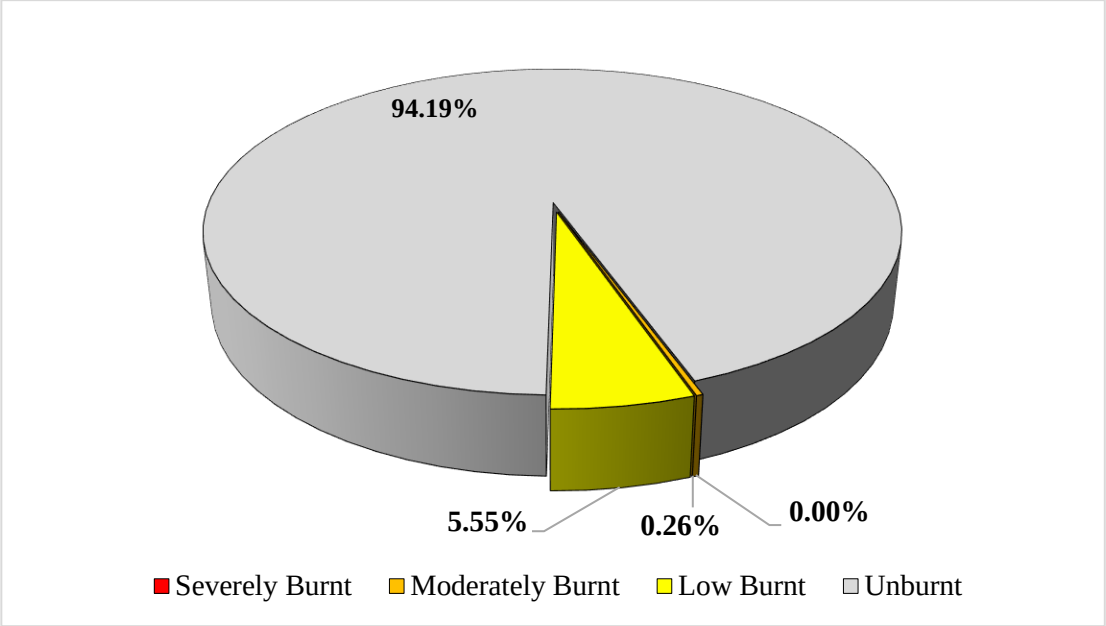


Figure 2.20.4 Distribution of burnt severity classes

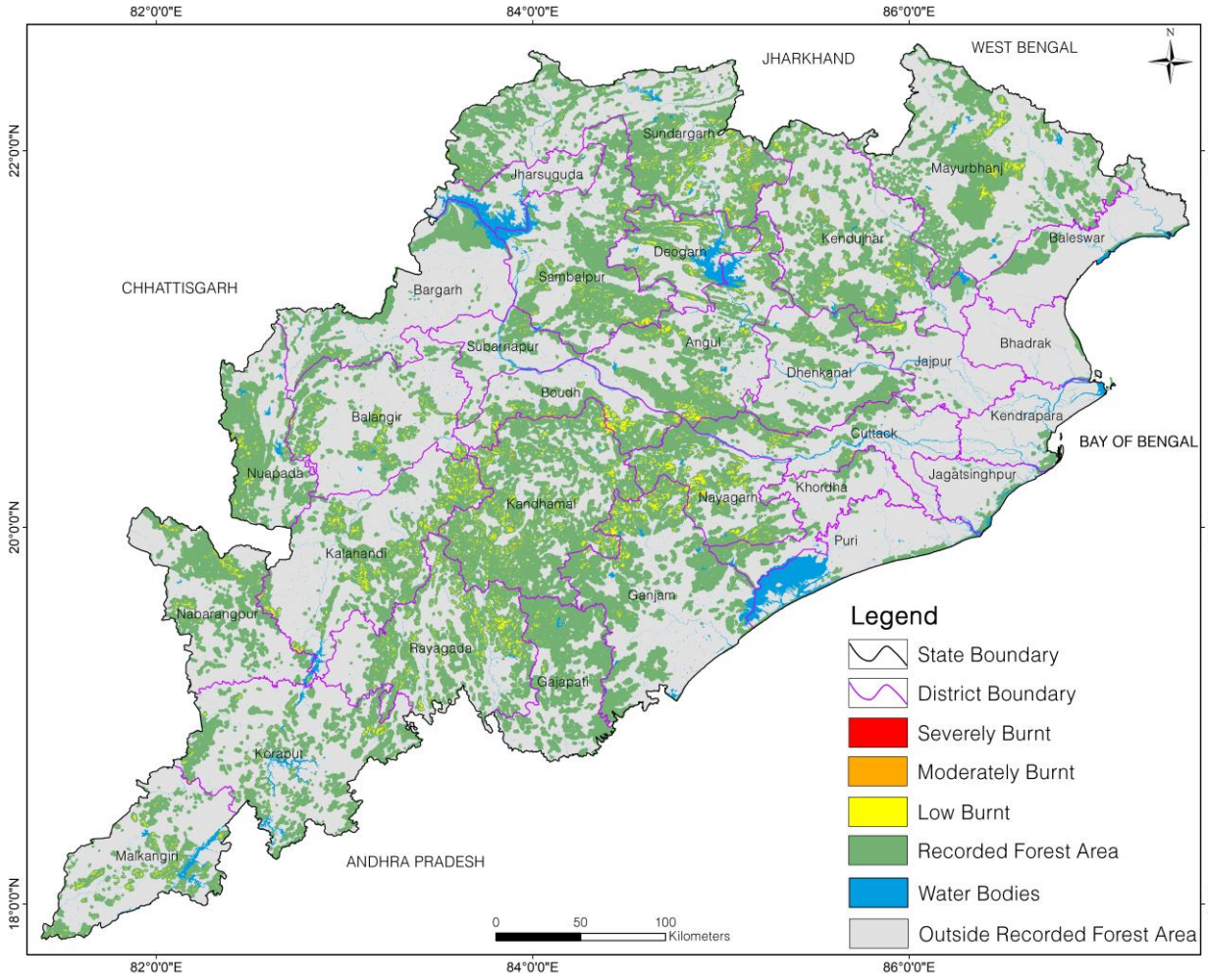


Figure 2.20.5 Map showing forest fire burnt area in Odisha

2.20.5 Results and Analysis

Based on the analysis, it is observed that Kandhamal followed by Kalahandi, Rayagada and Sundargarh are the most fire affected districts. The maximum affected area under moderately burnt severity class has been observed in Sundargarh and Kandhamal districts. Kandhamal district has reported the highest area under low burnt severity class followed by Kalahandi and Rayagada. A total of 2,463.74 km^2 fire affected forest area has been reported in the state, which constitute 5.81% of the RFA.

2.21 Punjab

2.21.1 Introduction

The state lies between 29°33' N to 32°32' N latitude and 73°53' E to 76°56' E longitude. It shares border with Himachal Pradesh in the North-East, Haryana & Rajasthan in the South and Jammu & Kashmir in the North. It is also shares international border with Pakistan in the West. Punjab is divided into three distinct regions on the basis of soil types: South-Western, Central, and Eastern[22.] Geographical area of the state is 50,362 km^2, which is 1.53% of the geographical area of the country. Sutlej, Beas, Ravi, Chenab and Jhelum are the major rivers of the state. The climate of the state is tropical and semi-arid with the average annual temperature of the state varies from 0°C to 47°C. Whereas, the rainfall in the state is mainly influenced by South-East monsoon with average annual rainfall ranges from 480 mm to 960 mm. The state is predominantly an agricultural State with almost 82% of the total geographical area under agriculture. The Recorded Forest Area (RFA) of the state is 3,084 km^2, which is 6.12% of its geographical area.

Majority of the incidents responsible for initiation and spread of fires may be attributed to influx of tourists nearby forest areas. Ground truthing was carried out by a joint team of FSI and State Forest Department during June 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of 03 points were visited by the team.

2.21.2 Forest Cover and Forest Type Group

As per the ISFR 2023, forest cover in the state is 1,846.09 km^2, which constitutes 3.67% of the state's geographical area. In terms of forest canopy density classes, the state has 9.44 km^2 under Very Dense Forest (VDF), 784.89 km^2 under Moderately Dense Forest (MDF), 1,051.76 km^2 under Open Forest (OF) and 41.61 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Punjab belong to four forest type groups, which are further categorized into eight forest types. The forest type groups comprise of Tropical Dry Deciduous Forests, Tropical Thorn Forests and Subtropical Pine Forests.

[22] https://en.wikipedia.org/wiki/Punjab, India

The most vulnerable forest types to fires in the state are Northern dry mixed deciduous forest followed by Ravine thorn forest and Dry deciduous scrub.

2.21.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.21.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.21.1. Table 2.21.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

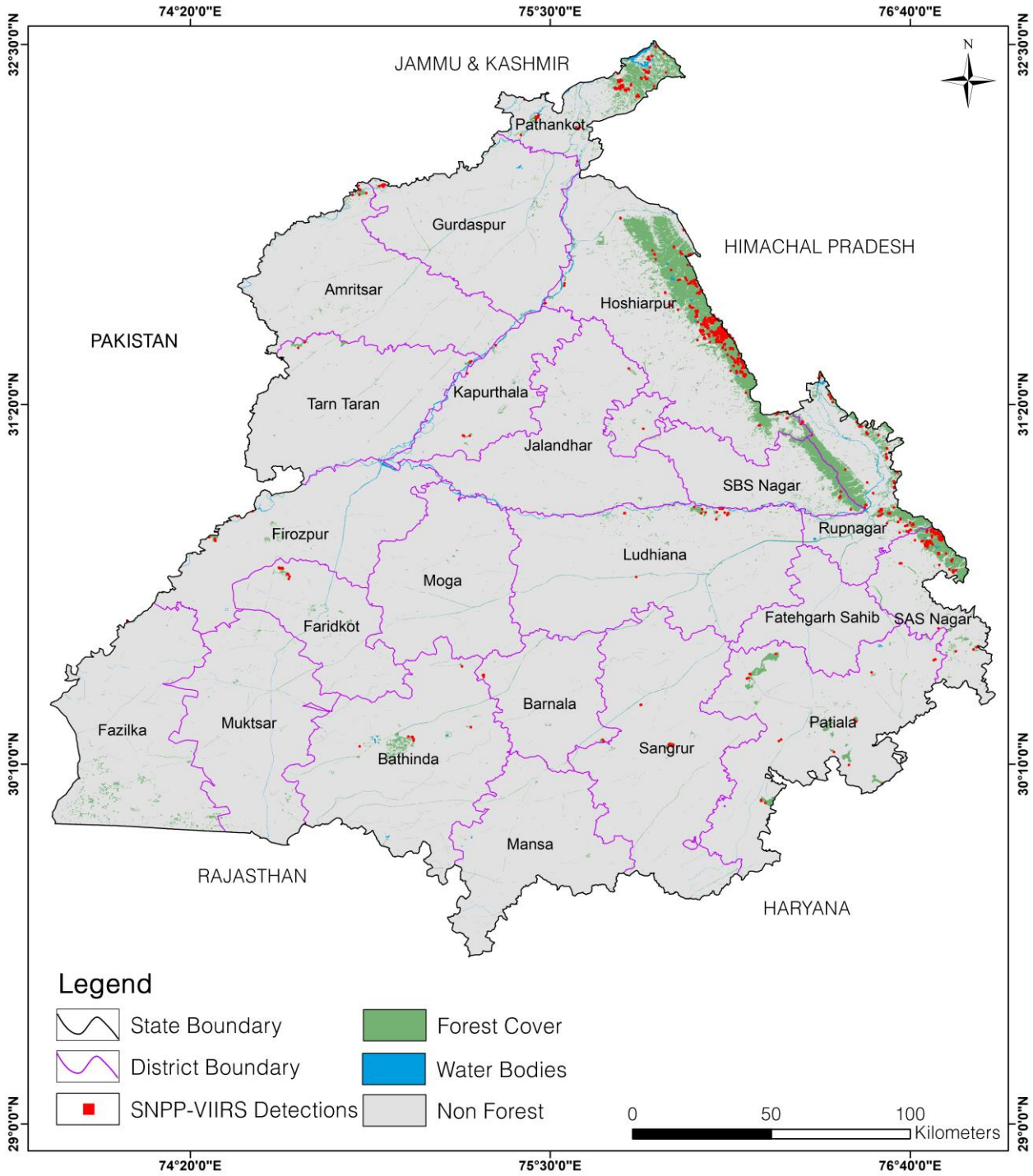


Figure 2.21.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.21.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Amritsar	3	7

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Barnala	7	5
Bathinda	15	9
Faridkot	2	7
Fatehgarh Sahib	0	0
Fazilka	1	2
Firozpur	4	5
Gurdaspur	2	8
Hoshiarpur	18	271
Jalandhar	0	1
Kapurthala	4	6
Ludhiana	5	14
Mansa	6	0
Moga	0	0
Muktsar	0	0
Pathankot	3	75
Patiala	13	18
Rupnagar	11	67
Sangrur	7	12
SAS Nagar	3	88
SBS Nagar	10	6
Tarn Taran	5	4
Total	**119**	**605**

Based on the analysis of forest fire detections of last eight years in the state, no clear correlation between year-wise forest fire detections appeared to determine the crucial period.

2.21.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.21.2. Table 2.21.2 shows the number of large forest fire detections during fire season 2022-23 and 2023-24.

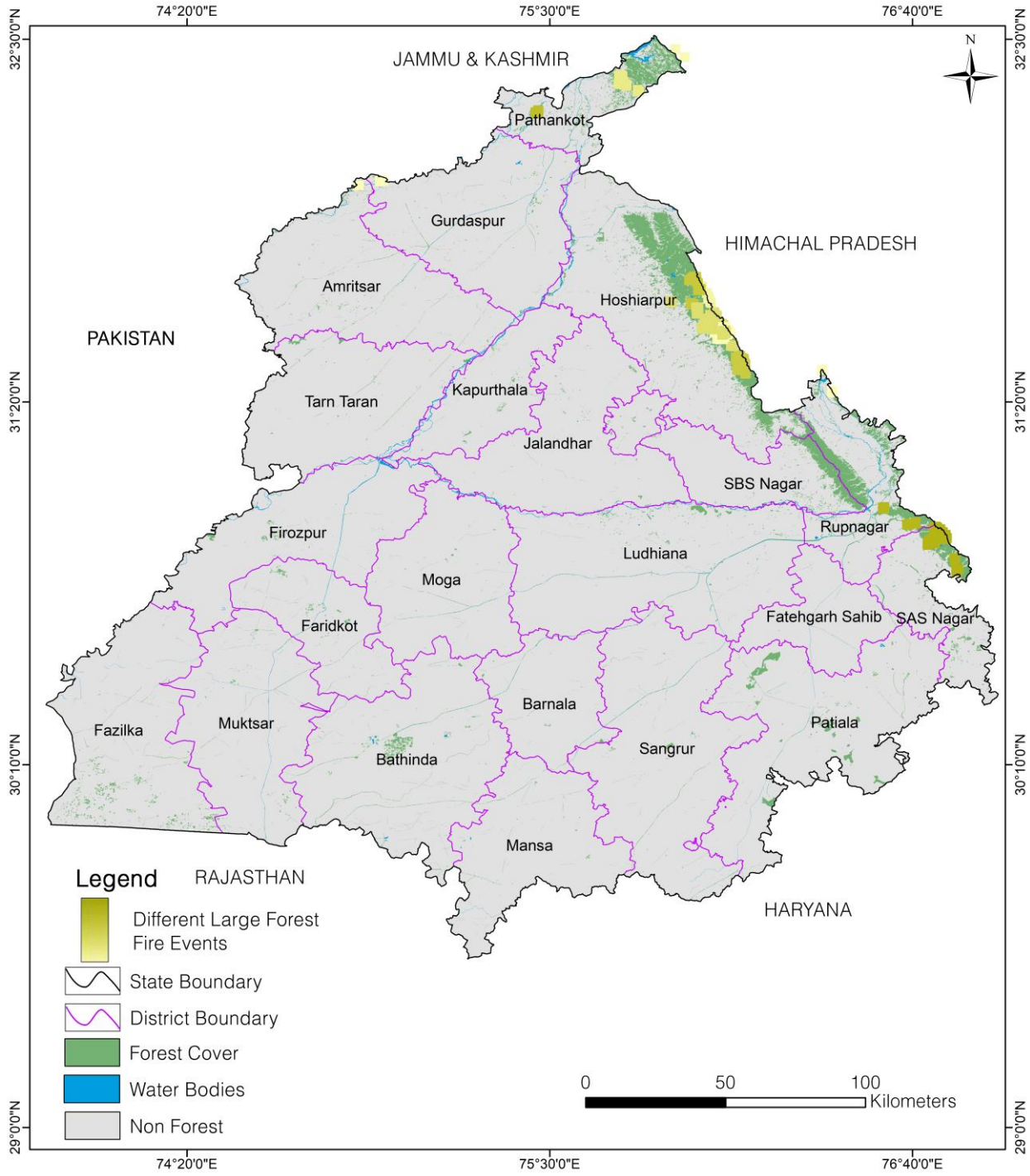


Figure 2.21.2 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.21.2 Number of large forest fire detections during fire season 2022-23 and 2023-24

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Punjab	4	37

2.21.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.21.3. From the Figure 2.21.3, it can be inferred that 4.39% of the GW has been affected by fires. A total of 3.70% of the GW falls under the low burnt class and 0.69% under moderately burnt class. Only 0.01 km^2 of the GW have been classified under severely burnt class. The burnt area map of Punjab is shown in Figure 2.21.4

Table 5.21.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
Amritsar	0.00	0.00	0.00	0.00
Barnala	0.00	0.00	0.00	0.00
Bathinda	0.00	0.00	0.00	0.00
Faridkot	0.00	0.00	0.00	0.00
Fatehgarh Sahib	0.00	0.00	0.00	0.00
Fazilka	0.00	0.00	0.00	0.00
Firozpur	0.00	0.00	0.00	0.00
Gurdaspur	0.00	0.00	0.00	0.00
Hoshiarpur	0.00	0.37	10.94	11.31
Jalandhar	0.00	0.00	0.00	0.00
Kapurthala	0.00	0.00	0.00	0.00
Ludhiana	0.00	0.00	0.00	0.00
Mansa	0.00	0.00	0.00	0.00
Moga	0.00	0.00	0.00	0.00
Muktsar	0.00	0.00	0.00	0.00
Pathankot	0.00	1.75	2.69	4.44
Patiala	0.00	0.00	0.00	0.00
Rupnagar	0.00	2.45	3.69	6.14
Sangrur	0.00	0.00	0.00	0.00
SAS Nagar	0.01	1.79	16.86	18.66
SBS Nagar	0.00	0.00	0.00	0.00

Tarn Taran	0.00	0.00	0.00	0.00
Total	**0.01**	**6.36**	**34.18**	**40.55**

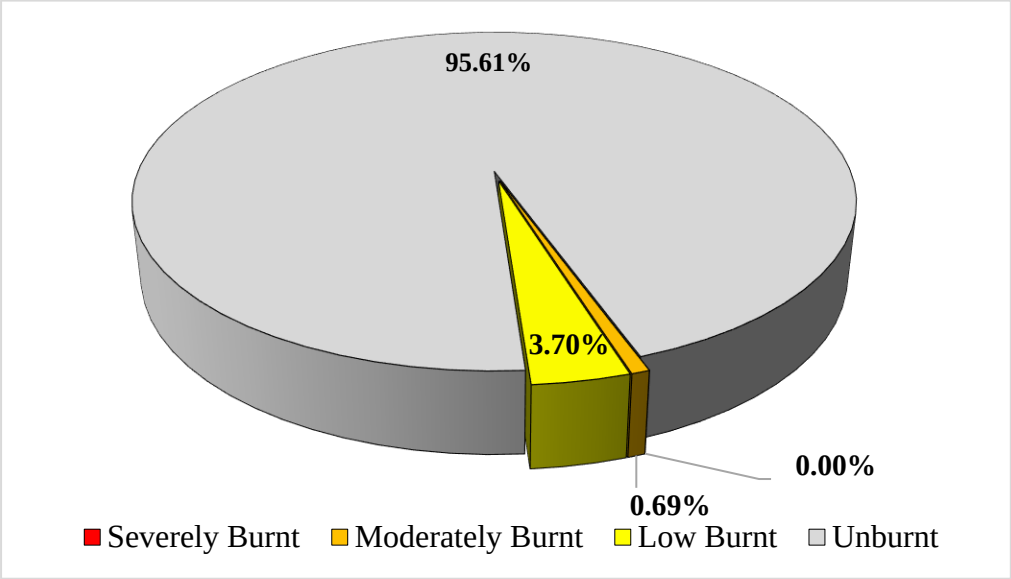


Figure 2.21.3 Distribution of burnt severity classes

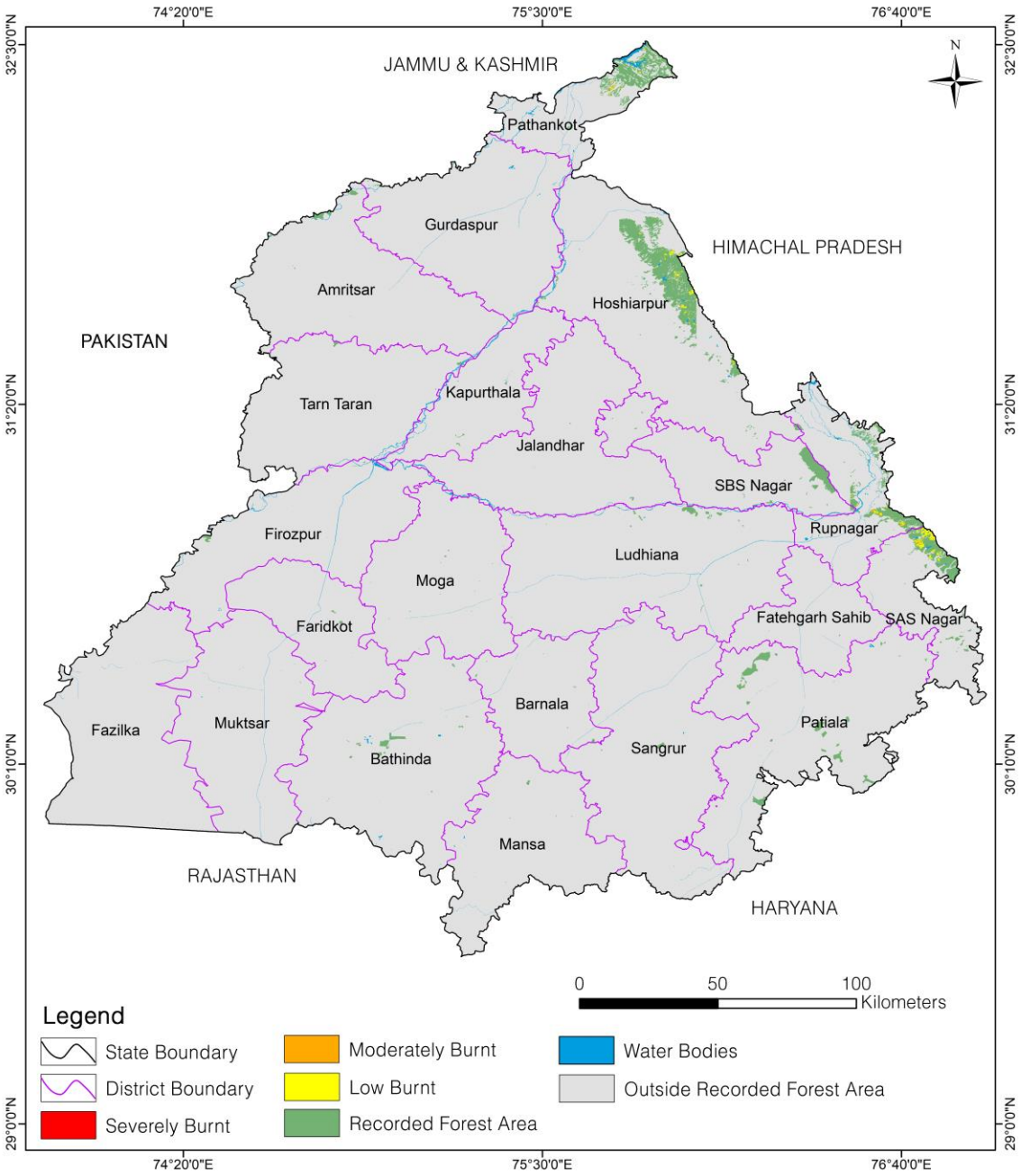


Figure 2.21.4 Map showing burnt area in Punjab

2.21.5 Results and Analysis

Based on the analysis, it is observed that SAS Nagar, Hoshiapur, and Rupnagar, are the most fire affected districts. The maximum affected area under moderately burnt severity class has been observed in Rupnagar and SAS Nagar districts. SAS Nagar district has reported the highest area under low burnt severity class followed by Hoshiapur, and Rupnagar. A total of 40.55 km^2 fire affected forest area has been reported in the state, which constitutes 4.39% of the GW.

2.22 Rajasthan

2.22.1 Introduction

The state lies between 23°4' N to 30°11' N latitude and 69°29' E to 78°17' E longitude. It shares border with Madhya Pradesh in the South-East, Gujarat in the South-West, Uttar Pradesh & Haryana in the North-East and Punjab in the North. It also shares international border with Pakistan. The state comprises of four main physiographic regions: The Aravalli Hills, Western Desert, Level Rocky & Sandy Plains and South-Eastern Plateau. Geographical area of the state is 3,42,239 km^2, which is 10.41% of the geographical area of the country. Banas, Chambal, Luni and Mahi are the major rivers of the state. The climate of the state is semi-arid to arid with the average annual temperature varies from 0°C to 50°C. The average annual rainfall ranges between 480 mm to 750 mm. The state experiences varied vegetation, from dense forests witnessed in the Mount Abu to Dry Grasslands of desert, from Dry Deciduous Forest of Aravalli to Wetlands of Bharatpur. The Recorded Forest Area (RFA) of the state is 32,869 km^2, which is 9.60% of its geographical area.

Majority of the incidents responsible for initiation and spread of fires may be attributed to the practice of regeneration of grass, tourism, and spiritual effect. Ground truthing was carried out by a joint team of FSI and State Forest Department during April 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of 21 points were visited by the team.

2.22.2 Forest Cover and Forest Type Group

As per ISFR 2023, forest cover in the state is 16,548.21 km^2, which constitutes 4.84% of the state's geographical area. In terms of forest canopy density classes, the state has 223.20 km^2 under Very Dense Forest (VDF), 4,237.41 km^2 under Moderately Dense Forest (MDF), 12,087.60 km^2 under Open Forest (OF) and 5,476.75 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Rajasthan belong to three forest type groups, which are further categorized into 21 forest types. The forest type groups comprises of Tropical Dry Deciduous Forests and Tropical Thorn Forests.

The most vulnerable forest types to fires in the state are Northern dry mixed deciduous forest followed by Very dry teak forest and Dry deciduous scrub.

2.22.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.22.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.22.1. Table 2.22.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

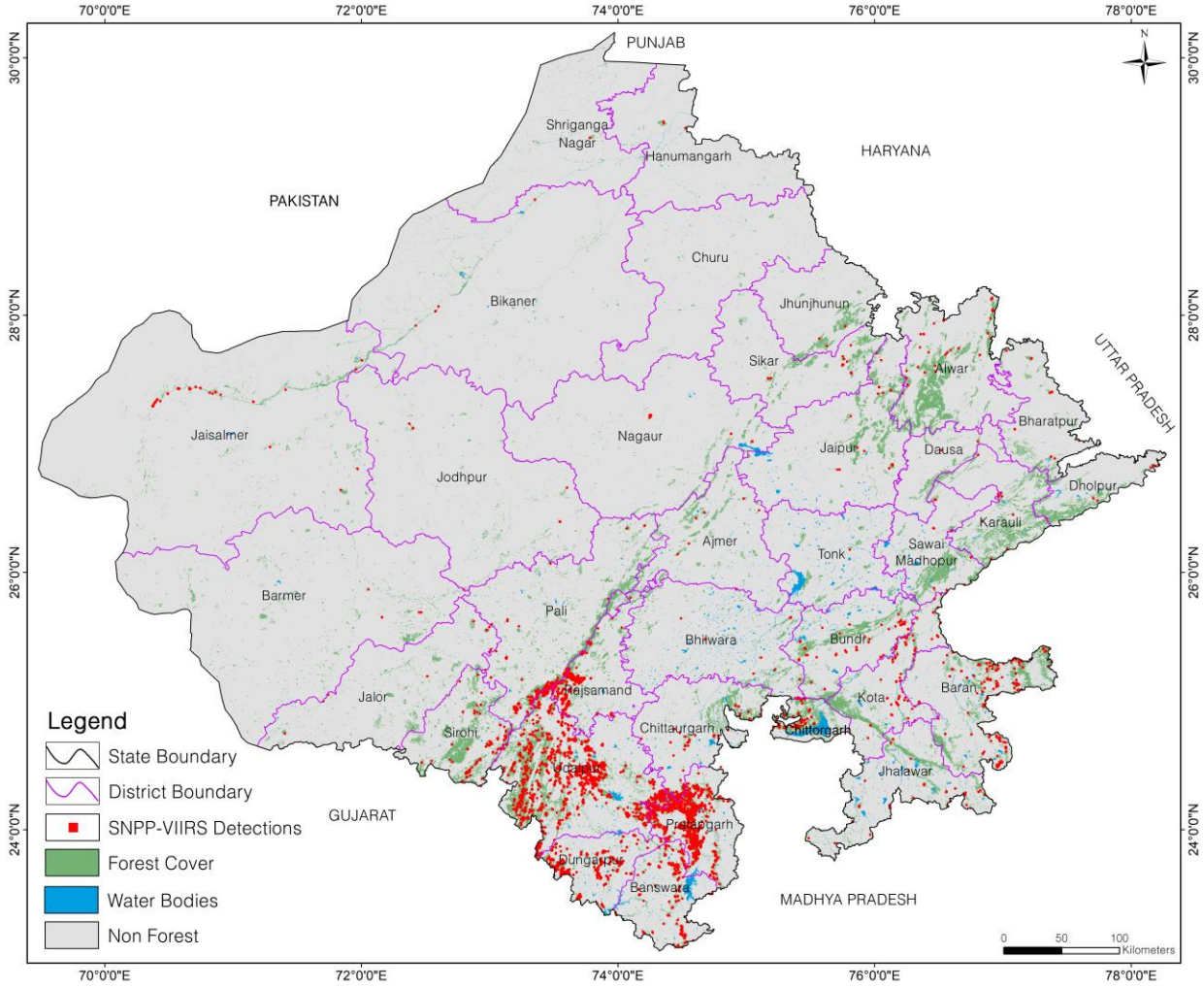


Figure 2.22.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.22.1 District-wise number of NRT detections using SNPP-VIIRS sensor during fire season November 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Ajmer	8	6
Alwar	6	30
Banswara	126	203
Baran	144	166
Barmer	3	4
Bharatpur	11	13
Bhilwara	15	17
Bikaner	7	5
Bundi	83	51
Chittaurgarh	90	198
Churu	2	0
Dausa	5	2
Dholpur	1	6
Dungarpur	77	314
Hanumangarh	3	4
Jaipur	9	0
Jaisalmer	78	44
Jalor	16	9
Jhalawar	17	30
Jhunjhunun	3	3
Jodhpur	0	6
Karauli	11	11
Kota	52	79
Nagaur	43	13
Pali	56	211
Pratapgarh	646	1,057
Rajsamand	40	300
Sawai Madhopur	15	11
Shriganga Nagar	2	2
Sikar	5	15
Sirohi	36	103
Tonk	6	1
Udaipur	443	1,438
Total	**2,059**	**4,352**

Based on the analysis of forest fire detections, the crucial period of forest fires in the state has been determined. The crucial period of forest fire detections in the state has been noticed to be tentatively between 22nd March to 8th May, which is based on the forest fire detections of last eight years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years is shown in the Figure 2.22.2.

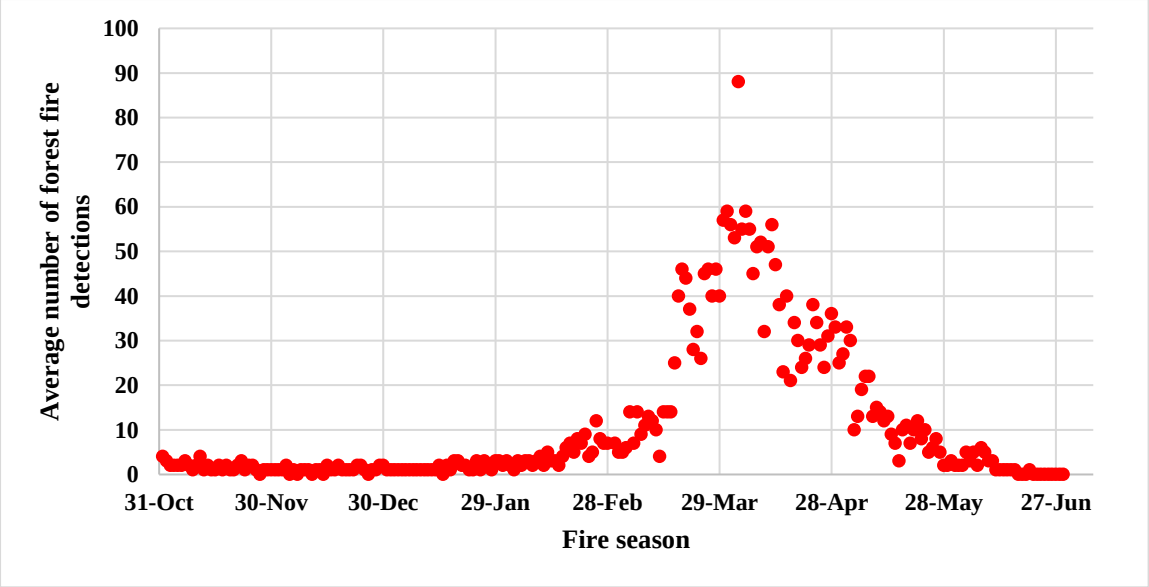


Figure 2.22.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.22.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.22.3. Table 2.22.2 shows district-wise number of large forest fire detections during fire season 2022-23 and 2023-24.

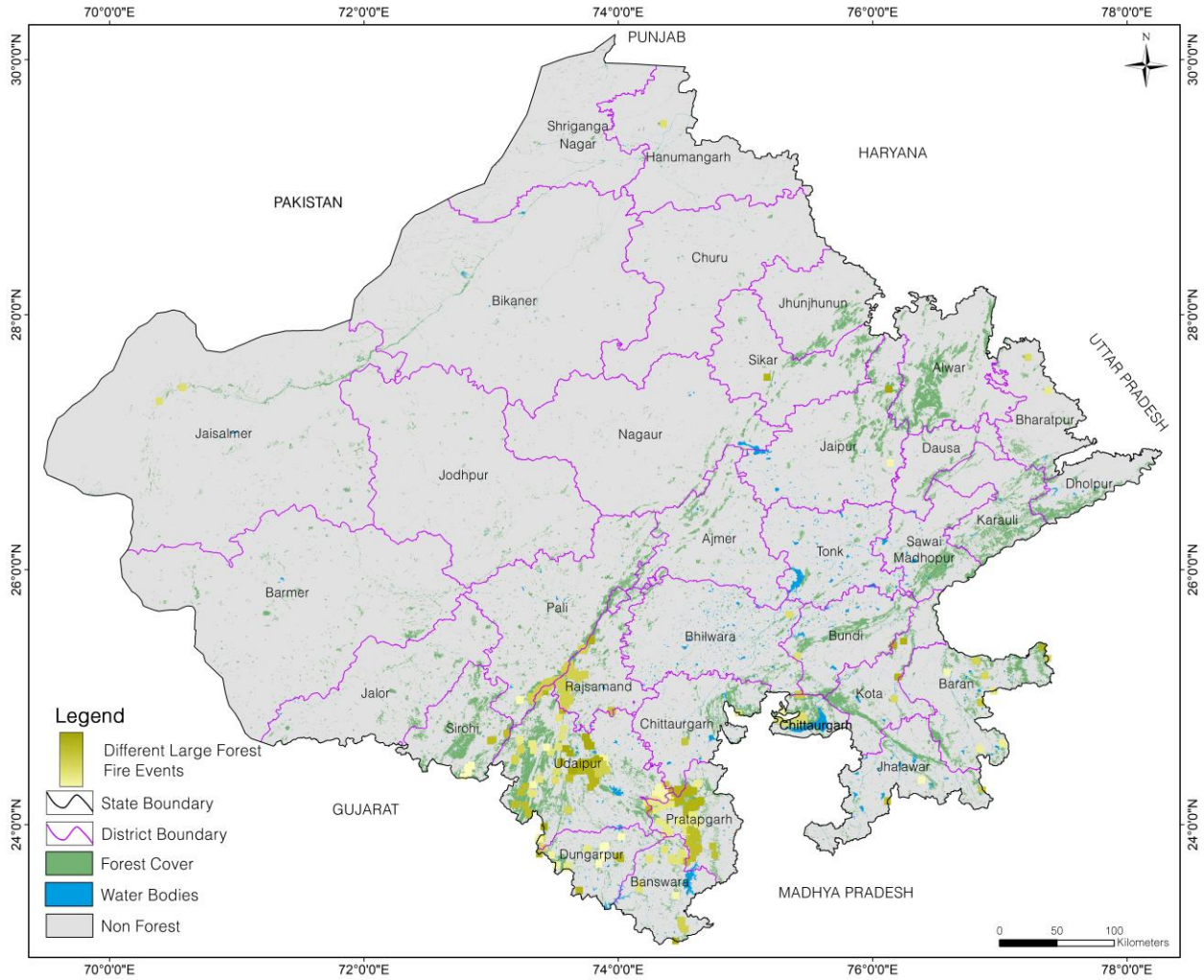


Figure 2.22.3 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.22.2 Number of large forest fire detections during fire season 2022-23 and 2023-24

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Rajasthan	102	253

2.22.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.22.3. From the Figure 2.22.4, it can be inferred that 1.18% of the RFA has been affected by fires, majority of which is categorised under low burnt. Only 0.01 km^2 and 0.53 km^2 of the forest cover inside RFA have been classified under severely burnt and moderately burnt class respectively. The burnt area map of Rajasthan is shown in Figure 2.22.5

Table 2.22.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
Ajmer	0.00	0.00	0.00	0.00
Alwar	0.00	0.00	0.00	0.00
Banswara	0.00	0.00	6.86	6.86
Baran	0.00	0.00	7.29	7.29
Barmer	0.00	0.00	0.00	0.00
Bharatpur	0.00	0.00	0.00	0.00
Bhilwara	0.00	0.00	1.15	1.15
Bikaner	0.00	0.00	0.00	0.00
Bundi	0.00	0.00	0.43	0.43
Chittaurgarh	0.00	0.00	37.34	37.34
Churu	0.00	0.00	0.00	0.00
Dausa	0.00	0.00	0.00	0.00
Dholpur	0.00	0.00	0.00	0.00
Dungarpur	0.00	0.01	18.04	18.05
Hanumangarh	0.00	0.00	0.00	0.00
Jaipur	0.00	0.00	0.00	0.00
Jaisalmer	0.00	0.00	0.00	0.00
Jalor	0.00	0.00	0.00	0.00
Jhalawar	0.00	0.00	0.00	0.00
Jhunjhunun	0.00	0.00	0.00	0.00
Jodhpur	0.00	0.00	0.00	0.00
Karauli	0.00	0.00	0.00	0.00
Kota	0.00	0.01	0.11	0.12
Nagaur	0.00	0.00	0.00	0.00
Pali	0.00	0.16	27.31	27.47
Pratapgarh	0.00	0.23	135.46	135.69
Rajsamand	0.01	0.05	31.19	31.25
Sawai Madhopur	0.00	0.00	0.00	0.00
Shriganga Nagar	0.00	0.00	0.00	0.00
Sikar	0.00	0.00	0.00	0.00
Sirohi	0.00	0.00	3.14	3.14
Tonk	0.00	0.00	0.00	0.00
Udaipur	0.00	0.07	155.61	155.68
Total	**0.01**	**0.53**	**423.93**	**424.47**

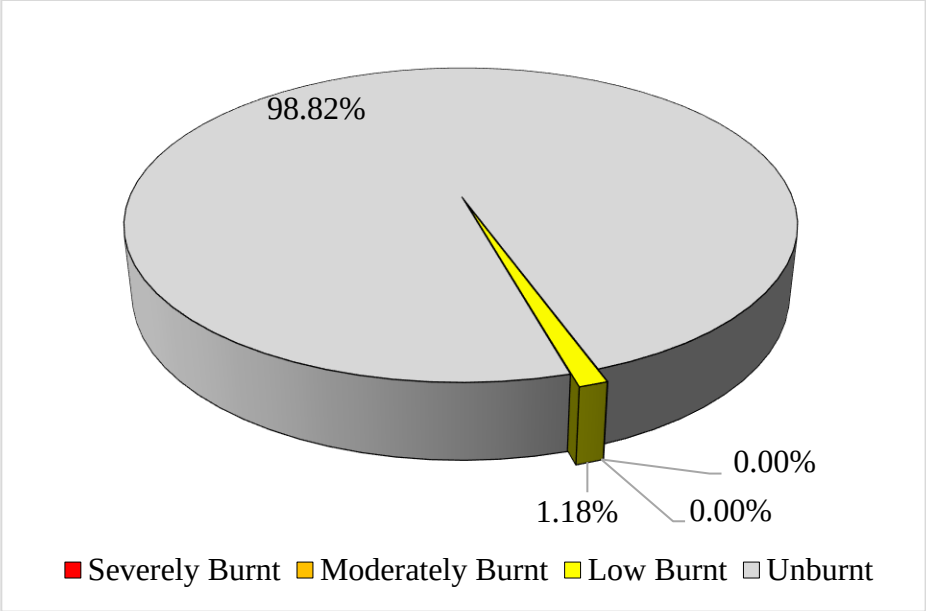


Figure 2.22.4 Distribution of burnt severity classes

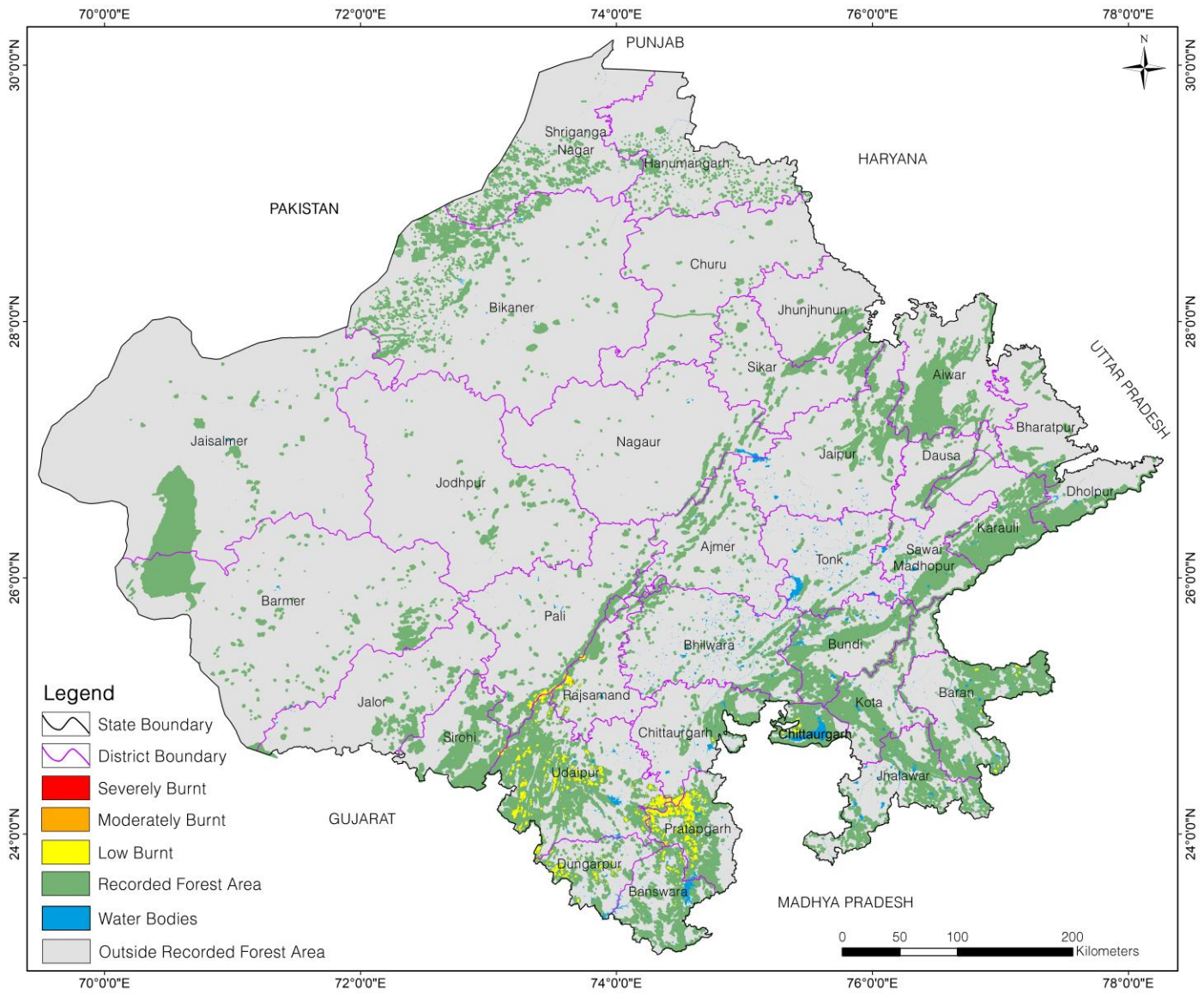


Figure 2.22.5 Map showing burnt area in Rajasthan

2.22.5 Result and Analysis

Based on the analysis, it is observed that Udaipur followed by Pratapgarh, Chittaurgarh, Rajsamand are the most affected districts. The maximum affected area under moderately burnt severity class has been observed in Pratapgarh districts. Udaipur district has reported the highest area under low burnt severity class. A total of 424.47 km^2 fire affected forest area has been reported in the state, which constitutes 1.18% of the RFA.

2.23 Sikkim

2.23.1 Introduction

The state lies between 27°04' N to 28°07' N latitude and 88°00' E to 88°55' E longitude and shares international border with Tibet in the North & the North-East, Bhutan in the East, Nepal in the West. The state is also bordered by West Bengal in the South. Geographical area of the state is 7,096 km^2, which is 0.22% of the Geographical area of the country. Teesta, Ranjeet, Rangpo and Lachen are the major rivers of the state. The climate of the state varies from sub-tropical to the tundra. The average annual temperature of the state varies from sub-zero to 28°C. The rainfall in the state is mainly influenced by South-West monsoon with average annual rainfall ranges from 2,700 to 3,200 mm. Orchids, Figs, Laurel, Bananas, Sal trees and Bamboo grow in the Himalayan Subtropical Broadleaved Forests of the lower altitudes of Sikkim. In Eastern Himalayan Broadleaved Forests, where Oaks, Chestnuts, Maples, Birches, Alders, and Magnolias grow in large numbers, as well as Himalayan Subtropical Pine Forests, dominated by Chir Pine. In lower elevations are found Juniper, Pine, Firs, Cypresses and Rhododendrons from the Eastern Himalayan Sub-Alpine Conifer Forests. Higher up are Eastern Himalayan Alpine Shrub and meadows and high-altitude wetlands, which are home to a wide variety of Rhododendrons and wildflowers. The Recorded Forest Area (RFA) of the State is 5,841 km^2, which is 82.31% of its geographical area.

Majority of the incidents responsible for initiation and spread of fires may be attributed to anthropogenic activity. Ground truthing was carried out by a joint team of FSI and State Forest Department during June 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of 09 points were visited by the team.

2.23.2 Forest Cover and Forest Type Group

As per ISFR 2023, forest cover in the state is 3,358.40 km^2, which constitutes 47.33% of the State's geographical area. In terms of forest canopy density classes, the state has 1,103.31 km^2 under Very Dense Forest (VDF), 1,555.89 km^2 under Moderately Dense Forest (MDF), 699.20 km^2 under Open Forest (OF) and 303.49 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Sikkim belong to seven forest type groups, which are further categorized into 12 forest types. The major forest type groups comprise of Sub-Alpine Forests followed by Subtropical Broadleaved Hill Forests and Montane Wet Temperate Forests.

The most vulnerable forest types to fires in the state are East Himalayan sal followed by East Himalayan moist mixed deciduous forest and East Himalayan subtropical wet hill forest.

2.23.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.23.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.23.1. Table 2.23.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

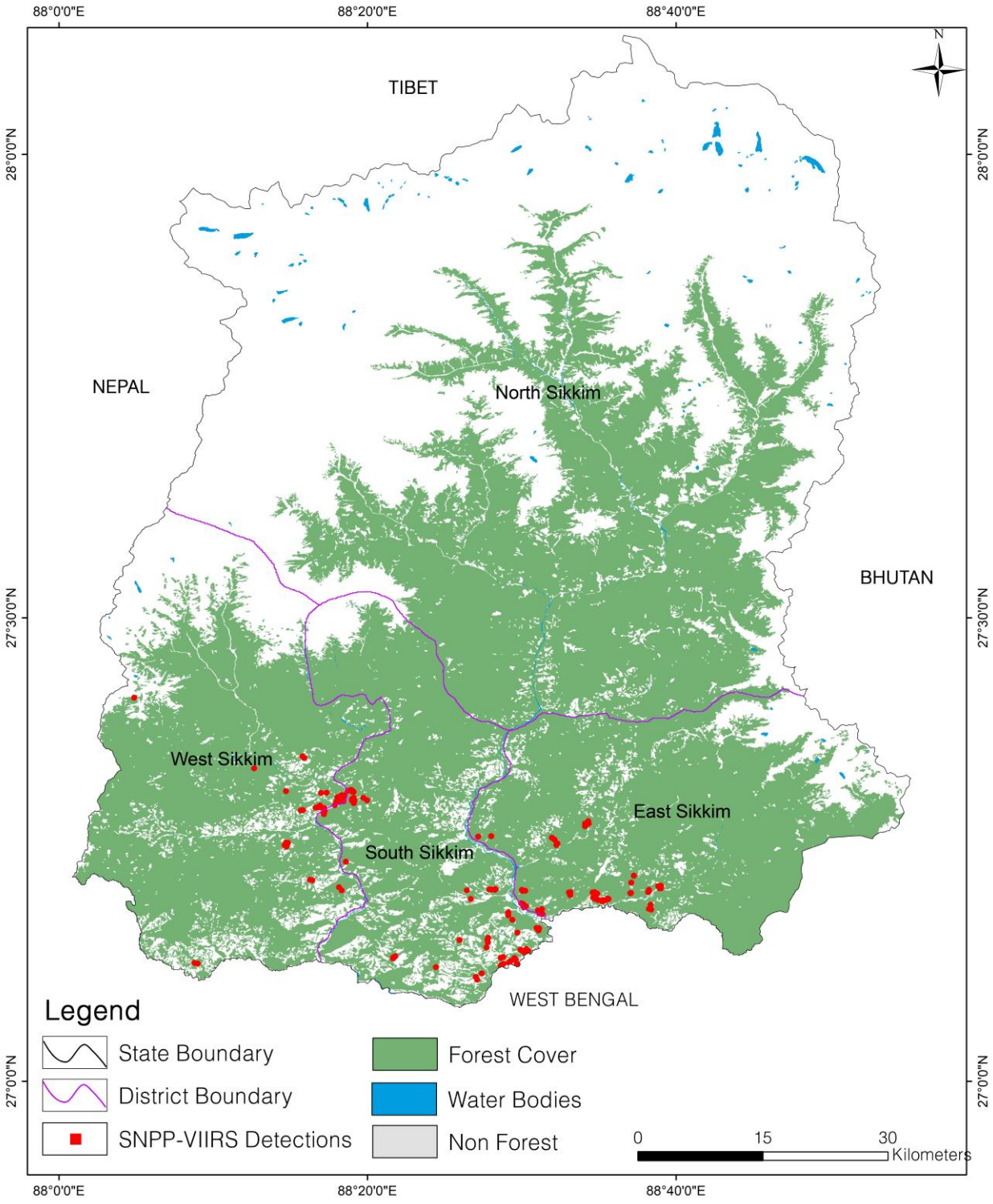


Figure 2.23.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.23.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
East Sikkim	4	36
North Sikkim	8	0
South Sikkim	30	39
West Sikkim	7	26
Total	**49**	**101**

Based on the analysis of forest fire detections, the crucial period of forest fires in the state has been determined. The crucial period of forest fire detections in the state has been noticed to be tentatively between 12th March to 8th April, which is based on the forest fire detections of last eight years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years is shown in the Figure 2.23.2.

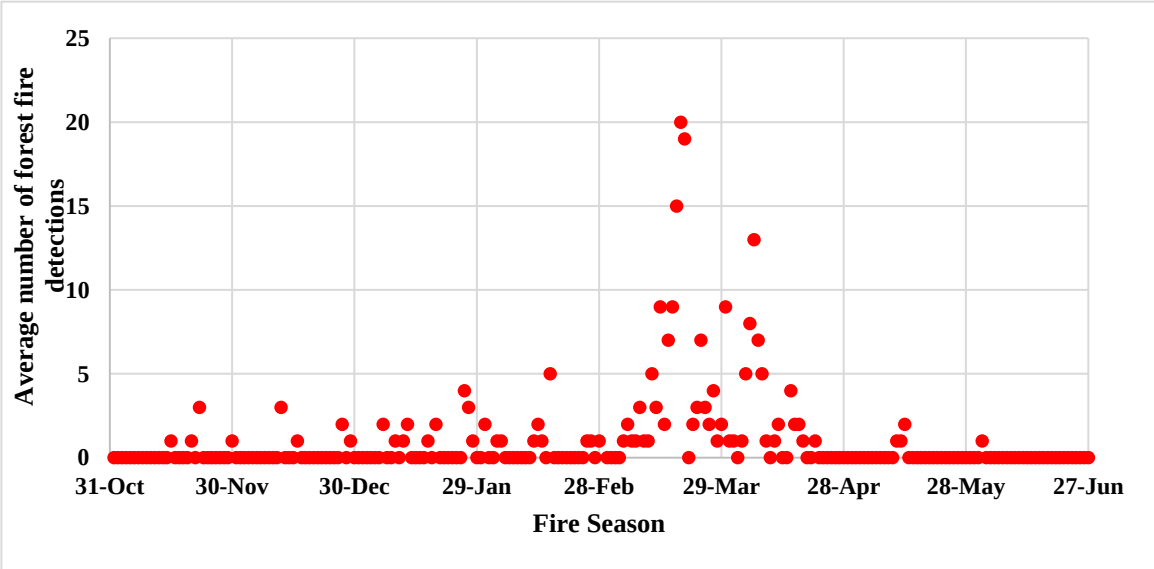


Figure 2.23.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.23.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.23.3. Table 2.23.2 shows the number of large forest fire detections during fire season 2022-23 and 2023-24.

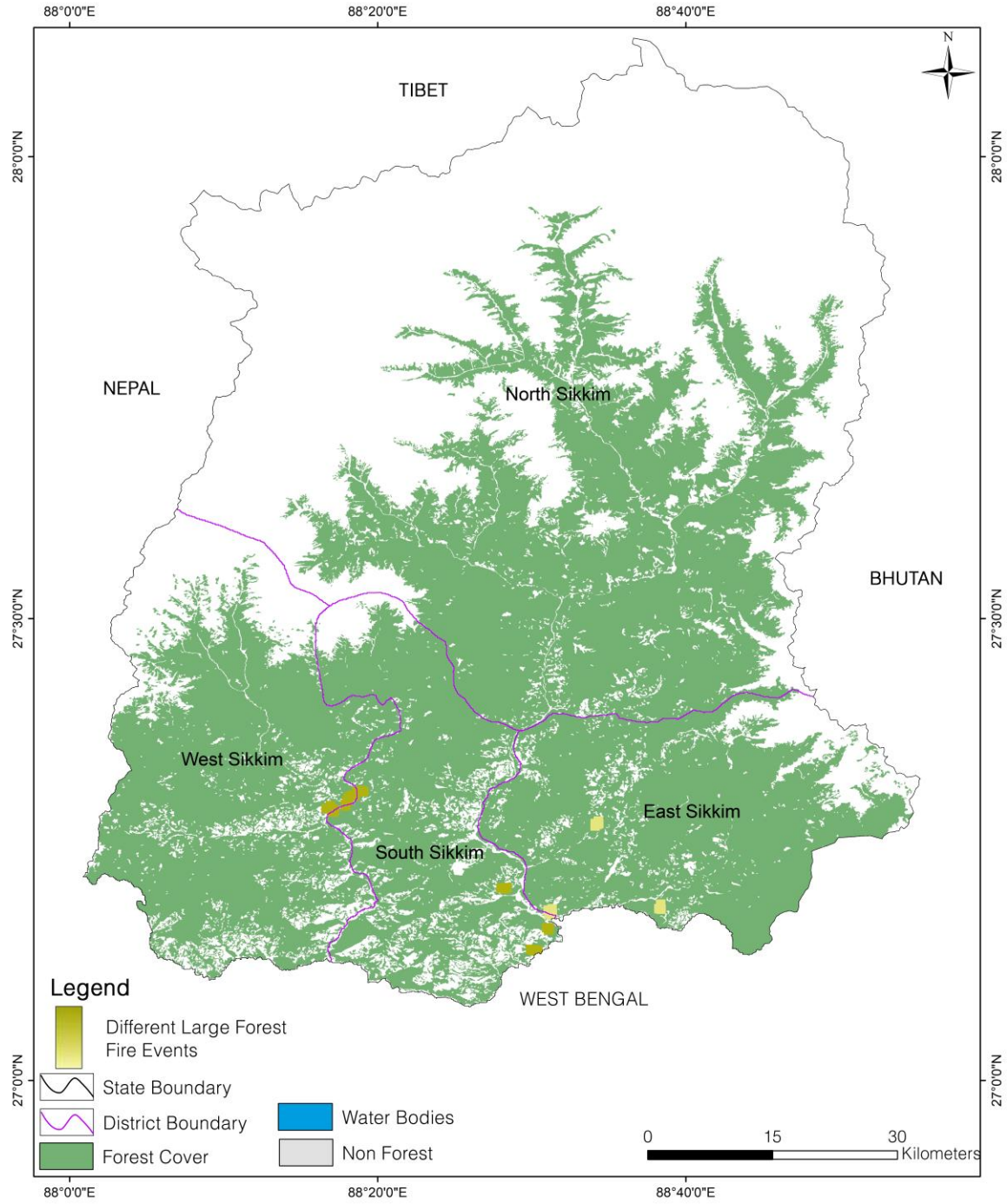


Figure 2.23.3 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.23.2 Number of large forest fire detections during fire season 2022-23 and 2023-24

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Sikkim	2	8

2.23.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.23.3. From the Figure 2.23.4, it can be inferred that 0.04% of the RFA has been affected by fires, majority of which falls under the low burnt class. No forest cover inside RFA have been classified under severely burnt class and only 0.04 km^2 falls under moderately burnt class. The burnt area map of Sikkim is shown in Figure 2.23.5

Table 2.23.3 District-wise distribution of burnt severity classes

District	Affected Area			Total
	Severe	Moderately	Low	
East Sikkim	0.00	0.00	0.19	0.19
North Sikkim	0.00	0.00	0.00	0.00
South Sikkim	0.00	0.01	0.60	0.61
West Sikkim	0.00	0.03	1.25	1.28
Total	**0.00**	**0.04**	**2.04**	**2.08**

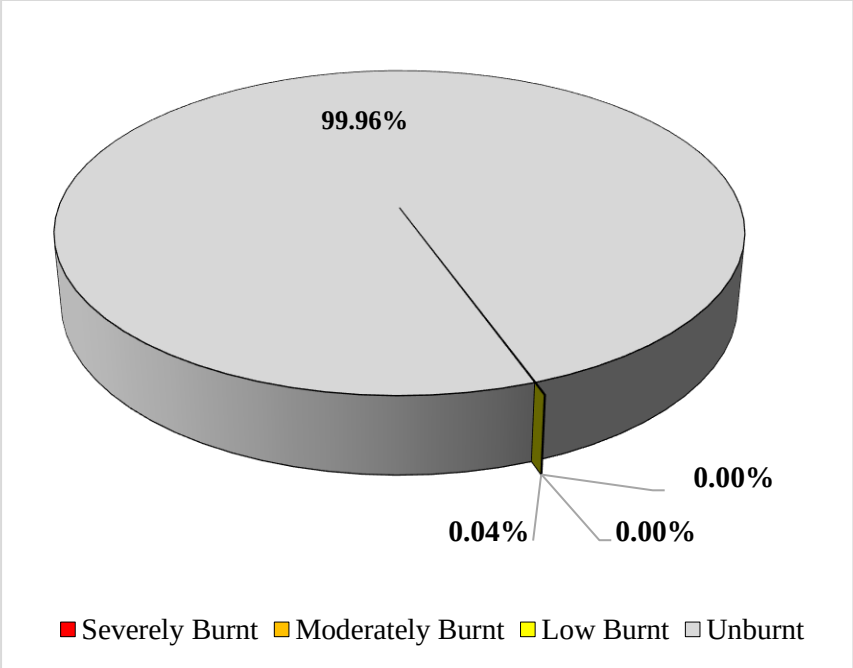


Figure 2.23.4 Distribution of burnt severity classes

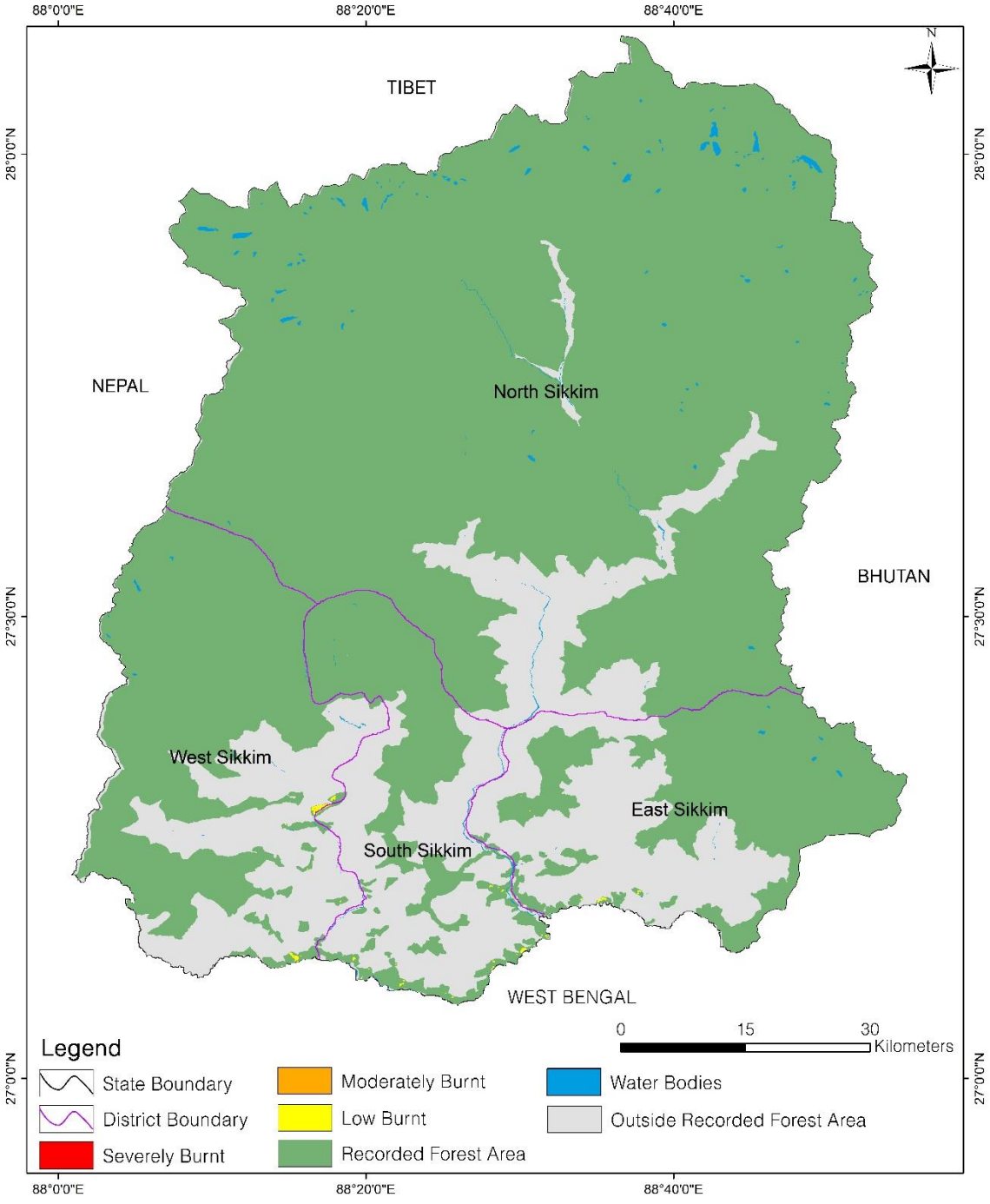


Figure 2.23.5 Map showing burnt area in Sikkim

2.23.5 Results and Analysis

Based on the analysis, it is observed that West Sikkim and South Sikkim are the most fire affected districts. West Sikkim has reported the highest area affected area followed by South Sikkim. A total of 2.08 km^2 fire affected forest area has been reported in the State, which constitute 0.04% of the RFA.

2.24 Tamil Nadu

2.24.1 Introduction

The State lies between 08°05' N to 13°35' N latitude and 76°15' E to 80°20' E longitude. It shares border with Kerala in the West, Karnataka in the North-West, Andhra Pradesh in the North, Bay of Bengal in the East and Indian Ocean in the South. Tamil Nadu has the third longest coastline among the other coastal States of India and is estimated to be around 906.90 km. The State comprises of four main physiographic regions: Coastal Plains, Eastern Ghats, Central Plateau and Western Ghats. Geographical area of the State is 1,30,060 km^2, which is 3.96% of the geographical area of the country. Cauvery, Palar, Bhavani, Vaigai and Thamirabharani are the major rivers of the State. The climate of the State ranges from dry sub-humid to semi-arid is humid tropical and the average annual temperature of the State varies from 19°C to 37°C. Whereas, the rainfall in the State is mainly influenced by both South-West and North-East monsoons with average annual rainfall ranges from 900 mm to 1,200 mm. The State is rich in diverse range of flora and fauna biodiversity. Common plant species include the State tree: Palmyra Palm, Eucalyptus, Rubber, Cinchona, Clumping Bamboos (*Bambusa arundinacea*), Teak etc. The Recorded Forest Area (RFA) of the State is 23,188 km^2, which is 17.83% of its geographical area.

Forest fires are quite frequent in the State during fire season and a considerable forest cover is affected due to the forest fire incidents in the State. There are many causative factors for initiation and spread of fires. In most of the cases, grazing, firewood collection, tourist spot, honey collection, hunting and for threatening wild animals from agricultural fields and habitation are the major causes of fire incidents in the State. Ground truthing was carried out in the fire affected areas by a joint team of FSI and State Forest Department during May 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of 18 points were visited by the team.

2.24.2 Forest Cover and Forest Type Group

As per the ISFR 2023, forest cover in the State is 26,450.22 km^2, which constitutes 20.34% of the State's geographical area. In terms of forest canopy density classes, the State has 3,586.19 km^2 under Very Dense Forest (VDF), 11,027.03 km^2 under Moderately Dense Forest (MDF), 11,837.00 km^2 under Open Forest (OF) and 878.29 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Tamil Nadu belong to 10 forest type groups, which are further categorized into 43 forest types. The major forest type groups comprises of Tropical Dry Deciduous Forests followed by Tropical Thorn Forests and Tropical Moist Deciduous Forests.

The most vulnerable forest types to fires in the State are Southern dry mixed deciduous forest followed by Secondary dry deciduous forest and Southern moist mixed deciduous forest.

2.24.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.24.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.24.1. Table 2.24.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

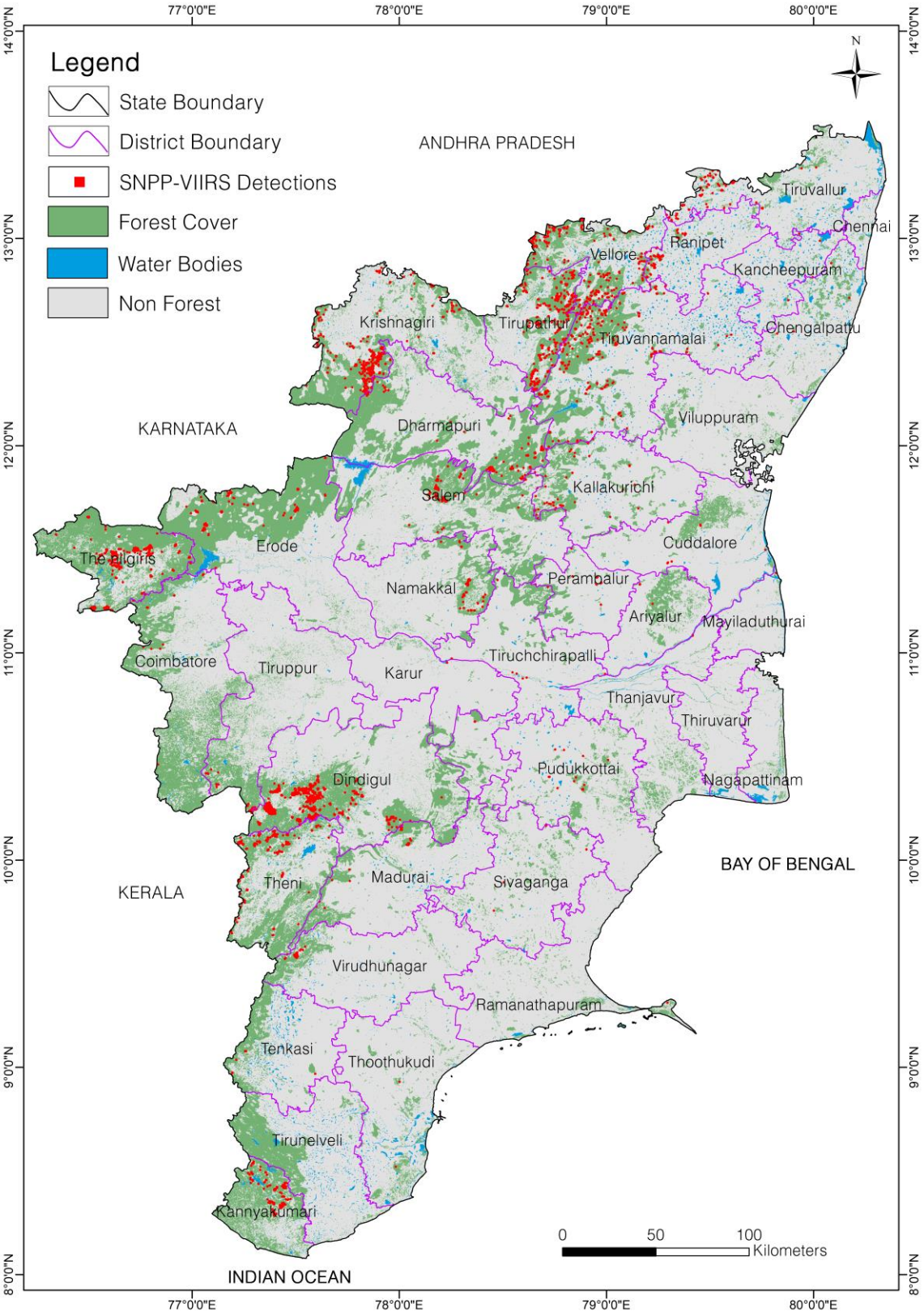


Figure 2.24.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.24.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Ariyalur	4	2
Chengalpattu	8	4
Chennai	0	0
Coimbatore	162	13
Cuddalore	1	8
Dharmapuri	39	101
Dindigul	205	798
Erode	44	100
Kallakurichi	52	43
Kancheepuram	4	4
Kannyakumari	178	118
Karur	0	1
Krishnagiri	277	348
Madurai	32	22
Mayiladuthurai	0	1
Nagapattinam	0	0
Namakkal	18	51
Perambalur	6	9
Pudukkottai	4	14
Ramanathapuram	1	1
Ranipet	50	58
Salem	29	90
Sivaganga	4	4
Tenkasi	4	7
Thanjavur	3	2
The Nilgiris	100	400
Theni	215	171
Thiruvarur	0	0
Thoothukudi	4	2
Tiruchchirapalli	6	14
Tirunelveli	2	0
Tirupathur	104	322
Tiruppur	133	54
Tiruvallur	89	80
Tiruvannamalai	109	260
Vellore	102	249
Viluppuram	4	0
Virudhunagar	5	29
Total	**1,998**	**3,380**

Based on the analysis of forest fire detections, the crucial period of forest fires in the state has been determined. The crucial period of forest fire detections in the state has been noticed to be tentatively between 21th Feb to 27th April, which is based on the forest fire detections of last eight

years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years is shown in the Figure 2.24.2.

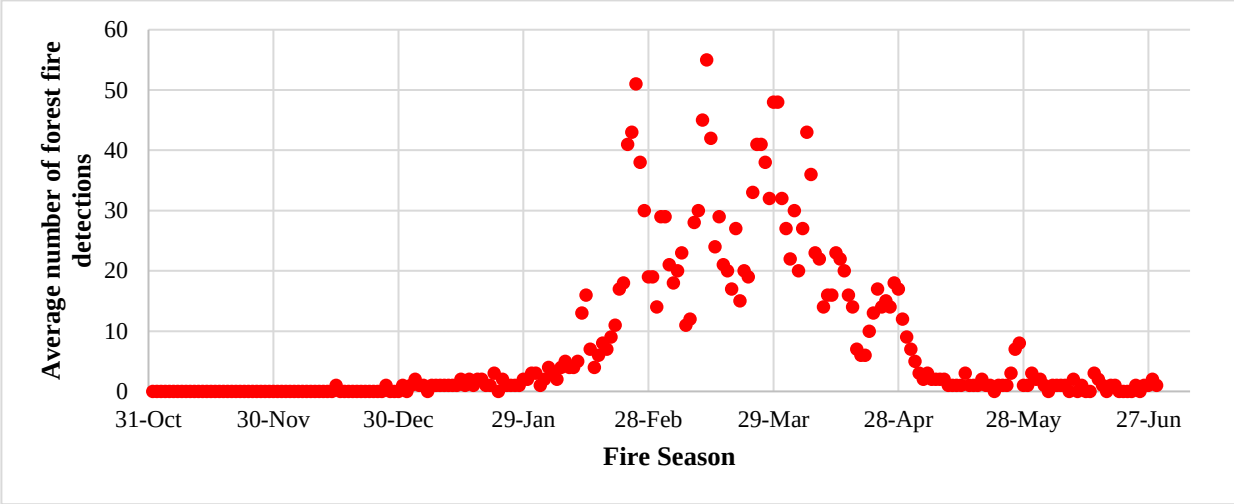


Figure 2.24.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.24.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.24.3. Table 2.24.2 shows the number of large forest fire detections during fire season 2022-23 and 2023-24.

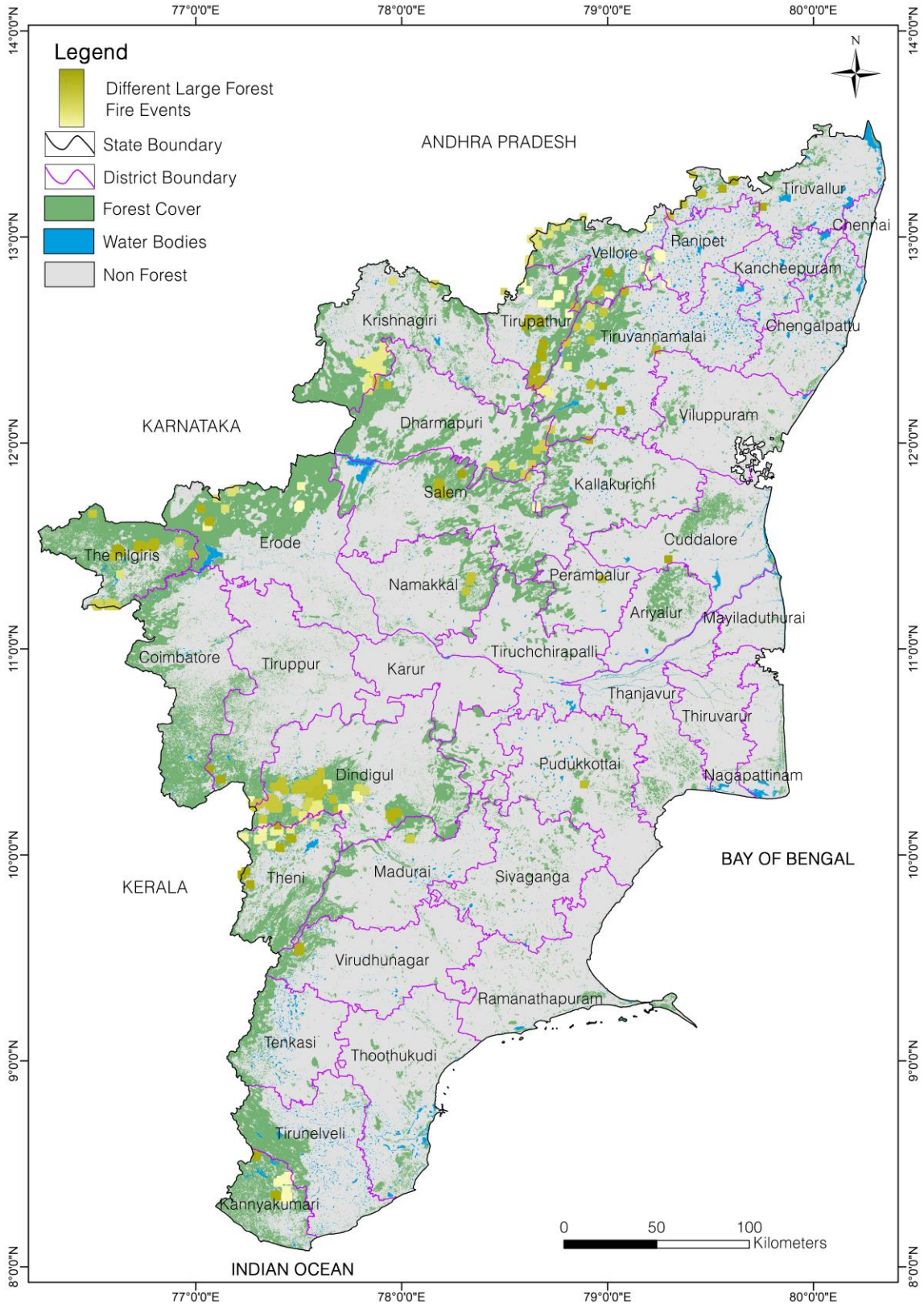


Figure 2.24.3 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.24.2 Number of large forest fire detections during fire season 2022-23 and 2023-24

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Tamil Nadu	156	218

2.24.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.24.3. From the Figure 2.24.4, it can be inferred that 6.13% of the RFA has been affected by fires. A total of 5.28% of the RFA falls under the low burnt class and 0.85% under moderately burnt class. No area inside RFA have been classified under severely burnt class. The burnt area map of Tamil Nadu is shown in Figure 2.24.5

Table 2.24.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
Ariyalur	0.00	0.00	0.00	0.00
Chengalpattu	0.00	0.00	0.86	0.86
Chennai	0.00	0.00	0.00	0.00
Coimbatore	0.00	0.00	7.07	7.07
Cuddalore	0.00	0.00	0.04	0.04
Dharmapuri	0.00	7.27	90.23	97.50
Dindigul	0.00	15.22	28.02	43.24
Erode	0.00	0.05	20.85	20.90
Kallakurichi	0.00	3.46	15.22	18.68
Kancheepuram	0.00	0.00	0.26	0.26
Kannyakumari	0.00	0.00	13.91	13.91
Karur	0.00	0.00	0.14	0.14
Krishnagiri	0.00	15.32	154.69	170.01
Madurai	0.00	5.37	4.19	9.56
Mayiladuthurai	0.00	0.00	0.00	0.00
Nagapattinam	0.00	0.00	0.00	0.00
Namakkal	0.00	0.00	39.00	39.00
Perambalur	0.00	0.00	13.29	13.29
Pudukkottai	0.00	0.00	0.00	0.00
Ramanathapuram	0.00	0.00	0.00	0.00
Ranipet	0.00	10.37	16.00	26.37
Salem	0.00	2.58	100.08	102.66
Sivaganga	0.00	0.00	0.00	0.00
Tenkasi	0.00	0.00	1.06	1.06
Thanjavur	0.00	0.00	0.00	0.00
The Nilgiris	0.00	0.00	17.98	17.98

District	Affected Area			Total
	Severely	Moderately	Low	
Theni	0.00	8.36	23.83	32.19
Thiruvarur	0.00	0.00	0.00	0.00
Thoothukudi	0.00	0.00	0.00	0.00
Tiruchchirapalli	0.00	0.00	6.12	6.12
Tirunelveli	0.00	0.00	0.71	0.71
Tirupathur	0.00	34.45	205.03	239.48
Tiruppur	0.00	1.19	10.98	12.17
Tiruvallur	0.00	4.08	11.68	15.76
Tiruvannamalai	0.00	32.19	133.18	165.37
Vellore	0.00	43.08	221.17	264.25
Viluppuram	0.00	0.09	3.42	3.51
Virudhunagar	0.00	0.40	0.25	0.65
Total	**0.00**	**183.48**	**1,139.26**	**1,322.74**

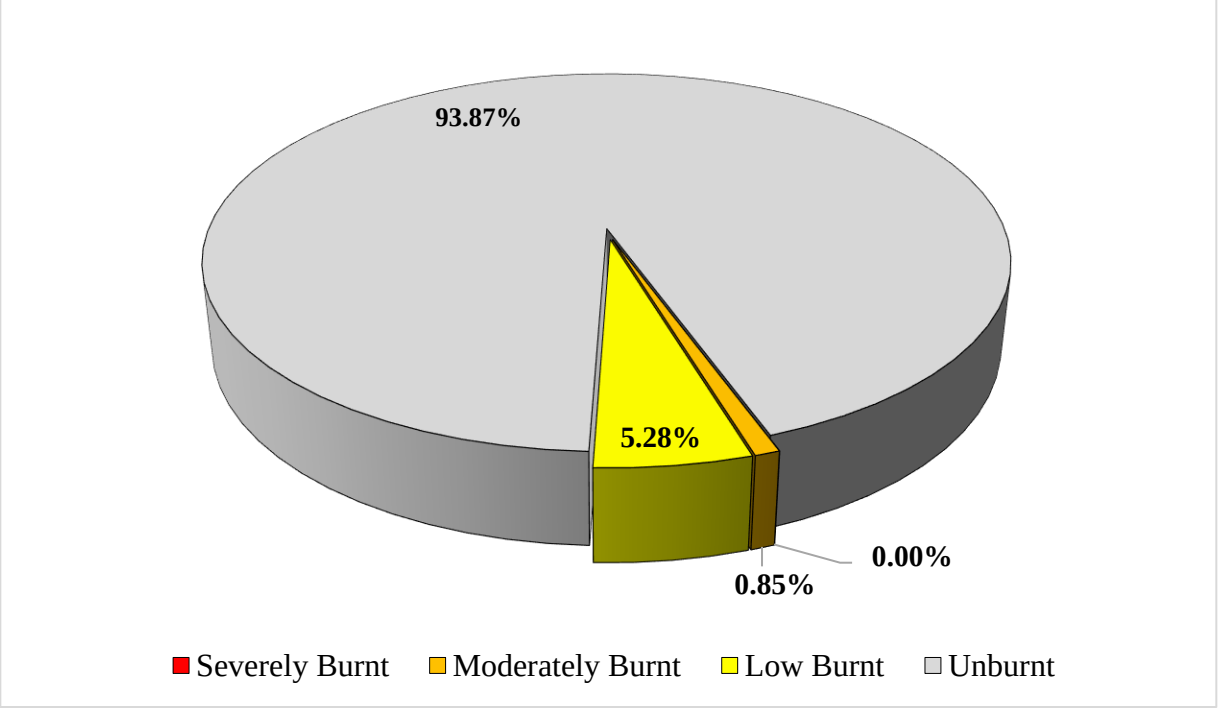


Figure 2.24.4 Distribution of burnt severity classes

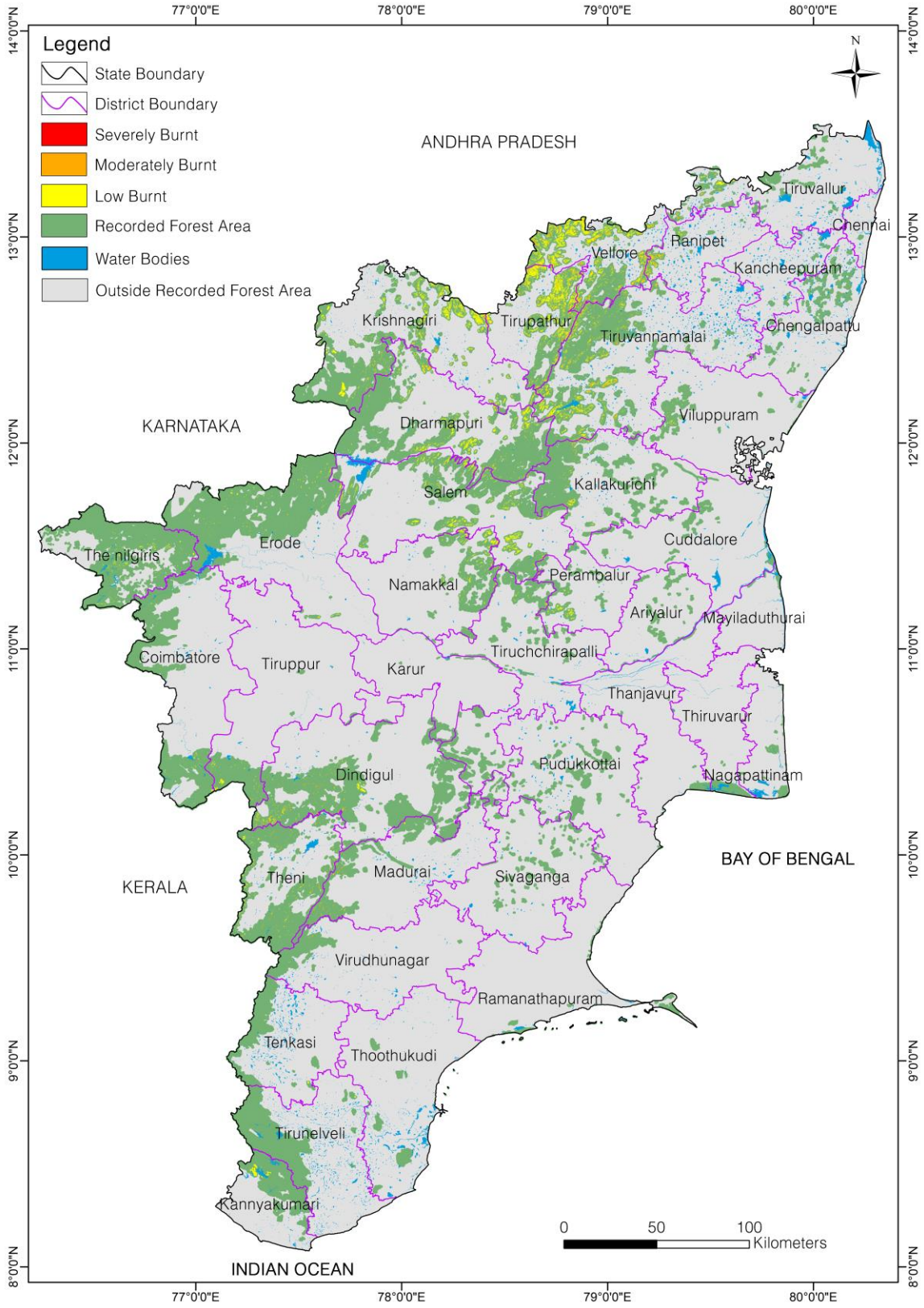


Figure 2.24.5 Map showing burnt area in Tamil Nadu

2.24.5 Results and Analysis

Based on the analysis, it is observed that Vellore followed by Tirunelveli and Krishnagiri are the most affected districts. The maximum affected area under moderately burnt severity class has been observed in Vellore and Tirunelveli districts. Vellore district has reported the highest area under low burnt severity class. A total of 1,322.74 km^2 fire affected forest area has been reported in the state, which constitute 6.13% of the RFA.

2.25 Telangana

2.25.1 Introduction

The state lies between 15°50' N to 19°55' N latitude and 77°14' E to 81°19' E longitude. It shares border with Maharashtra in the North, Chhattisgarh in the East, Karnataka in the West and Andhra Pradesh in the South & South-East. The state comprises of two main physiographic regions: South Deccan and Eastern Ghats. Geographical area of the state is 1,12,122 km^2, which is 3.41% of the geographical area of the country. Godavari and Krishna are the major rivers of the state. The climate of the state is hot and dry, with the average annual temperature of the state varies from 15°C to 45°C. Whereas, average annual rainfall ranges from 1,100 mm to 1,200 mm. Telangana is part of the Deccan Plateau with dense Teak forests on the northern part, along the bank of Godavari river. The state is known for its rich heritage in bio-diversity, which is distributed in nine agro-climatic regions. The Recorded Forest Area (RFA) of the state is 27,688 km^2, which is 24.69% of its geographical area.

Forest fires are quite frequent in the state during fire season and a considerable area under forest is affected due to the forest fires every year. There are many causative factors for initiation and spread of fires. In majority of the incidents, grazing, firewood collection and other Non-Timber Forest Products (NTFP) collection are the major causes of fire incidents in the state. Ground truthing was carried out in the fire affected areas by a joint team of FSI and State Forest Department during May 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of 05 points were visited by the team.

2.25.2 Forest Cover and Forest Type Group

As per the ISFR 2023, forest cover in the state is 21,179.04 km^2, which constitutes 18.89% of the state's geographical area. In terms of forest canopy density classes, the state has 1,613.32 km^2 under Very Dense Forest (VDF), 8,909.90 km^2 under Moderately Dense Forest (MDF), 10,655.82 km^2 under Open Forest (OF) and 2,829.88 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Telangana belong to four forest type groups, which are further categorized into 14 forest types. The forest type groups comprises of Tropical Dry Deciduous Forests followed Tropical Thorn Forests and Tropical Moist Deciduous Forests.

The most vulnerable forest types to fires in the state are Southern dry mixed deciduous forest followed by Dry teak forest and Dry deciduous scrub.

2.25.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.25.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.25.1. Table 2.25.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

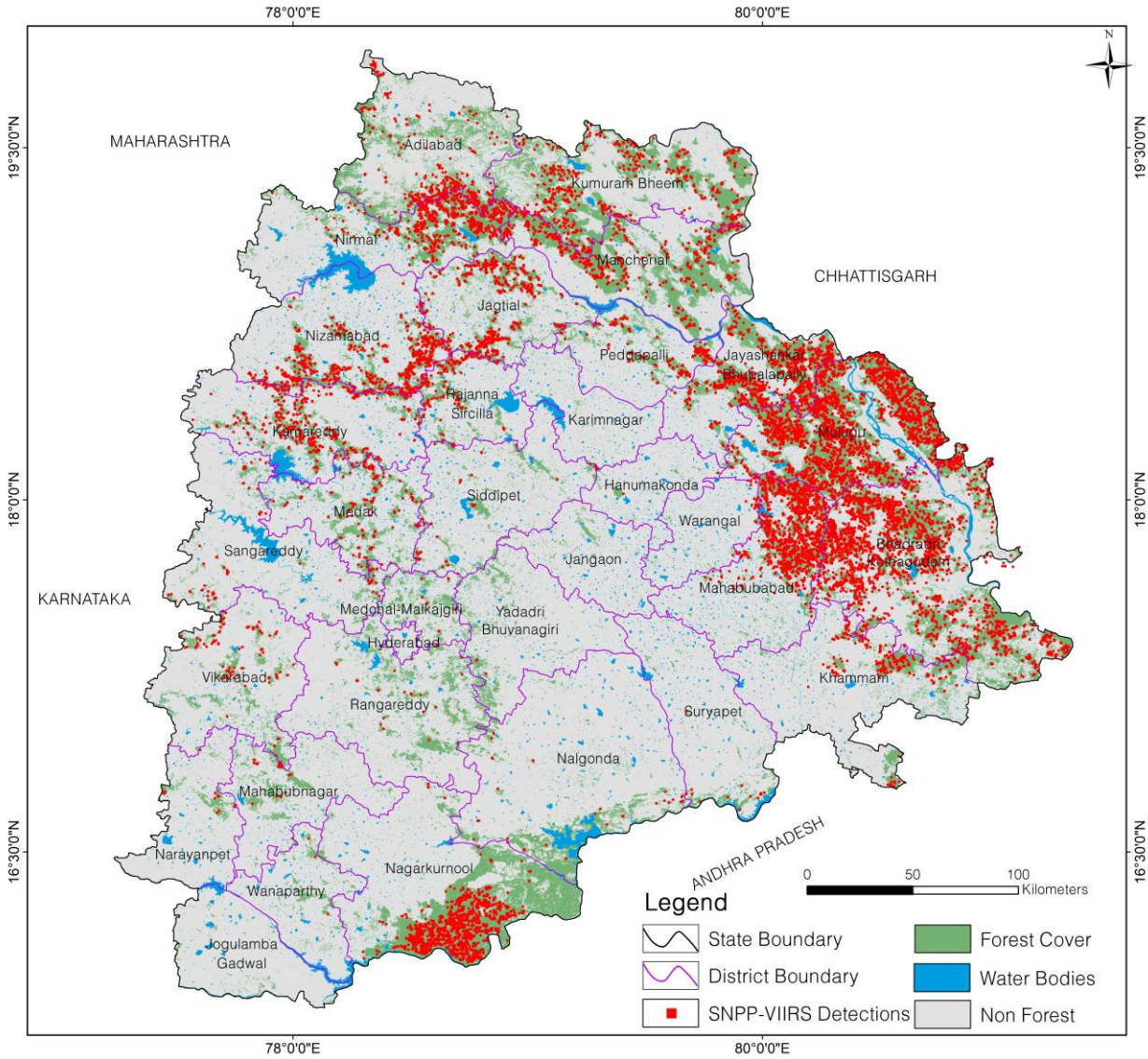


Figure 2.25.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.25.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Adilabad	786	391
Bhadradri Kothagudem	1,942	2,600
Hanumakonda	4	2
Hyderabad	0	0
Jagtial	510	455
Jangaon	2	0
Jayashankar Bhupalpally	659	1,006

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Jogulamba Gadwal	0	0
Kamareddy	347	403
Karimnagar	1	1
Khammam	381	260
Kumuram Bheem	889	582
Mahabubabad	1,318	1,245
Mahabubnagar	9	21
Mancherial	714	513
Medak	140	155
Medchal-Malkajgiri	22	11
Mulugu	1,783	2,597
Nagarkurnool	1,207	1,185
Nalgonda	14	29
Narayanpet	11	11
Nirmal	1,166	685
Nizamabad	552	680
Peddapalli	170	177
Rajanna Sircilla	94	170
Rangareddy	66	23
Sangareddy	77	76
Siddipet	80	45
Suryapet	3	17
Vikarabad	77	97
Wanaparthy	4	3
Warangal	72	36
Yadadri Bhuvanagiri	17	3
Total	**13,117**	**13,479**

Based on the analysis of forest fire detections, the crucial period of forest fires in the state has been determined. The crucial period of forest fire detections in the state has been noticed to be tentatively between 25th February to 15th April, which is based on the forest fire detections of last eight years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years is shown in the Figure 2.25.2.

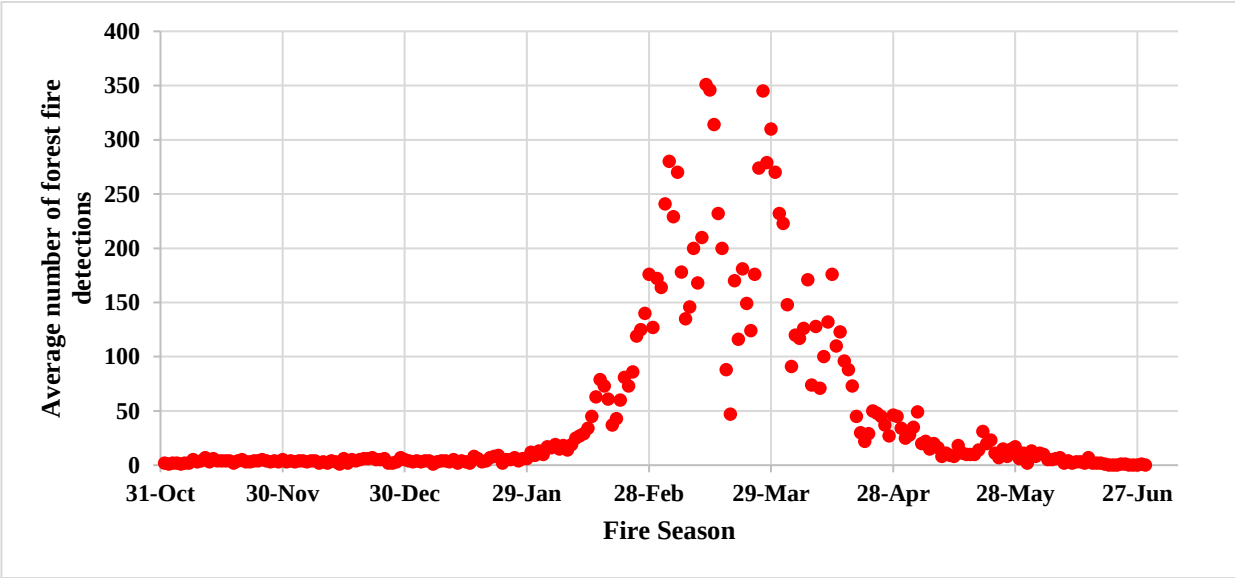


Figure 2.25.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.25.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.25.3. Table 2.25.2 shows the number of large forest fire detections during fire season 2022-23 and 2023-24.

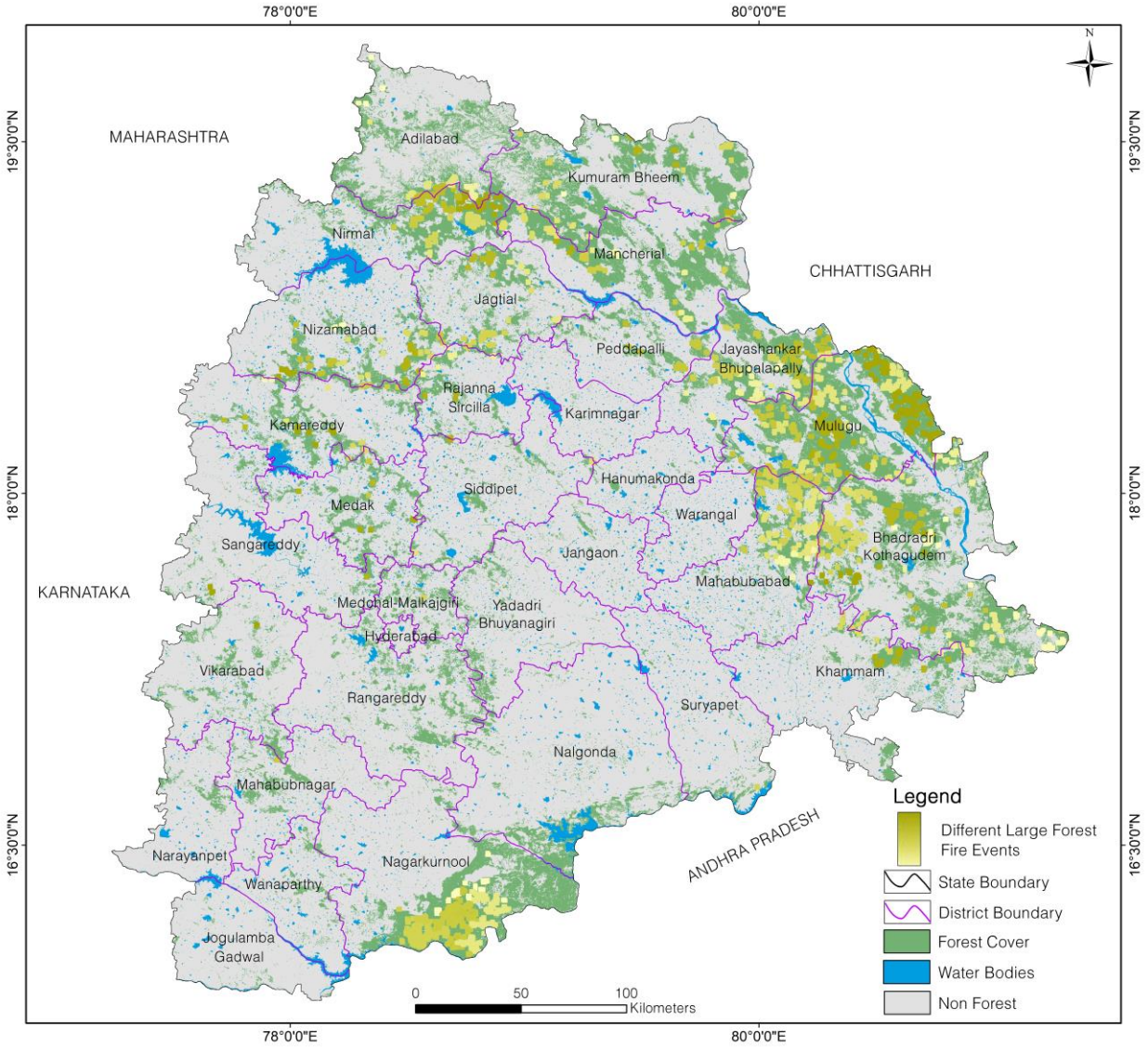


Figure 2.25.3 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.25.2 Number of large forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Telangana	752	833

2.25.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.25.3. From the Figure 2.25.4, it can be inferred that 14.82% of the RFA has been affected by fires. A total of 14.64% of the RFA falls under the low burnt class and 0.18% under moderately burnt class. No

area inside RFA have been classified under severely burnt class. The burnt area map of Telangana is shown in Figure 2.25.5

Table 2.25.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
Adilabad	0.00	0.00	36.21	36.21
Bhadradri Kothagudem	0.00	0.00	454.41	454.41
Hanumakonda	0.00	0.00	0.00	0.00
Hyderabad	0.00	0.00	0.00	0.00
Jagtial	0.00	0.00	143.43	143.43
Jangaon	0.00	0.00	0.00	0.00
Jayashankar Bhupalpally	0.00	0.00	325.53	325.53
Jogulamba Gadwal	0.00	0.00	0.00	0.00
Kamareddy	0.00	0.00	111.99	111.99
Karimnagar	0.00	0.00	0.13	0.13
Khammam	0.00	0.00	77.97	77.97
Kumuram Bheem	0.00	0.00	213.30	213.30
Mahabubabad	0.00	0.00	351.03	351.03
Mahabubnagar	0.00	0.39	5.23	5.62
Mancherial	0.00	0.00	214.88	214.88
Medak	0.00	0.00	53.38	53.38
Medchal-Malkajgiri	0.00	0.00	0.41	0.41
Mulugu	0.00	0.00	1,062.89	1,062.89
Nagarkurnool	0.00	46.74	536.62	583.36
Nalgonda	0.00	0.01	0.76	0.77
Narayanpet	0.00	0.03	5.09	5.12
Nirmal	0.00	0.00	195.36	195.36
Nizamabad	0.00	0.00	18.46	18.46
Peddapalli	0.00	0.00	63.63	63.63
Rajanna Sircilla	0.00	0.00	10.74	10.74
Rangareddy	0.00	0.00	5.25	5.25
Sangareddy	0.00	0.00	10.11	10.11
Siddipet	0.00	0.00	10.64	10.64
Suryapet	0.00	0.00	0.00	0.00
Vikarabad	0.00	0.22	16.20	16.42
Wanaparthy	0.00	0.00	0.00	0.00
Warangal	0.00	0.00	10.32	10.32
Yadadri Bhuvanagiri	0.00	0.00	1.92	1.92
Total	**0.00**	**47.39**	**3,935.89**	**3,983.28**

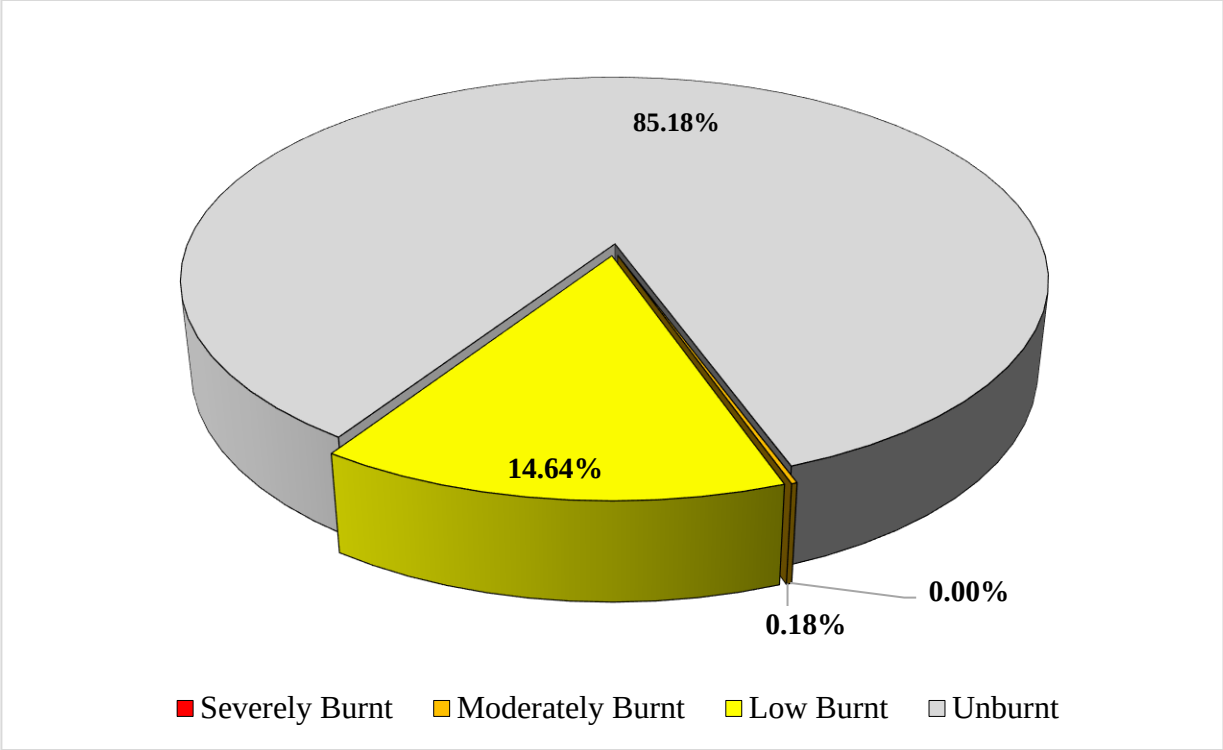


Figure 2.25.4 Distribution of burnt severity classes

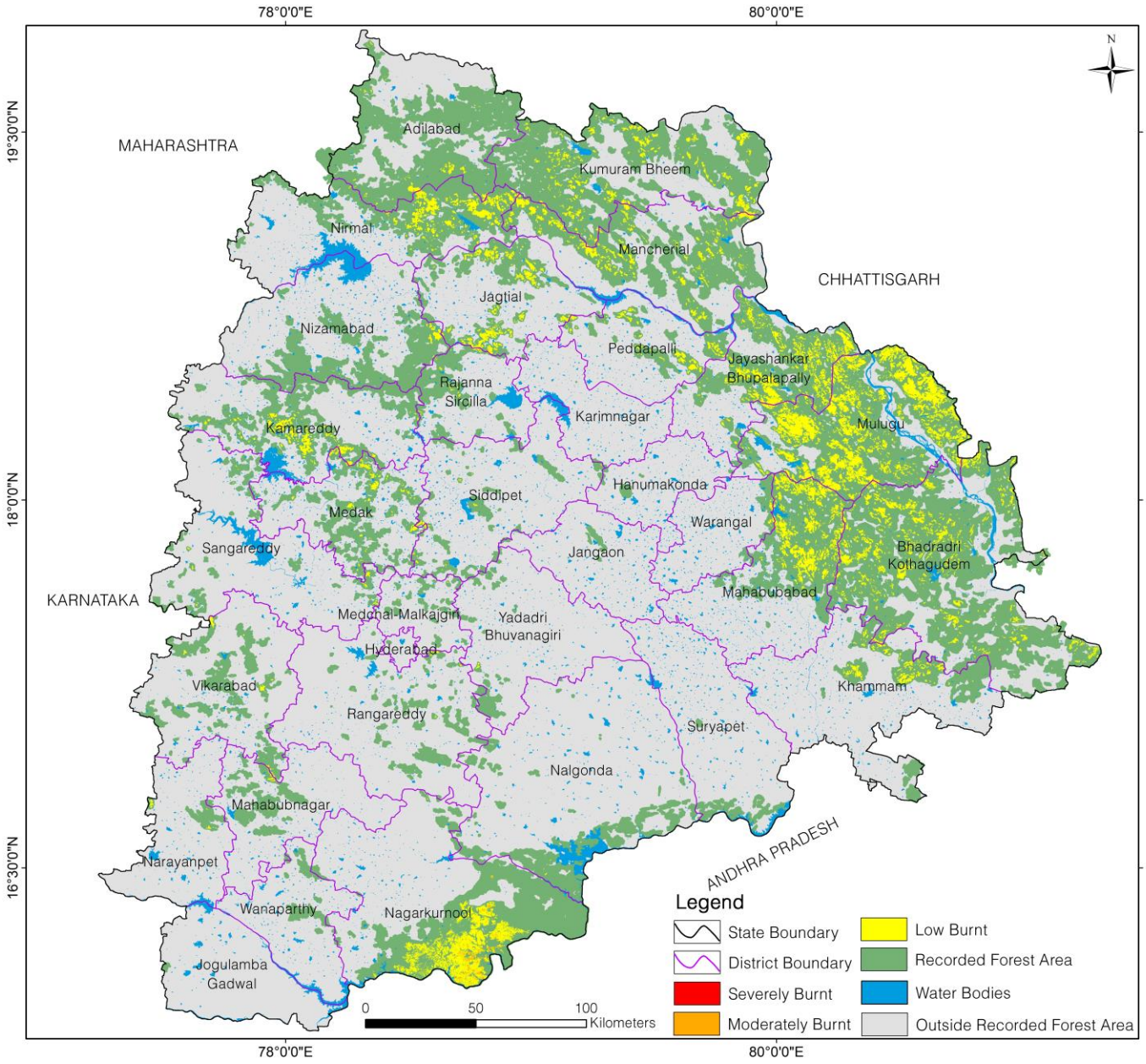


Figure 2.25.5 Map showing burnt area in Telangana

2.25.5 Results and Analysis

Based on the analysis, it is observed that Mulugu, Nagarkurnool, Bhadradri Kothagudem, Jayashanka and Bhupalpally are the most affected districts. The maximum affected area under moderately burnt severity class has been observed in Nagarkurnool and Mahabubnagar districts. Mulugu district has reported the highest area under low burnt severity class. A total of 3,983.28 km^2 fire affected forest area has been reported in the state, which constitute 14.82% of the RFA.

2.26 Tripura

2.26.1. Introduction

The state lies between 22°57' N to 24°32' N latitude and 91°10' E to 92°20' E longitude. It shares border with Assam in the North-East and Mizoram in the East. It also shares international border with Bangladesh in the North, South and West. Geographical area of the state is 10,486 km2, which is 0.32% of the geographical area of the country. Khowai, Dhalai, Gomati, Manu and Deo are the major rivers of the state. The climate of the state is warm and humid tropical. The average annual temperature which varies from 7°C to 36°C. Whereas, the average annual rainfall in the state ranges from 2,250 mm to 2,500 mm. The state is rich in diverse range of flora and fauna biodiversity. About 1,573 taxa comprising 1,545 species and 28 extra typical varieties in 862 genera and 192 families of vascular plants representing 12.86% of the flora of India are reported in the state. The state is also rich in bamboo diversity with 19 indigenous species of bamboo. A large area in the state is also under Sal, Teak & Rubber plantations. The Recorded Forest Area (RFA) of the state is 6,295 km^2, which is 60.03% of its geographical area.

Forest fires are quite frequent in the state during fire season and a considerable area under forest is affected due to the forest fires every year. There are many causative factors for initiation and spread of fires. In majority of the incidents, the practice of shifting cultivation commonly termed as Jhum cultivation is the major cause of fire incidents in the state. Ground truthing was carried out by a joint team of FSI and State Forest Department during May 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of 19 points were visited by the team.

2.26.2 Forest Cover and Forest Type Group

As per ISFR 2023, forest cover in the state is 7,584.77 km^2, which constitutes 72.33% of the state's geographical area. In terms of forest canopy density classes, the state has 614.43 km^2 under Very Dense Forest (VDF), 4,929.99 km^2 under Moderately Dense Forest (MDF), 2,040.35 km^2 under Open Forest (OF) and 173.27 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Tripura belong to three forest type groups, which are further categorized into six forest types. The two forest type groups are Tropical Moist Deciduous Forests and Tropical Semi-Evergreen Forests.

The most vulnerable forest types to fires in the state are Cachar semi-evergreen forest, East Himalayan moist mixed deciduous forest and Secondary moist bamboo brakes.

2.26.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.26.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.26.1. Table 2.26.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

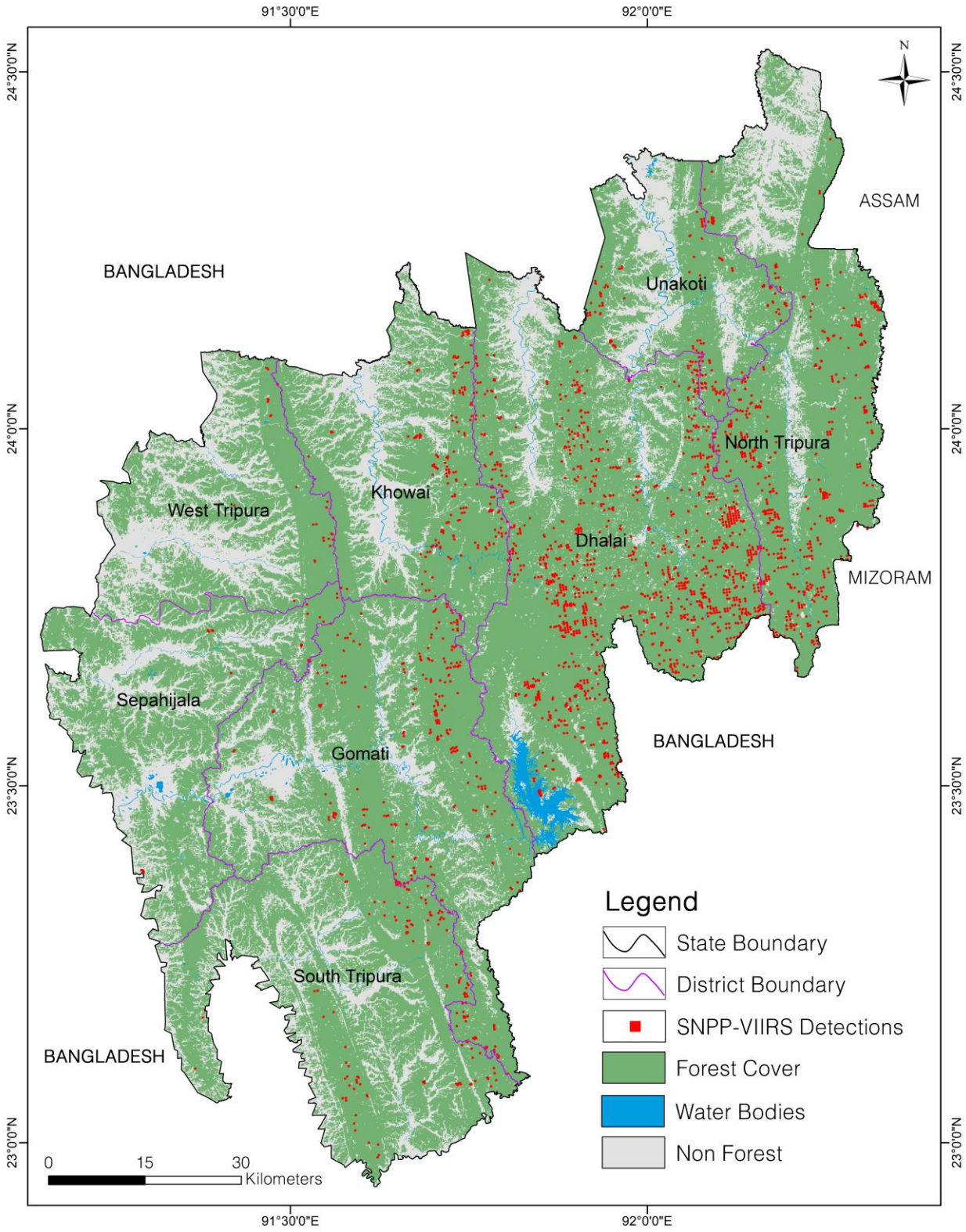


Figure 2.26.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.26.1 District-wise number of NRT detections using SNPP-VIIRS sensor during fire season 2023 to June 2024

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Dhalai	1,935	1,070
Gomati	665	210
Khowai	306	137
North Tripura	788	436
Sepahijala	60	14
South Tripura	248	100
Unakoti	261	99
West Tripura	69	23
Total	**4,332**	**2,089**

Based on the analysis of forest fire detections, the crucial period of forest fires in the state has been determined. The crucial period of forest fire detections in the state has been noticed to be tentatively between 17th March to 20th April, which is based on the forest fire detections of last eight years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years is shown in the Figure 2.26.2.

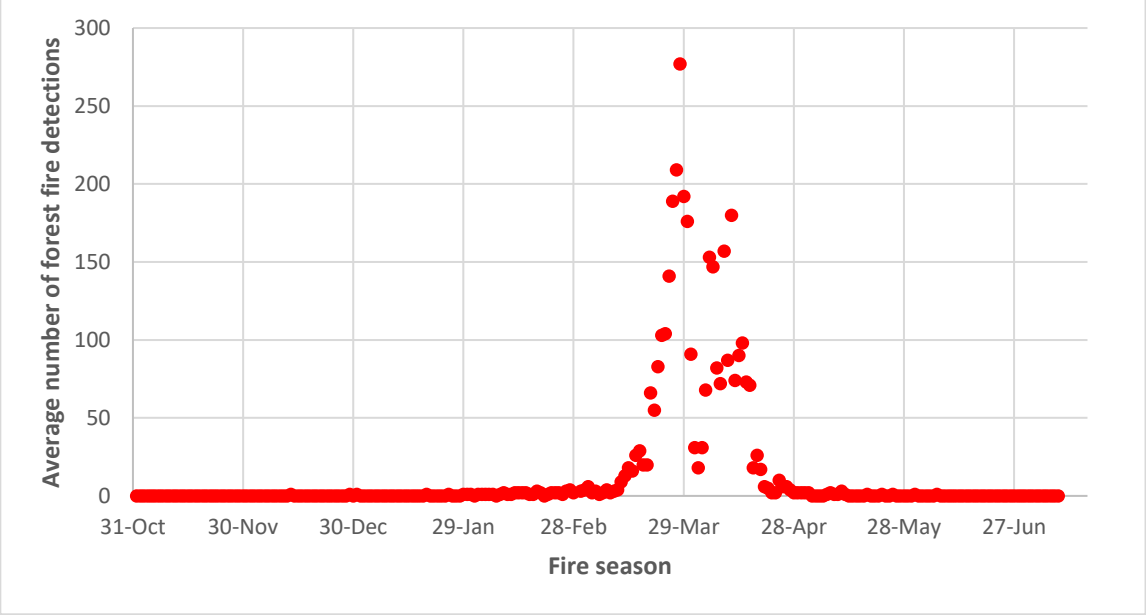


Figure 2.26.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.26.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.26.3. Table 2.26.2 shows the number of large forest fire detections during fire season 2022-23 and 2023-24.

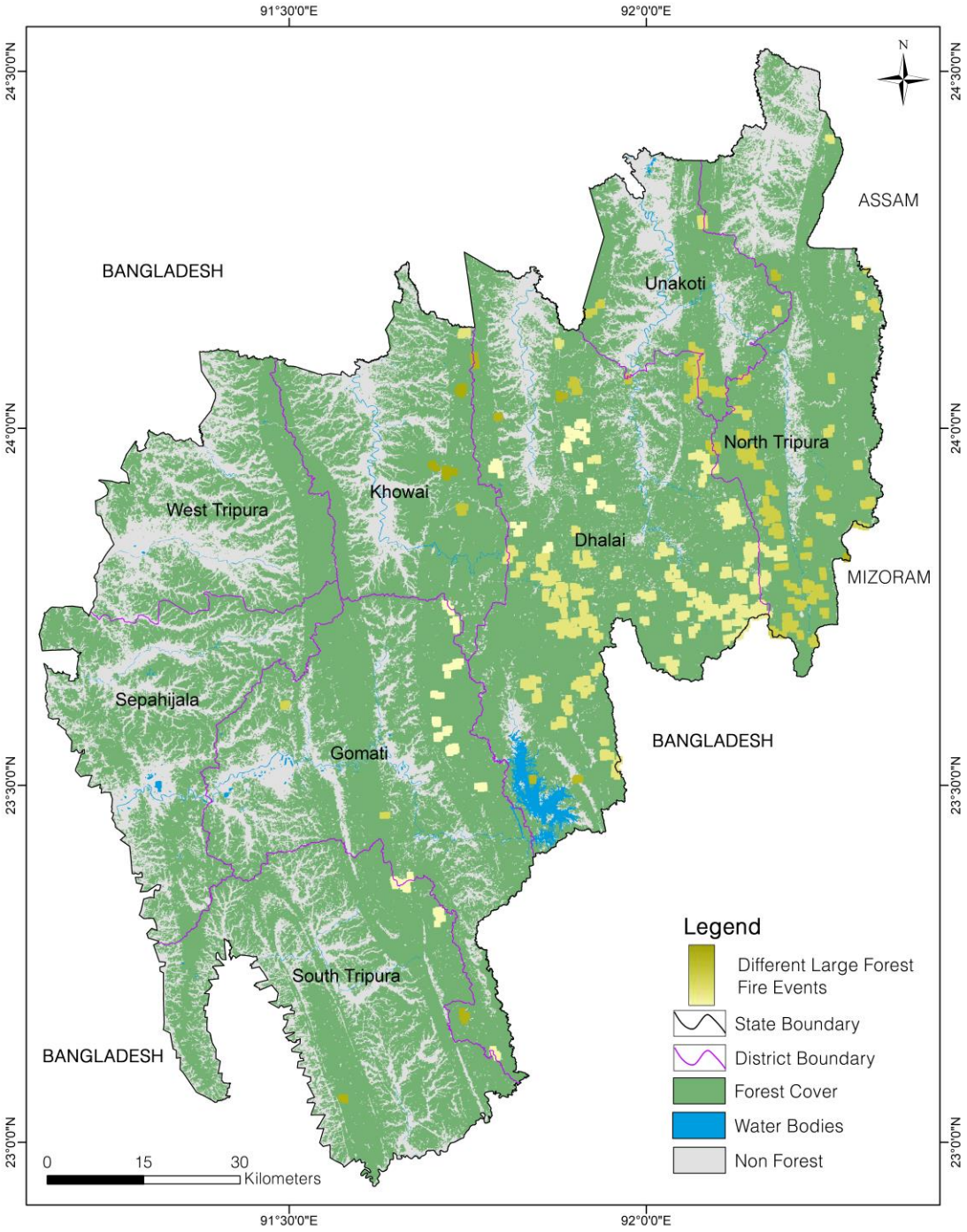


Figure 2.26.3 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.26.2 Number of large forest fire detections during fire season 2022-23 and 2023-24

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Tripura	295	147

2.26.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.26.3. From the Figure 2.26.4, it can be inferred that 3.20% of the RFA has been affected by fires. A total of 2.44% of the RFA falls under the low burnt class and 0.76% under moderately burnt class. Only 0.35 km^2 of the forest cover inside RFA have been classified under severely burnt class. The burnt area map of Tripura is shown in Figure 2.26.5

Table 2.26.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
Dhalai	0.13	24.26	73.67	98.06
Gomati	0.12	8.14	21.15	29.41
Khowai	0.00	2.08	11.17	13.25
North Tripura	0.05	1.54	18.68	20.27
Sepahijala	0.00	0.34	0.49	0.83
South Tripura	0.01	4.06	8.58	12.65
Unakoti	0.04	3.71	8.70	12.45
West Tripura	0.00	0.91	2.64	3.55
Total	**0.35**	**45.04**	**145.08**	**190.47**

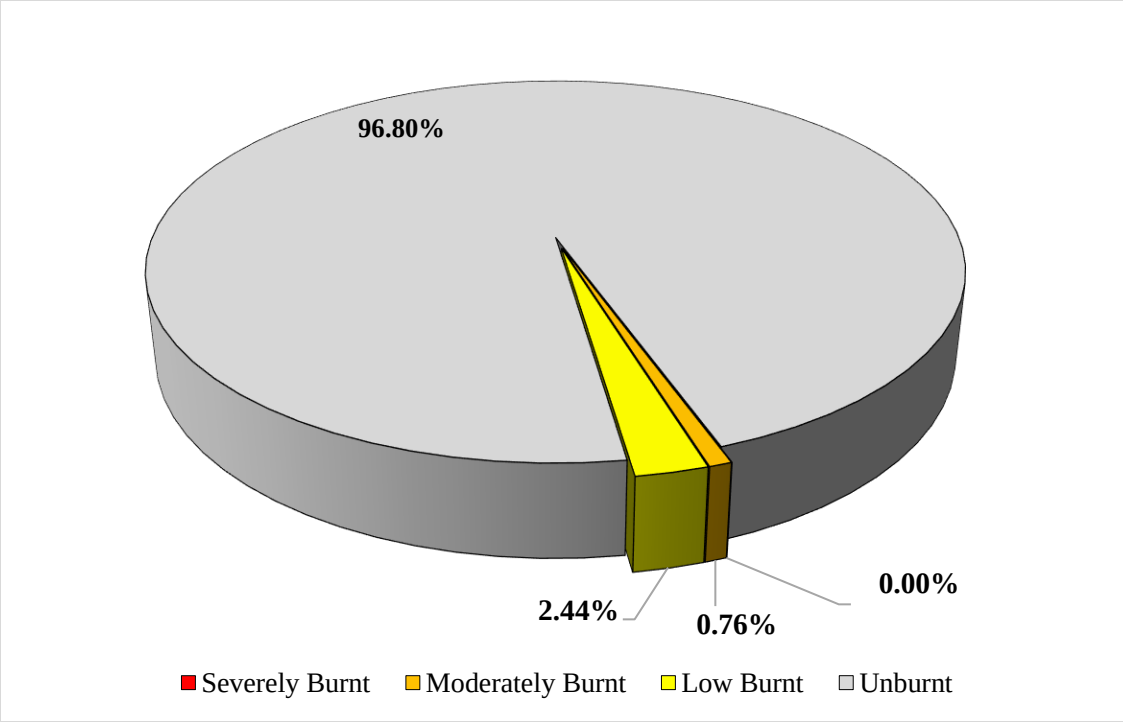


Figure 2.26.4 Distribution of burnt severity classes

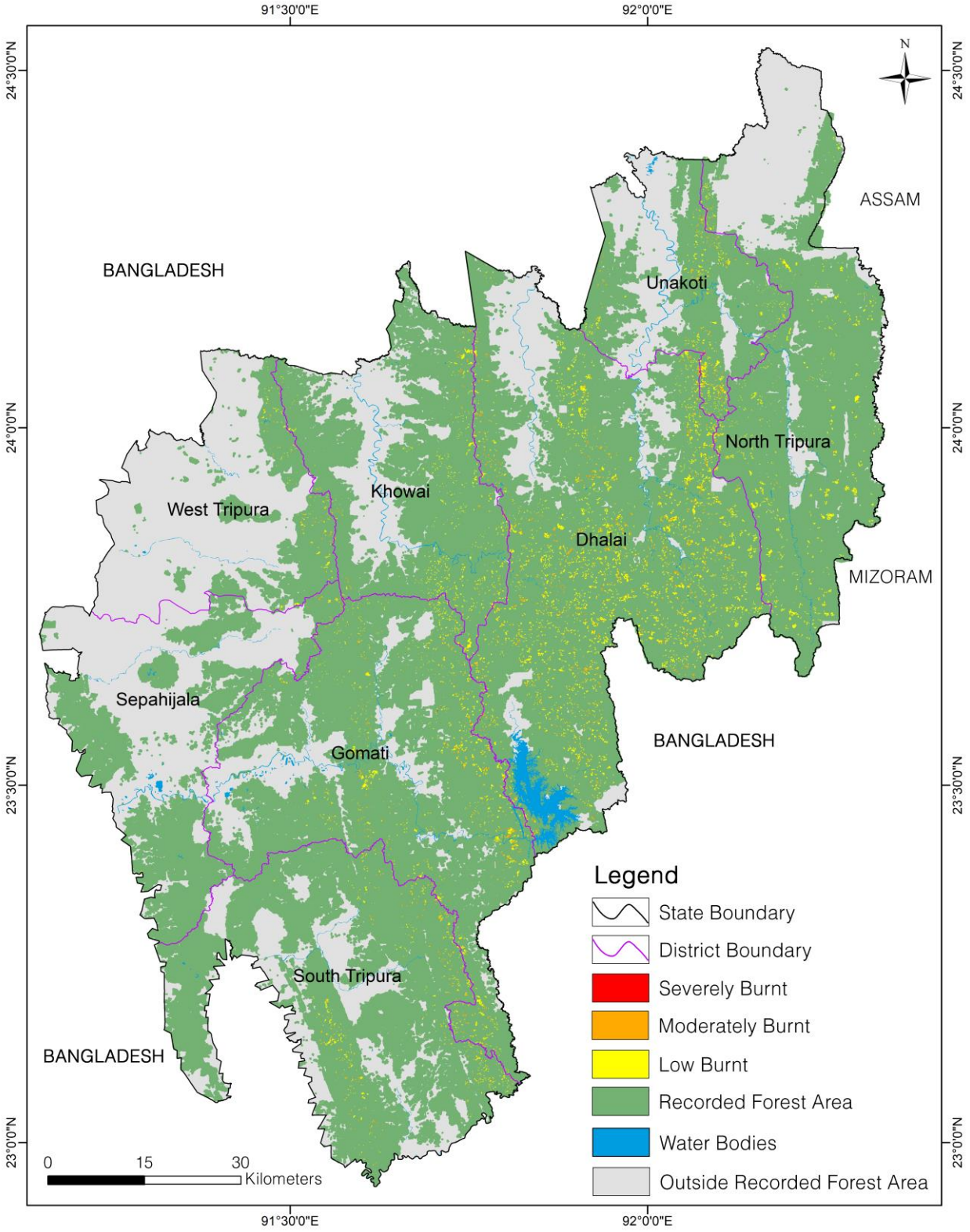


Figure 2.26.5 Map showing burnt area in Tripura

2.26.5 Results and Analysis

Based on the analysis, it is observed that Dhalai followed by Gomati, West Tripura are the most affected districts. The maximum affected area under severely and moderately burnt severity class has been observed in Dhalai districts. Dhalai district has reported the highest area under low burnt severity class. A total of 190.47 km^2 fire affected forest area has been reported in the state, which constitute 3.20% of the RFA.

2.27 Uttar Pradesh

2.27.1 Introduction

The state lies between 23°52' N to 31°28' N latitude and 77°30' E to 84°39' E longitude. It shares border with Uttarakhand in the North, Haryana, Delhi & Rajasthan in the West, Madhya Pradesh in the South-West and South, Chhattisgarh in the South and Bihar in the East. It also shares international border with Nepal in the North. The state comprises of three distinct regions: The Shiwaliks region in the North, Gangetic plain the Central region & Vindhyan hills in the South. Geographical area of the state is 2,40,928 km^2, which is 7.33% of the geographical area of the country. Ganga, Yamuna, Gomti, Ghagra, Betwa, Chambal and Gandak are the major rivers of the state. The climate of the state is humid subtropical. The average annual temperature varies from 3°C to 47°C, whereas, the rainfall in the state is mainly influenced by both South-West and North-East monsoons with average annual rainfall ranges between 1,000 mm to 1,200 mm. The Recorded Forest Area (RFA) of the state is 17,435 km^2, which is 7.24% of its geographical area.

Forest fires are quite frequent in the state during fire season and a considerable area under forest is affected due to the forest fires every year. There are many causative factors for initiation and spread of fires. In majority of the incidents, anthropogenic activity is the major cause of fire incidents in the state. Ground truthing was carried out by a joint team of FSI and State Forest Department during May 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of 22 points were visited by the team.

2.27.2 Forest Cover and Forest Type Group

As per the ISFR 2023, forest cover in the state is 15,045.80 km^2, which constitutes 6.24% of the state's geographical area. In terms of forest canopy density classes, the state has 2,688.73 km^2 under Very Dense Forest (VDF), 4,001.41 km^2 under Moderately Dense Forest (MDF), 8,355.66 km^2 under Open Forest (OF) and 639.51 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Uttar Pradesh belong to six forest type groups, which are further categorized into 29 forest types. The major forest type groups comprises of Tropical Dry Deciduous Forests followed by Tropical Moist Deciduous Forests, Tropical Thorn Forests and Littoral & Swamp Forests.

The most vulnerable forest types to fires in the state are Northern dry mixed deciduous forest followed by Western light alluvium plains sal and Eastern heavy alluvium plains sal.

2.27.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.27.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.27.1. Table 2.27.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

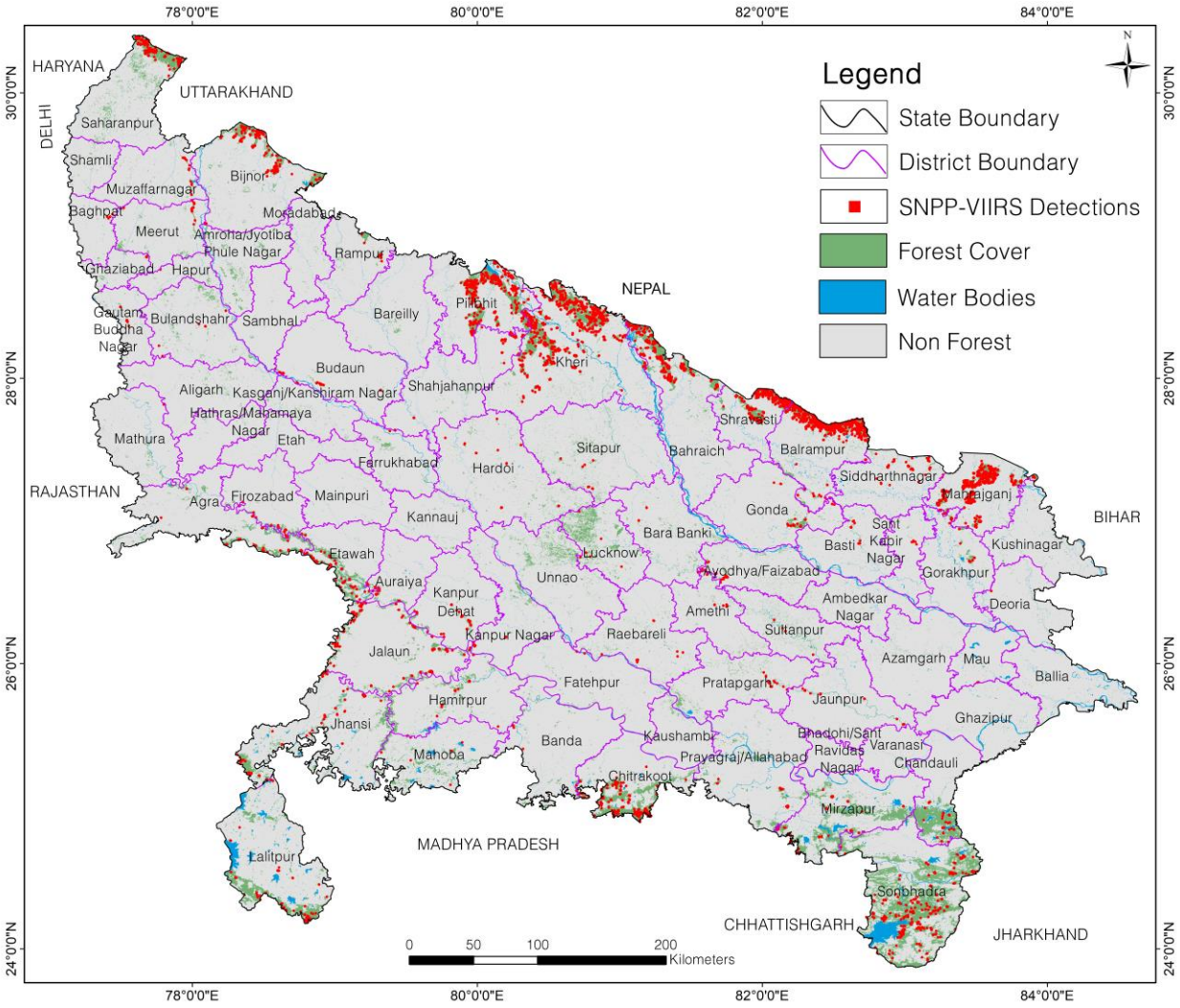


Figure 2.27.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.27.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

Districts	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Agra	15	37
Aligarh	0	0
Ambedkar Nagar	1	0
Amethi	9	9
Amroha /Jyotiba Phule Nagar	9	0
Auraiya	8	20
Ayodhya / Faizabad	8	26
Azamgarh	1	0
Baghpat	0	4
Bahraich	195	288

Districts	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Ballia	0	0
Balrampur	407	626
Banda	0	5
Bara Banki	5	5
Bareilly	0	0
Basti	1	11
Bhadohi / Sant Ravidas Nagar	0	0
Bijnor	88	155
Budaun	12	22
Bulandshahr	9	5
Chandauli	94	28
Chitrakoot	54	174
Deoria	0	1
Etah	1	0
Etawah	13	63
Farrukhabad	4	1
Fatehpur	0	2
Firozabad	4	19
Gautam Buddha Nagar	12	5
Ghaziabad	1	2
Ghazipur	0	0
Gonda	7	22
Gorakhpur	9	22
Hamirpur	12	17
Hapur	2	1
Hardoi	12	14
Hathras / Mahamaya Nagar	0	0
Jalaun	41	98
Jaunpur	8	11
Jhansi	61	52
Kannauj	0	0
Kanpur Dehat	17	22
Kanpur Nagar	0	11
Kasganj / Kanshiram Nagar	0	0
Kaushambi	0	0
Kheri	557	689
Kushinagar	0	0
Lalitpur	113	58
Lucknow	4	7

Districts	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Mahoba	7	6
Mahrajganj	333	462
Mainpuri	0	0
Mathura	3	1
Mau	1	2
Meerut	6	15
Mirzapur	48	49
Moradabad	3	0
Muzaffarnagar	15	14
Pilibhit	294	430
Pratapgarh	10	16
Prayagraj / Allahabad	25	22
Raebareli	7	11
Rampur	7	10
Saharanpur	74	158
Sambhal	0	0
Sant Kabir Nagar	8	5
Shahjahanpur	14	32
Shamli	0	0
Shravasti	93	328
Siddharthnagar	29	48
Sitapur	2	7
Sonbhadra	457	272
Sultanpur	2	4
Unnao	1	0
Varanasi	2	0
Total	**3,235**	**4,424**

Based on the analysis of forest fire detections, the crucial period of forest fires in the state has been determined. The crucial period of forest fire detections in the state has been noticed to be tentatively between 25th March to 10th May, which is based on the forest fire detections of last eight years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years is shown in the Figure 2.27.2.

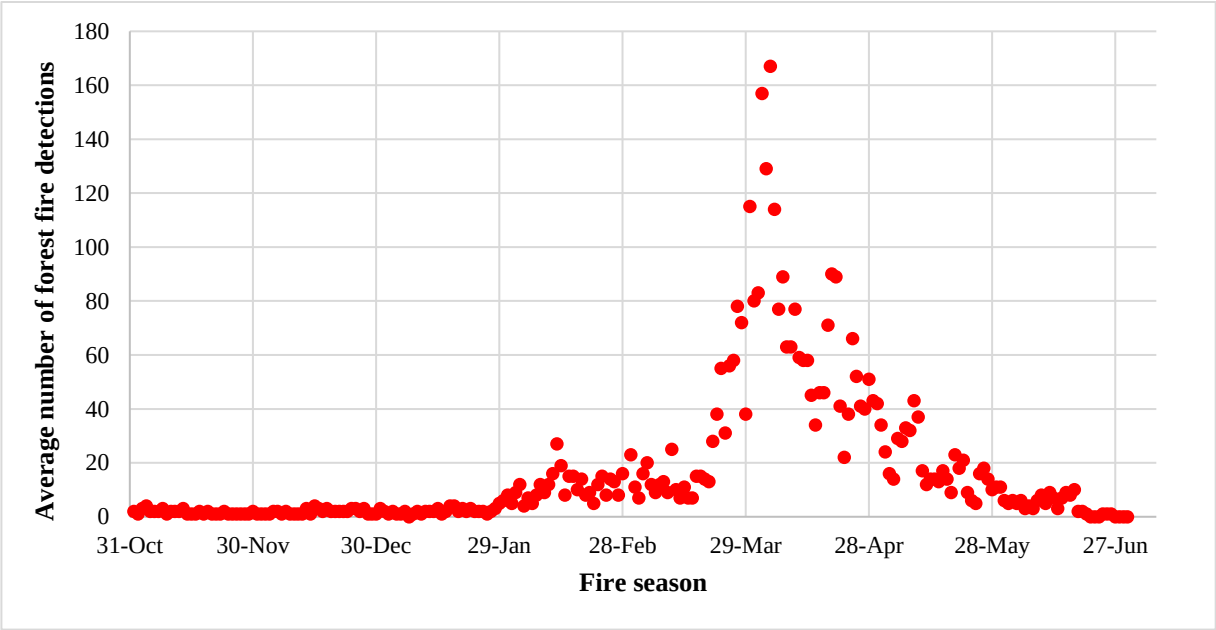


Figure 2.27.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.27.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.27.3. Table 2.27.2 shows the number of large forest fire detections during fire season 2022-23 and 2023-24.

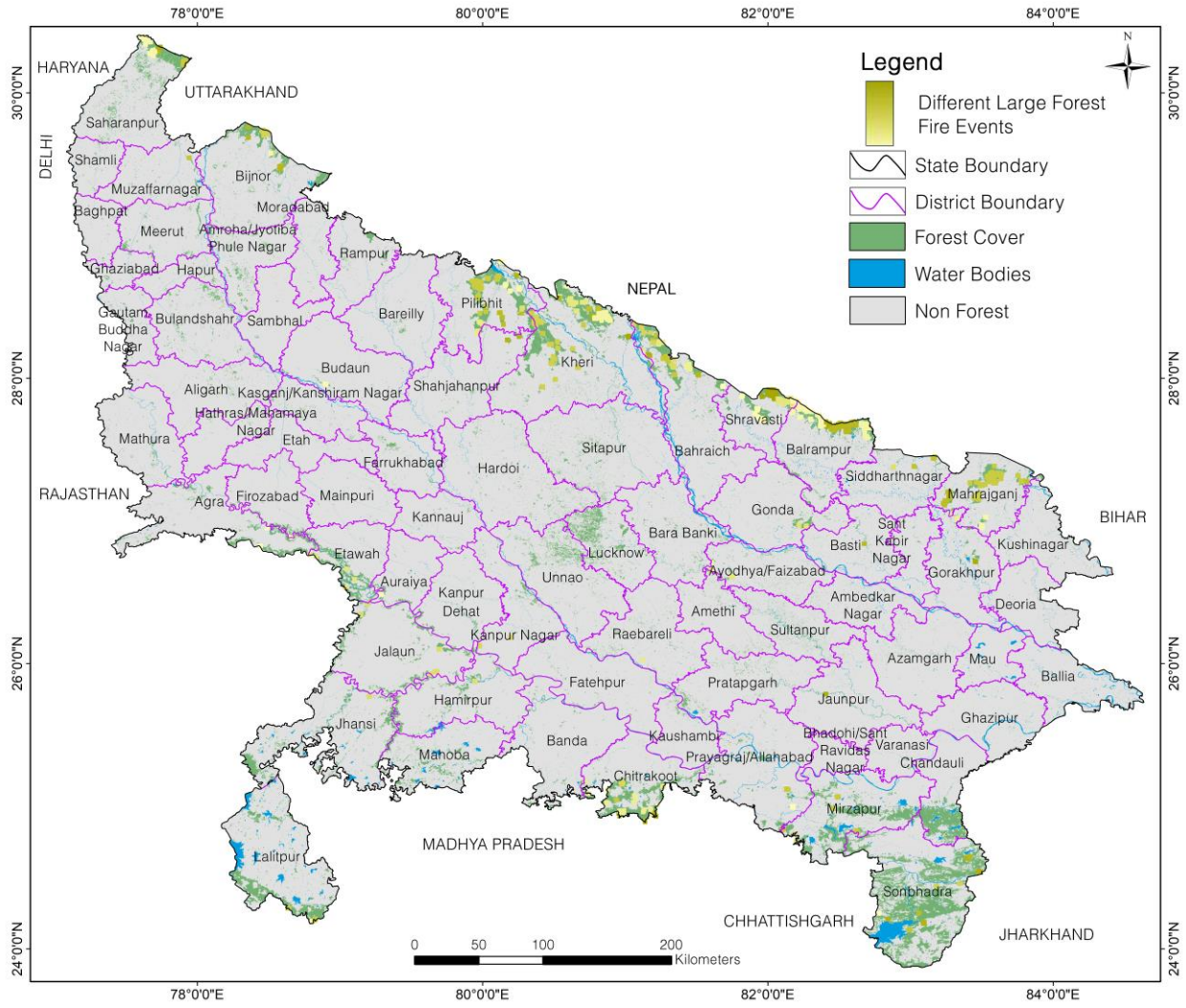


Figure 2.27.3 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.27.2 Number of large forest fire detections during fire season 2022-23 and 2023-24

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Uttar Pradesh	190	285

2.27.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.27.3. From the Figure 2.27.4, it can be inferred that 1.93% of the GW has been affected by fires. A total of 1.92 % of the GW falls under the low burnt class and 0.01% under moderately burnt class. Only 0.15 km^2 of the GW have been classified under severely burnt class. The burnt area map of Uttar Pradesh is shown in Figure 2.27.5.

Table 2.27.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
Agra	0.00	0.00	0.27	0.27
Aligarh	0.00	0.00	0.00	0.00
Ambedkar Nagar	0.00	0.00	0.00	0.00
Amethi	0.00	0.00	0.00	0.00
Amroha /Jyotiba Phule Nagar	0.00	0.00	0.00	0.00
Auraiya	0.00	0.00	0.02	0.02
Ayodhya / Faizabad	0.00	0.00	0.00	0.00
Azamgarh	0.00	0.00	0.00	0.00
Baghpat	0.00	0.00	0.00	0.00
Bahraich	0.00	0.00	68.76	68.76
Ballia	0.00	0.00	0.00	0.00
Balrampur	0.00	0.00	1.48	1.48
Banda	0.00	0.00	0.43	0.43
Bara Banki	0.00	0.00	0.00	0.00
Bareilly	0.00	0.00	0.00	0.00
Basti	0.00	0.00	0.00	0.00
Bhadohi / Sant Ravidas Nagar	0.00	0.00	0.00	0.00
Bijnor	0.00	0.00	0.00	0.00
Budaun	0.00	0.00	0.00	0.00
Bulandshahr	0.00	0.00	0.00	0.00
Chandauli	0.00	0.00	1.36	1.36
Chitrakoot	0.00	0.00	30.41	30.41
Deoria	0.00	0.00	0.00	0.00
Etah	0.00	0.00	0.00	0.00
Etawah	0.00	0.00	1.24	1.24
Farrukhabad	0.00	0.00	0.00	0.00
Fatehpur	0.00	0.00	0.00	0.00
Firozabad	0.00	0.00	0.07	0.07
Gautam Buddha Nagar	0.00	0.00	0.00	0.00
Ghaziabad	0.00	0.00	0.00	0.00
Ghazipur	0.00	0.00	0.00	0.00
Gonda	0.00	0.00	0.00	0.00
Gorakhpur	0.00	0.00	0.00	0.00
Hamirpur	0.00	0.00	0.00	0.00
Hapur	0.00	0.00	0.00	0.00
Hardoi	0.00	0.00	0.00	0.00
Hathras / Mahamaya Nagar	0.00	0.00	0.00	0.00
Jalaun	0.00	0.00	1.36	1.36
Jaunpur	0.00	0.00	0.00	0.00

District	Affected Area			Total
	Severely	Moderately	Low	
Jhansi	0.00	0.00	0.00	0.00
Kannauj	0.00	0.00	0.00	0.00
Kanpur Dehat	0.00	0.00	0.00	0.00
Kanpur Nagar	0.00	0.00	0.00	0.00
Kasganj / Kanshiram Nagar	0.00	0.00	0.00	0.00
Kaushambi	0.00	0.00	0.00	0.00
Kheri	0.04	0.17	54.19	54.40
Kushinagar	0.00	0.00	0.00	0.00
Lalitpur	0.00	0.00	0.00	0.00
Lucknow	0.00	0.00	0.00	0.00
Mahoba	0.00	0.00	0.00	0.00
Mahrajganj	0.00	0.00	0.00	0.00
Mainpuri	0.00	0.00	0.00	0.00
Mathura	0.00	0.00	0.00	0.00
Mau	0.00	0.00	0.00	0.00
Meerut	0.00	0.00	0.00	0.00
Mirzapur	0.00	0.00	0.57	0.57
Moradabad	0.00	0.00	0.00	0.00
Muzaffarnagar	0.00	0.00	0.00	0.00
Pilibhit	0.11	0.57	6.30	6.98
Pratapgarh	0.00	0.00	0.00	0.00
Prayagraj / Allahabad	0.00	0.00	0.00	0.00
Raebareli	0.00	0.00	0.00	0.00
Rampur	0.00	0.00	0.00	0.00
Saharanpur	0.00	0.00	0.00	0.00
Sambhal	0.00	0.00	0.00	0.00
Sant Kabir Nagar	0.00	0.00	0.00	0.00
Shahjahanpur	0.00	0.00	0.00	0.00
Shamli	0.00	0.00	0.39	0.39
Shravasti	0.00	0.00	33.90	33.90
Siddharthnagar	0.00	0.00	0.00	0.00
Sitapur	0.00	0.00	0.00	0.00
Sonbhadra	0.00	0.00	56.24	56.24
Sultanpur	0.00	0.00	0.00	0.00
Unnao	0.00	0.00	0.00	0.00
Varanasi	0.00	0.00	0.00	0.00
Total	**0.15**	**0.74**	**256.99**	**257.88**

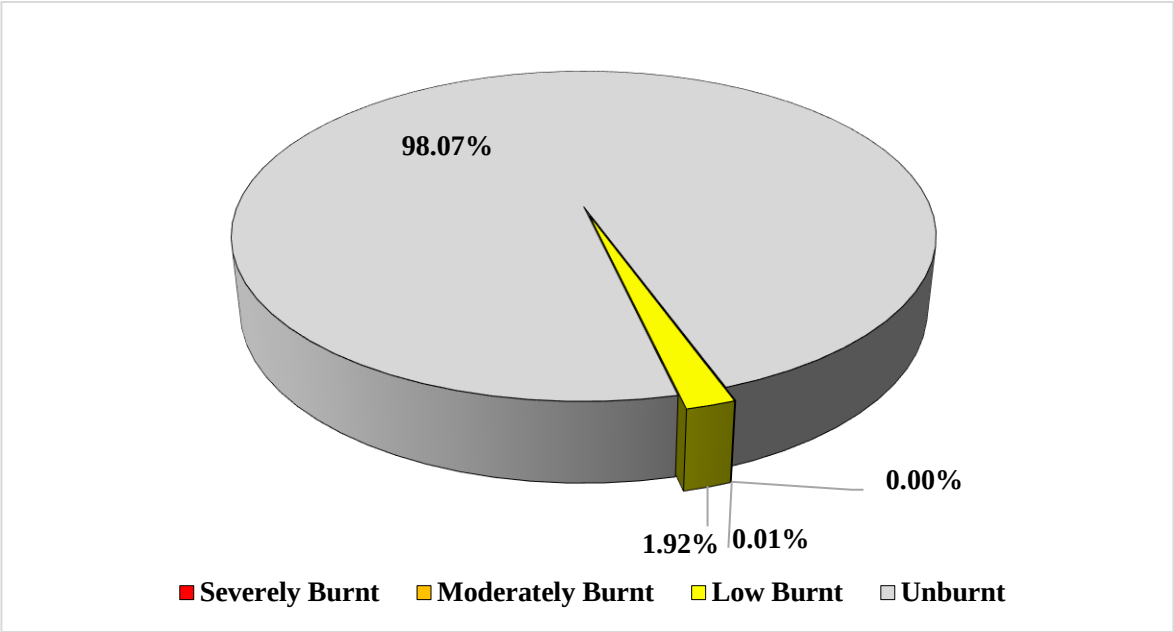


Figure 2.27.4 Distribution of burnt severity classes

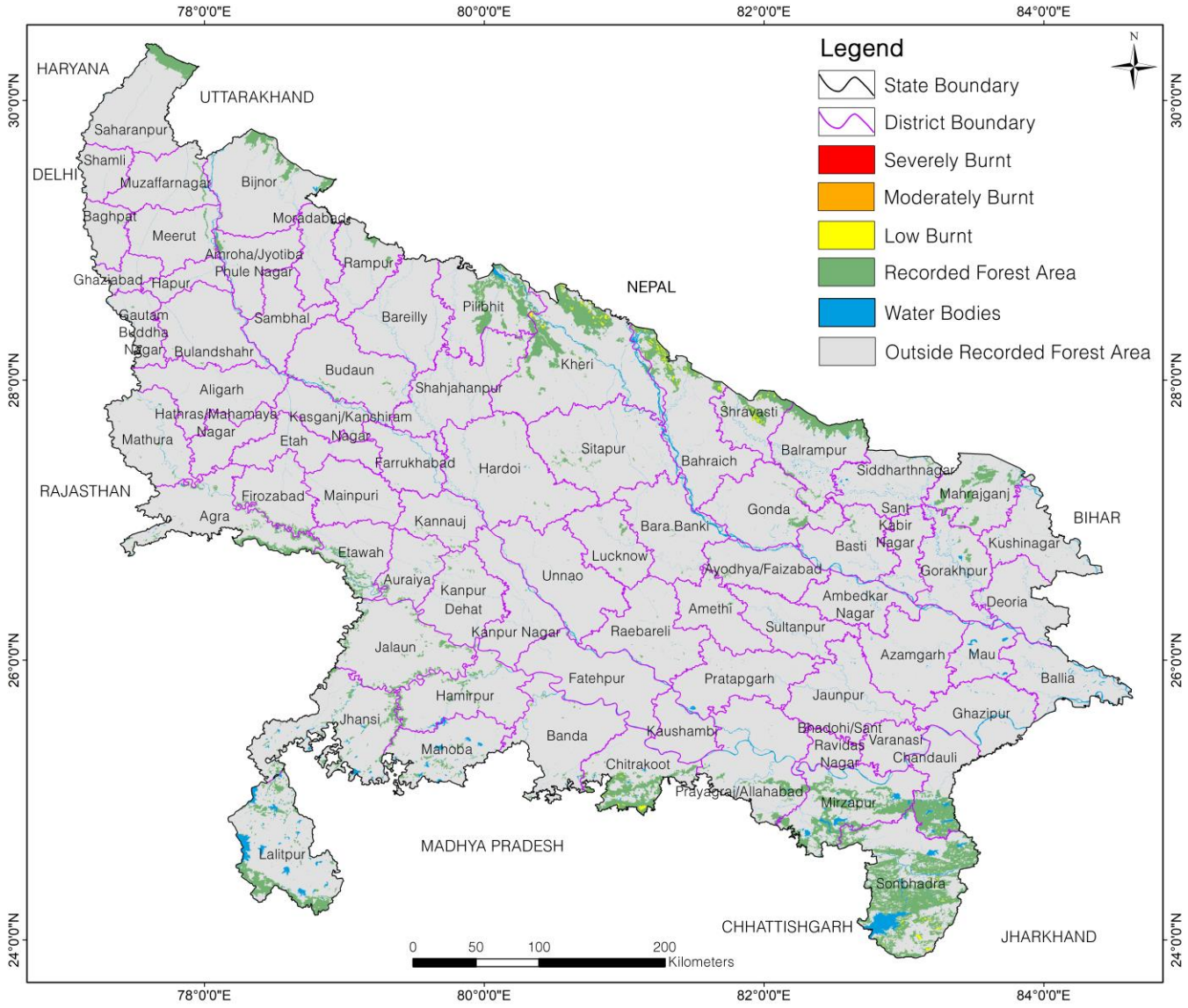


Figure 2.27.5 Map showing burnt area in Uttar Pradesh

2.27.5 Results and Analysis

Based on the analysis, it is observed that Kheri, Bahraich, Sonbhadra and Pilibhit are the most fire affected districts. The maximum affected area under moderately burnt severity class has been observed in Kheri and Pilibhit districts. Bahraich district has reported the highest area under low burnt severity class. A total of 257.88 km^2 fire affected forest area has been reported in the state, which constitute 1.93% of the GW. Most of the fire affected area has been found in the Northern dry mixed deciduous forest followed by Western light alluvium plains sal and Eastern heavy alluvium plains sal.

2.28 Uttarakhand

2.28.1 Introduction

The state lies between 28°43' N to 31°28' N latitude and 77°34' E to 81°03' E longitude. It shares border with Himachal Pradesh in the North-West and Uttar Pradesh in the South. It also shares international border with China in the North and Nepal in the East. The Himalayan range is the main physiographic region: which further divided into three regions viz. the Himalayas, the Shiwaliks and the Tarai. Geographical area of the state is 53,483 km^2, which is 1.63% of the geographical area of the country. Ganga, Yamuna, Ramganga and Kali are the major rivers of the state. The climate of the state is temperate and it varies from sub-tropical at lower elevation to glaciers at higher elevation. The average annual temperature of the state varies from -10°C to 43°C. Whereas, the rainfall in the state is mainly influenced by South-West monsoon with average annual rainfall of 1,500 mm and it varies from place to place due to its rugged topography. The Recorded Forest Area (RFA) of the state is 38,000 km^2, which is 71.05% of its geographical area.

Forest fires are quite frequent in the state during fire season and a considerable area under forest is affected due to the forest fires every year. There are many causative factors for initiation and spread of fires. In majority of the incidents, anthropogenic activities, regeneration of grasses, tourism activities nearby forest areas are the major cause of fire incidents in the state. Ground truthing was carried out by a joint team of FSI and State Forest Department during May 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of 64 points were visited by the team.

2.28.2 Forest Cover and Forest Type Group

As per ISFR 2023, forest cover in the state is 24,303.83 km^2, which constitutes 45.44% of the state's geographical area. In terms of forest canopy density classes, the state has 5,266.58 km^2 under Very Dense Forest (VDF), 12,517.63 km^2 under Moderately Dense Forest (MDF), 6,519.62 km^2 under Open Forest (OF) and 412.88 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Uttarakhand belong to 10 forest type groups, which are further categorized into 46 forest types. The major forest type groups comprises of Himalayan Moist Temperate Forests followed by Subtropical Pine Forest, Tropical Moist Deciduous Forest and Tropical Dry Deciduous Forest.

The most vulnerable forest types to fires in the state are Upper or Himalayan chir pine forest followed by Moist Siwalik sal forest and Ban oak forest (*Q. incana*).

2.28.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.28.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.28.1. Table 2.28.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

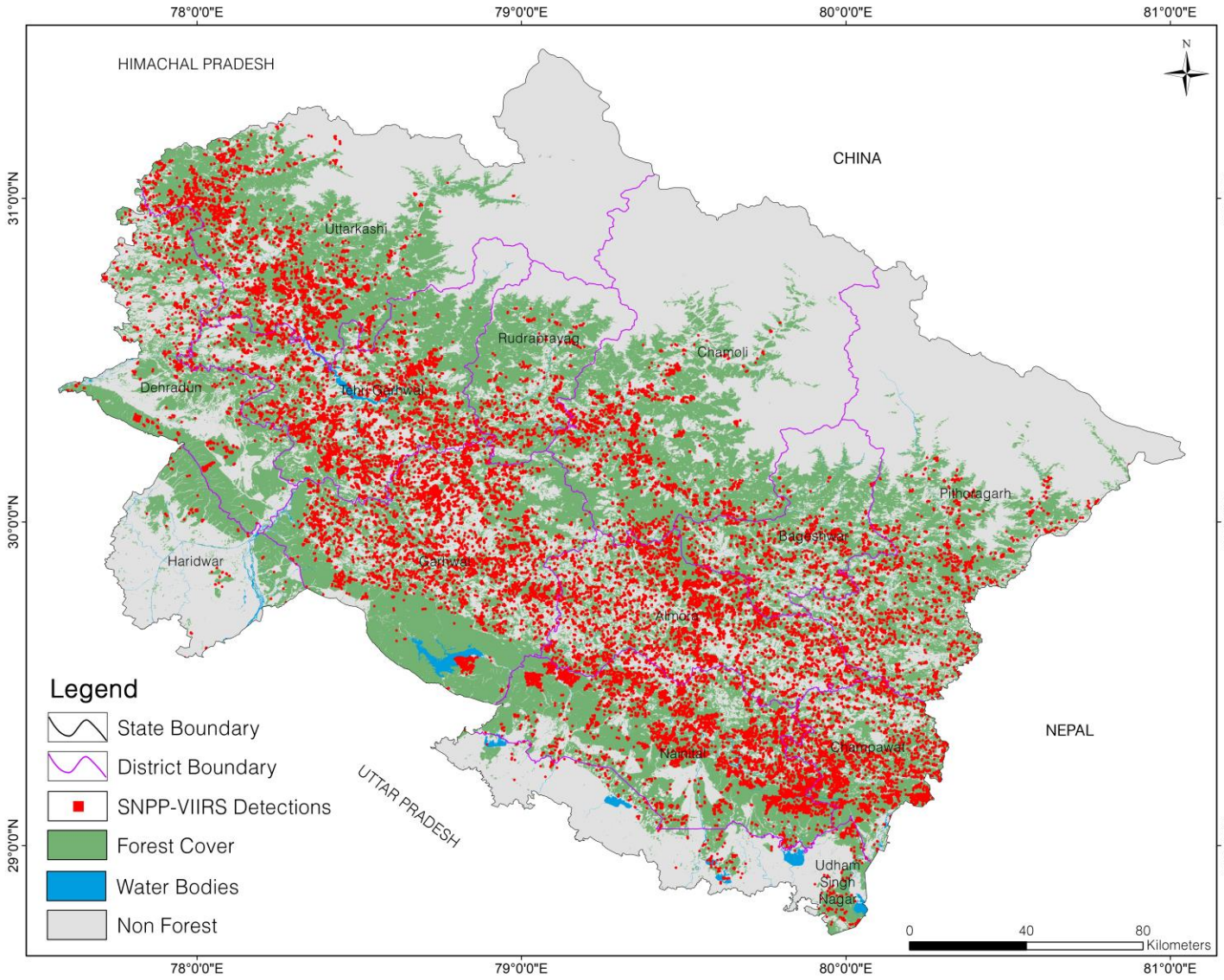


Figure 2.28.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.28.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Almora	786	2,810
Bageshwar	321	805
Chamoli	330	1331
Champawat	470	1782
Dehradun	230	705
Garhwal	928	3,193
Haridwar	99	59

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Nainital	570	3,320
Pithoragarh	785	1204
Rudraprayag	70	489
Tehri Garhwal	310	2,589
Udham Singh Nagar	128	289
Uttarkashi	324	2,457
Total	**5,351**	**21,033**

Based on the analysis of forest fire detections, the crucial period of forest fires in the state has been determined. The crucial period of forest fire detections in the state has been noticed to be tentatively between 30th March to 17th June, which is based on the forest fire detections of last eight years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years is shown in the Figure 2.28.2.

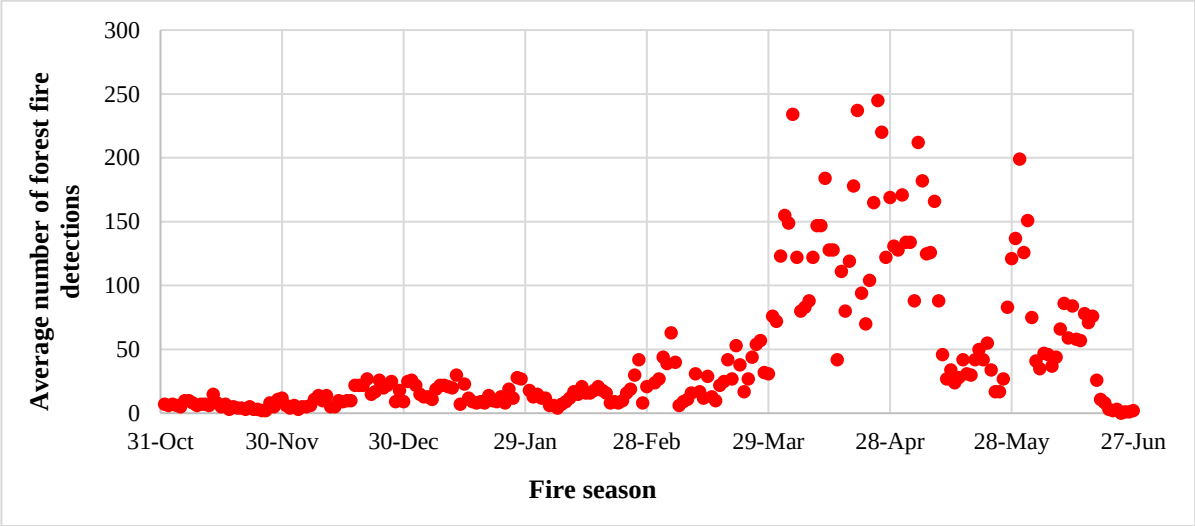


Figure 2.28.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.28.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.28.3. Table 2.28.2 shows the number of large forest fire detections during fire season 2022-23 and 2023-24.

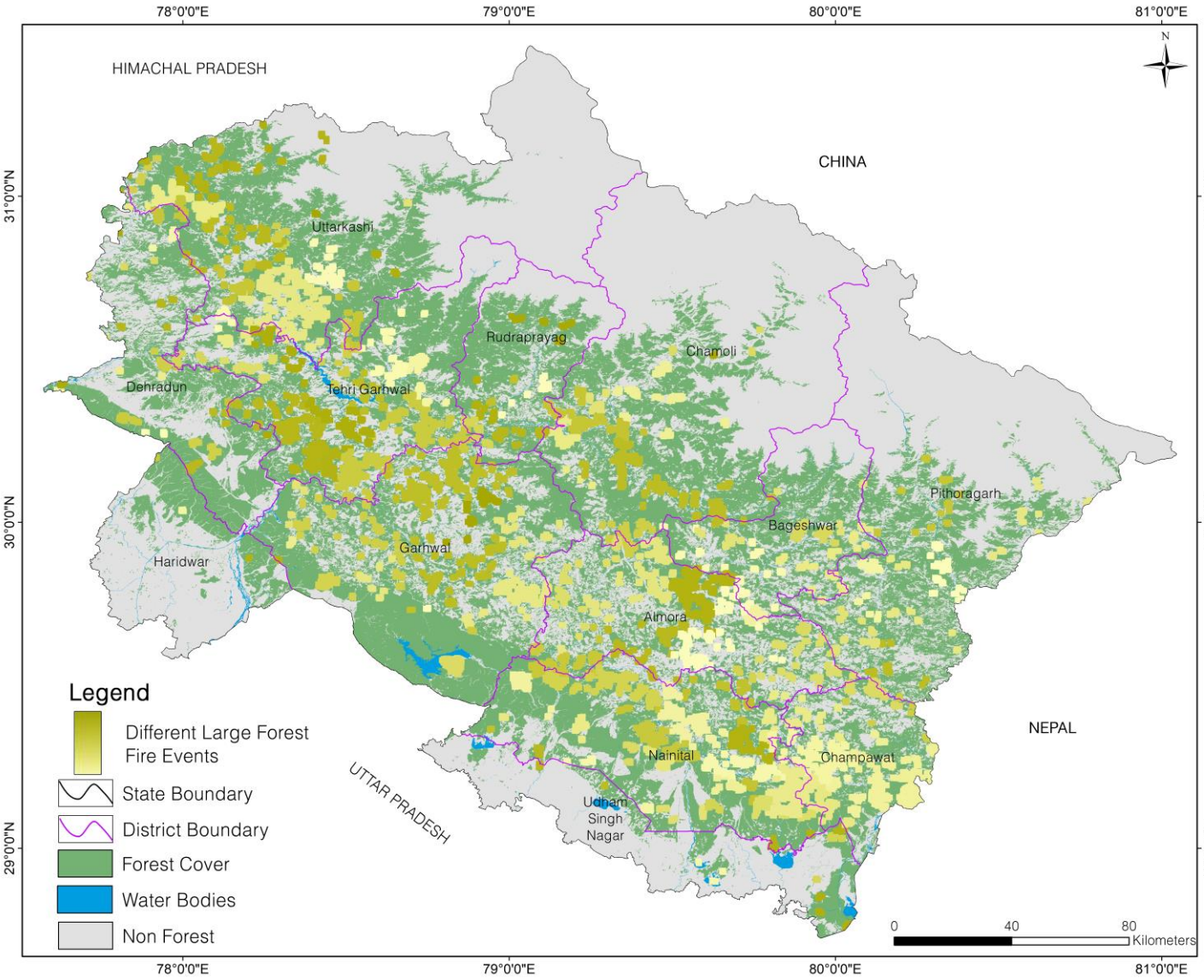


Figure 2.28.3 Spatial distribution of large forest fire events during November 2023 to June 2024

Table 2.28.2 Number of large forest fire detections during fire season 2022-23 and 2023-24

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Uttarakhand	268	1,313

2.28.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.28.3. From the Figure 2.28.4, it can be inferred that 7.09% of the RFA has been affected by fires. A total of 6.39% of the RFA falls under the low burnt class and 0.70% under moderately burnt class. Only

1.02 km^2 of the RFA have been classified under severely burnt class. The burnt area map of Uttarakhand is shown in Figure 2.28.5

Table 2.28.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
Almora	0.03	23.65	197.06	220.74
Bageshwar	0.02	13.49	180.29	193.80
Chamoli	0.36	18.86	115.30	134.52
Champawat	0.02	40.29	159.16	199.47
Dehradun	0.00	2.06	32.72	34.78
Garhwal	0.07	7.87	95.20	103.14
Haridwar	0.00	0.36	1.72	2.08
Nainital	0.09	51.25	285.24	336.58
Pithoragarh	0.04	4.44	102.72	107.20
Rudraprayag	0.00	1.87	36.91	38.78
Tehri Garhwal	0.18	9.41	194.35	203.94
Udham Singh Nagar	0.00	0.03	0.32	0.35
Uttarkashi	0.21	4.39	228.92	233.52
Total	**1.02**	**177.97**	**1,629.91**	**1,808.90**

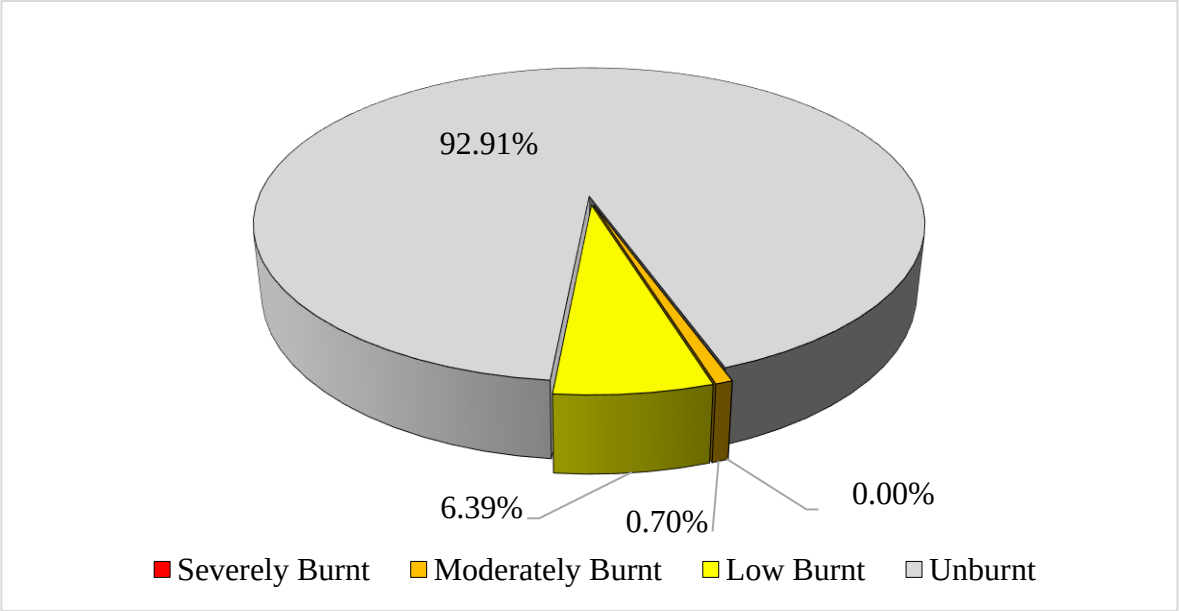


Figure 2.28.4 Distribution of burnt severity classes

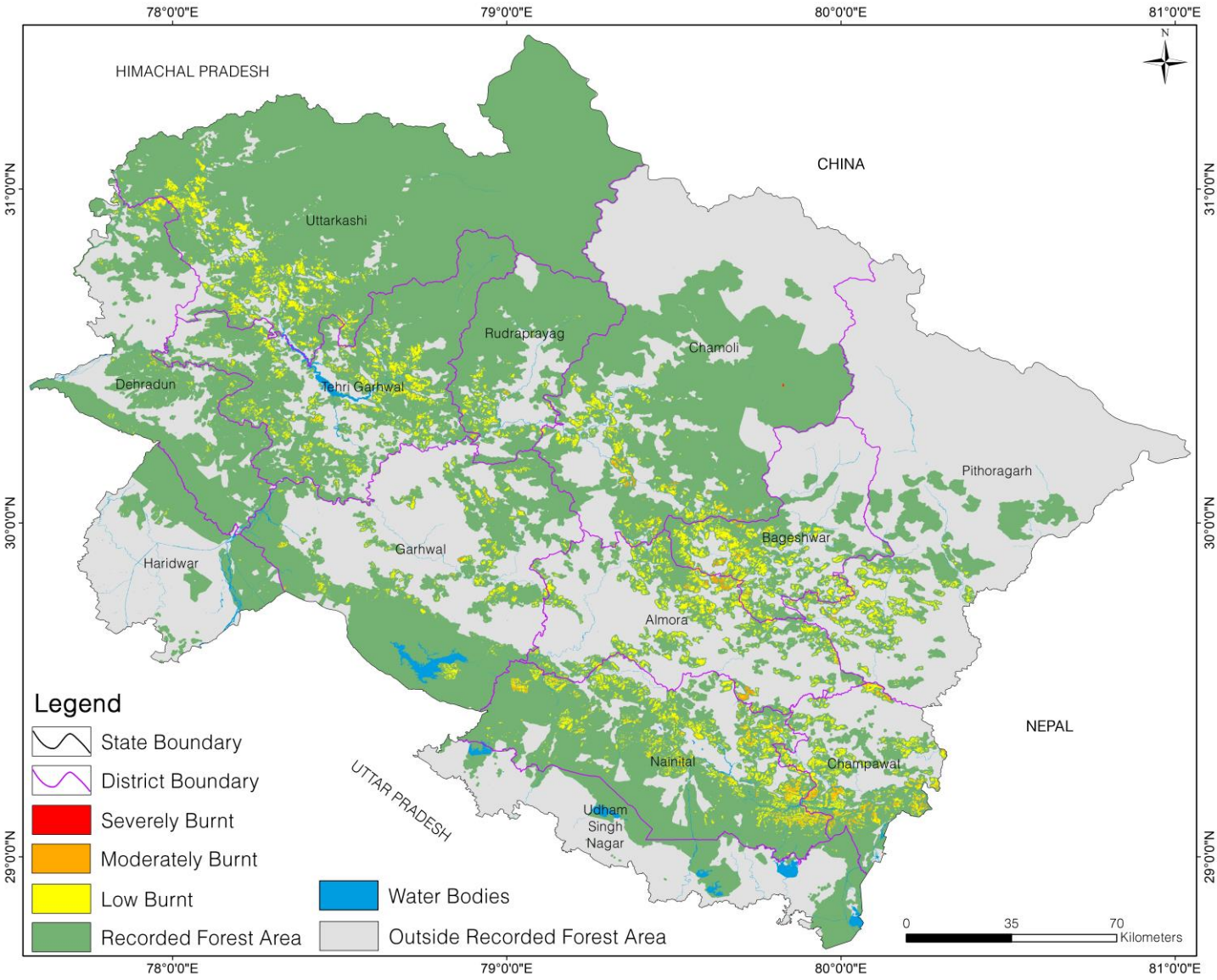


Figure 2.28.5 Map showing burnt area in Uttarakhand

2.28.5 Results and Analysis

Based on the analysis, it is observed that Nanital, Almora and Bageshwar are the most forest fire affected districts. The maximum affected area under moderately burnt severity class has been observed in Nanital and Champawat districts. Nanital district has also reported the highest area under low burnt severity class. A total of 1,808.90 km^2 fire affected forest area has been reported in the state, which constitute 7.09% of the RFA.

2.29 West Bengal

2.29.1 Introduction

The state lies between 21°29' N to 27°13' N latitude and 85° 50' E to 89° 52' E longitude and shares international border with Bangladesh in the east, Nepal in the northwest and Bhutan in the northeast. The state is also bordered by Sikkim in the north, Assam in the east, Bihar & Jharkhand in the west and Odisha and the Bay of Bengal in the south. The state comprises of two main physiographic regions: The North Himalayan region and the South Alluvial Gangetic Plains. Geographical area of the state is 88,752 km^2, which is 2.70% of the geographical area of the country. Damodar, Hugli, Teesta, Torsa and Jaldhaka are the major rivers of the state. The climate of the state is moist-tropical in the South-East to dry tropical in the South-West and from sub-tropical to temperate in the mountains of the North. The average annual temperature of the state varies from 0°C to 46°C.The rainfall in the state is mainly influenced by South-East monsoon with average annual rainfall ranges between 900 mm to 5000 mm. The state is rich in diverse range of flora and fauna biodiversity. The delta of the Hugli constitutes the western end of the dense coastal mangrove forest called the Sundarbans.Indian devil tree/ White cheesewood (Alstonia scholaris) locally called Chatim is the state tree of West Bengal. State Flower is Nyctanthes arbor-tristis locally called Shiuli/ Parijat. The Recorded Forest Area (RFA) of the state is 11,885 km^2, which is 13.39% of its geographical area.

Majority of the incidents responsible for initiation and spread of fires may be attributed to regeneration of grasses for agricultural practices. Ground truthing was carried out by a joint team of FSI and State Forest Department during June 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of 26 points were visited by the team.

2.29.2 Forest Cover and Forest Type Group

As per ISFR 2023, forest cover in the state is 16,832.33 km^2, which constitutes 18.96% of the state's geographical area. In terms of forest canopy density classes, the state has 3,037.10 km^2 under Very Dense Forest (VDF), 4,175.38 km^2 under Moderately Dense Forest (MDF), 9,619.85 km^2 under Open Forest (OF) and 137.92 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in West Bengal consists of nine forest type groups which are further categorized into 33 forest types. The major forest type groups comprise of Tropical Dry Deciduous Forests followed by Littoral & Swamp Forests and Tropical Moist Deciduous Forests.

The most vulnerable forest types to fires in the state are Sub-Himalayan secondary wet mixed forest followed by East Himalayan sal and East Himalayan upper bhabar sal.

2.29.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.29.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the state is shown in Figure 2.29.1. Table 2.29.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

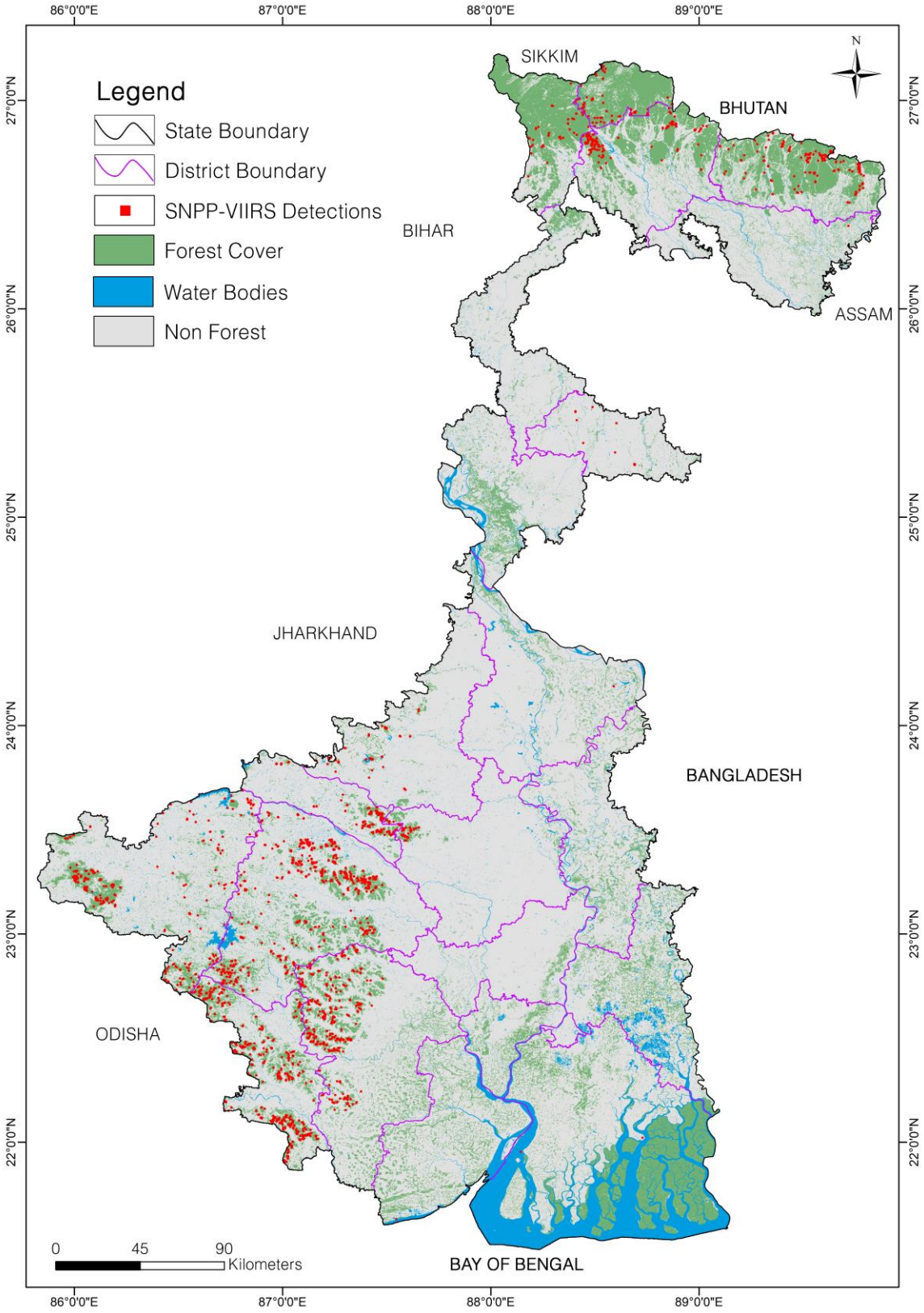


Figure 2.29.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.29.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Alipurduar	56	151
Bankura	772	456
Birbhum	56	37
Cooch Behar	1	1
Dakshin Dinajpur	16	13
Darjeeling	34	41
Hoogly	2	0
Howrah	0	0
Jalpaiguri	109	128
Jhargram	698	371
Kalimpong	90	78
Kolkata	0	0
Malda	8	0
Murshidabad	0	1
Nadia	5	0
North 24 Parganas	0	0
Paschim Bardhaman	161	128
Paschim Medinipur	692	295
Purba Bardhaman	73	36
Purba Medinipur	0	0
Purulia	323	282
South 24 Parganas	0	2
Uttar Dinajpur	0	0
Total	**3,096**	**2,020**

Based on the analysis of forest fire detections, the crucial period of forest fires in the state has been determined. The crucial period of forest fire detections in the state has been noticed to be tentatively between 03rd February to 26th April, which is based on the forest fire detections of last eight years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years is shown in the Figure 2.29.2.

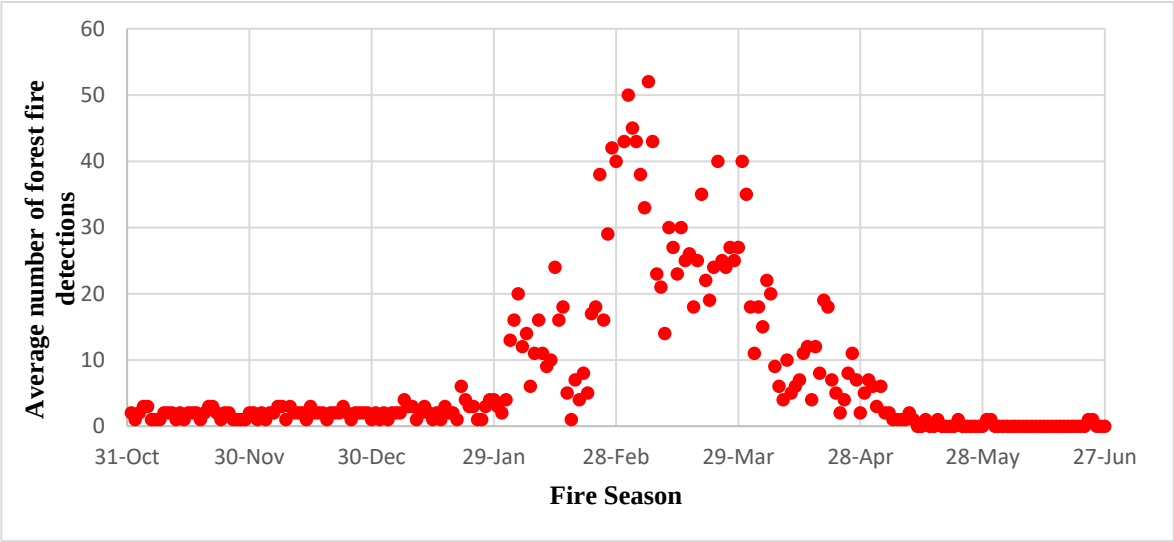


Figure 2.29.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.29.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the state is shown in Figure 2.29.3. Table 2.29.2 shows the number of large forest fire detections during fire season 2022-23 and 2023-24.

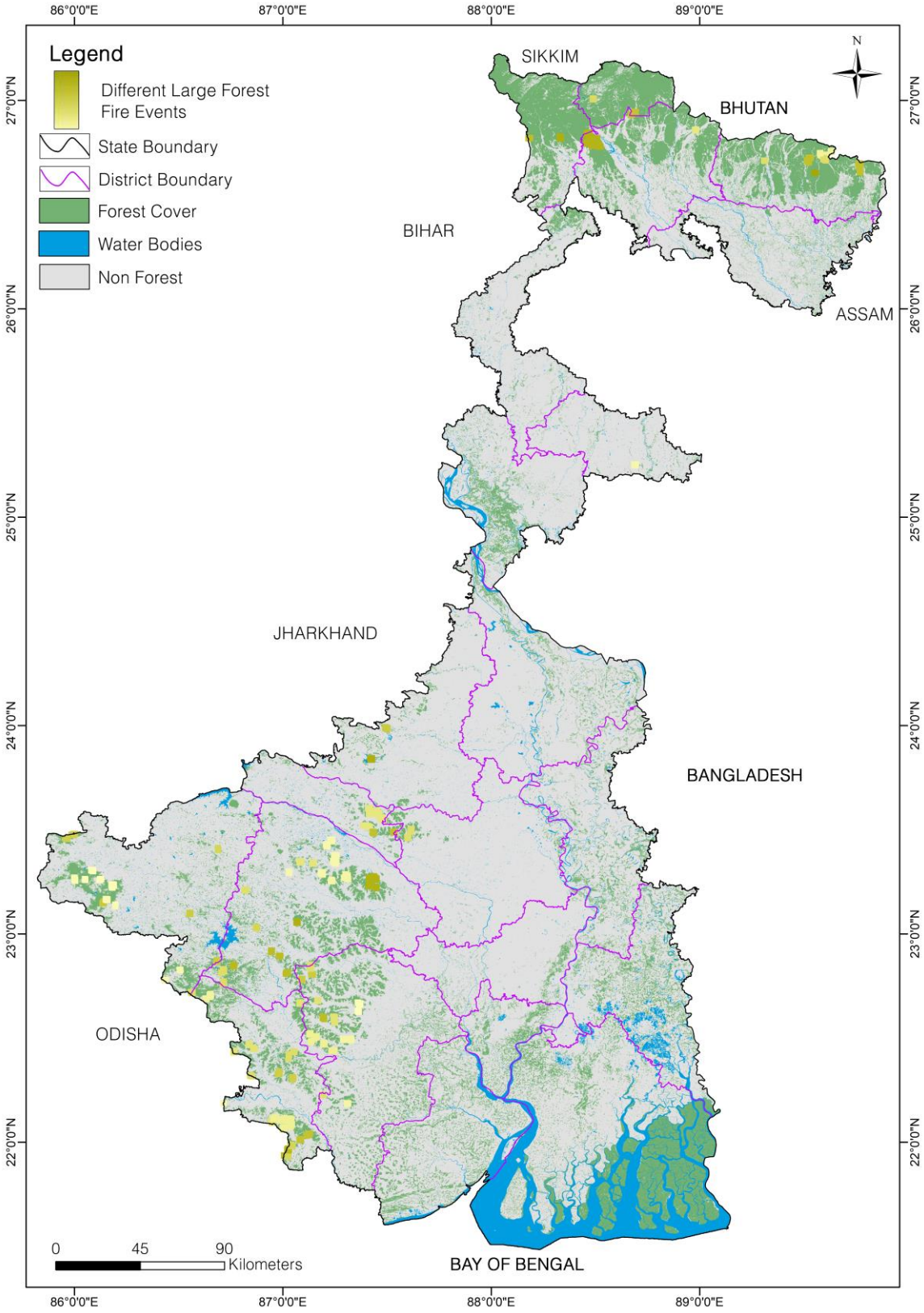


Figure 2.29.3 Spatial distribution of large forest fire events during November 2023 to June 2024

Table 2.29.2 Number of large forest fire detections during fire season 2022-23 and 2023-24

State	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
West Bengal	175	120

2.29.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.29.3. From the Figure 2.29.4, it can be inferred that 2.21% of the RFA has been affected by fires. A total of 2.01% of the RFA falls under the low burnt class and 0.20% under moderately burnt class. Only 0.09 km^2 of the RFA have been classified under severely burnt class. The burnt area map of West Bengal is shown in Figure 2.29.5

Table 2.29.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			
	Severely	Moderately	Low	Total
Alipurduar	0.00	0.27	13.14	13.41
Bankura	0.07	4.04	60.58	64.69
Birbhum	0.00	0.00	0.00	0.00
Cooch Behar	0.00	0.00	0.00	0.00
Dakshin Dinajpur	0.00	0.00	0.00	0.00
Darjeeling	0.00	0.23	2.37	2.60
Hoogly	0.00	0.00	0.00	0.00
Howrah	0.00	0.00	0.00	0.00
Jalpaiguri	0.00	0.02	4.35	4.37
Jhargram	0.01	8.01	51.52	59.54
Kalimpong	0.00	0.09	4.42	4.51
Kolkata	0.00	0.00	0.00	0.00
Malda	0.00	0.00	0.00	0.00
Murshidabad	0.00	0.00	0.00	0.00
Nadia	0.00	0.00	0.00	0.00
North 24 Parganas	0.00	0.00	0.00	0.00
Paschim Bardhaman	0.00	2.27	26.68	28.95
Paschim Medinipur	0.01	6.20	41.04	47.25
Purba Bardhaman	0.00	0.79	8.29	9.08
Purba Medinipur	0.00	0.00	0.00	0.00
Purulia	0.00	1.30	24.23	25.53
South 24 Parganas	0.00	0.00	0.00	0.00
Uttar Dinajpur	0.00	0.00	0.00	0.00
Total	**0.09**	**23.22**	**236.62**	**259.93**

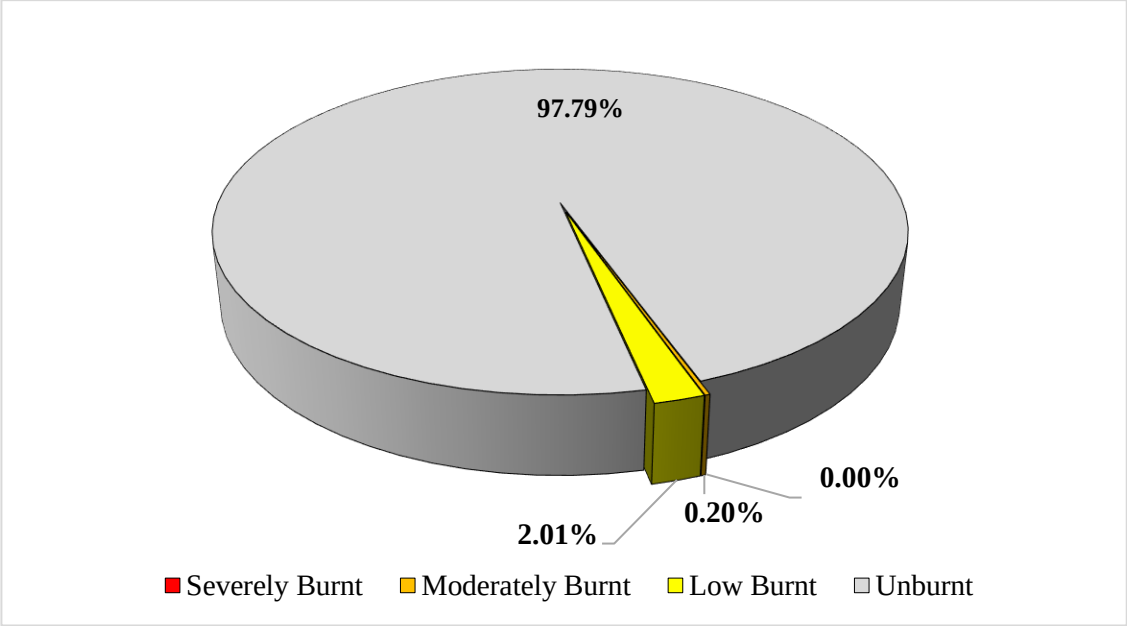


Figure 2.29.4 Distribution of burnt severity classes

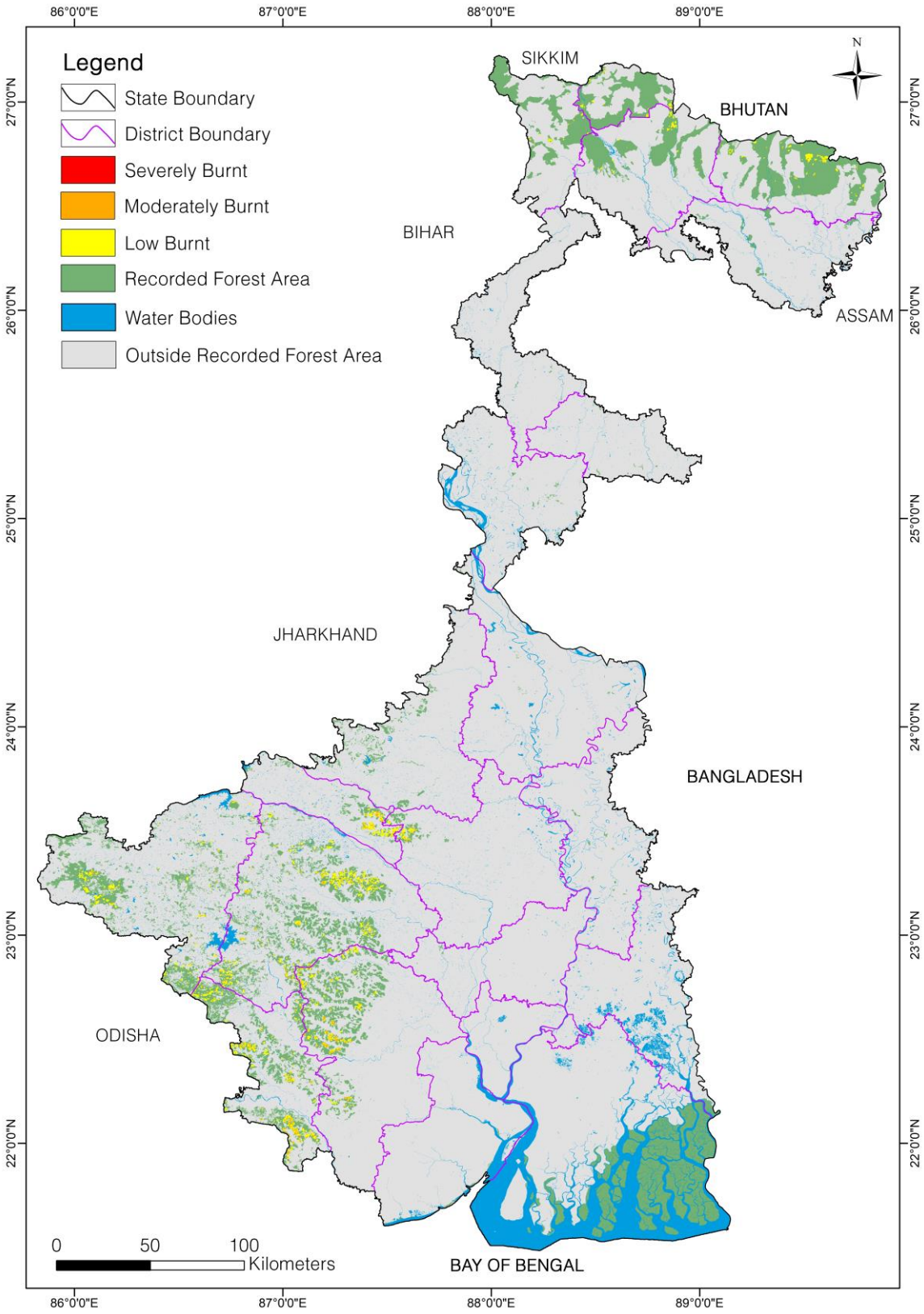


Figure 2.29.5 Map showing burnt area in West Bengal

2.29.5 Results and Analysis

Based on the analysis, it is observed that Bankura followed by Jhargram and Paschim Medinipur are the most fire affected districts. The maximum affected area under moderately burnt severity class has been observed in Jhargram and Paschim Medinipur districts. Bankura district has reported the highest area under low burnt severity class followed by Jhargram and Paschim Medinipur. A total of 259.93 km^2 fire affected forest area has been reported in the state, which constitute 2.21% of the RFA.

2.30 Andaman & Nicobar Islands

2.30.1 Introduction

The Union Territory (UT) of Andaman & Nicobar Islands lies between 6° N to 14°N latitude and 92° E to 94° E longitude. The UT lies in the Bay of Bengal. The extent of UT from North to South is more than 700 km and have a coastline of 1,962 km. The UT comprises two groups of islands, namely the Andaman group and the Nicobar group, separated geographically by 10° N parallel. Out of the 572 islands, only 38 are inhabited. Geographical area of the UT is 8,249 km^2, which is 0.25% of the geographical area of the country. Kalpong is the major river in Diglipur Island. The climate of the UT is tropical warm and humid climate. The average annual temperature of the UT varies from 24°C to 28°C. Whereas, the rainfall in the UT is mainly influenced by both South-West monsoon and North-East monsoon with average annual rainfall varies from 1,400 mm to 3,000 mm. The region is famous for its rich biodiversity housing 650 species of angiosperms, ferns, gymnosperms, bryophytes and lichens. The Recorded Forest Area (RFA) of the UT is 7,171 km^2, which is 86.93% of its geographical area.

2.30.2 Forest Cover and Forest Type Group

As per ISFR 2023, forest cover in the UT is 6,732.92 km^2, which constitutes 81.62% of the UT's geographical area. In terms of forest canopy density classes, the UT has 5,702.87 km^2 under Very Dense Forest (VDF), 653.20 km^2 under Moderately Dense Forest (MDF), 376.85 km^2 under Open Forest (OF) and 4.16 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Andaman & Nicobar Islands belong to five forest type groups, which are further categorized into 14 forest types. The major forest type groups comprise of Tropical Wet Evergreen Forests followed by Tropical Semi-Evergreen Forests, Littoral & Swamp Forests and Tropical Moist Deciduous Forests.

The most vulnerable forest types to fires in the UT are Andamans semi-evergreen forest followed by Andamans moist deciduous forest and Mangrove forest.

2.30.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the UT comprising near real-time forests fire detections and large forest fire detections are as follows:

2.30.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the UT is shown in Figure 2.30.1. Table 2.30.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

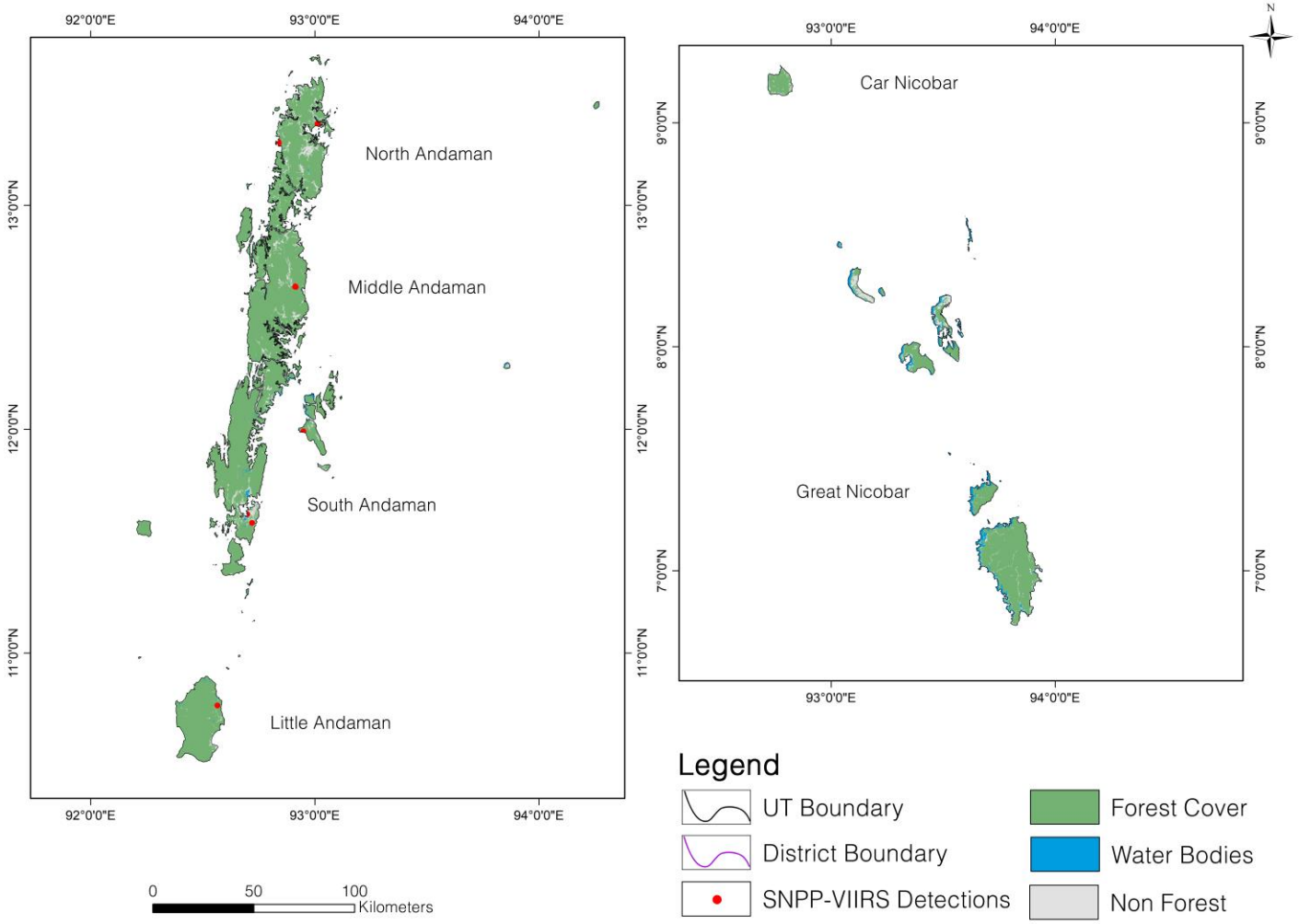


Figure 2.30.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.30.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Nicobar	17	11
North & Middle Andaman	2	6
South Andaman	1	4
Total	**20**	**21**

Based on the analysis of forest fire detections of last eight years in the state, no clear correlation between year-wise forest fire detections appeared to determine the crucial period.

2.30.3.2 Large Forest Fire Detections

No large forest fire detections has been observed in the UT during fire season 2022-23 and 2023-24.

2.30.4 Burnt Scar Assessment

No burnt scars has been observed in the UT during fire season 2023-24.

2.30.5 Results and Analysis

No burnt scars have been observed in Chandigarh during 2023-24 fire season.

2.31 Chandigarh

2.31.1 Introduction

The Union Territory (UT) of Chandigarh lies between 30° 39' N to 30° 49' N latitude and 75° 41 E to 75° 51' E longitude. It shares border with Punjab in the North, West & South and Haryana in the East. Geographical area of the Union territory of Chandigarh is 114 km^2, which is 0.003% of the geographical area of the country. Physiographically, Chandigarh falls in the Great Indian Northern Plains although existing near to the foothills of the Shiwalik hills. The Chandigarh has humid sub-tropical climate with average annual temperature varying from 1°C to 45°C. The average annual rainfall ranges between 400 mm to 600 mm. Majority of the forest is present in Sukhna Wildlife Sanctuary, which forms the part of Sukhna lake catchment area falling in Shiwalik hills. The Recorded Forest Area (RFA) of the UT is 35 km^2, which is 30.70% of its geographical area.

2.31.2 Forest Cover and Forest Type Group

As per the ISFR 2023, forest cover in the UT is 25.00 km^2, which constitutes 21.93 % of the UT's geographical area. In terms of forest canopy density classes, the UT has 1.44 km^2 under Very Dense Forest (VDF), 13.52 km^2 under Moderately Dense Forest (MDF), 10.04 km^2 under Open Forest (OF) and 0.78 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forest type group present in Chandigarh belongs to Tropical Dry Deciduous Forests and ToF/Plantation, which is further categorized into three forest types.

The most vulnerable forest types to fires in the UT is Northern dry mixed deciduous forest.

2.31.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the UT comprising near real-time forests fire detections and large forest fire detections are as follows:

2.31.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the UT is shown in Figure 2.31.1. Table 2.31.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

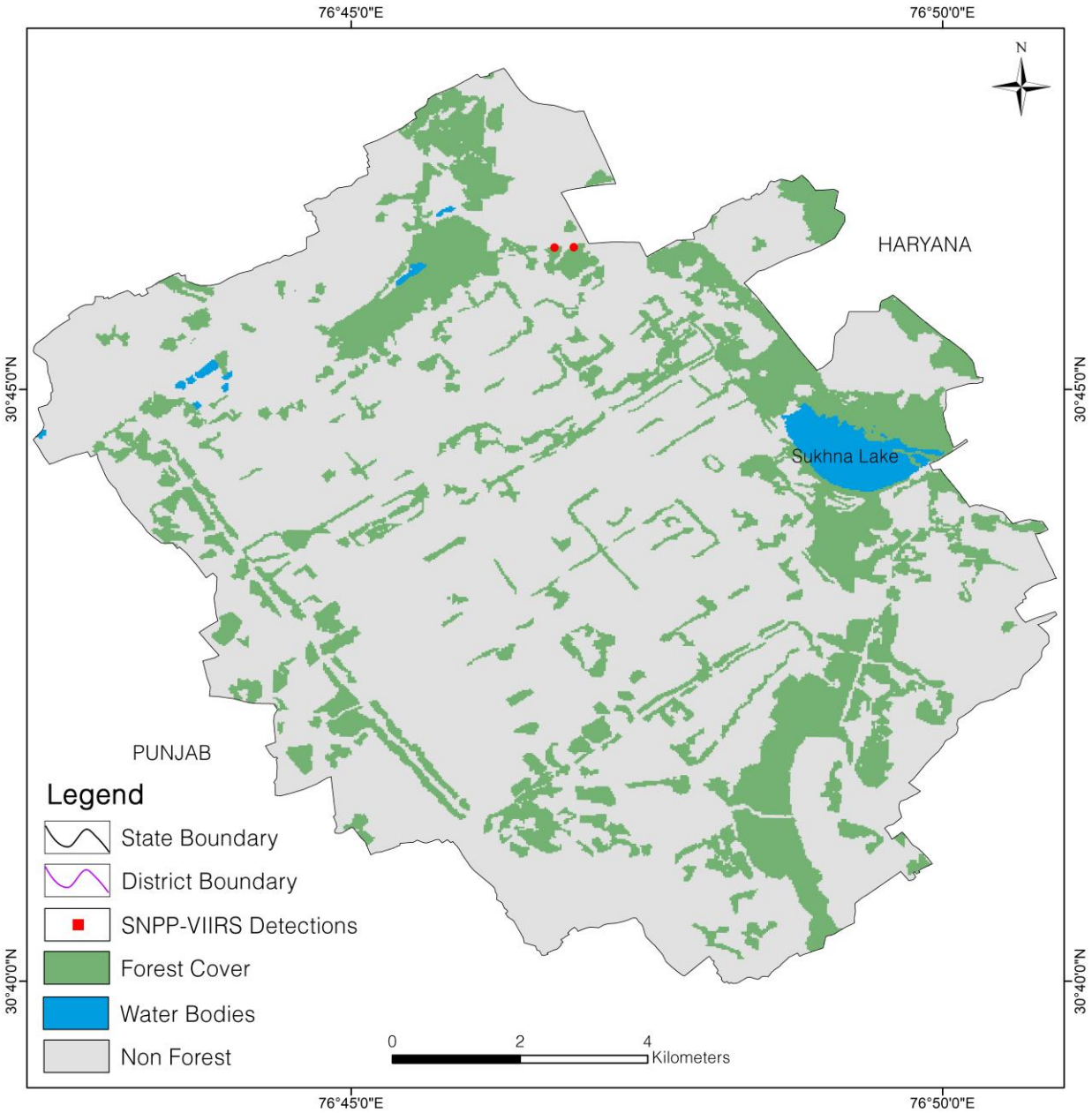


Figure 2.31.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.31.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Chandigarh	1	1
Total	**1**	**1**

Based on the analysis of forest fire detections of last eight years in the state, no clear correlation between year-wise forest fire detections appeared to determine the crucial period.

2.31.3.2 Large Forest Fire Detections

No large forest fire detections has been observed in the UT during fire season 2022-23 and 2023-24.

2.31.4 Burnt Scar Assessment

No burnt scars has been observed in the UT during fire season 2023-24.

2.31.5 Results and Analysis

No burnt scars have been observed in Chandigarh during 2023-24 fire season.

2.32 Dadra & Nagar Haveli and Daman & Diu

2.32.1 Introduction

Dadra & Nagar Haveli lies is a between 20° N to 20° 25' N latitude and 72° 50' E to 73° 15' E longitude. It situated between the states of Gujarat in the North and Maharashtra in the South. Geographical area of Dadra & Nagar Haveli is 602 km^2, which is 0.02% of the geographical area of the country. Damanganga river is the major river. The climate of Dadra & Nagar Haveli is typical North Indian Ocean Maritime climate. The average annual temperature varies from 12°C to 39°C. Whereas, the rainfall is mainly influenced by South-West monsoon with average annual rainfall varies from 2,500 mm to 3,000 mm.

Daman & Diu is located in the Gulf of Cambay. Daman lies between 20° 22' N to 20° 28' N latitude and 71° 46' E to 72° 55' E longitude and Diu lies between 20° 42' N to 20° 48' N latitude and 70° E to 71° 10' E longitude. Geographical area of Daman & Diu is 111 km^2, which is 0.003 % of the geographical area of the country. Damanganga river is the major river. The climate of Daman & Diu is moderate. The annual temperature varies from 20°C to 38°C. Whereas, the rainfall is mainly influenced by South-West monsoon with average annual rainfall of 1,700 mm. The Recorded Forest Area (RFA) of Dadra & Nagar Haveli and Daman & Diu is 217 km^2, which is 36.05% of its geographical area.

2.32.2 Forest Cover and Forest Type Group

As per ISFR 2023, forest cover in the UT is 225.62 km^2, which constitutes 37.48% of the UT's geographical area. In terms of forest canopy density classes, the UT has 1.36 km^2 under Very Dense Forest (VDF), 78.59 km^2 under Moderately Dense Forest (MDF), 145.67 km^2 under Open Forest (OF) and 4.66 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Dadra & Nagar Haveli and Daman & Diu belong to five forest type groups, which are further categorized into eight forest types. The major forest type groups comprises of Moist mixed deciduous forest followed by Tropical Dry Deciduous Forests, Littoral & Swamp Forests and Tropical Thorn Forests.

The most vulnerable forest types to fires in the UT are Southern moist mixed deciduous forest followed by Moist teak Forest and Southern dry mixed deciduous forest.

2.32.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the UT comprising near real-time forests fire detections and large forest fire detections are as follows:

2.32.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the UT is shown in Figure 2.32.1. Table 2.32.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

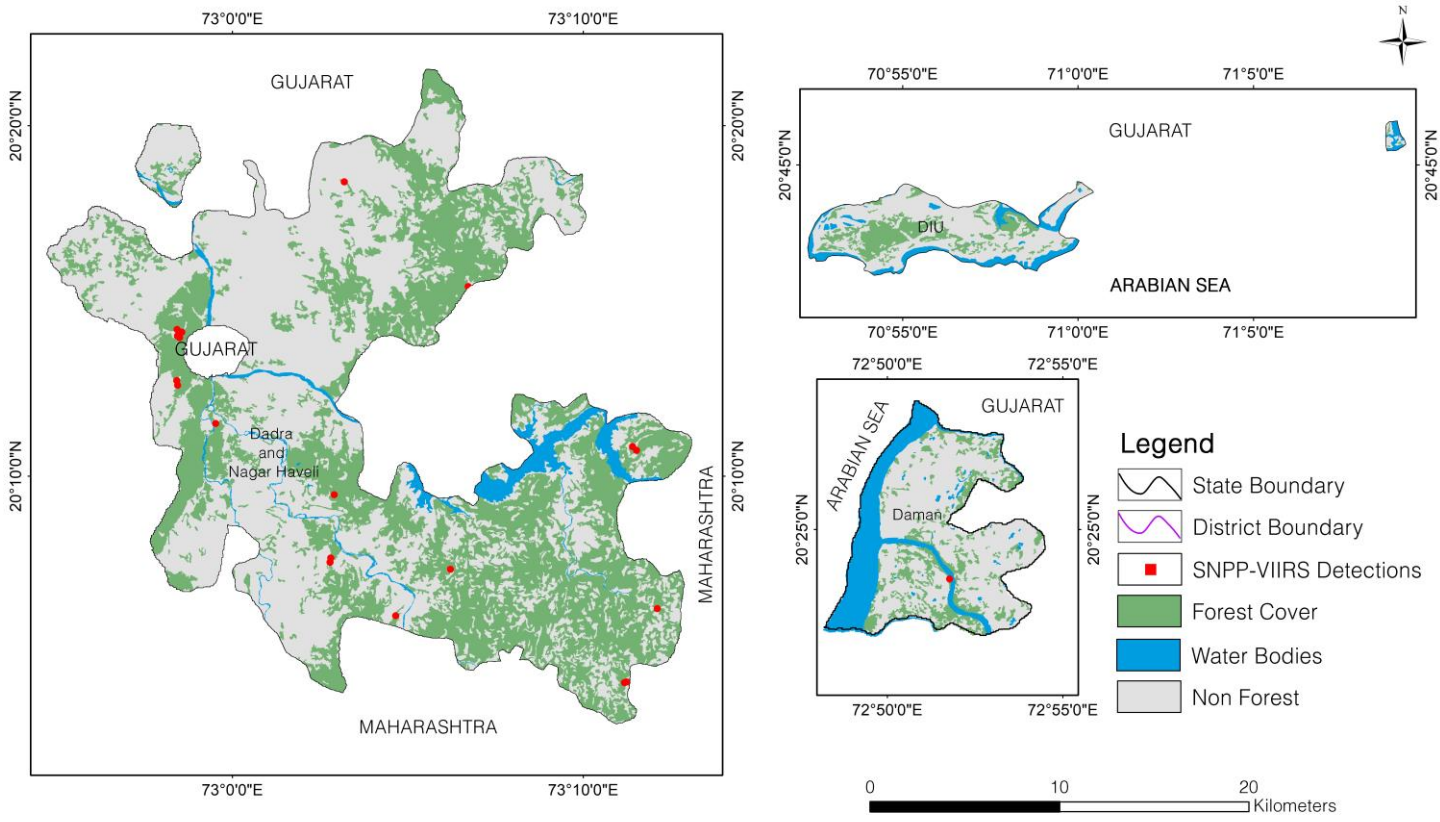


Figure 2.32.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.32.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Dadra & Nagar Haveli	15	15
Daman	0	1
Diu	1	0
Total	**16**	**16**

Based on the analysis of forest fire detections of last eight years in the state, no clear correlation between year-wise forest fire detections appeared to determine the crucial period.

2.31.3.2 Large Forest Fire Detections

No large forest fire detections has been observed in the UT during fire season 2022-23 and 2023-24.

2.32.4 Burnt Scar Assessment

No burnt scar has been observed in the UT during this fire season 2023-24.

2.32.5 Results and Analysis

No burnt scars have been observed in the UT during 2023-24 fire season.

2.33 Jammu & Kashmir

2.33.1 Introduction

The Union Territory (UT) of Jammu & Kashmir lies between 32°17' N to 35°08' N latitude and 73°25' E to 76°45' E longitude. It shares border with Ladakh in the North & East and Himachal Pradesh & Punjab in the South. It shares international border with Pakistan in the West. The UT is divided into two geographically distinct regions viz. Jammu and Kashmir valley. Geographical area of the UT is 54,634 km^2 (area of the shape file provided by Survey of India), which is 1.66% of the geographical area of the country. Jhelum, Chenab, Indus, Ravi, Tawi etc. are the major rivers of the UT. The UT have two climatic regions viz. Kashmir valley with temperate climate and Jammu region with subtropical climate. South-Western regions of the UT have sub-tropical climate with hot summer & cool winter. In the East and North, summers are usually pleasant. Due to western disturbances, much of the rainfall happens in winter season in Kashmir valley and in summer, the South-West monsoon winds cause rains in outer plains and outer hills. The temperature of the UT varies from sub-zero in the alpine and cold desert areas to 40°C in the plains. The average annual rainfall ranges from 650 mm in Kashmir region and 1,116 mm in the Jammu region. The UT is rich in diverse range of flora and fauna biodiversity. The Recorded Forest Area (RFA) of the UT is 20,199 km^2, which is 36.97% of its geographical area.

Forest fires are quite frequent in the UT during fire season and a considerable area under forest is affected due to the forest fires every year. There are many causative factors for initiation and spread of fires. In majority of the incidents, anthropogenic activities, tourism nearby forest area is the major cause of fire incidents in the UT. Ground truthing was carried out by a joint team of FSI and State Forest Department during June 2024 for the validation of the fire affected polygons, collection of data on surface fuel load and validation of layers in fire risk zonation. A total of 02 points were visited by the team.

2.33.2 Forest Cover and Forest Type Group

As per the ISFR 2023, forest cover in the UT is 21,346.39 km^2, which constitutes 39.07% of the UT's geographical area. In terms of forest canopy density classes, the UT has 4,208.79 km^2 under Very Dense Forest (VDF), 8,006.56 km^2 under Moderately Dense Forest (MDF), 9,131.04 km^2 under Open Forest (OF) and 262.27 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Jammu & Kashmir belong to nine forest type groups, which are further categorized into 43 forest types. The major forest type groups comprises of Himalayan Moist Temperate Forests followed by Subtropical Pine Forests, Sub-Alpine Forests, Moist Alpine Scrub and Himalayan Dry Temperate Forests.

The most vulnerable forest types to fires in the UT are Lower or Siwalik chir pine forest followed by Upper or Himalayan chir pine forest and Northern dry mixed deciduous forest.

2.33.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the UT comprising near real-time forests fire detections and large forest fire detections are as follows:

2.33.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the UT is shown in Figure 2.33.1. Table 2.33.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

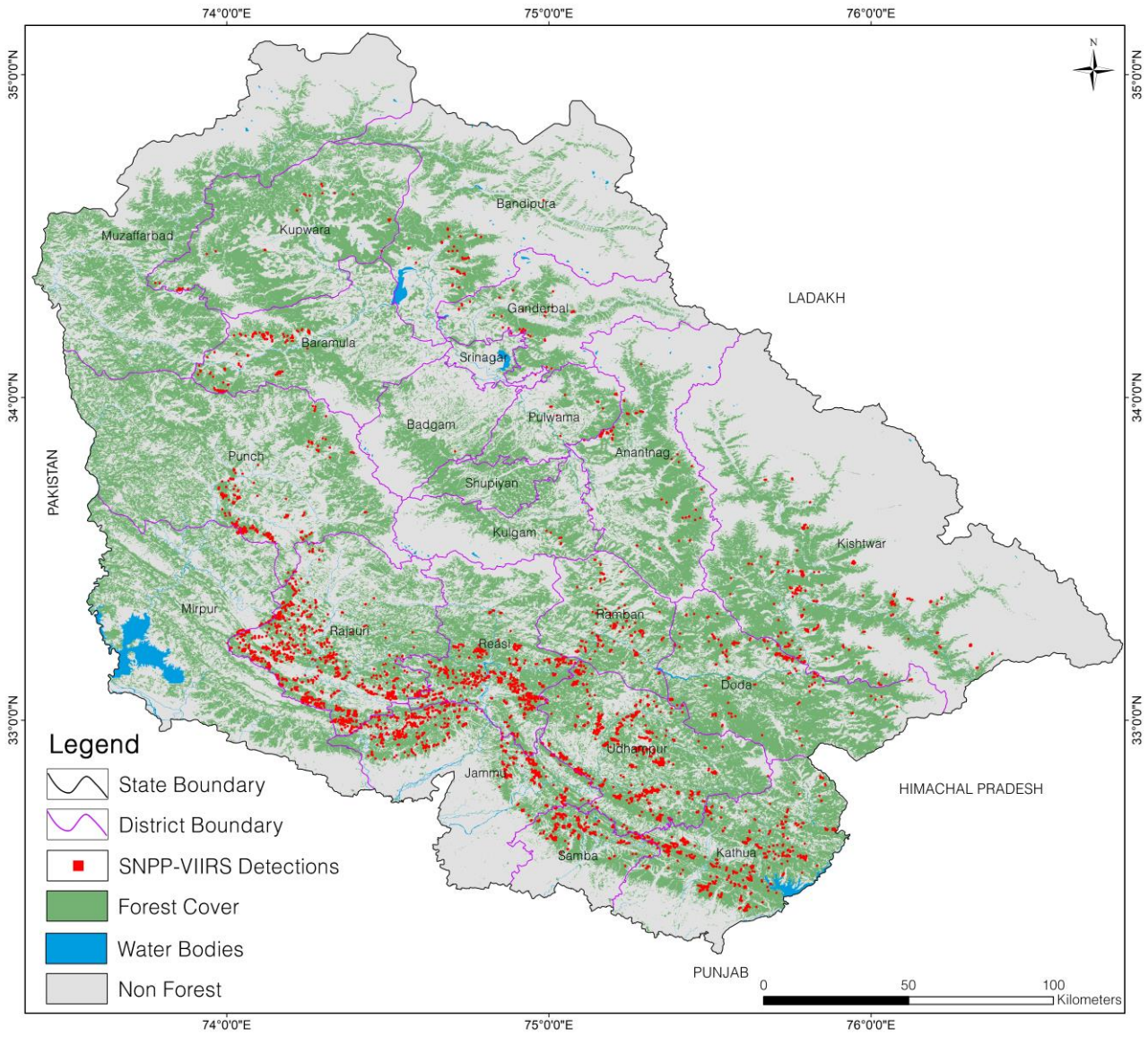


Figure 2.33.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.33.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Anantnag	5	56
Badgam	0	1
Bandipura	8	39
Baramula	14	113
Doda	5	132
Ganderbal	6	38
Jammu	8	458

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Kathua	17	403
Kishtwar	5	193
Kulgam	1	7
Kupwara	3	28
Mirpur	4	33
Muzaffarabad	0	0
Pulwama	4	12
Punch	8	168
Rajauri	26	797
Ramban	4	116
Reasi	9	502
Samba	4	174
Shupiyan	0	0
Srinagar	0	2
Udhampur	0	557
Total	**131**	**3,829**

Based on the analysis of forest fire detections, the crucial period of forest fires in the UT has been determined. The crucial period of forest fire detections in the UT has been noticed to be tentatively between 28th April to 30th June, which is based on the forest fire detections of last eight years. The scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years is shown in the Figure 2.33.2.

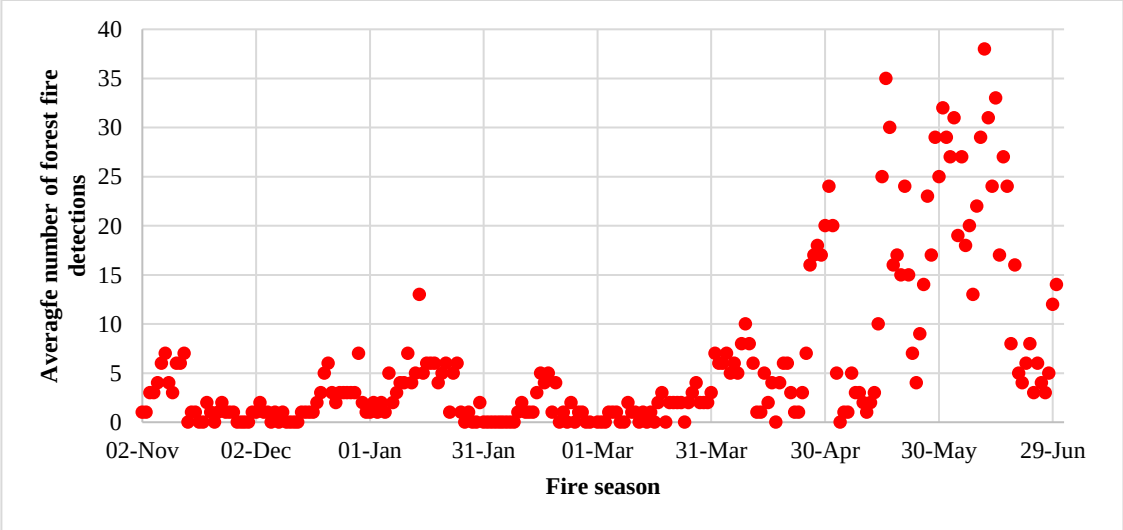


Figure 2.33.2 Scatter-plot of the average number of forest fire detections using SNPP-VIIRS sensor of last eight years during fire season

2.33.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the UT is shown in Figure 2.33.3. Table 2.33.2 shows the number of large forest fire detections during fire season 2022-23 and 2023-24.

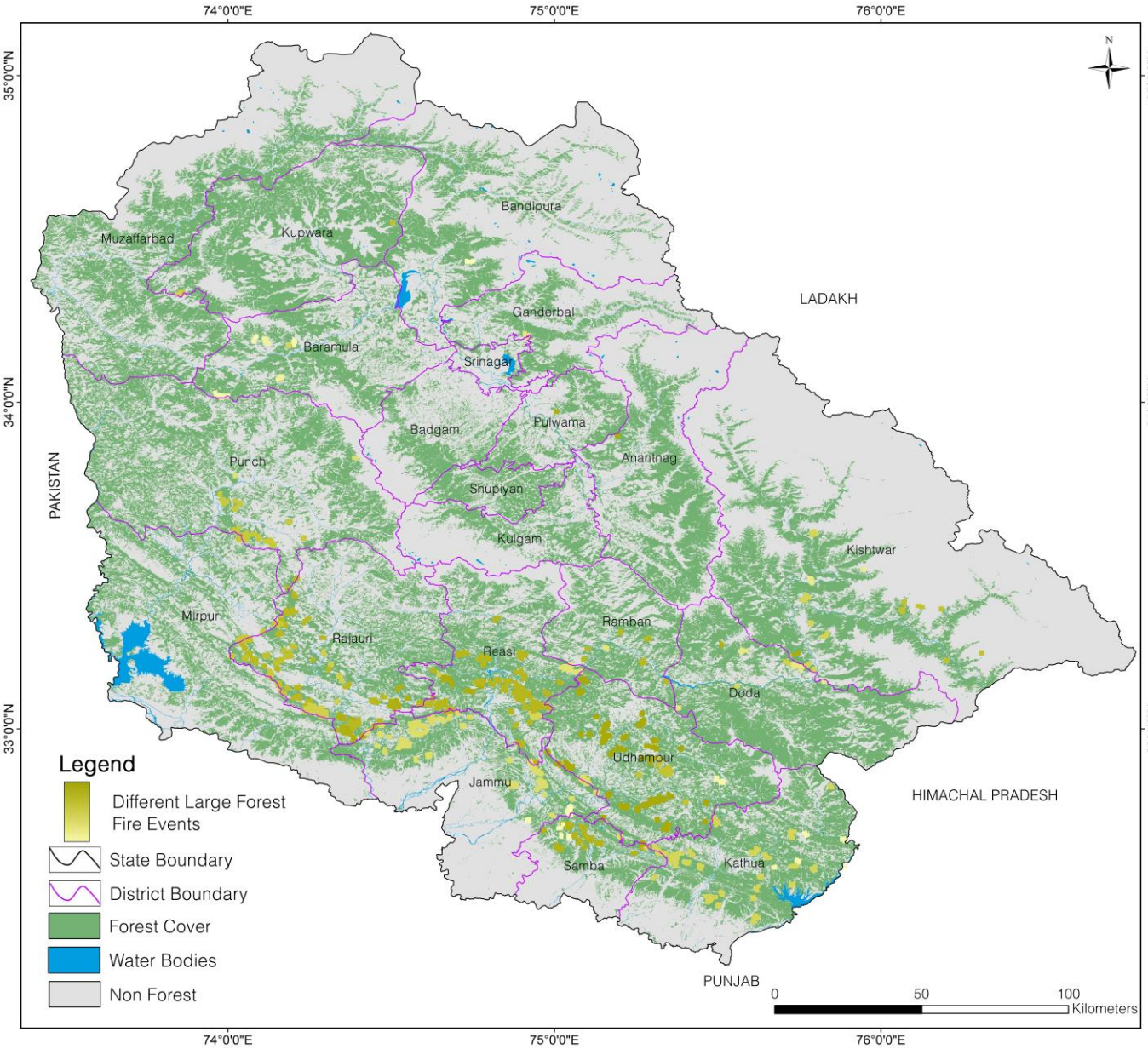


Figure 2.33.3 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.33.2 Number of large forest fire detections during fire season 2022-23 and 2023-24

UT	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Jammu & Kashmir	06	281

2.33.4 Burnt Scar Assessment

District-wise burnt severity area based on the analysis of the data is given in Table 2.33.3. From the Figure 2.33.4, it can be inferred that 1.58% of the RFA has been affected by fires. A total of 1.50% of the RFA falls under the low burnt class and 0.08% under moderately burnt class. Only 0.19 km^2 of the RFA area have been classified under severely burnt class. The burnt area map of Jammu & Kashmir is shown in Figure 2.33.5

Table 5.33.3 District-wise distribution of burnt severity classes

Area in km^2

District	Affected Area			Total
	Severely	Moderately	Low	
Anantnag	0.00	0.00	0.00	0.00
Badgam	0.00	0.00	0.00	0.00
Bandipura	0.00	0.00	0.00	0.00
Baramula	0.00	0.00	0.00	0.00
Doda	0.00	0.00	0.00	0.00
Ganderbal	0.00	0.00	0.00	0.00
Jammu	0.00	4.12	79.90	84.02
Kathua	0.00	1.80	46.82	48.62
Kishtwar	0.00	0.00	0.00	0.00
Kulgam	0.00	0.00	0.00	0.00
Kupwara	0.00	0.00	0.00	0.00
Mirpur	0.00	0.13	1.55	1.68
Muzaffarabad	0.00	0.00	0.00	0.00
Pulwama	0.00	0.00	0.00	0.00
Punch	0.00	0.07	11.76	11.83
Rajauri	0.19	7.23	141.41	148.83
Ramban	0.00	0.19	1.89	2.08
Reasi	0.00	6.06	49.24	55.30
Samba	0.00	0.35	20.40	20.75
Shupiyan	0.00	0.00	0.00	0.00
Srinagar	0.00	0.00	0.00	0.00
Udhampur	0.00	2.50	63.25	65.75
Total	**0.19**	**22.45**	**416.22**	**438.86**

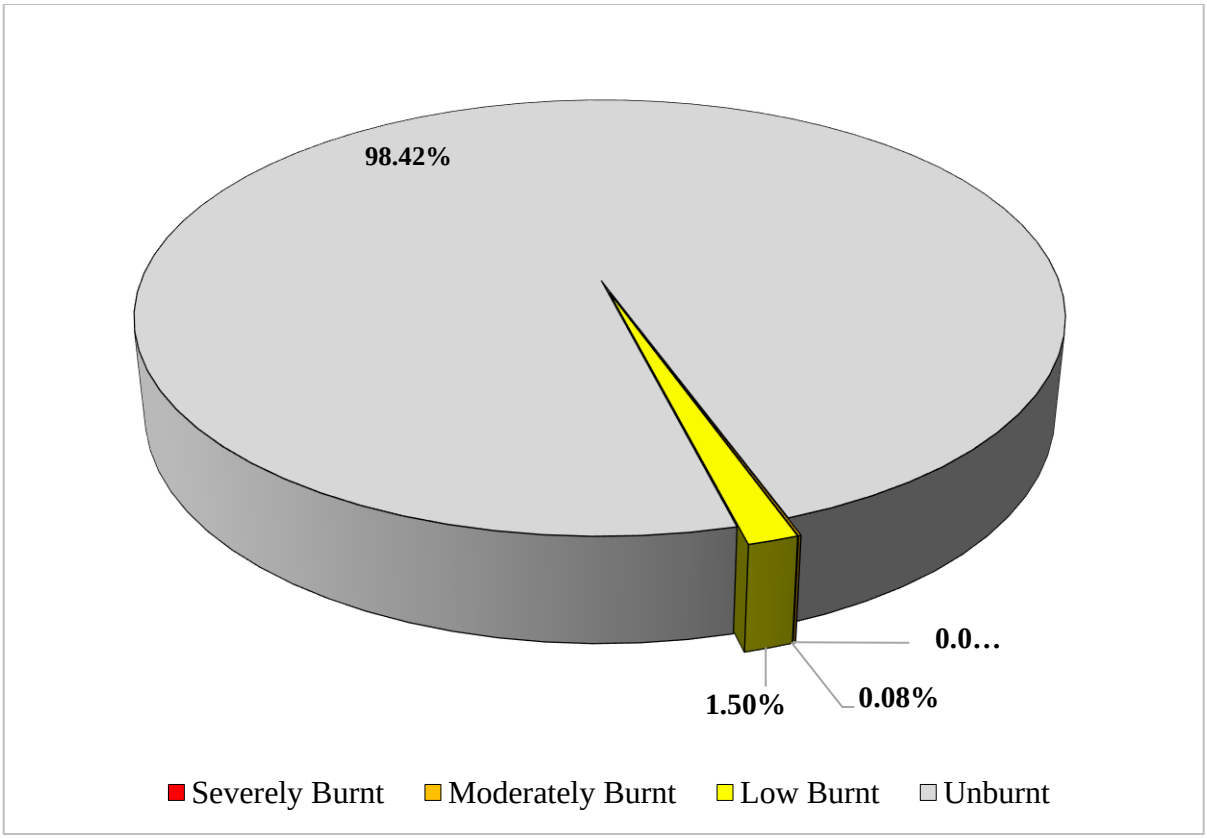


Figure 2.33.4 Distribution of burnt severity classes

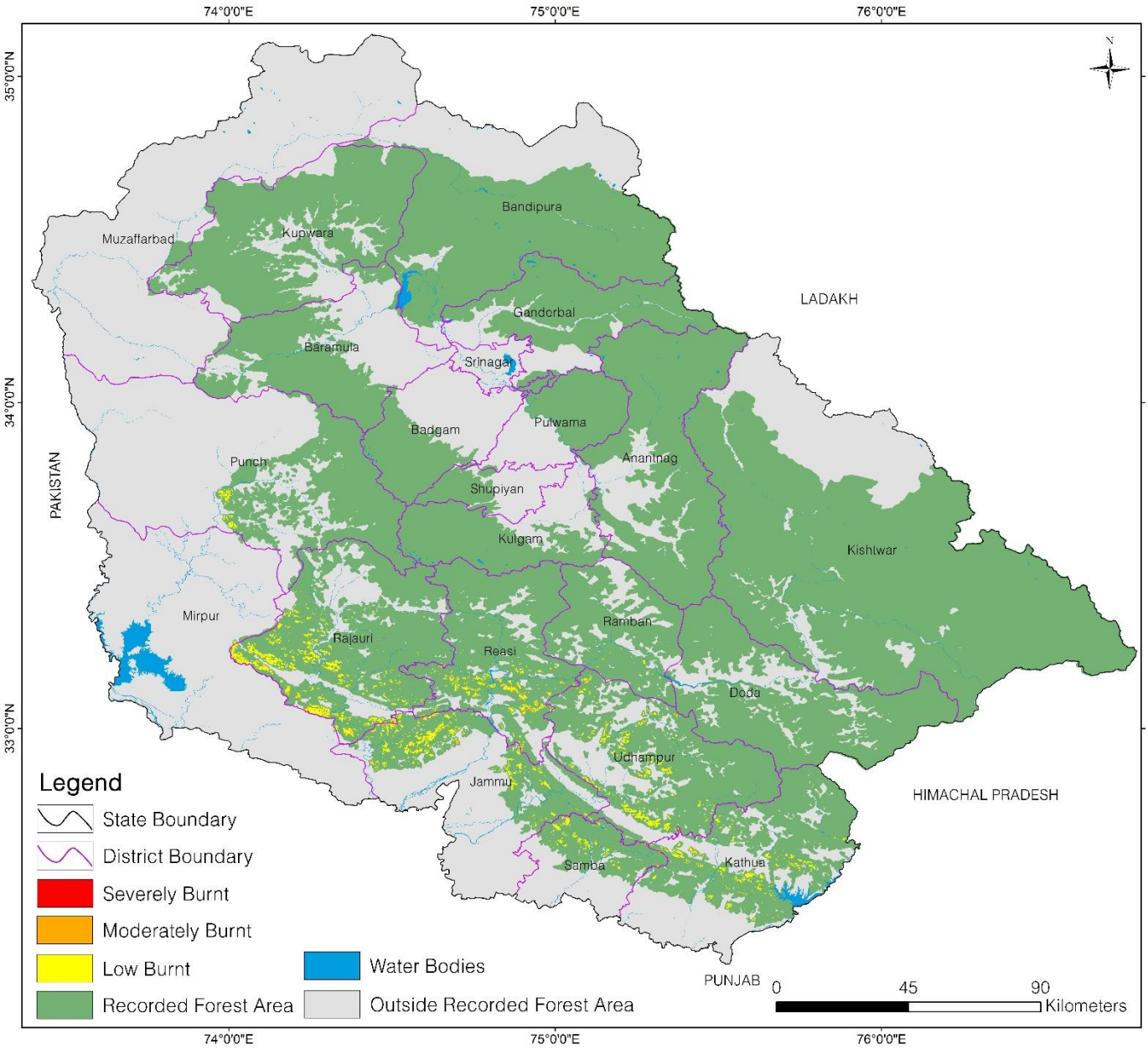


Figure 2.33.5 Map showing burnt area in Jammu & Kashmir

2.33.5 Results and Analysis

Based on the analysis, it is observed that Rajauri followed by Reasi, and Jammu are the most fire affected districts. The maximum affected area under moderately burnt severity class has been observed in Rajauri and Reasi districts. Rajauri district has reported the highest area under low burnt severity class followed by Udhampur and Reasi. A total of 438.83 km^2 fire affected forest area has been reported in the UT, which constitute 1.58 % of the RFA.

2.34 Ladakh

2.34.1 Introduction

The Union Territory (UT) of Ladakh lies between 32°20' N to 37°05' N latitude and 72°30' E to 80°20' E longitude. The UT shares international border with Pakistan in the West, Afghanistan in the East and China in the North. It also shares border with Jammu & Kashmir in the West and Himachal Pradesh in the South. Ladakh has been carved out from the erstwhile UT of Jammu & Kashmir on 31st October, 2019. Geographical area of the UT is 1,68,327 km^2 (area of the shape file provided by Survey of India), which is 5.12% of the geographical area of the country. Indus is the major river of the UT. Natural vegetation commonly seen along watercourses includes seabuckthorn (*Hippophae spp*.), wild roses of pink or yellow varieties, tamarisk (*Myricaria spp*.), caraway, stinging nettles, mint, Physochlaina praealta and various grasses (https://en.wikipedia.org/wiki/Ladakh). Ladakh has cold and dry climate with average temperature of Ladakh varies from - 40°C to 35°C. The average annual rainfall is 92.60 mm in the UT. The Recorded Forest Area (RFA) of the UT is 7 km^2.

2.34.2 Forest Cover and Forest Type Group

As per the ISFR 2023, forest cover in the UT is 2,285.92 km^2, which constitutes 1.36% of the UT's geographical area. In terms of forest canopy density classes, the UT has 2.27 km^2 under Very Dense Forest (VDF), 509.07 km^2 under Moderately Dense Forest (MDF), 1,774.58 km^2 under Open Forest (OF) and 325.49 km^2 as Scrub.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Ladakh belong to five forest type groups, which are further categorized into 14 forest types. The major forest type groups comprises of Dry Alpine Scrub followed by Sub-Alpine Forests, Himalayan Dry Temperate Forests and Moist Alpine Scrub.

The most vulnerable forest types to fires in the UT are West Himalayan sub-alpine fir forest followed by Dry broadleaved and coniferous forest (*Quercus ilex- P*. gerardiana) and Sub-alpine blue pine (P. *wallichiana*) forests.

2.34.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the UT comprising near real-time forests fire detections and large forest fire detections are as follows:

2.34.3.1 Near Real-Time Forest Fire Detections

Map showing near real-time forest fire detections using SNPP-VIIRS sensor in the UT is shown in Figure 2.34.1. Table 2.34.1 shows district-wise number of near real-time forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

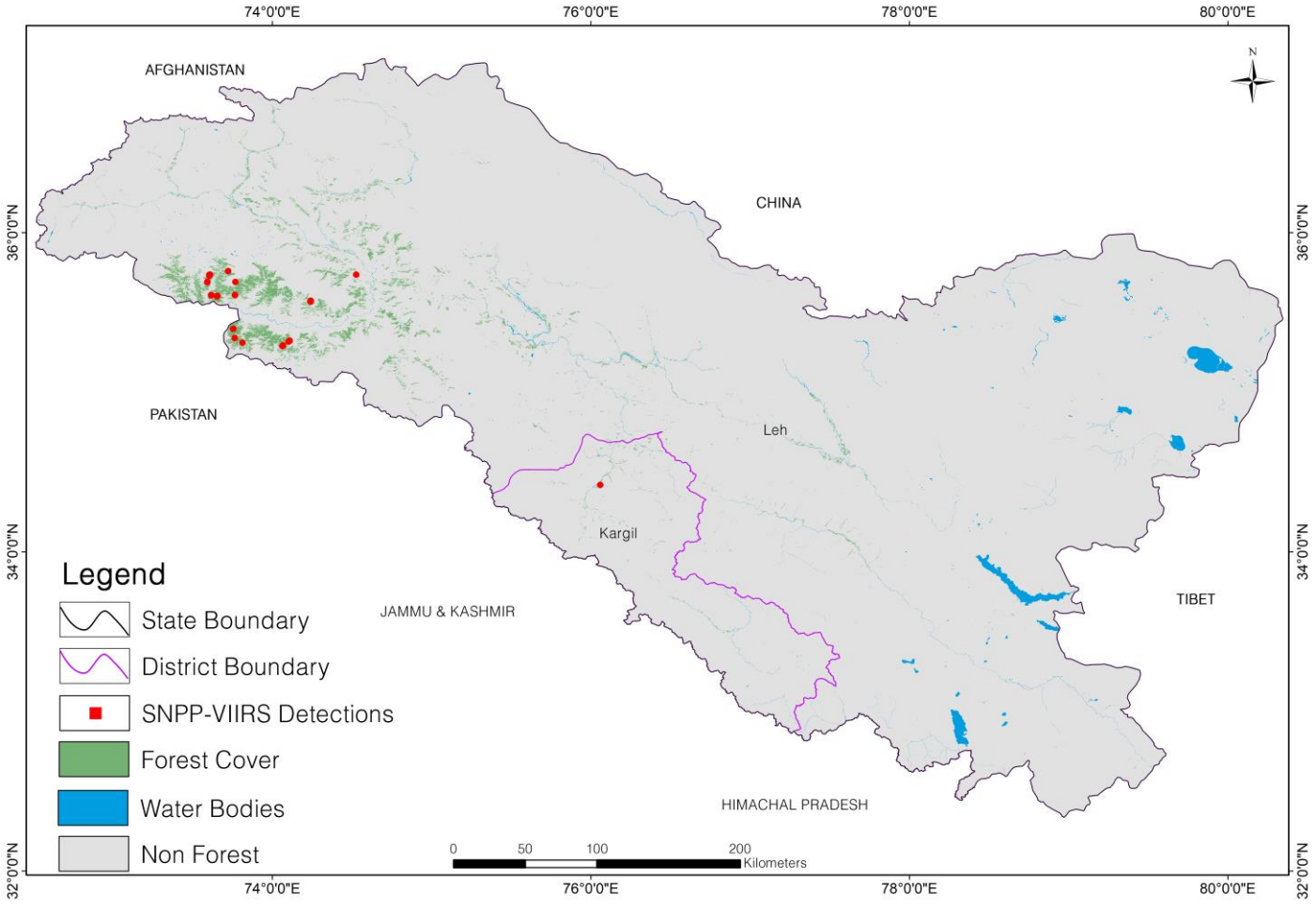


Figure 2.34.1 Spatial distribution of NRT forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024

Table 2.34.1 District-wise number of NRT forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24

District	No. of Forest Fire Detections	
	Season 2022-23	Season 2023-24
Kargil	0	1
Leh	20	31
Total	**20**	**32**

Based on the analysis of forest fire detections of last eight years in the state, no clear correlation between year-wise forest fire detections appeared to determine the crucial period.

2.34.3.2 Large Forest Fire Detections

Map showing large forest fire events during November 2023 to June 2024 in the UT is shown in Figure 2.34.2. Table 2.34.2 shows the number of large forest fire detections using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

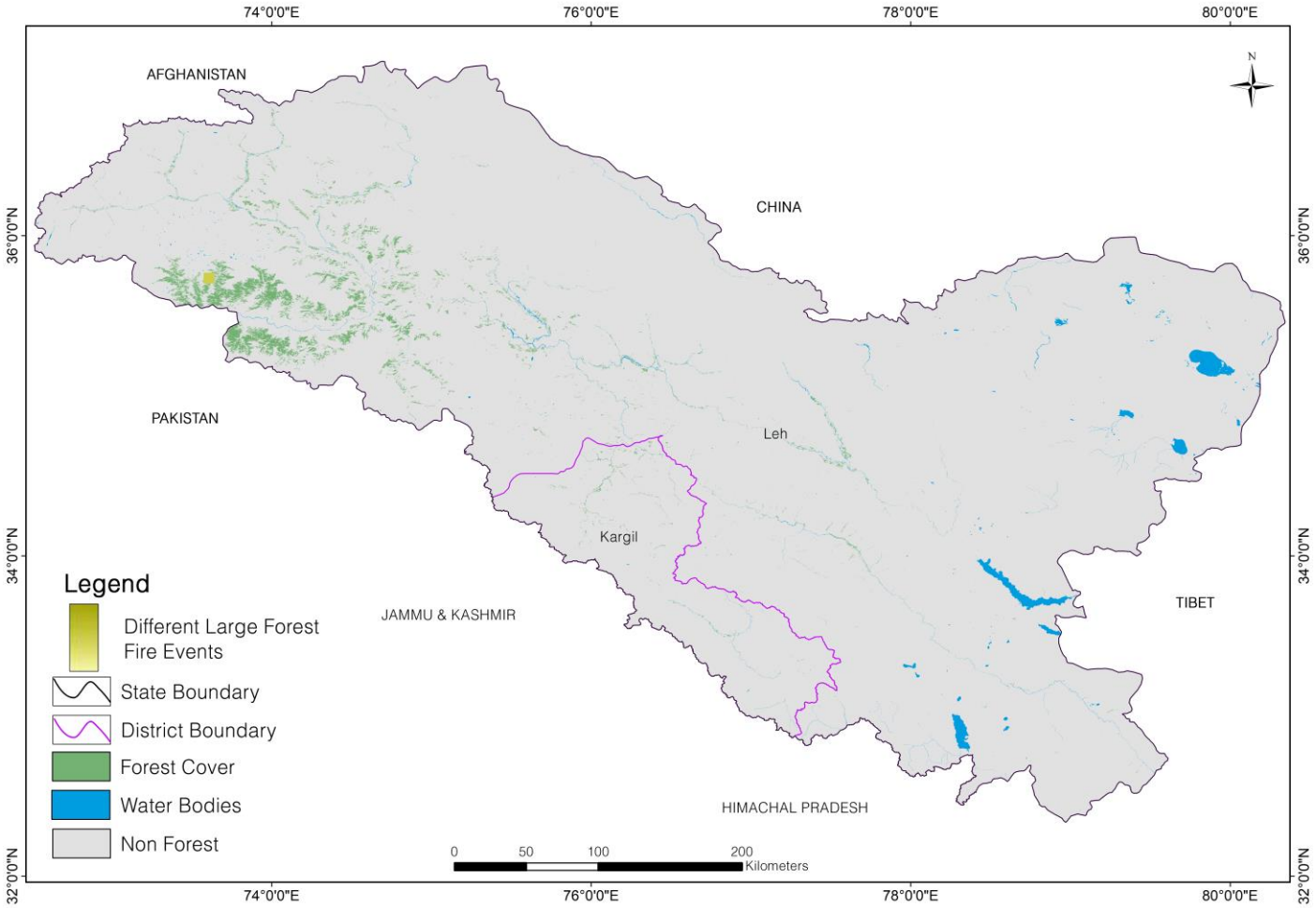


Figure 2.34.2 Spatial distribution of large forest fire detections during November 2023 to June 2024

Table 2.34.2 Number of large forest fire detections during fire season 2022-23 and 2023-24

UT	No. of Large Forest Fire Detections	
	Season 2022-23	Season 2023-24
Ladakh	2	1

2.34.4 Burnt Scar Assessment

No burnt scars has been observed in the UT during fire season 2023-24.

2.34.5 Results and Analysis

No burnt scars have been observed in Ladakh during fire season 2023-24.

2.35 Lakshadweep

2.35.1 Introduction

The Union Territory (UT) of Lakshadweep lies between 8°15' N to 11°45' N latitude and 72° E to 74° E longitude. It is located in the Arabian Sea on the South-West coast of India and is a group of 36 scattered islands comprising of 12 atolls, three reefs, five submerged sand banks and 10 inhabited islands. It has the coastline estimated to be around 132 km. Main islands of Lakshadweep are Kavaratti, Agatti, Minicoy and Amini. Geographical area of the UT is 30 km^2. The climate of the UT is tropical humid, warm and generally pleasant with the average annual temperature of the UT varies from 25°C to 35°C. Whereas, average rainfall ranges between 1,000 mm to 2,000 mm. The UT does not have any forests or recorded forest area. About 82% of the land mass is covered by privately owned coconut plantations. The UT has 248 species of plants, three species of Mangroves and 148 species of Corals. The protected area network in the Lakshadweep has Pitti Wildlife Sanctuary, which covers the area of one hectare.

2.35.2 Forest Cover and Forest Type Group

As per the ISFR 2023, forest cover in the UT is 27.06 km^2, which constitutes 91.33% of the UT's geographical area. In terms of forest canopy density classes, the UT has 16.97 km^2 under Moderately Dense Forest (MDF) and 10.09 km^2 under Open Forest (OF). No VDF and Scrub areas has been observed in the UT.

As per the Champion & Seth Classification of Forest Types (1968), the forests in the UT is 100 % plantation/TOF.

2.35.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.35.3.1 Near Real-Time Forest Fire Detections

No real-time forest fire detections has been observed in the UT using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

2.35.3.2 Large Forest Fire Detections

No large forest fire detections has been observed in the UT during fire season 2022-23 and 2023-24.

2.35.4. Burnt Scar Assessment

No burnt scar has been observed in the UT during fire season 2023-24.

2.35.5 Results and Analysis

As the UT does not have any reported RFA, the forest cover in the UT is mainly under ToF/Plantation.

2.36 Puducherry

2.36.1 Introduction

The Union Territory (UT) of Puducherry is scattered over four locations and each having the status of a district. The main territory of Puducherry lies in the East coast, about 180 km South of Chennai between 11° 45' N to 12° 30' N latitude and 79° 36' E to 79° 53' E longitude. Karaikal is about 150 km South of Puducherry on the East coast and is situated between 10° 49' N to 11° 01' N latitude and 79° 43' E to 79° 52' E longitude. Mahe on the Malabar coast on the Western Ghats is situated between 11° 42' N to 11° 46' N latitude to 75° 31' E to 75° 33' E longitude, whereas Yanam on the East coast adjoining Godavari is situated between 16° 42' N to 16° 46' N latitude and 82° 11' E to 82° 19' E longitude. Puducherry and Karaikal are bordered by Tamil Nadu, Yanam is bordered by Andhra Pradesh and Mahe is bordered by Kerala. UT has the coastline estimated to be around 45 km. Geographical area of the UT is 490 km^2, which is 0.01 % of the geographical area of the country. Gingee or Senji and Pennaiyar are the major rivers of the UT. The climate of the UT is warm and humid with average annual temperature varies from 15°C to 41°C. Whereas, the rainfall in the UT is mainly influenced by North-East monsoon with average annual rainfall ranges from 1,143 to 3,743 mm. The UT has mangrove forest mainly in the geographical regions of Puducherry and Yanam. The Recorded Forest Area (RFA) of the UT is 13 km^2, which is 2.65 % of its geographical area.

2.36.2 Forest Cover and Forest Type Group

As per the ISFR 2023, forest cover in the UT is 44.31 km^2, which constitutes 9.04% of the UT's geographical area. In terms of forest canopy density classes, the UT has 10.33 km^2 under Moderately Dense Forest (MDF), 33.98 km^2 under Open Forest (OF) and 0.07 km^2 as Scrub. No VDF areas has been observed in the UT.

As per the Champion & Seth Classification of Forest Types (1968), the forest type group present in the UT belongs to Littoral & Swamp Forests and ToF/Plantation.

2.36.3 Forest Fire Detections

The near real-time forest fire detections using SNPP-VIIRS sensor during November 2023 to June 2024 has been used as supportive information to identify and map burnt scars. The details of the

fire detections reported in the state comprising near real-time forests fire detections and large forest fire detections are as follows:

2.36.3.1 Near Real-Time Forest Fire Detections

No real-time forest fire detections has been observed in the UT using SNPP-VIIRS sensor during fire season 2022-23 and 2023-24.

2.36.3.2 Large Forest Fire Detections

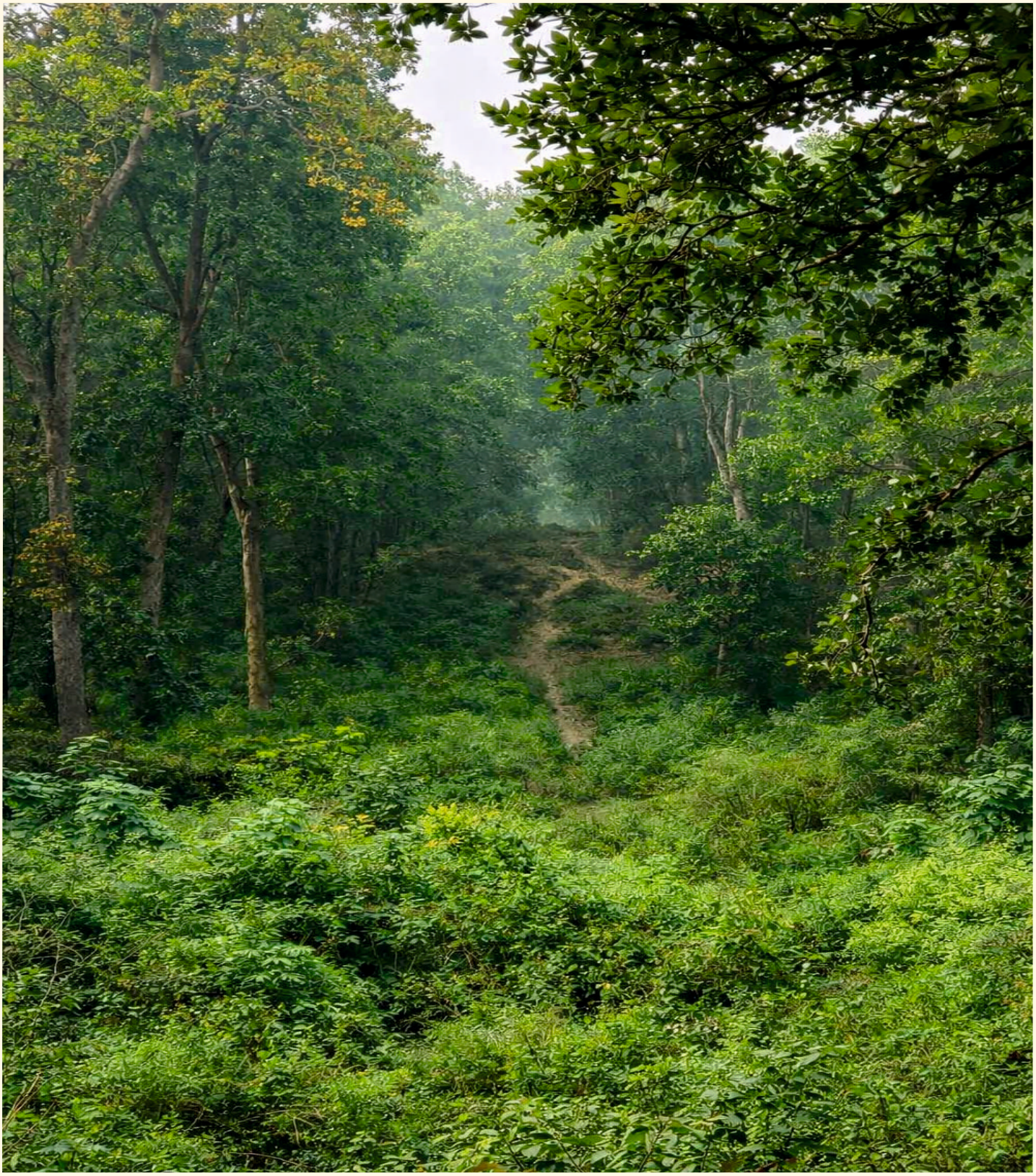
No large forest fire detections has been observed in the UT during fire season 2022-23 and 2023-24.

2.36.4 Burnt Scar Assessment

No burnt scar has been observed in the UT during fire season 2023-24.

2.36.5 Results and Analysis

No burnt scar has been observed in the UT during fire season 2023-24.



भारतीय वन सर्वेक्षण

Forest Survey of India

Ministry of Environment, Forest & Climate Change

Government of India Dehradun-248195