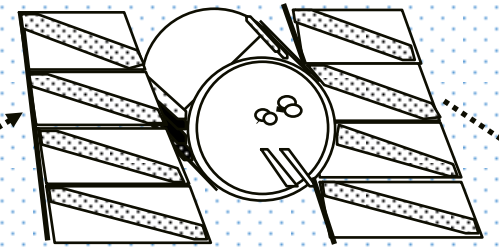
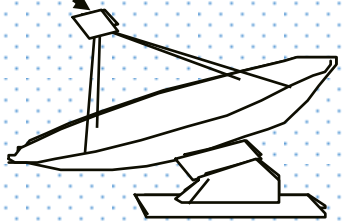
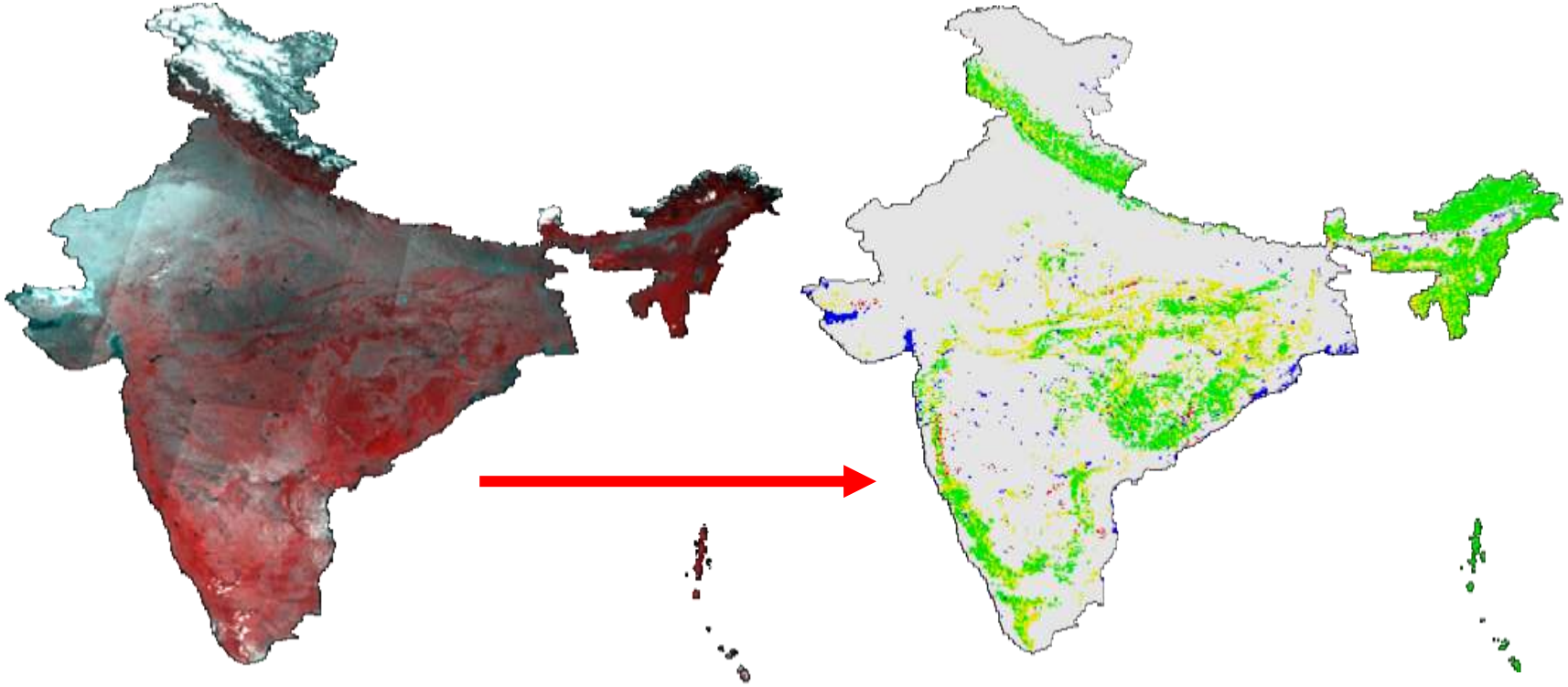
Forest Fire Monitoring



Dr. Sunil Chandra
Deputy Director
Forest Survey of India
Ministry of Environment, Forest and Climate Change, Govt. of India
Dehradun, Uttarakhand, sunilchandra.iitr@gmail.com; ddpna@fsi.nic.in



Forest resources assessment using remote sensing

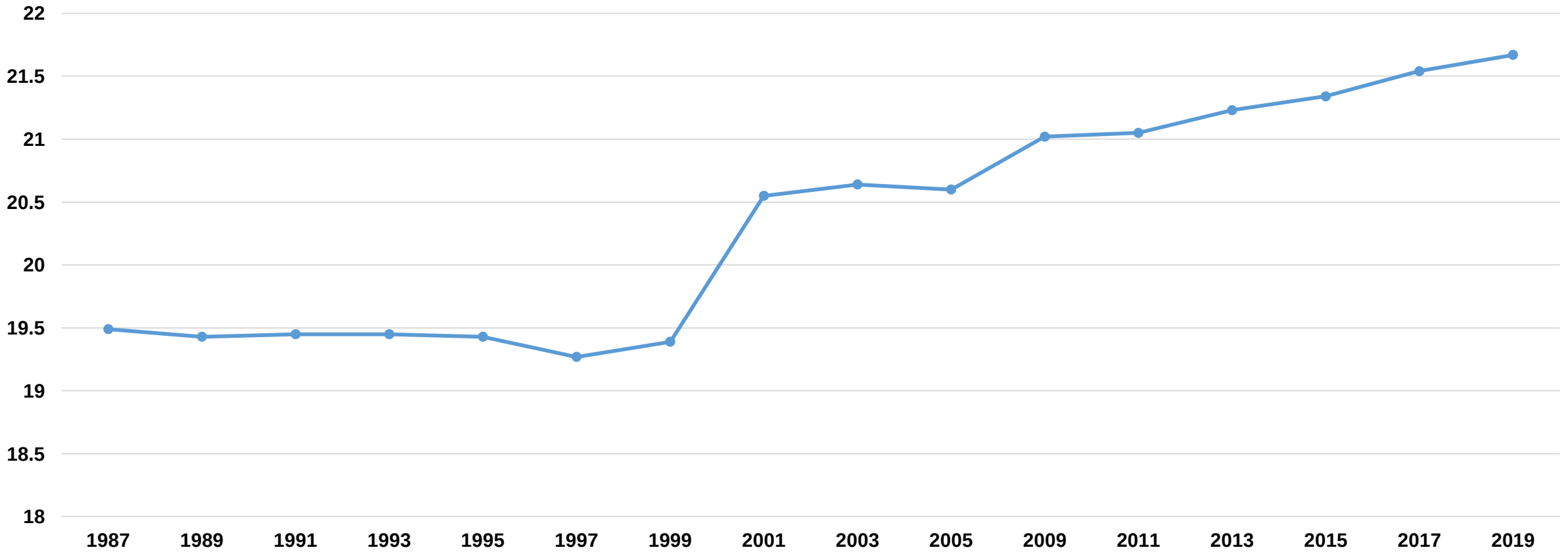


Satellite Image

Forest Cover Map based on the interpretation of Satellite Image

Forest Cover Situation in the Country since 1987

Year	1987	1989	1991	1993	1995	1997	1999	2001	2003	2005	2009	2011	2013	2015	2017	2019
Forest Cover %age	19.49	19.43	19.45	19.45	19.43	19.27	19.39	20.55	20.64	20.6	21.02	21.05	21.23	21.34	21.54	21.67



Forest Fires

- One of the major cause of forest degradation
- 3.73 million ha forest areas affected annually
- Loss of valuable timber resources
- Loss of bio-diversity and extinction of rare plants and animals species
- Loss of wild-life habitat and depletion of wild-life
- Loss of natural regeneration and reduction in forest cover
- Global warming
- Soil erosion affecting productivity of soils and production

Some of the Impacts of Forest Fires

- Ozone layer depletion
- Health problems leading to diseases
- Loss of livelihood for the tribals and rural poor

Forest Fires in India- Some Facts

- According to the India State of Forest Report,2019 the estimated fire prone area under extremely, very high, highly and moderately fire prone is 3.89%, 6.01% and 11.50% and 14.70% respectively.

- Total forest fire prone area within the recorded forest area in the above category is 36.10%.

- The extent of forest area annually experiencing surface fire which affects ground flora and organic matter is estimated to be 3.69 % of the recorded forest area.(ISFR 2013)

Forest Fires in India- Some Facts…

- Separate Studies carried out have shown that 54.7% of India's forests are prone to forest fire of which 9.2% are affected by frequent fires whereas 45.5% by occasional fires-study by MoEF&CC

- Further, about 2.3% of the total forest of the country is found to be affected by forest fire annually-FSI

In one of the study carried out by FSI in year 1999, about 22.6% of the total forest in Uttarakhand was affected by forest fires

- **There is a necessity for measures to curtail the impacts of forest fires…?**

Methods could be :

- **Real Time Monitoring of forest fires**
- **Pre- warning for forest regions/ Early-warning**
- **Burnt Area Impact Assessment**

Forest Fire Scenario in India

- Most fires are man-made (intentional and unintentional)
- NTFP collection, pasture burning, shifting cultivation, encroachment
- Most are ground fires affecting the ground vegetation and lower storey
- Lack of modern fire fighting methods; put out by state forest departments with the help of locals
- Many areas are annually affected in Western Himalayas, North Eastern States, Central highlands
- Pine Forests and deciduous forest types are mostly affected

Forest Fire Statistics

1995 - 8.90% heavily affected; 44.2% mildly affected;

2015 - 9.89% heavily affected; 54.40% mildly affected;

~ 20,000 sq kms area burnt under severe forest fire

INDIAN SATELLITE IMAGING SYSTEMS – EVOLUTION

resourcesat-1

IRS-P5

PAN : 2.5 m Fore +26° Aft: -5°

IRS-P6

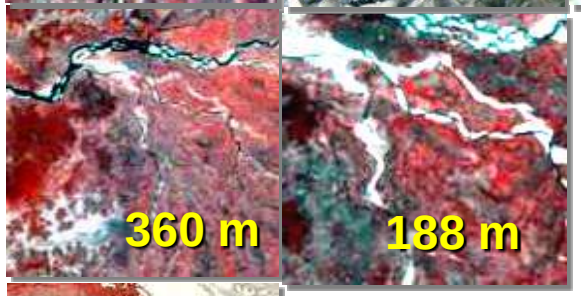
LISS-3: 23 m, 4 XS, LISS-4: 5.8 m, 3-XS, AWiFS: 56 m, 4-XS

oceansat-1

Cartosat-1 & 2,2D

IRS-P4

OCM, MSMR



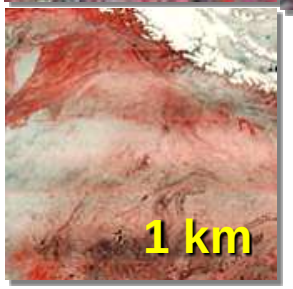
INSAT-2E **operational Met**

CCD (1 km res; every 30 min)

IRS-1C/1D

LISS-3: 23/70 m, Steerable PAN: 5.8 m, WiFS: 188 m

operational 2G



IRS-P2 LISS-2

IRS-P3 WiFS, MOS, X-Ray

research

IRS-1A & 1B

LISS-1&2: 72/36 m, 4 Bands, VIS & NIR

operational-1G

RS-D1 **experimental**

BHASKARA 1 /2

Data at different spatial resolutions in identical spectral bands

High Repetivity/Revisit

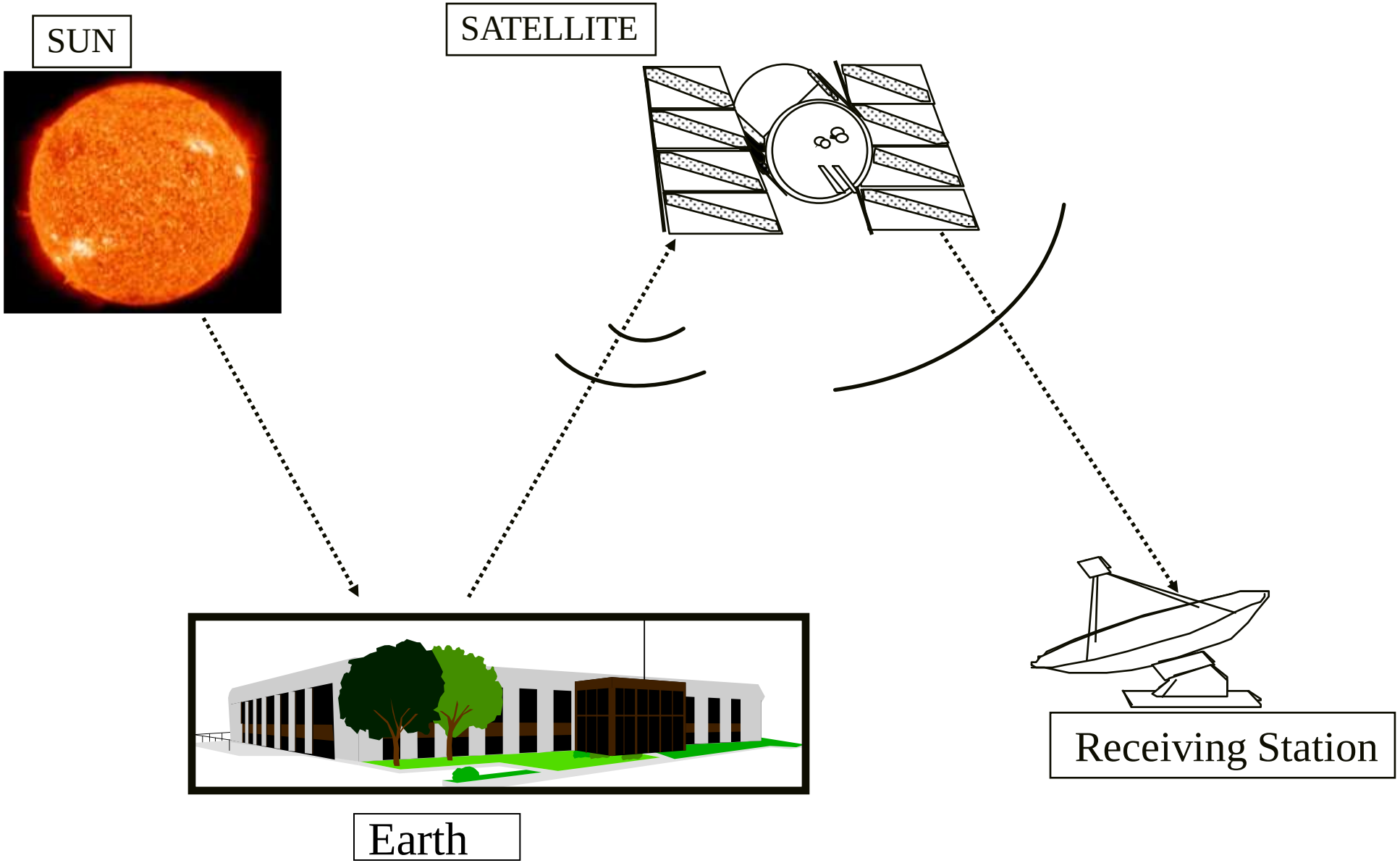
Specific narrow bands (High S/N)

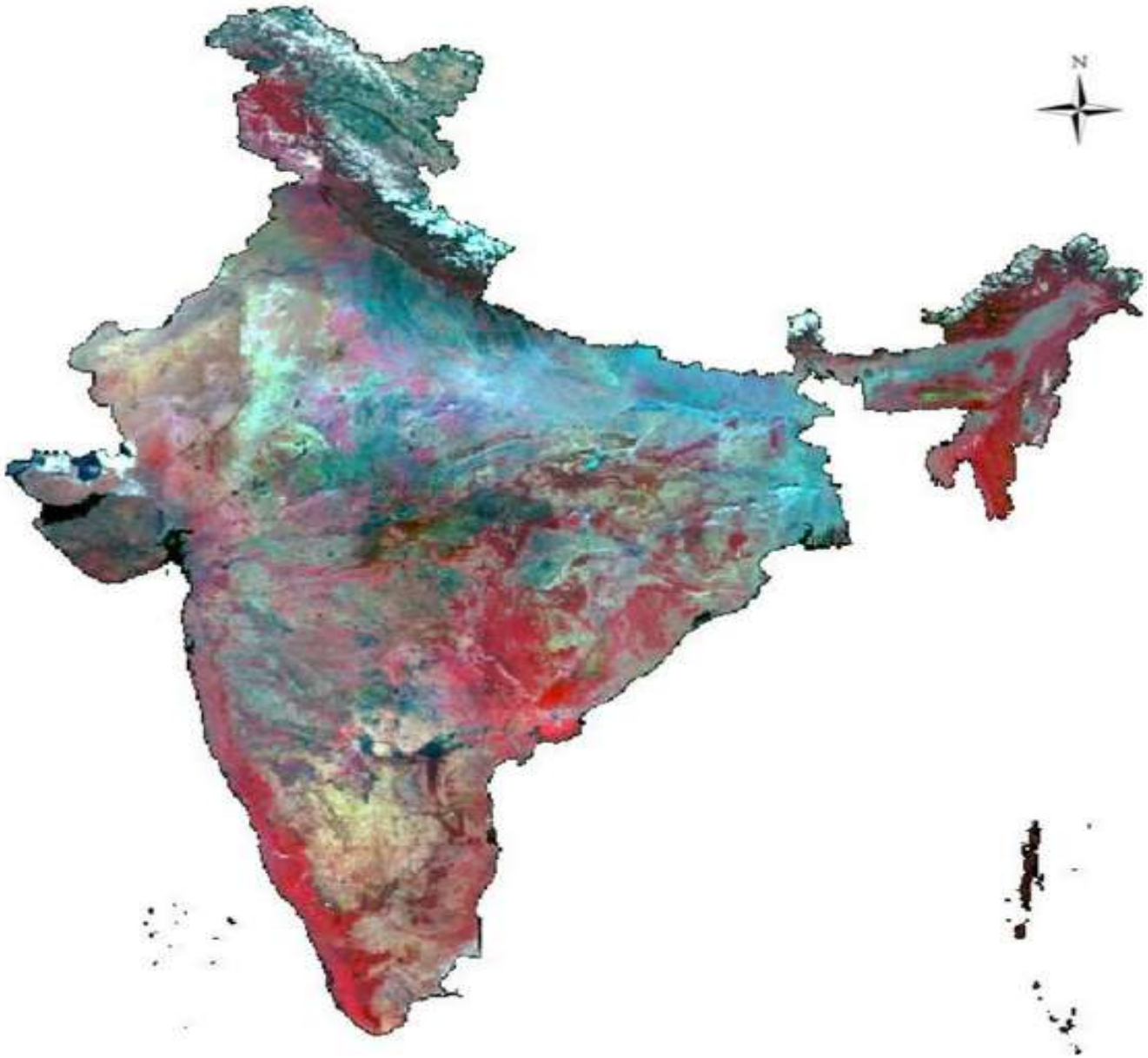
High Spatial Resolution (PAN) & Stereo Capability

Observations over land, ocean and atmosphere

1979 1981 1988 1991 1994 1995 1996 1997 1999 2003 2005 ... 2021

REMOTE SENSING

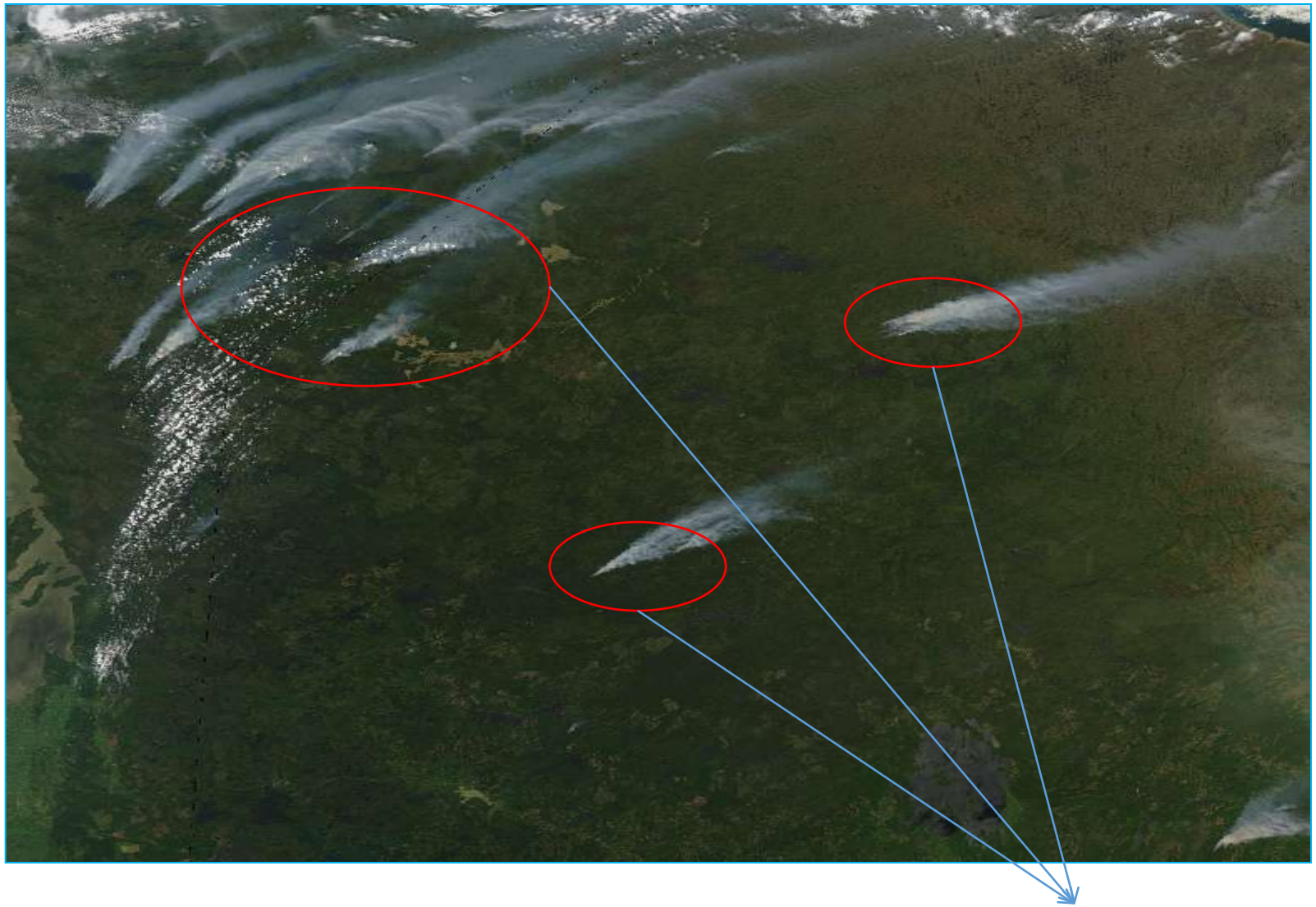




India as viewed from satellite
(False Color Composite image from AWiFS)

Satellite Remote Sensing in Forest Fire Management- some examples

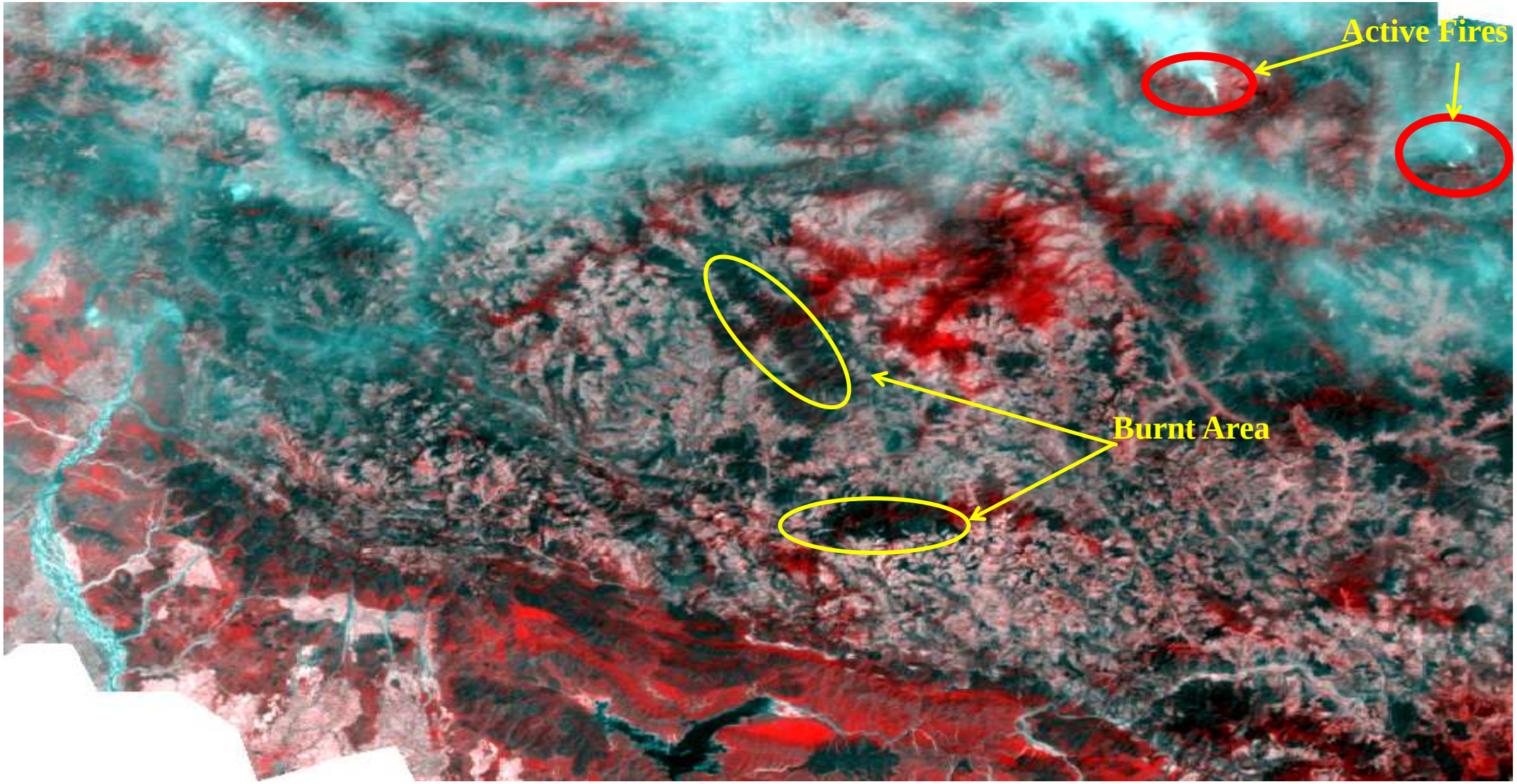
Active Forest Fires Seen on MODIS Image



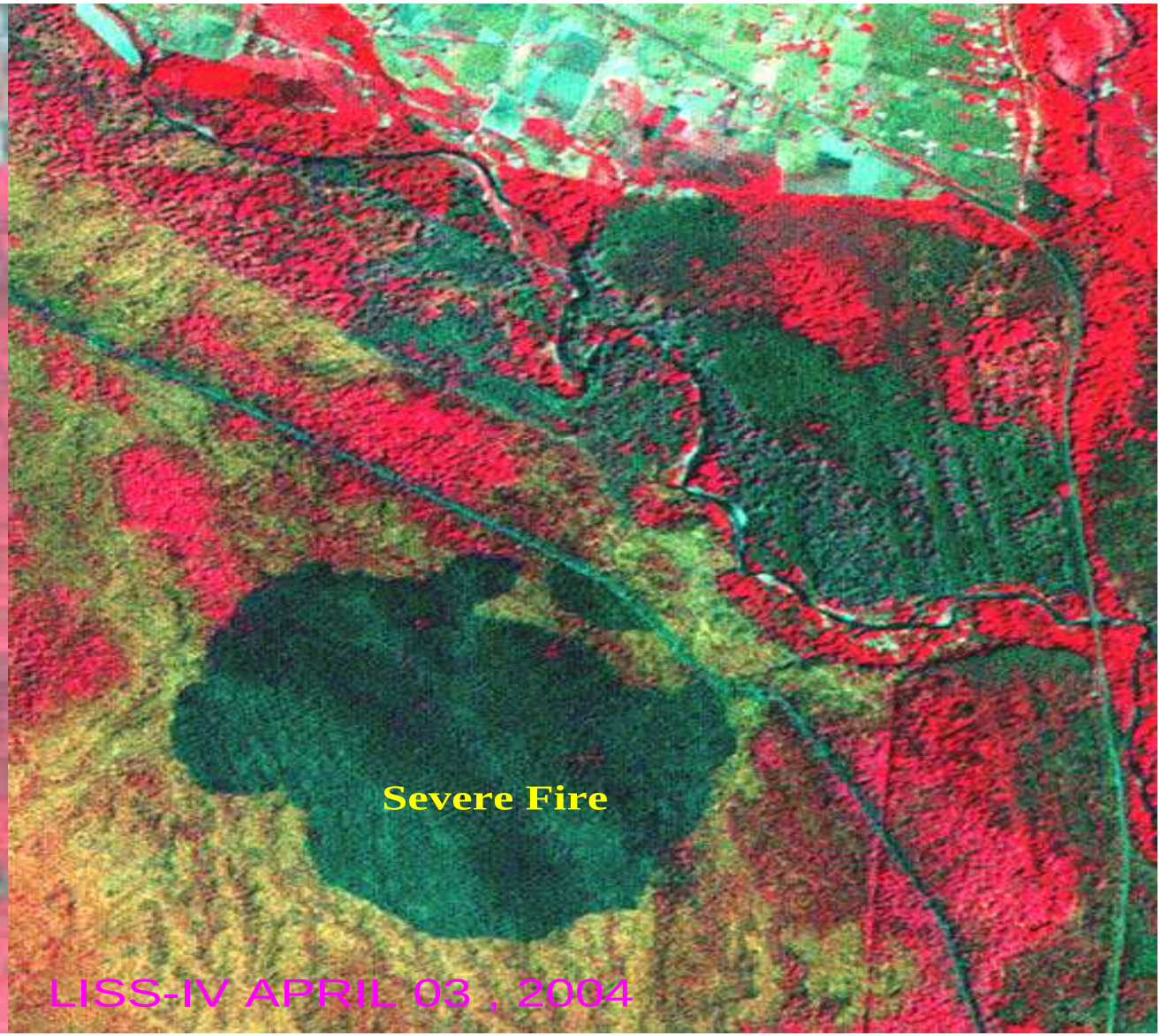
Particulars Of MODIS

MODIS (or Moderate Resolution Imaging Spectroradiometer) is a key instrument on-board the Terra (EOS AM) and Aqua (EOS PM) satellites providing data for the major part of the country every six(6) hours

Fire Affected Area- Monitoring using Indian Remote Sening Satellite-AWiFS



FIRE DAMAGE ASSESSMENT



Role of Technology in Fire Management

Forest fire studies- some initiatives in FSI

- Burnt area assessment for Uttarakhand during state the wild fires of years - 1995 and 1999
- Near Real Time Monitoring of Forest Fires (Nov 2004-2011)
- Real time forest fire monitoring (2012 onwards) in collaboration with NRSC/ISRO
- Forest fire vulnerability assessment at country level using fire points, and other parameters including forest cover and forest types, rainfall, poverty index(2012)
- Burnt area assessment for Maharashtra(2014)
- Pre warning alert system for forest fires(2016)
- Burnt area assessment for the country for 2015 and 2016
- Large Fire Monitoring Programme(2019)
- Creation of a Forest Fire Portal(Van Agni)
- Target mapping of extent and damages caused by large forest fires(In collaboration with ICFRE on pilot basis)

Role of Technology in Forest Fire Management

- Pre-Warning Alert System for Forest Fires
- Real time Monitoring of Forest Fires
- Near Real Time Burnt Area Assessment
- Fire Risk Zonation Mapping
- Vulnerability Assessment of India's Forest to Fires
- Hazard Zonation Modeling and Mapping
- Large Forest Fire Monitoring System

Near Real Time Monitoring of Forest Fires

Near Real Time Monitoring of Forest Fires

Alerts to Fire fighters

Feedback to SFD's and FSI

Signals Transmitted to Earth Station

Data Receiving Station (NRSC)

Data Processing Centre

FAST 3.0

python

Dissemination

ArcGIS

Automated Processing

FSI van Agni Geo-portal

Near Real Time

Large Forest Fire

Email Alerts to states nodal officers

SMS alerts to Subscriber

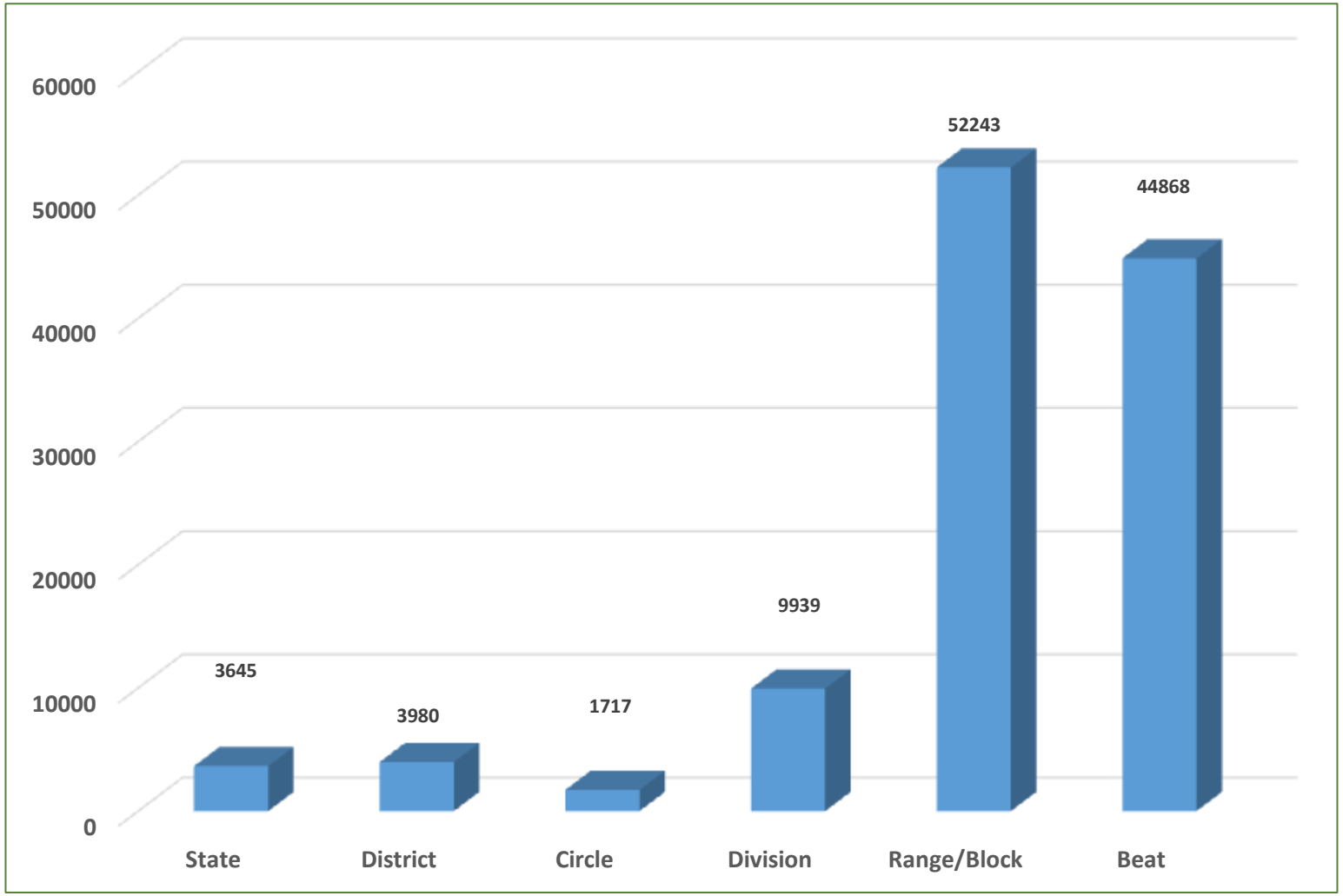
Information Dissemination at Beat Level

FOREST FILTER MECHANISM

Sl No	State	Recorded Forest Area (RFA)/Forest Cover Map(FCM)
1	ANDHRA PRADESH	RFA
2	GOA	RFA
3	HARYANA	RFA
4	MADHYA PRADESH	RFA
5	TAMIL NADU	RFA
6	TELANGANA	RFA
7	WEST BENGAL	RFA
8	CHHATTISGARH	RFA+FCM
9	ODISHA	RFA+FCM
10	UTTARAKHAND	RFA+FCM
11	BIHAR	FCM
12	GUJARAT	FCM
13	HIMACHAL PRADESH	FCM
14	JHARKHAND	FCM
15	KARNATAKA	FCM
16	KERALA	FCM
17	MAHARASHTRA	FCM
18	MANIPUR	FCM
19	MEGHALAYA	FCM
20	MIZORAM	FCM
21	PUNJAB	FCM
22	TRIPURA	FCM

SMS Subscription Details

SMS Subscription Details	
State	3645
District	3980
Circle	1717
Division	9939
Range/Block	52243
Beat	44868
Total	116392



EXAMPLE OF EMAIL ALERT

KMZ & CSV FILE OF FOREST FIRE POLYGONS OF SNPP__20190222_1334_CHHATISGARH.csv', 'SNPP__20190222_1334_CHHATISGARH.kmz

forestfiremonitoring@gmail.com 3:14 PM (1 hour ago)

to draboaz, maniiyer1958, dfonpur1, abhishek.choudhery23

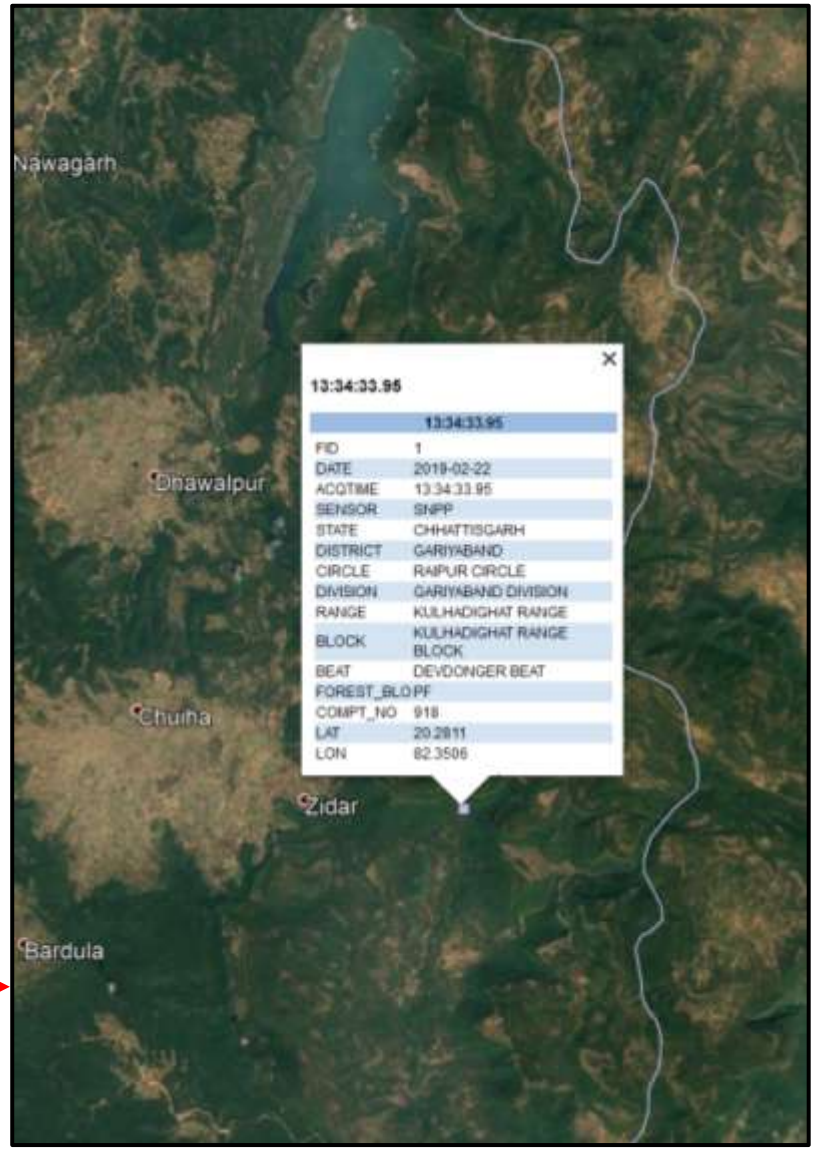
Sir/Madam,
Please find enclosed the fire polygons of CHHATISGARH as a KMZ file attachment.
KMZ file is google earth compatible and would be uploaded automatically on google earth.
The CSV file with details such as Latitude, Longitude of centroid of fire pixel along with available administrative attributes are also attached.

With Regards,
Forest Fire Monitoring Team,
Forest Survey of India,
Ministry of Environment, Forest and Climate Change,
Kaulagarh Road, Dehradun- 248195.
0135-2754191 Ex-272

2 Attachments

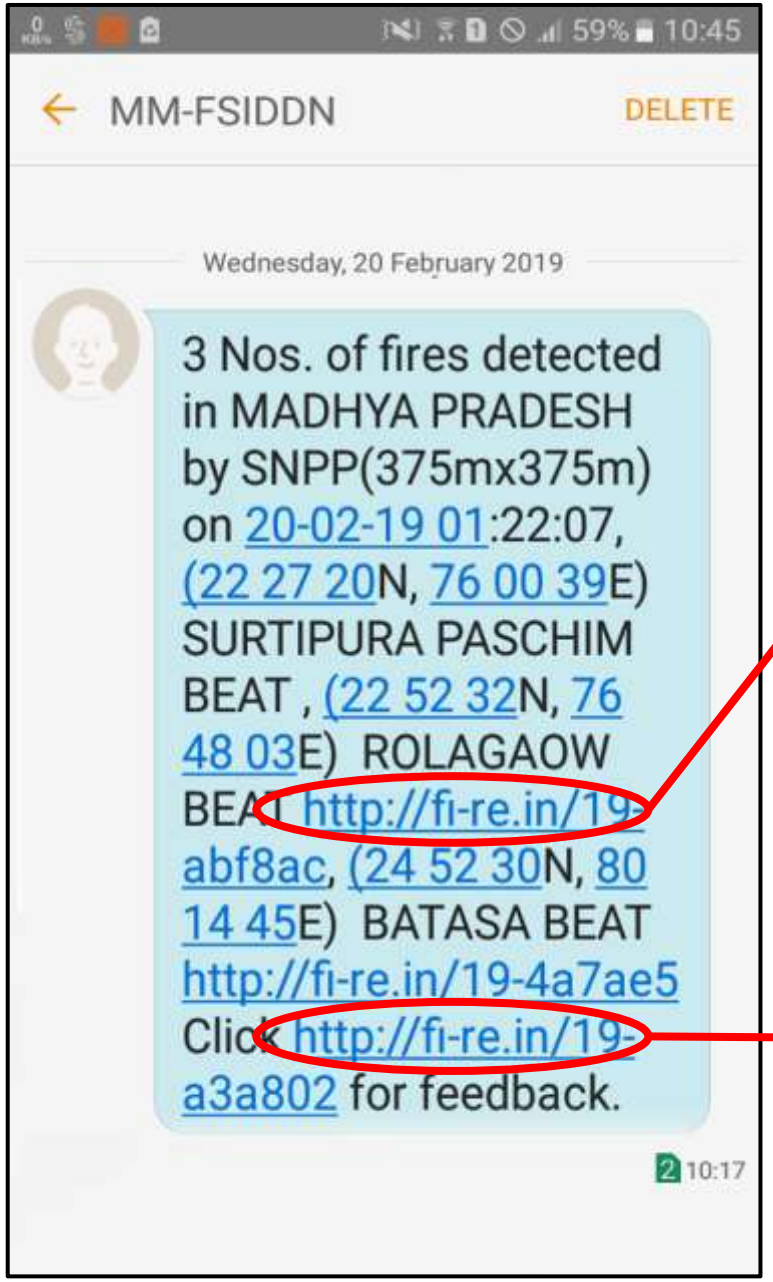
SNPP__20190222_1334_CHHATISGARH.csv
1 KB

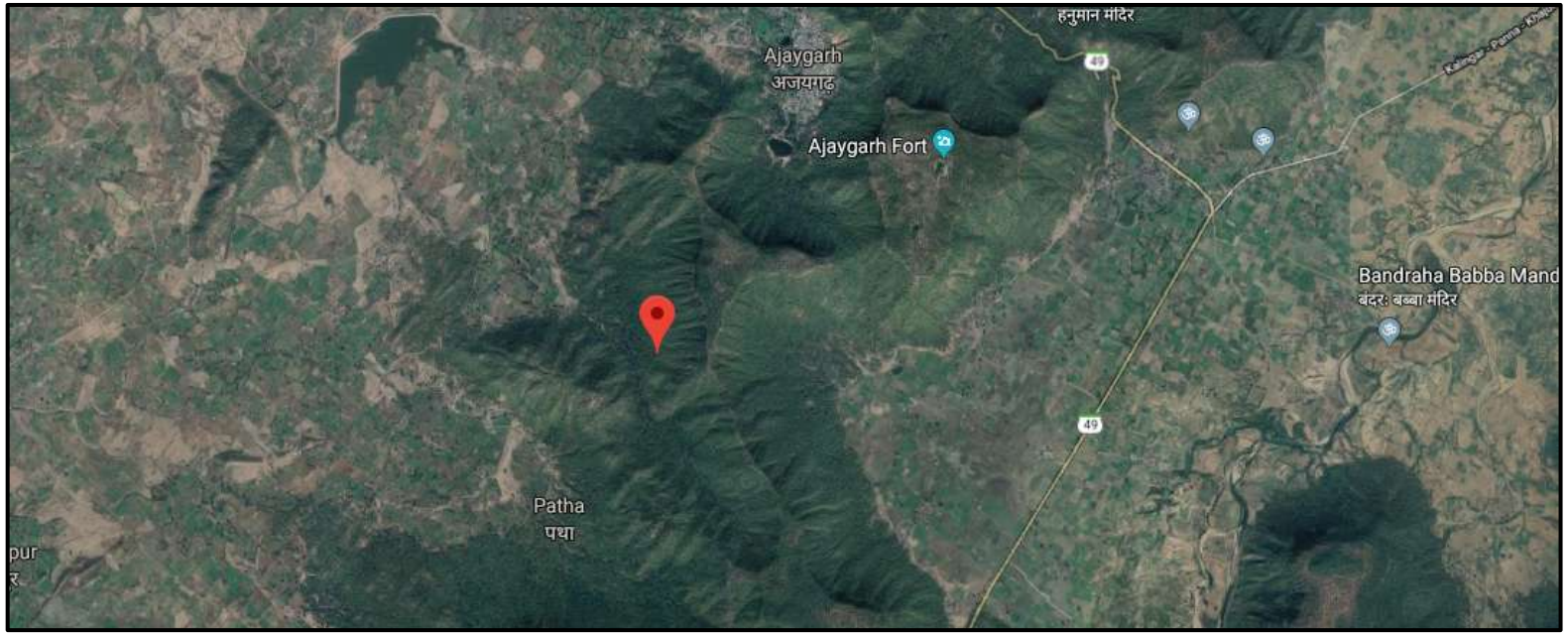
SNPP__20190222_...



DATE	ACQTIME	SENSOR	LON (DD)	LAT (DD)	LON (DD MM SS)	LAT (DD MM SS)	STATE	DISTRICT	CIRCLE	DIVISION	RANGE	BLOCK	BEAT	FOREST BLOCK	COMPT NO
22-02-2019	13:34:33	SNPP	82.0154	19.4208	82° 00' 55"E	19° 25' 14"N	CHHATTISGARH	BASTAR	JAGDALPUR CIRCLE	BASTAR DIVISION	KARPAWAND RANGE	KARPAWAND RANGE BLOCK	JAIBEL BEAT	RF	1210P
22-02-2019	13:34:33	SNPP	82.3506	20.2811	82° 21' 02"E	20° 16' 51"N	CHHATTISGARH	GARIYABAND	RAIPUR CIRCLE	GARIYABAND DIVISION	KULHADIGHAT RANGE	KULHADIGHAT RANGE BLOCK	DEVDONGER BEAT	PF	918
22-02-2019	13:34:33	SNPP	83.1022	21.5517	83° 06' 07"E	21° 33' 06"N	CHHATTISGARH	RAIGARH	BILASPUR CIRCLE	RAIGARH DIVISION	SARANGGARH GOMARDA RANGE	SARANGGARH GOMARDA RANGE BLOCK	KAWLAJHAR BEAT	PF	886
22-02-2019	13:34:33	SNPP	83.1022	21.5517	83° 06' 07"E	21° 33' 06"N	CHHATTISGARH	RAIGARH	BILASPUR CIRCLE	RAIGARH DIVISION	SARANGGARH GOMARDA RANGE	SARANGGARH GOMARDA RANGE BLOCK	KAWLAJHAR BEAT	RF	891

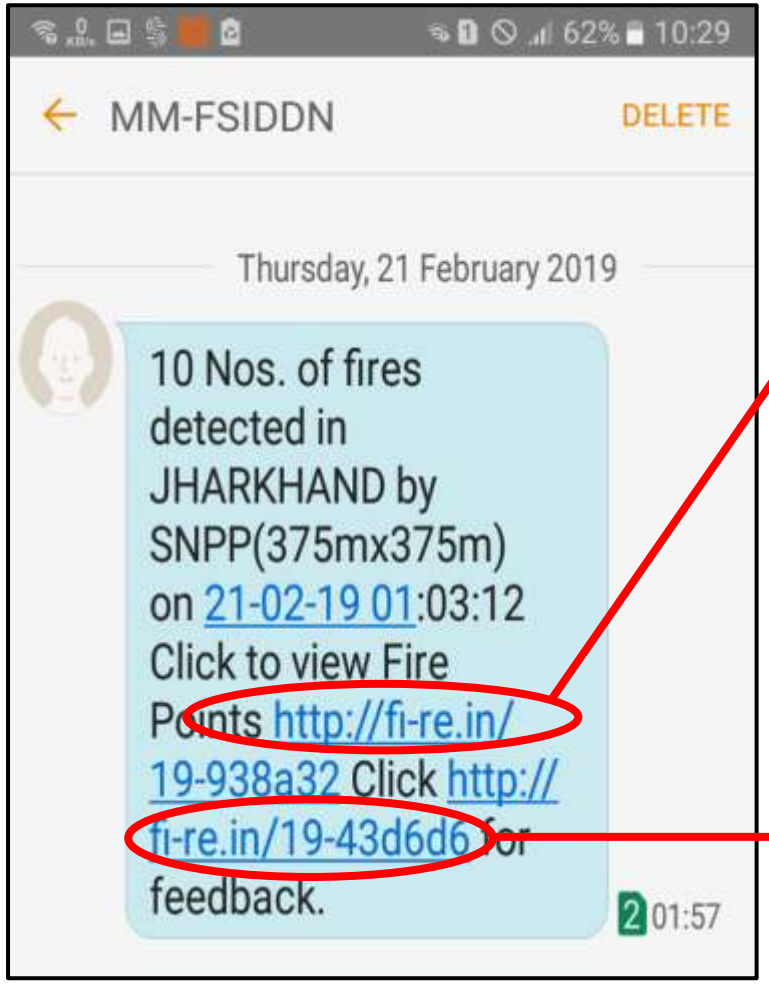
EXAMPLE OF SMS ALERT





#	Alert Details	Fire Observed	Type of Land	Cause of Fire	Feedback Details
1	22 27 20 N / 76 00 39 E State: MADHYA PRADESH District: INDORE Circle: INDORE CIRCLE Division: INDORE DIVISION Range: CHORAL RANGE Block: CHORAL RANGE BLOCK Beat: SURTIPURA PASCHIM BEAT Compt. No.: 171 Source: SNPP	Yes	Forest Land Ground Fire	Controlled Burnin	Area in Hectres Remarks
2	22 52 32 N / 76 48 03 E State: MADHYA PRADESH District: SEHORE Circle: BHOPAL CIRCLE Division: SEHORE DIVISION Range: ASHTA RANGE Block: ASHTA RANGE BLOCK Beat: ROLAGAOW BEAT Compt. No.: 169 Source: SNPP	Yes	Forest Land Ground Fire	Agriculture	Area in Hectres Remarks

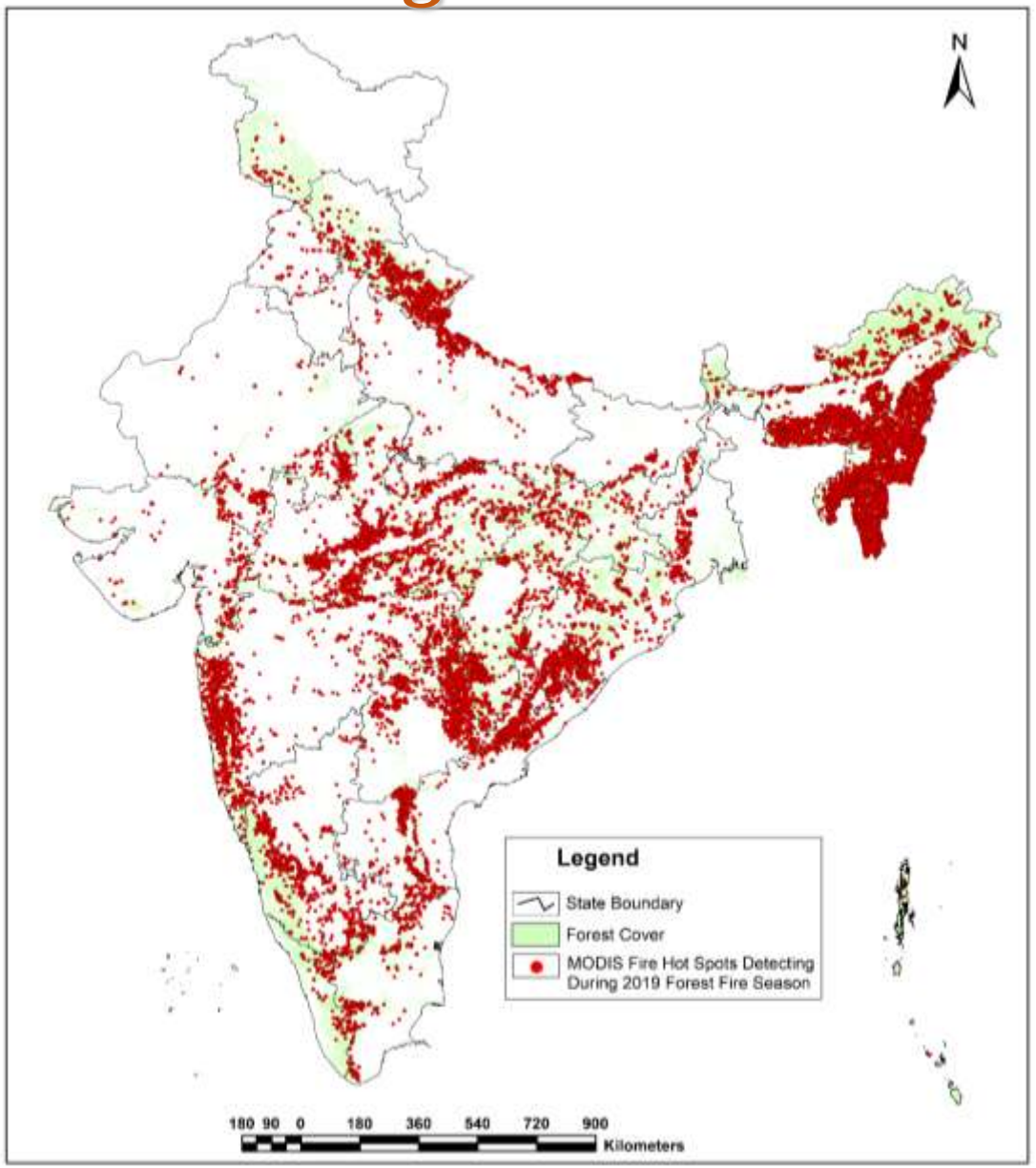
EXAMPLE OF SMS ALERT



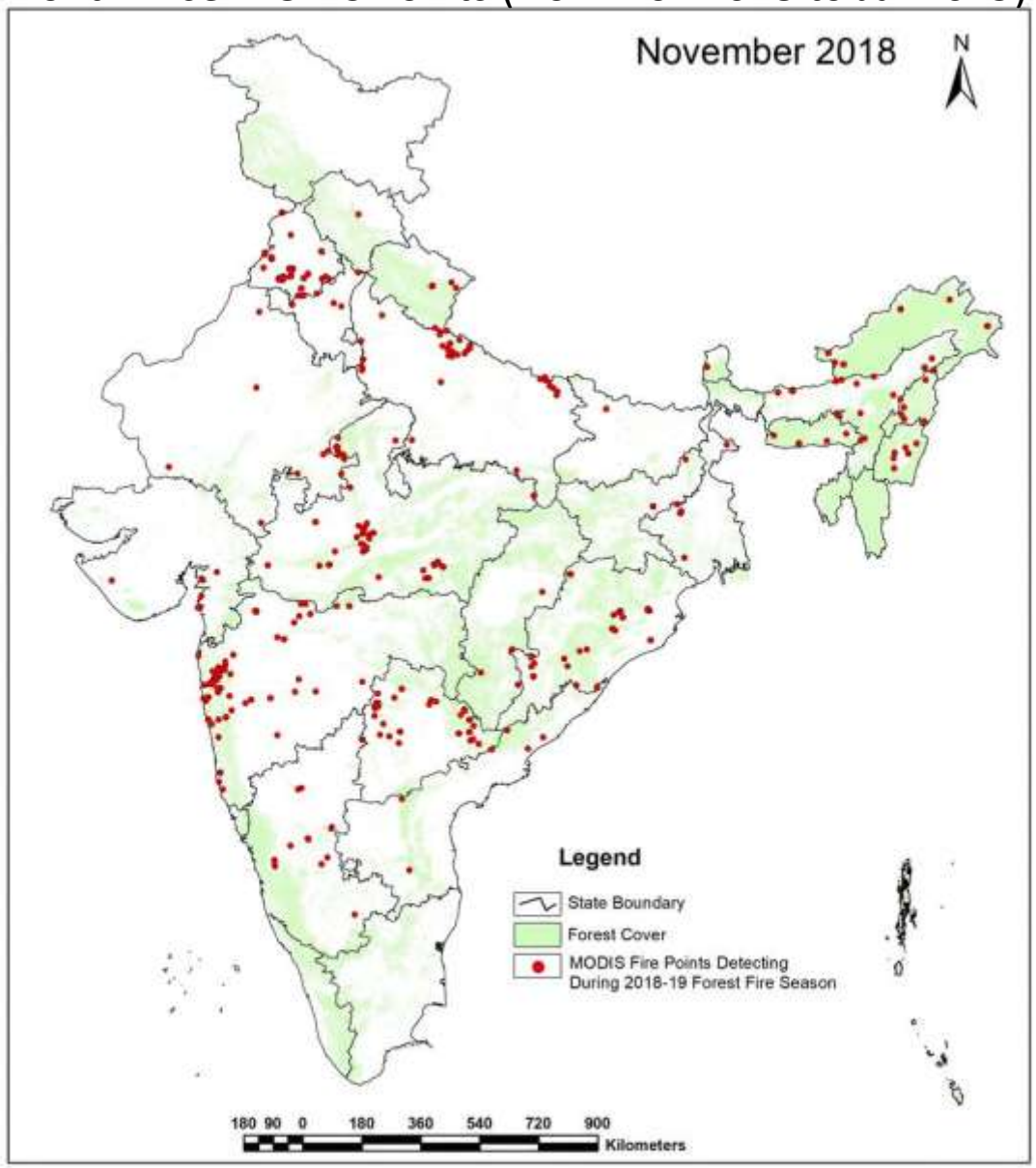
#	Fire Date	Fire Time	Latitude	Longitude	Source	State	District	Circle & Others
1.	21-02-2019	01:03:12	23 49 55 N	84 57 22 E	SNPP	JHARKHAND	CHATRA	CHATRA CIRCLE Division: CHATRA SOUTH DIVISION Range: TANDWA RANGE Block: TANDWA RANGE Beat: MISRAUL BEAT
2.	21-02-2019	01:03:12	23 49 54 N	84 57 25 E	SNPP	JHARKHAND	CHATRA	CHATRA CIRCLE Division: CHATRA SOUTH DIVISION Range: TANDWA RANGE Block: TANDWA RANGE Beat: MISRAUL BEAT
3.	21-02-2019	01:03:12	23 49 23 N	85 30 08 E	SNPP	JHARKHAND	HAZARIBAGH	BOKARO CIRCLE Division: RAMGARH DIVISION Range: MANDU RANGE Block: MANDU RANGE Beat: HONHEMODA BEAT
4.	21-02-2019	01:03:12	24 03 38 N	87 04 16 E	SNPP	JHARKHAND	JAMTARA	DEOGHAR CIRCLE Division: JAMTARA DIVISION Range: KUNDHIT RANGE Block: KUNDHIT RANGE Beat: DHASANIYA BEAT
5.	21-02-2019	01:03:12	24 03 37 N	87 04 30 E	SNPP	JHARKHAND	JAMTARA	DEOGHAR CIRCLE Division: JAMTARA DIVISION Range: KUNDHIT RANGE Block: KUNDHIT RANGE Beat: DHASANIYA BEAT
6.	21-02-2019	01:03:12	24 06 11 N	87 16 33 E	SNPP	JHARKHAND	DUMKA	DUMKA CIRCLE Division: DUMKA DIVISION Range: HIZLA EAST RANGE Block: HIZLA EAST RANGE Beat: RANI BAHAL BEAT
7.	21-02-2019	01:03:12	24 05 45 N	87 16 49 E	SNPP	JHARKHAND	DUMKA	DUMKA CIRCLE Division: DUMKA DIVISION Range: HIZLA EAST RANGE Block: HIZLA EAST RANGE Beat: RANI BAHAL BEAT

#	Alert Details	Fire Observed	Type of Land	Cause of Fire	Feedback Details
1	23 49 55 N / 84 57 22 E State: JHARKHAND District: CHATRA Circle: CHATRA CIRCLE Division: CHATRA SOUTH DIVISION Range: TANDWA RANGE Block: TANDWA RANGE Beat: MISRAUL BEAT Source: SNPP	Yes	Forest Land Ground Fire	Controlled Burnir	Area in Hectres Remarks
2	23 49 54 N / 84 57 25 E State: JHARKHAND District: CHATRA Circle: CHATRA CIRCLE Division: CHATRA SOUTH DIVISION Range: TANDWA RANGE Block: TANDWA RANGE Beat: MISRAUL BEAT Source: SNPP	No			Remarks
3	23 49 23 N / 85 30 08 E State: JHARKHAND District: HAZARIBAGH Circle: BOKARO CIRCLE Division: RAMGARH DIVISION Range: MANDU RANGE Block: MANDU RANGE Beat: HONHEMODA BEAT Source: SNPP	Yes	Agriculture Land		Remarks

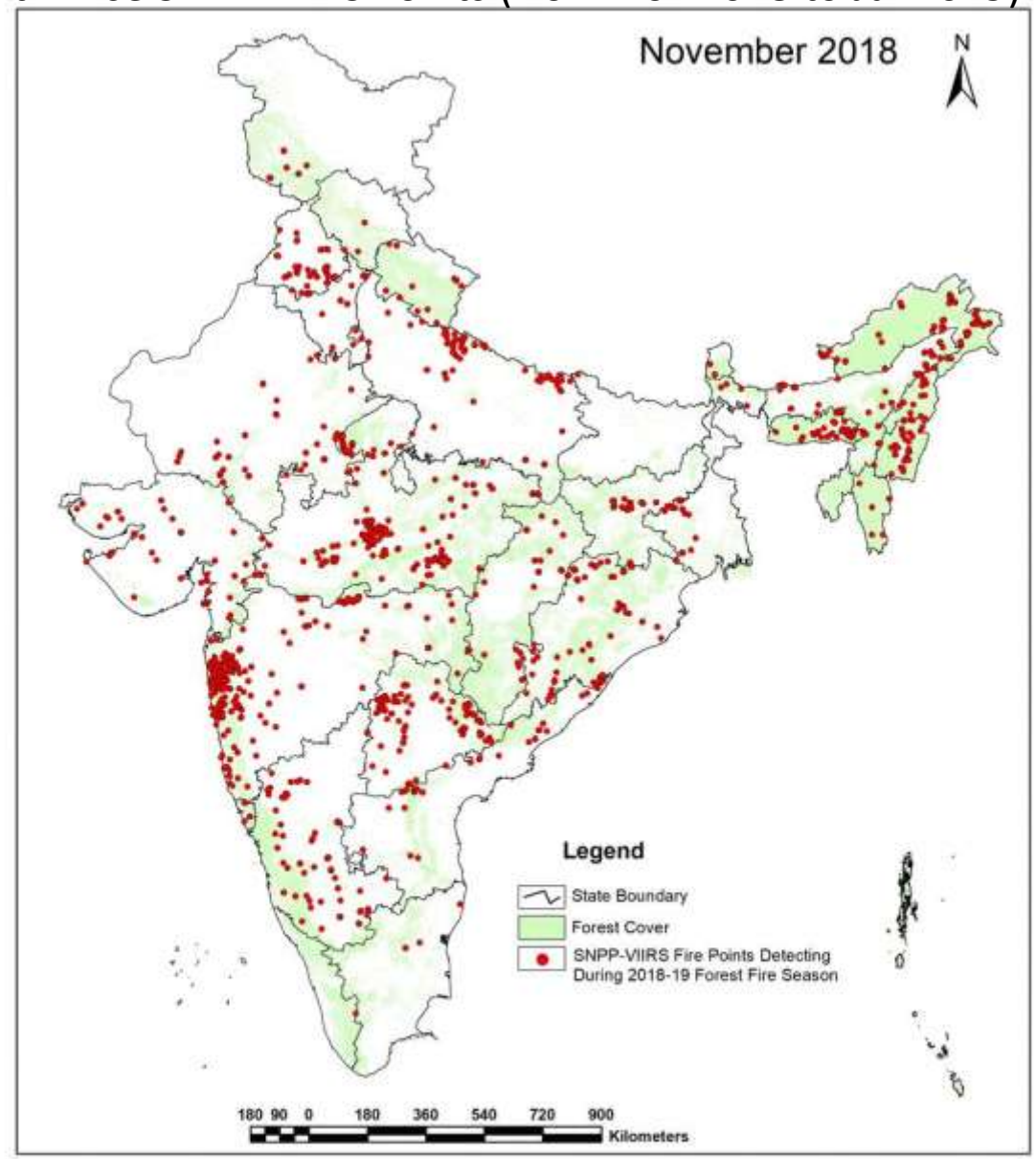
Map showing MODIS Forest Fire detections by Forest Survey of India During 2019 Forest fire season

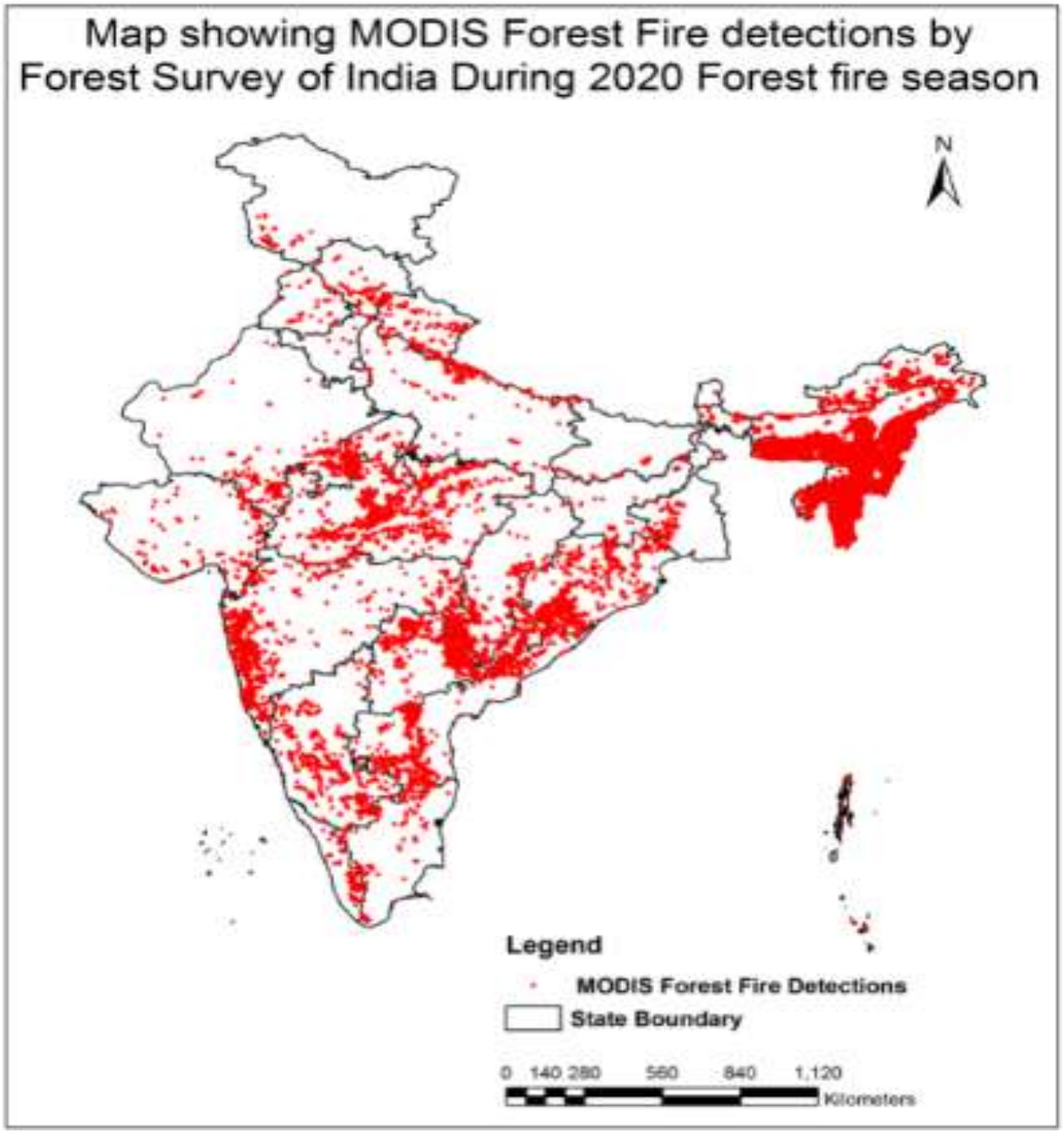


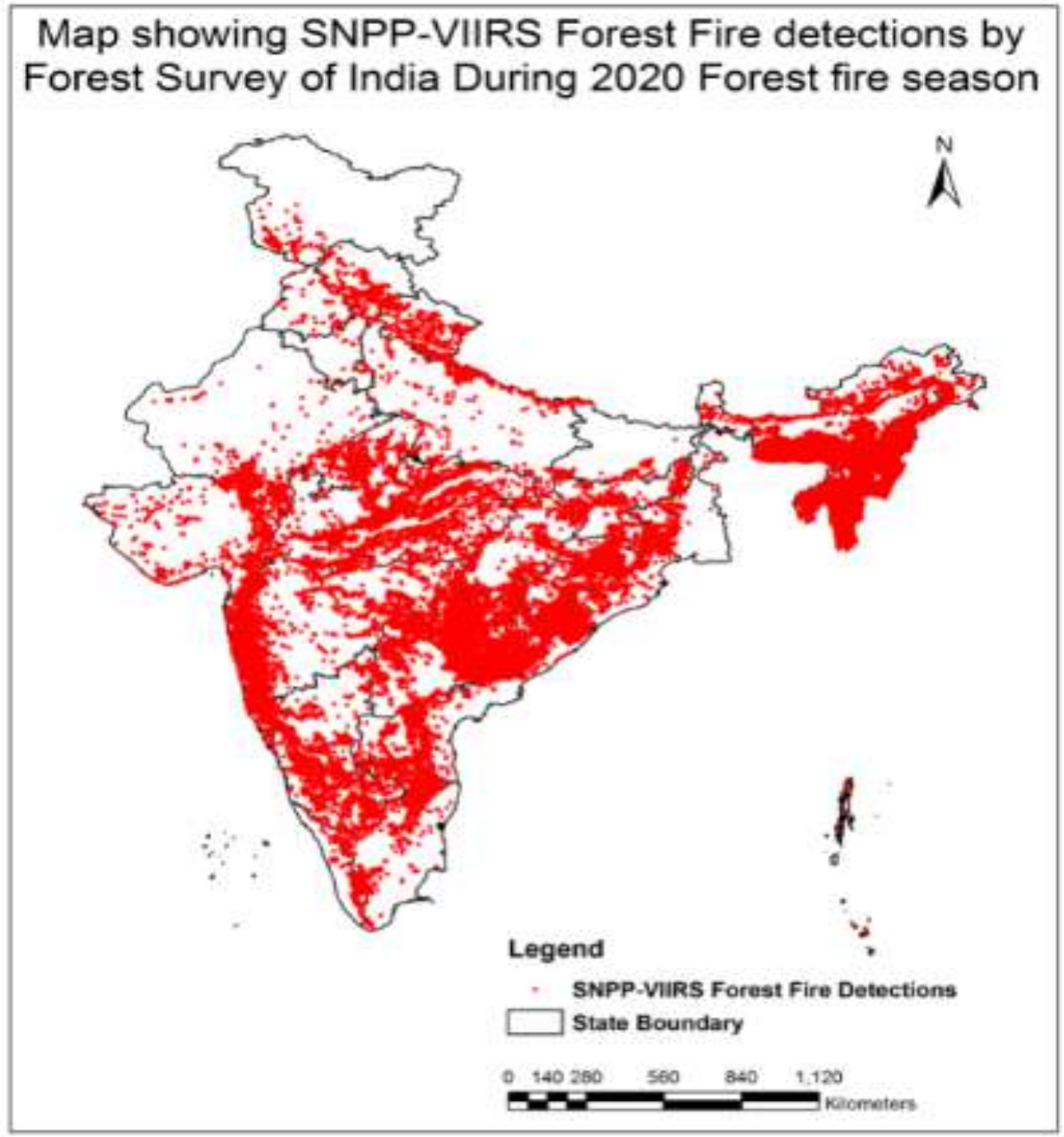
Month wise MODIS Points (from Nov 2018 to Jun2019)



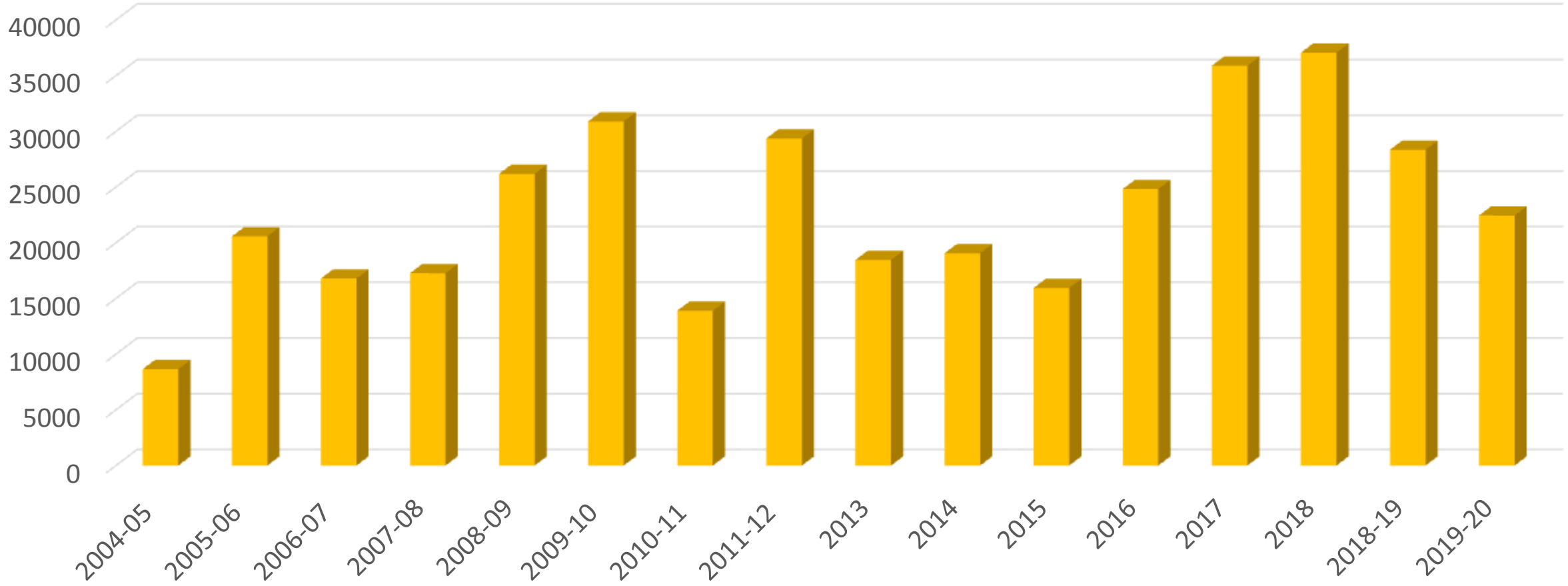
Month wise SNPP-VIIRS Points (from Nov 2018 to Jun2019)




Map showing MODIS Forest Fire detections by Forest Survey of India During 2020 Forest fire season
N
Legend
MODIS Forest Fire Detections
State Boundary
0 140 280 560 840 1,120
Kilometers

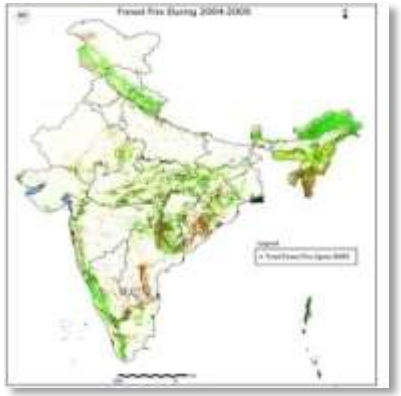

Map showing SNPP-VIIRS Forest Fire detections by Forest Survey of India During 2020 Forest fire season
N
Legend
SNPP-VIIRS Forest Fire Detections
State Boundary
0 140 280 560 840 1,120
Kilometers

Forest Fire Incidences between 2004-2020



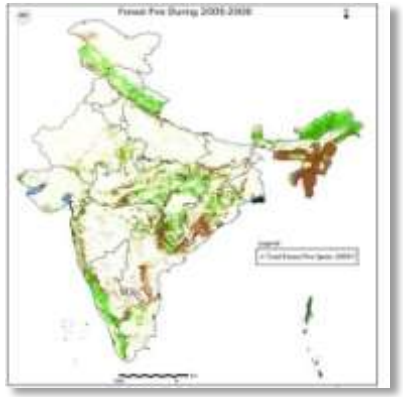
Near Real time of Detection of Forest Fire Using MODIS Data: Since 2004

Year - 2004-2005



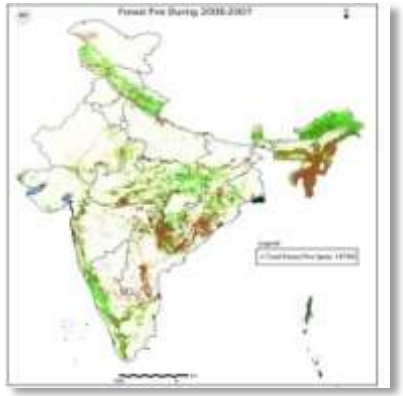
Forest Fire Spots - 8647

Year - 2005-2006



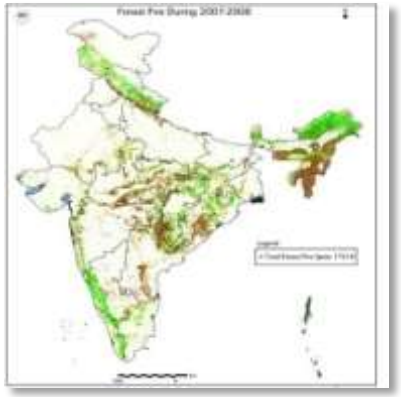
Forest Fire Spots - 20575

Year - 2006-2007



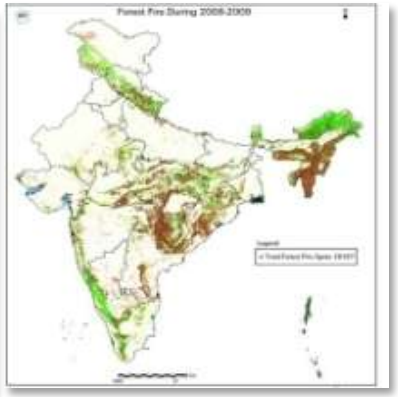
Forest Fire Spots - 16787

Year - 2007-2008



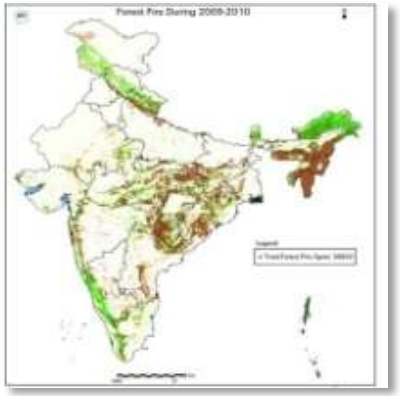
Forest Fire Spots - 17264

Year - 2008-2009



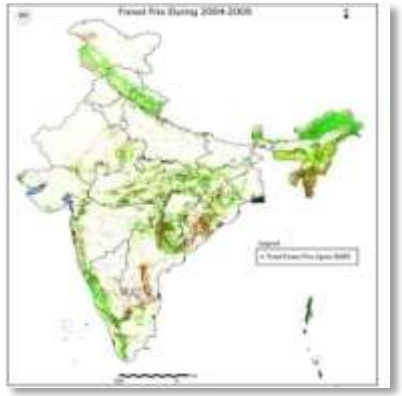
Forest Fire Spots - 26178

Year - 2009-2010



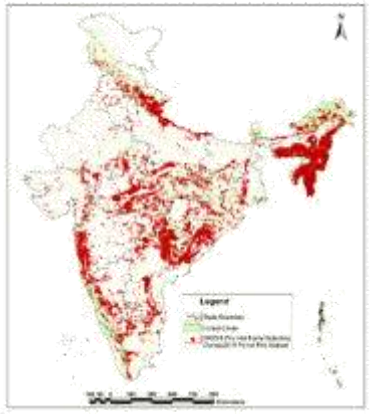
Forest Fire Spots - 30892

Year - 2010-2011



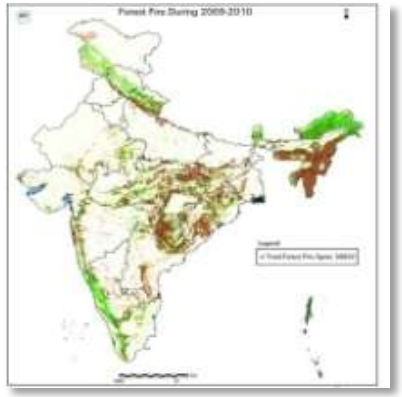
Forest Fire Spots - 13898

Year - 2012



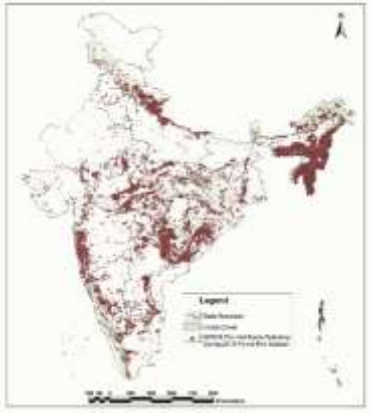
Forest Fire Spots - 29362

Year - 2013



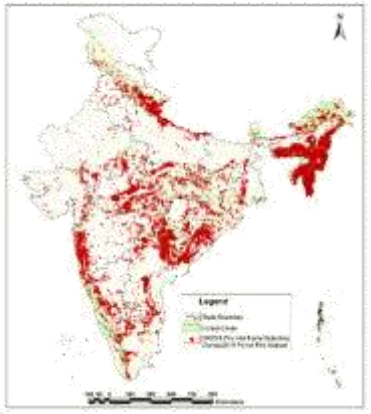
Forest Fire Spots -18451

Year - 2014



Forest Fire Spots - 19054

Year - 2015



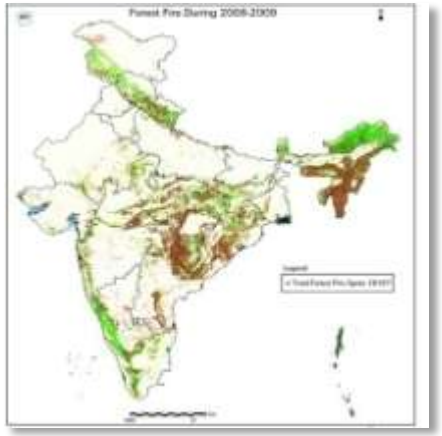
Forest Fire Spots - 15937

Year - 2016

Forest Fire Spots - 24817

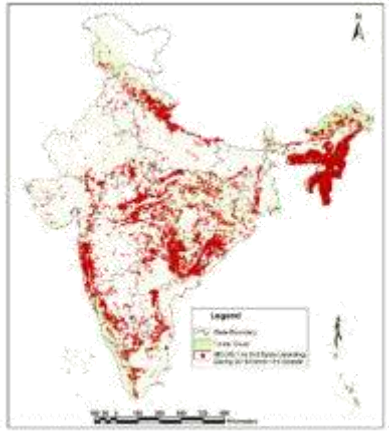
Near Real time of Detection of Forest Fire Using MODIS Data: Since 2004 …

Year - 2017



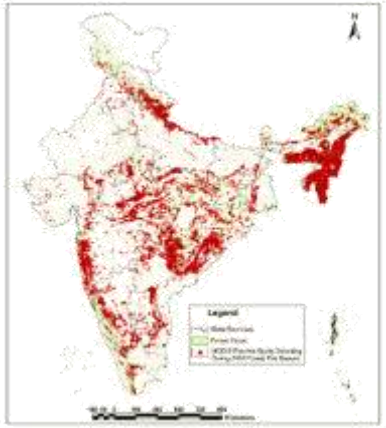
Forest Fire Spots - 35888

Year - 2018



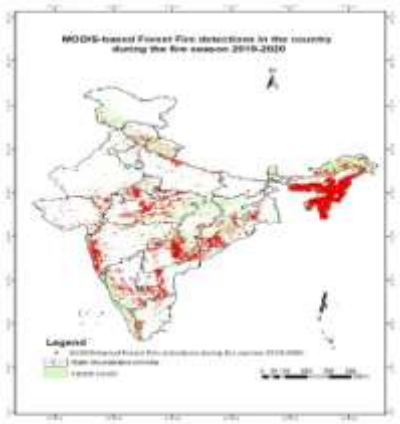
Forest Fire Spots - 37059

Year – 2018-19



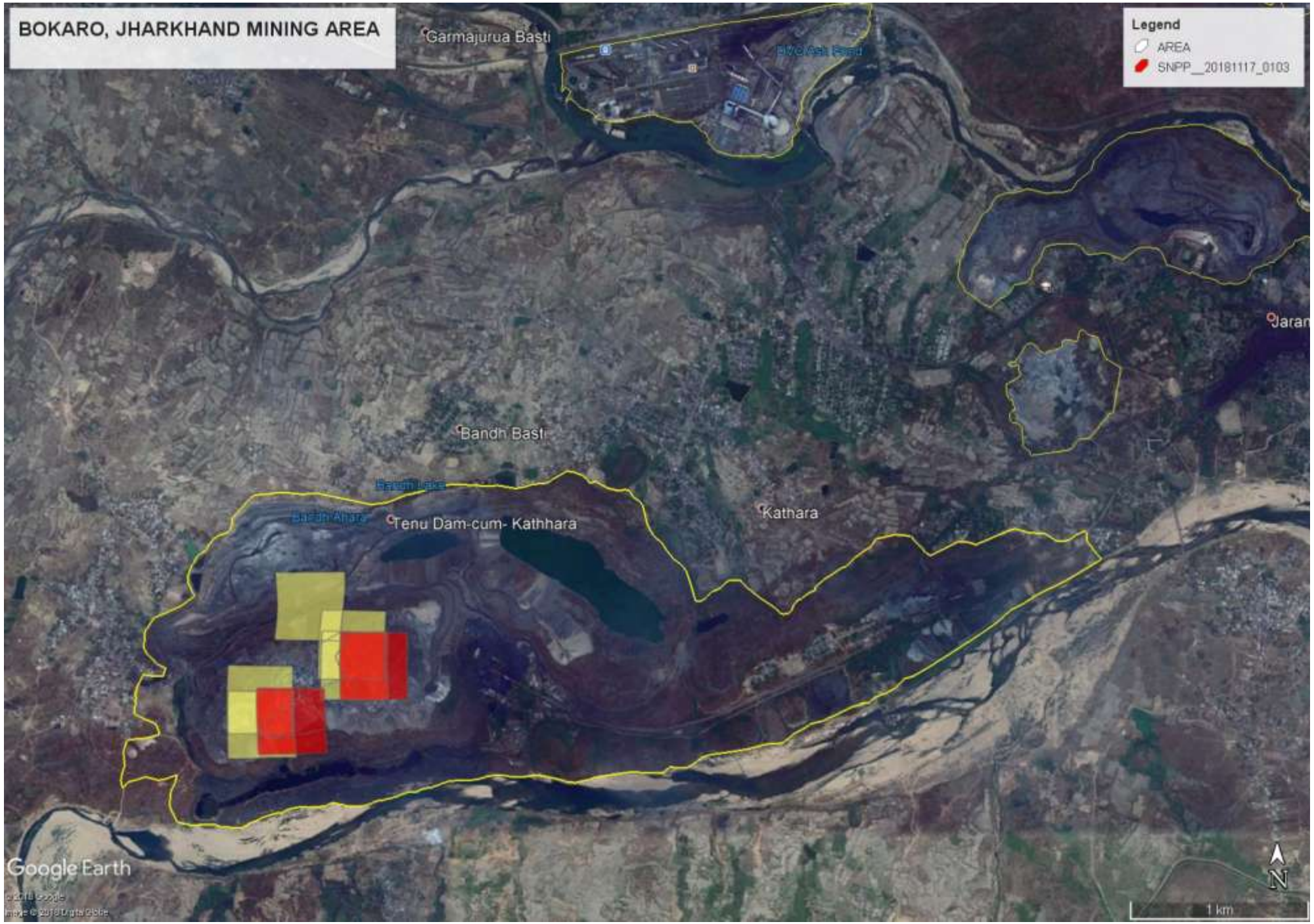
Forest Fire Spots - 28346

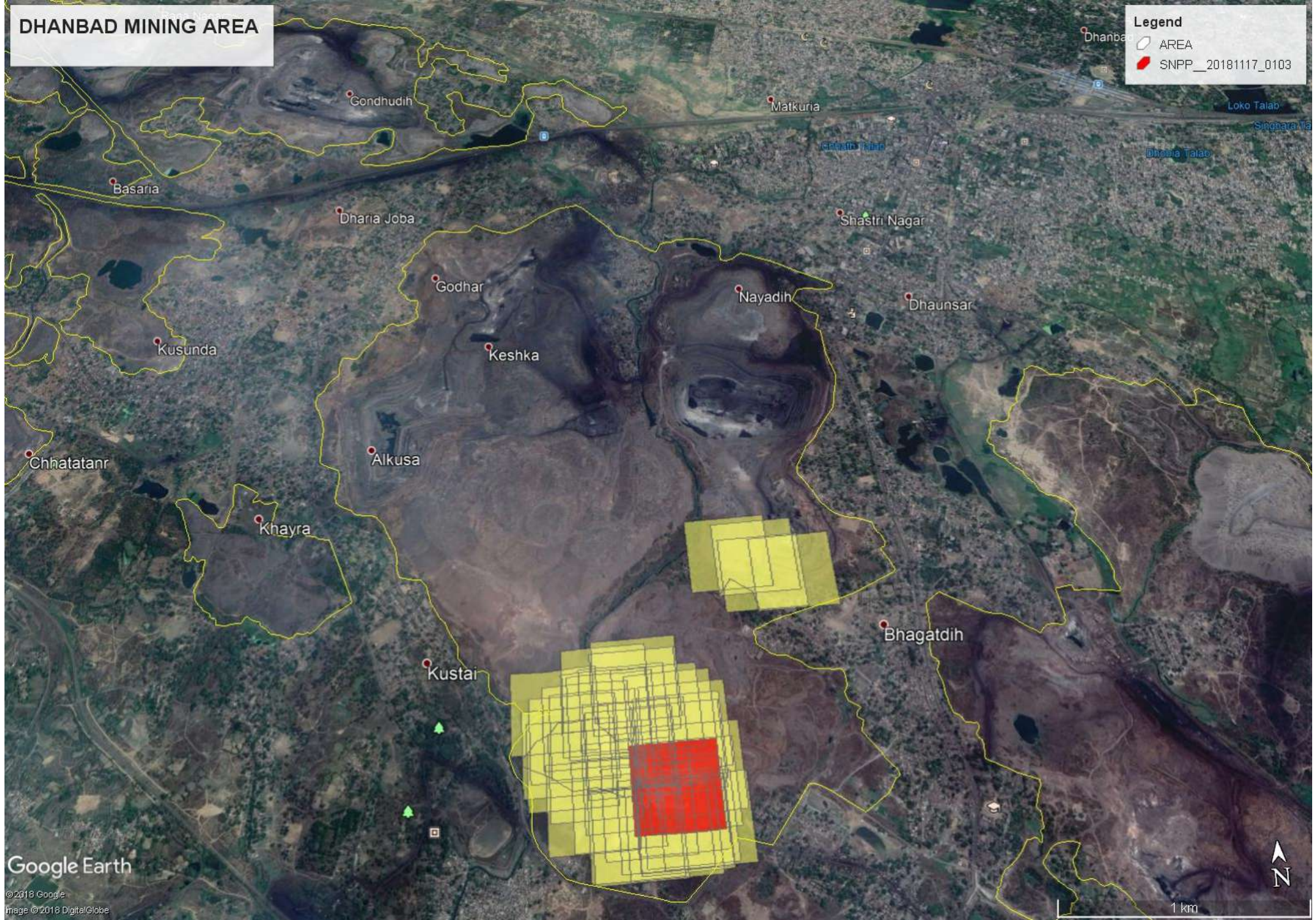
Year – 2019-20



Forest Fire Spots - 22447

INDUSTRIAL MASKING FOR IMPROVING ACCURACY OF FSI FIRE ALERT SYSTEM


BOKARO, JHARKHAND MINING AREA
Garmajurua Basti
Legend
AREA
SNPP__20181117_0103
Bandh Basti
Tenu Dam-cum- Kathhara
Kathara
Google Earth
1 km


DHANBAD MINING AREA
Legend
AREA
SNPP__20181117_0103
Gondhudih
Matkuria
Basaria
Dharia Joba
Shastri Nagar
Godhar
Nayadih
Dhaunsar
Kusunda
Keshka
Chhatatanr
Alkusa
Khayra
Bhagatdih
Kustai
Loko Talab
Dhobra Talab
Google Earth
©2018 Google
Image © 2018 DigitalGlobe
N
1 km


DUMMAS, GUJARAT INDUSTRIAL AREA
Legend
AREA
SNPP__20181117_0103
Sunvali
Kidiabet
Hazira
Dumas
Dumas
Google Earth
©2018 Google
Image © 2018 TerraMetrics
Image © 2018 DigitalGlobe
N
2 km

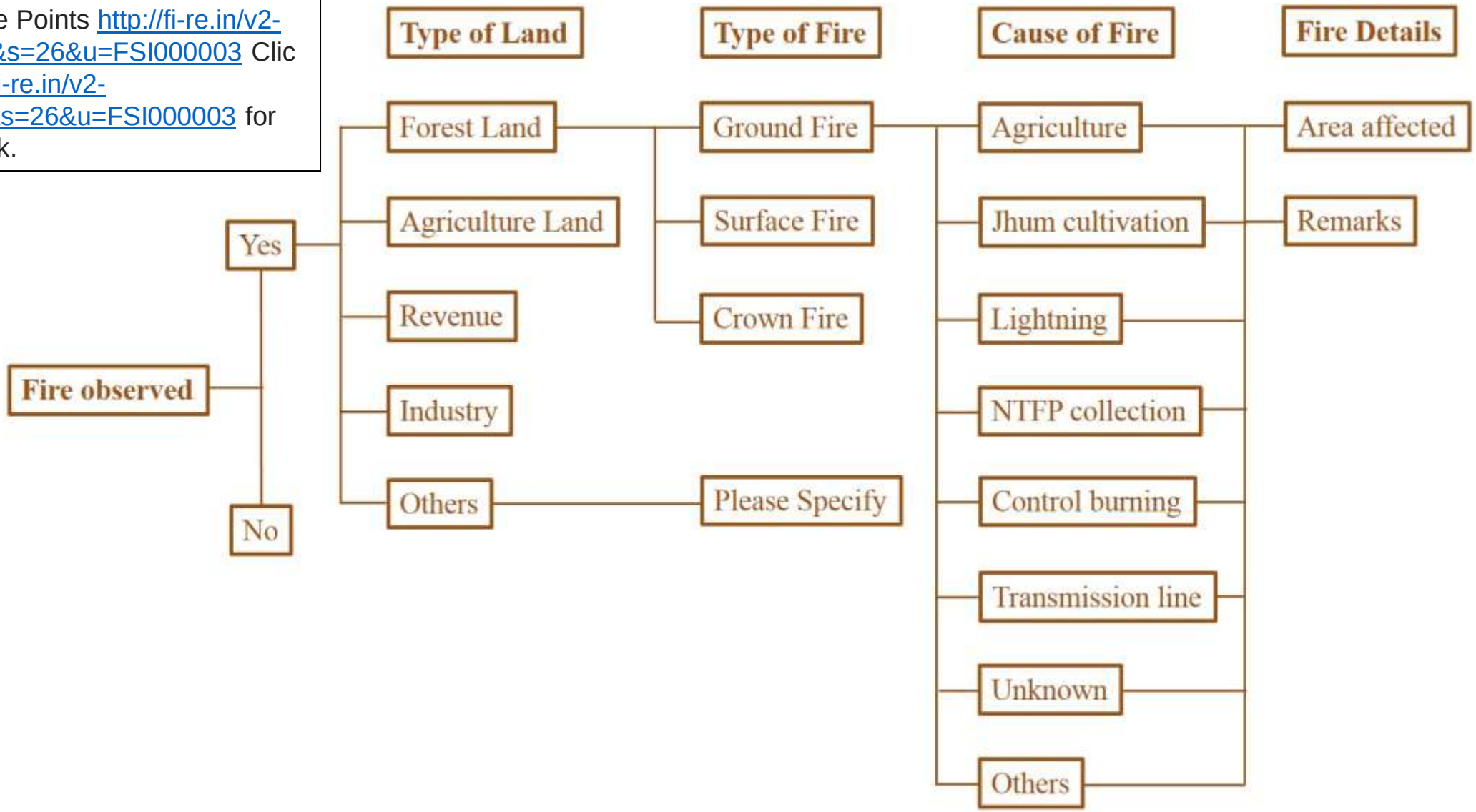
STATE WISE MINING, INDUSTRIAL & VOLCANIC ACTIVITIES LOCATED BY SNPP-VIIRS 375m

STATE NAME	MINING AREA	INDUSTRIAL AREA	VOLCANIC ACTIVITY
JHARKHAND	42	4	
ODISHA	9	16	
MADHYA PRADESH	2	6	
CHHATTISGARH	2	12	
UTTAR PRADESH	3	5	
MAHARASHTRA	4	4	
TAMIL NADU	2	0	
TELANGANA	3	1	
GUJARAT	0	6	
KARNATAKA	0	1	
HIMACHAL PRADESH	0	1	
WEST BENGAL	2	10	
ANDHRA PRADESH	0	1	
ASSAM	0	5	
RAJASTHAN	0	1	
KERALA	0	2	
ANDAMAN & NICOBAR ISLAND (UT)	0	0	1

Feedback System

9 Nos. of fires detected in ODISHA by SNPP(375mx375m) on 29-05-19 13:34:32 Click to view Fire Points http://fi-re.in/v2-07d5dc&s=26&u=FSI000003 Click http://fi-re.in/v2-b6f186&s=26&u=FSI000003 for feedback.

Feedback System



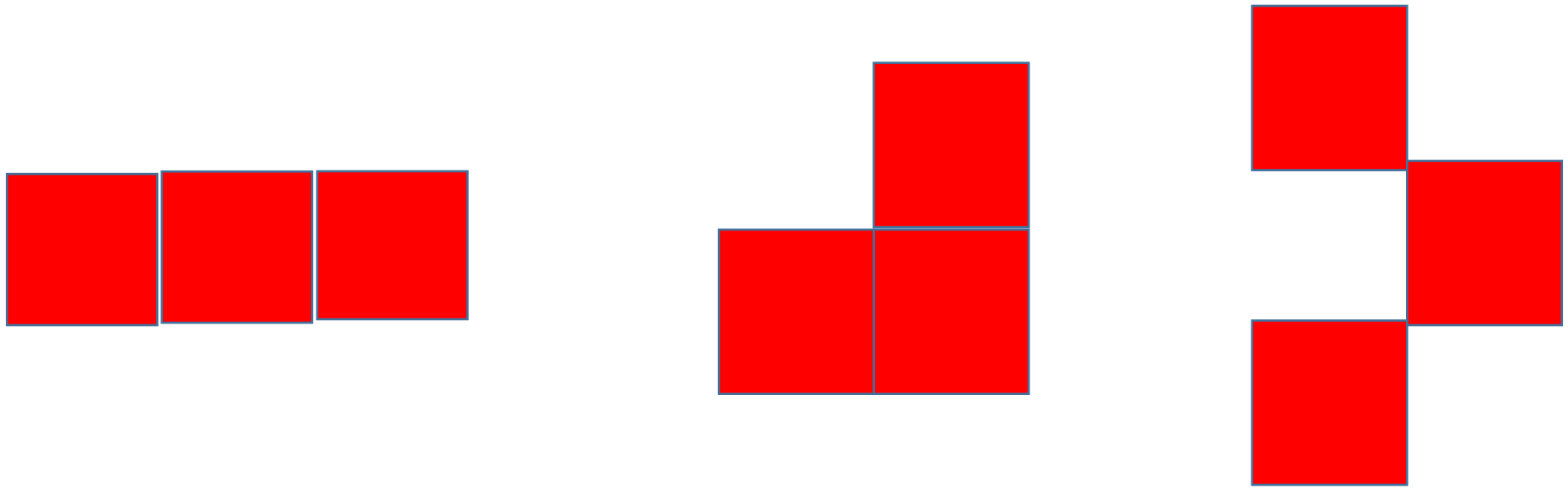
Large Forest Fire Monitoring System

Objectives

- To enable SFDs to monitor large forest fire events and provide special emphasis in fire control of these events
- To provide disaster escalation support in order to bring in timely additional support from other agencies such as District Administration, SDMA, NDMA, Armed forces etc
- National Large Forest Fire Database would help in future planning especially in development of State Crisis Management Plans, Working Plans
- To support rehabilitation of fire affected areas

Definition & Objectives

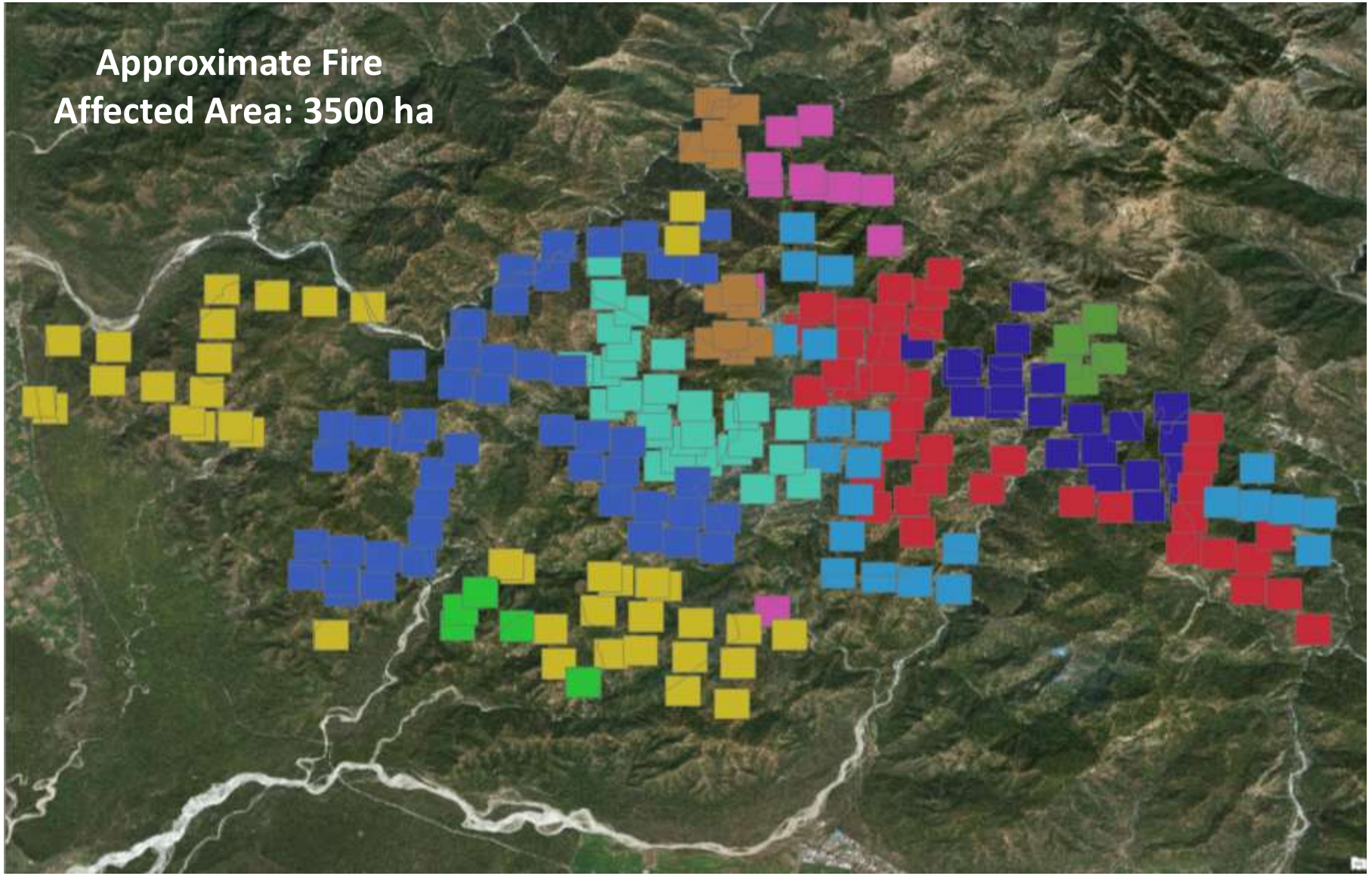
- A fire event comprising of at least 3 proximate VIIRS pixels



CANDIDATE LARGE FIRES

Example of
Large Forest Fires 2018

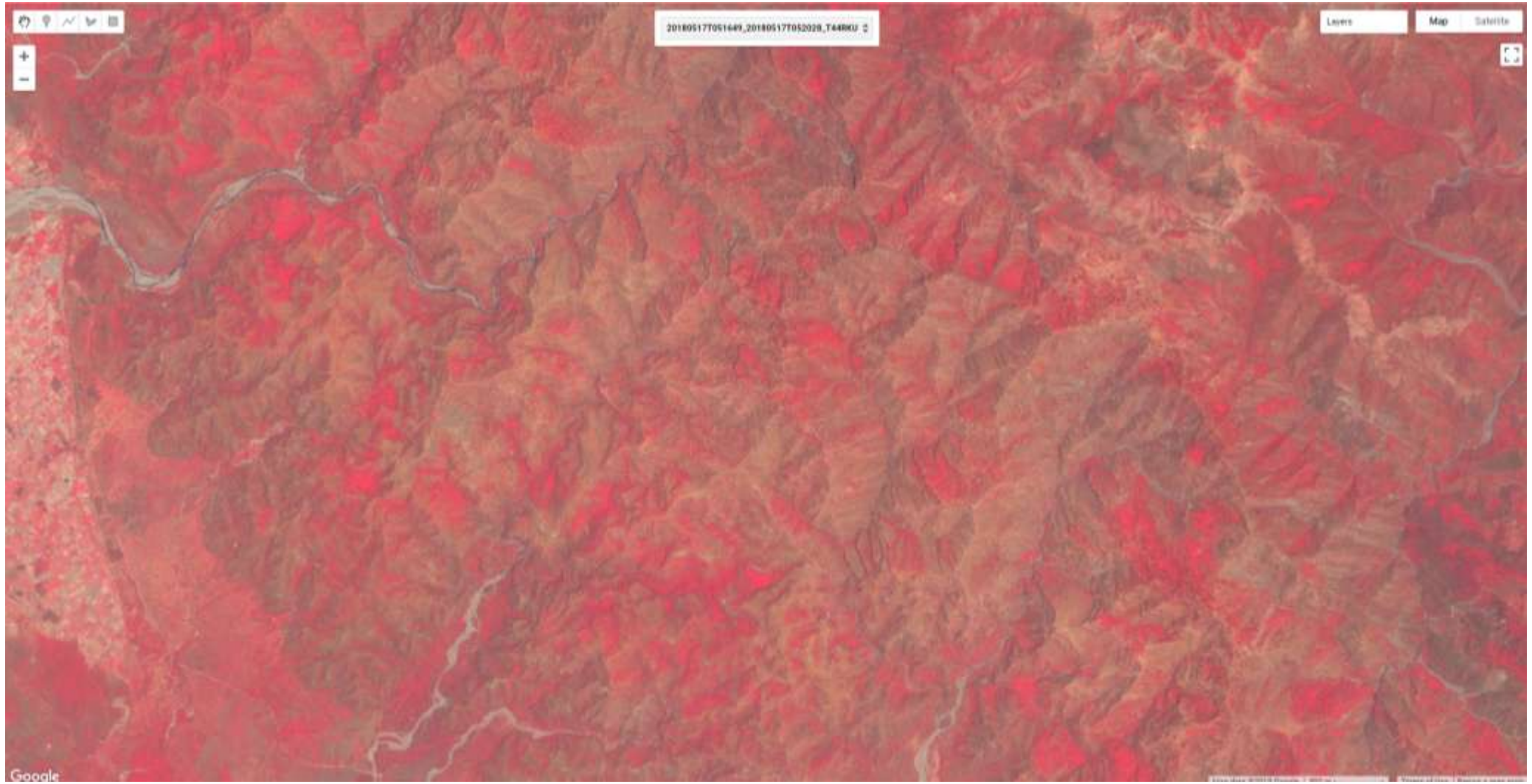
Fire Name	State	First Detection Time	Last Detection Time	No. of Days fire remained active	No. of Pixels
KOTDWAR -5	UTTARAKHAND	2018-05-20	2018-05-30	9	233



STATE	UTTARAKHAND
DISTRICT	PAURI GARHWAL
CIRCLE	SHIVALIK CIRCLE
DIVISION	LANSDOWNE FOREST DIVISION
RANGE	KOTDWAR RANGE, LALDANG RANGE

Satellite Image Validation By Google Earth Engine

Fire Name	State	First Detection Time	Last Detection Time	No. of Days fire remained active	No. of Pixels
KOTDWAR -5	UTTARAKHAND	2018-05-20	2018-05-30	9	233



Pre Fire Date – 2018-05-17, Image - Sentinel 2

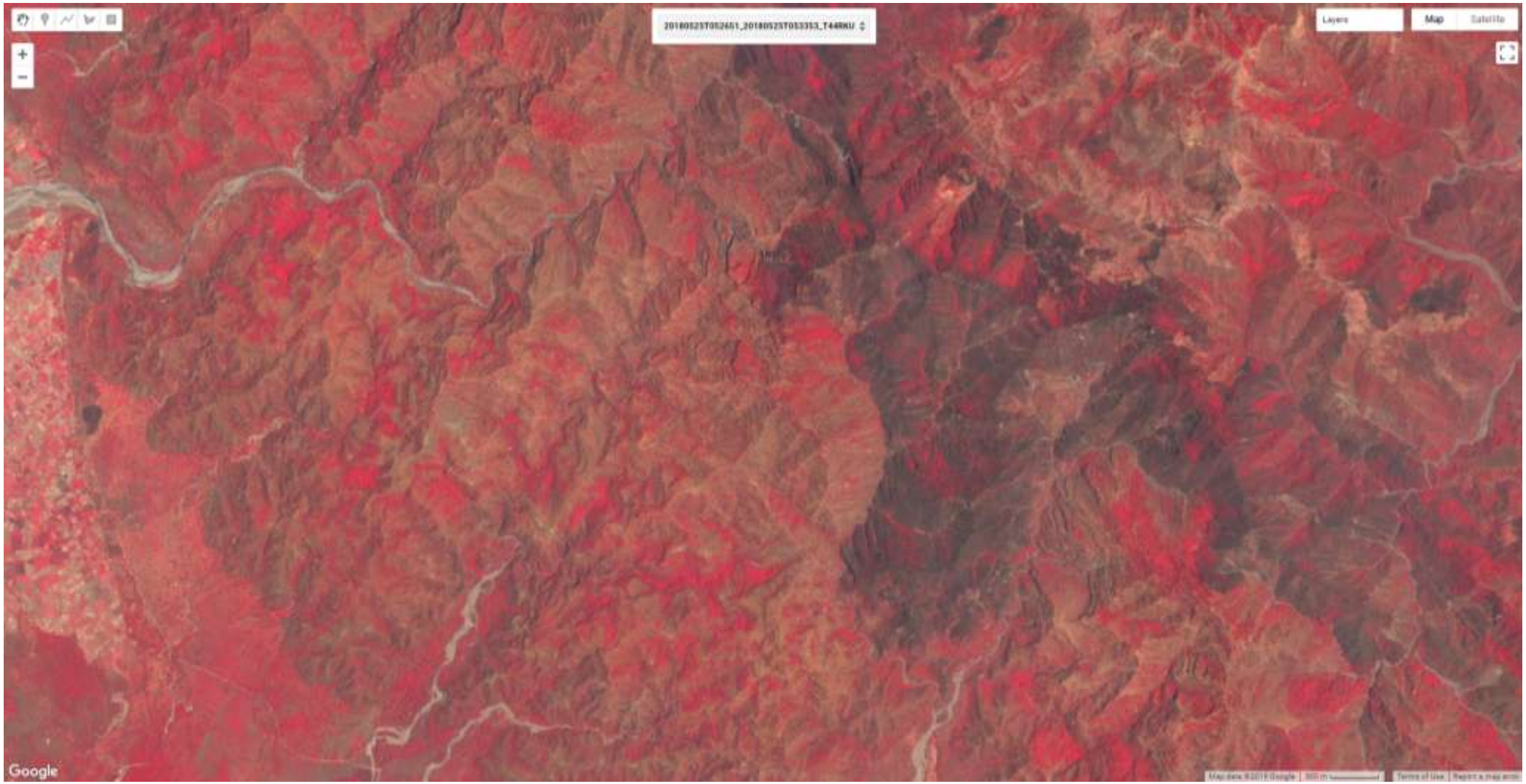
Satellite Image Validation By Google Earth Engine

Fire Name	State	First Detection Time	Last Detection Time	No. of Days fire remained active	No. of Pixels
KOTDWAR -5	UTTARAKHAND	2018-05-20	2018-05-30	9	233

Fire Date – 2018-05-22, Image - Sentinel 2

Satellite Image Validation By Google Earth Engine

Fire Name	State	First Detection Time	Last Detection Time	No. of Days fire remained active	No. of Pixels
KOTDWAR -5	UTTARAKHAND	2018-05-20	2018-05-30	9	233



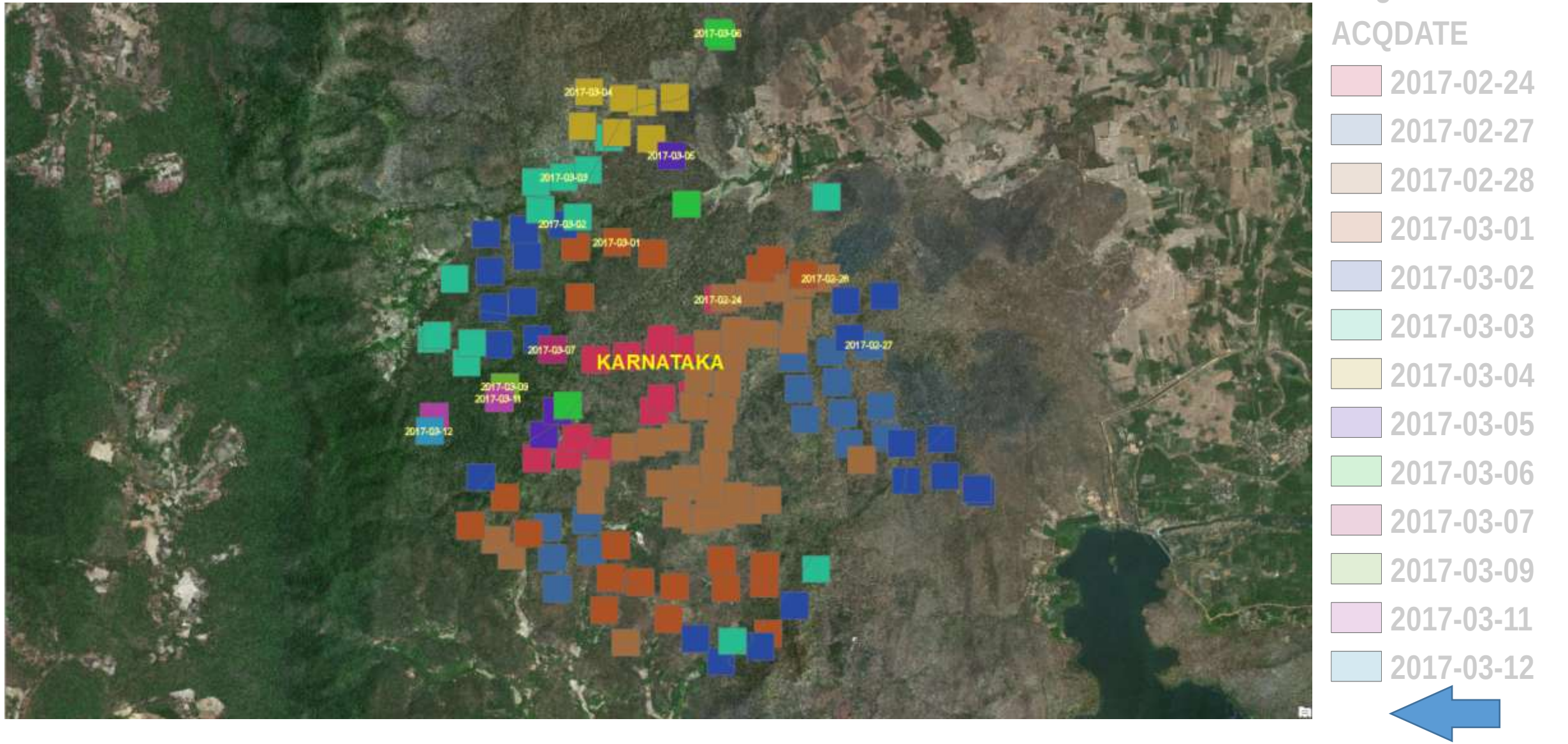
Fire Date – 2018-05-25, Image - Sentinel 2

Satellite Image Validation By Google Earth Engine

Fire Name	State	First Detection Time	Last Detection Time	No. of Days fire remained active	No. of Pixels
KOTDWAR -5	UTTARAKHAND	2018-05-20	2018-05-30	9	233

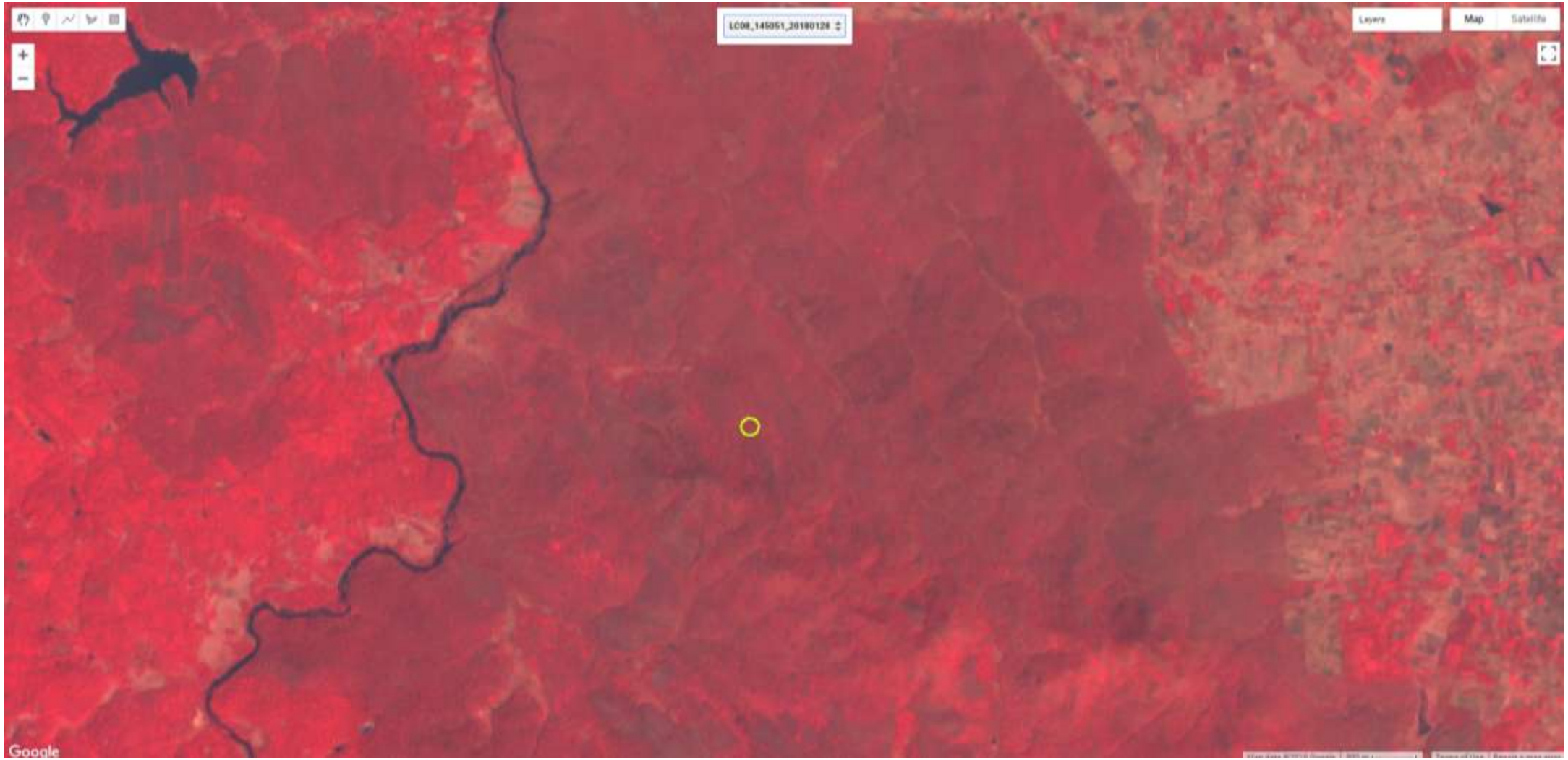
Fire Date – 2018-05-30, Image - Sentinel 2

Fire Name	State	First Detection Time	Last Detection Time	No. of Days fire remained active
SACRE BYLE -3	KARNATAKA	20170224	20170312	16



Satellite Image Validation By Google Earth Engine

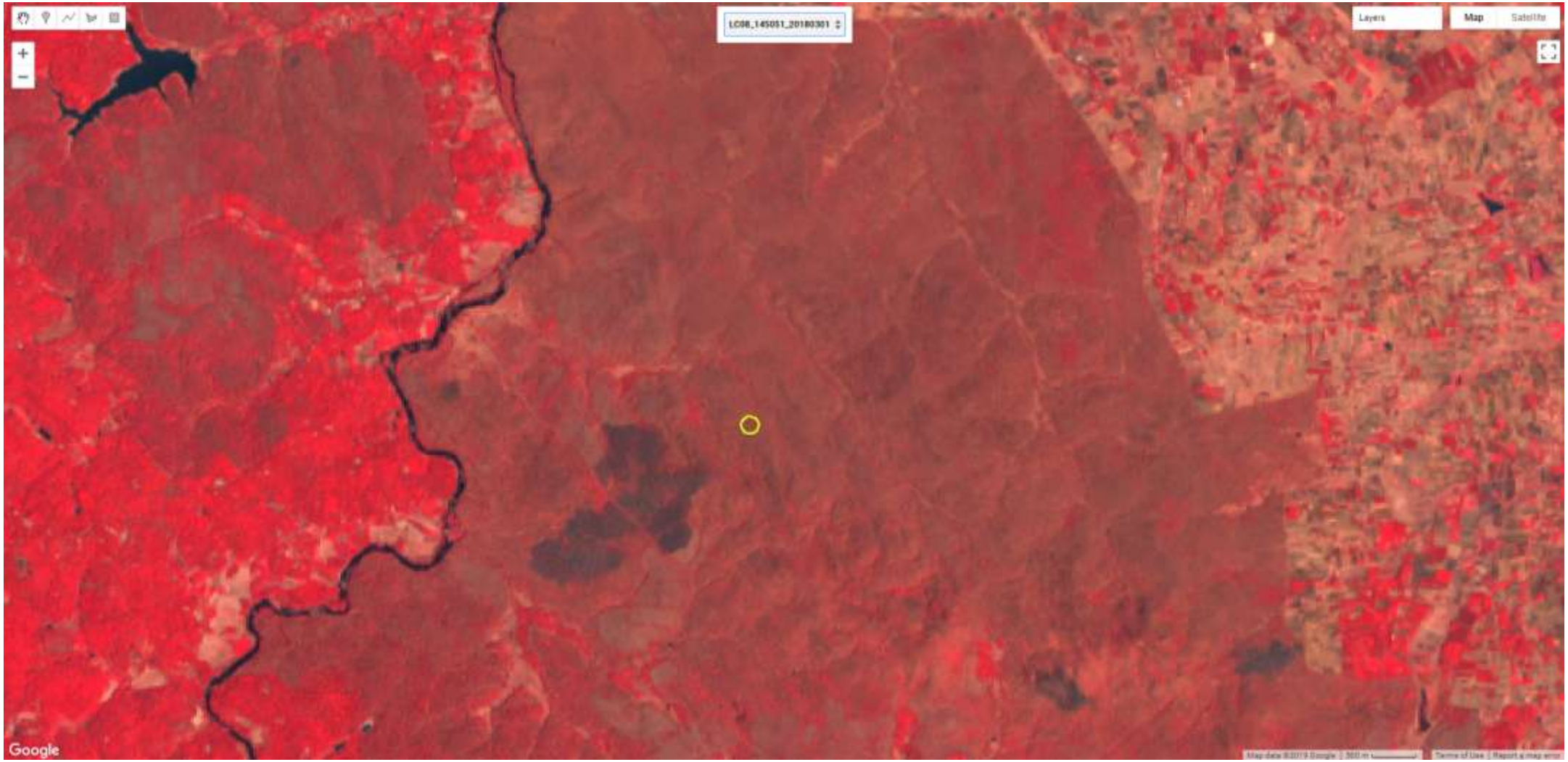
Fire Name	State	First Detection Time	Last Detection Time	No. of Days fire remained active
KUSHALNAGAR -2	KARNATAKA	2016-03-01	2016-03-10	9



Pre Fire Date – 2018-01-28, Image -Landsat-8

Satellite Image Validation By Google Earth Engine

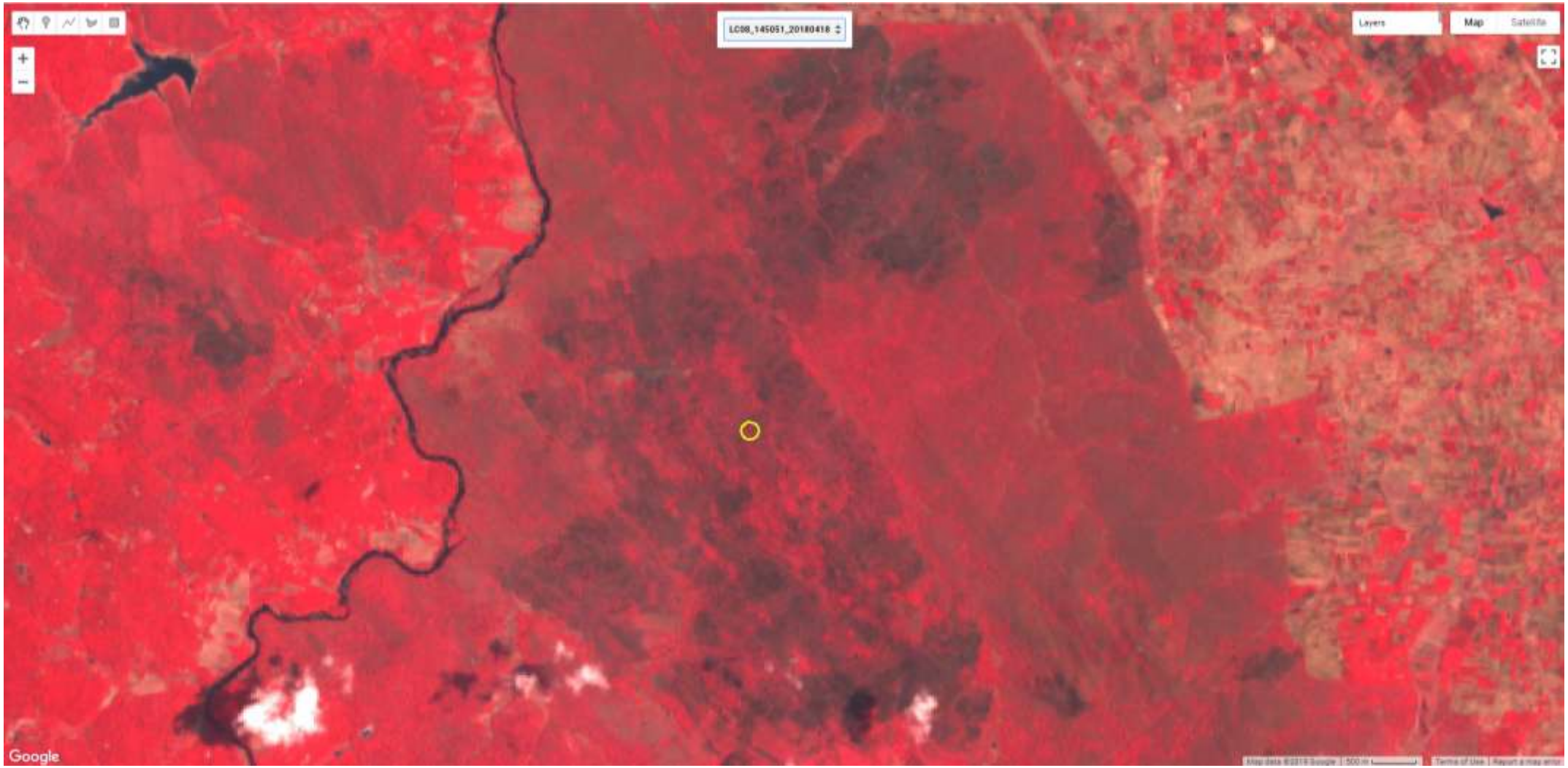
Fire Name	State	First Detection Time	Last Detection Time	No. of Days fire remained active
KUSHALNAGAR -2	KARNATAKA	2016-03-01	2016-03-10	9



Fire Date – 2018-03-01, Image -Landsat-8

Satellite Image Validation By Google Earth Engine

Fire Name	State	First Detection Time	Last Detection Time	No. of Days fire remained active
KUSHALNAGAR -2	KARNATAKA	2016-03-01	2016-03-10	9



Post Fire Date – 2018-04-18, Image -Landsat-8

EXAMPLE OF EMAIL ALERT OF LARGE FOREST FIRE

KMZ & CSV FILE OF 2 ACTIVE LARGE FOREST FIRES OF HIMACHAL PRADESH DETECTED IN SNPP__20190528_1353

Office/FSI_CSV ×

fsilargeforestfire2018@gmail.com 2:59 PM (1 hour ago)

to ccffpfc, apnagar, apnagar, biswastapas007, anupampal88, harshijn18, gk7shatty7, me, abhishek.choudhery23, evforester

Sir/Madam,
It is to bring to your attention that 2 of LARGE FOREST FIRES are currently active in HIMACHAL PRADESH as per the recent satellite data pertaining to SNPP__20190528_1353.

Forest Survey of India is currently testing the LARGE FOREST FIRE MONITORING PROGRAMME using near real time SNPP-VIIRS data.
Herein, FSI will disseminate Large Forest Fire alerts with the objective to identify,track and report serious forest fire incidents so as to help monitor such fires at senior level in the State Forest Department and also seek timely additional assistance that may be required to contain such fires.

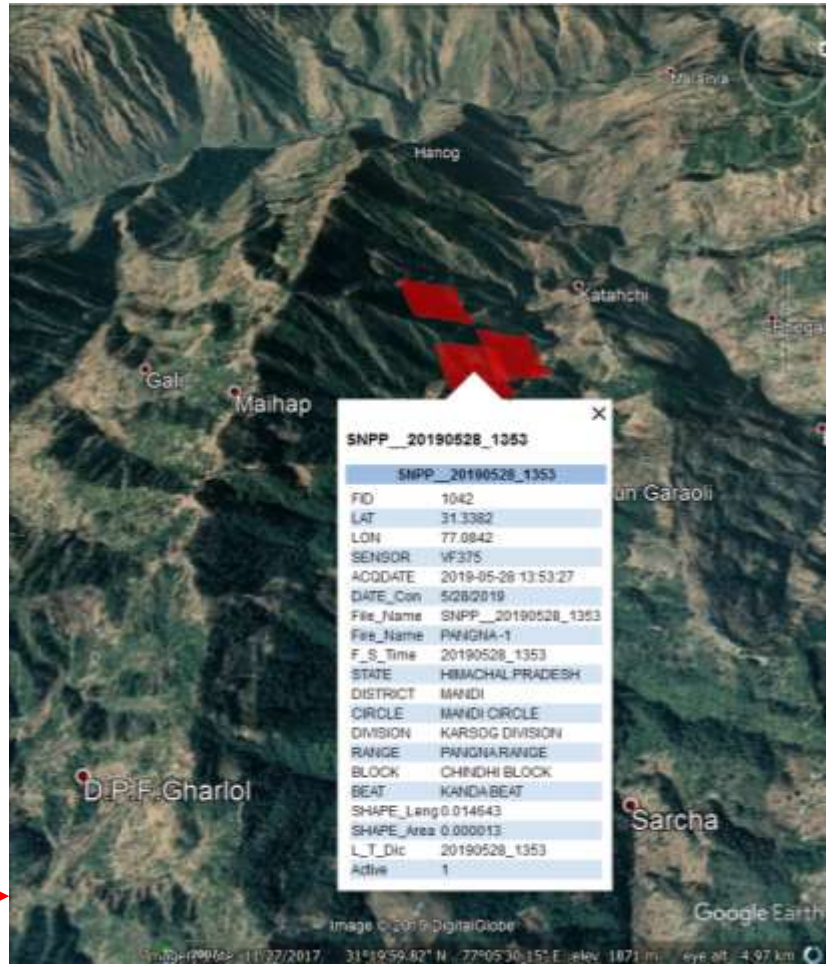
Please find enclosed the Large Forest Fire polygons of HIMACHAL PRADESH as a KMZ file attachment.
- KMZ file is google earth compatible and would be uploaded automatically on google earth.
- Kindly click on the fire pixels for detailed administrative information as well as time-span of the fire.
- For a particular large-fire, Active fire pixels are depicted in color RED in contrast with Previous fire pixels in a single kmz file to track its spread, extents and time-span.
Please find enclosed CSV file for the Large Forest Fire polygons detailed of HIMACHAL PRADESH.

We would really appreciate if you could share your feedback on this new initiative which will help us to improve and provide useful information to the decision makers.
You may revert to us for queries or feedback.

With Regards,
Forest Fire Monitoring Team,
Forest Survey of India,
Ministry of Environment, Forest and Climate Change,
Kaulagarh Road, Dehradun- 248195.
0135-2754191 Ex-272

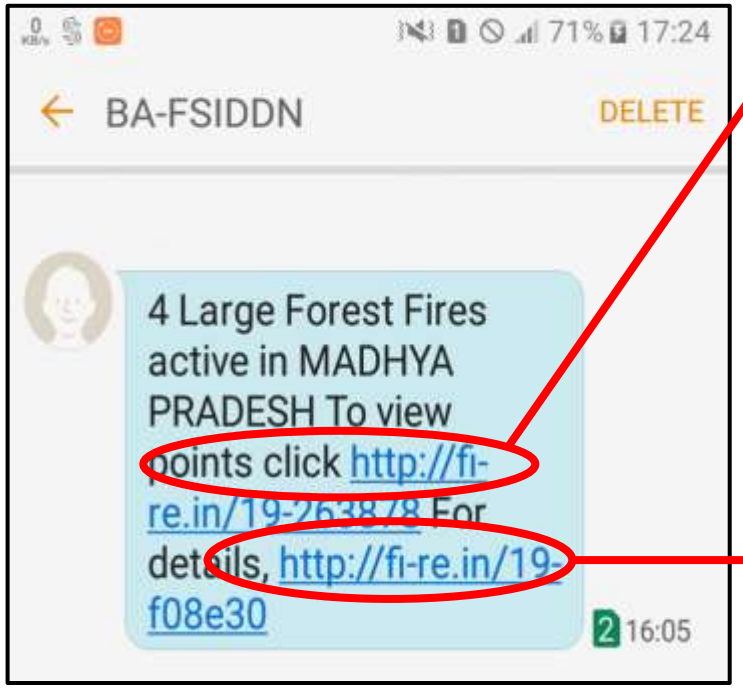
2 Attachments

SNPP__20190528_... SNPP__20190528_...



LAT	LON	SENSOR	ACQDATE	FIRE NAME	FIRST DETECTED	STATE	DISTRICT	CIRCLE	DIVISION	RANGE	BLOCK	BEAT	LATEST DETECTED	STATUS*
31.0184	76.8745	VF375	28-05-2019 13:53	KUTHAR -1	20190528_1353	HIMACHAL PRADESH	SOLAN	BILASPUR CIRCLE	KUNIHAR DIVISION	KUTHAR RANGE	PATTA BLOCK	AWAD BEAT	20190528_1353	1
31.0185	76.8719	VF375	28-05-2019 13:53	KUTHAR -1	20190528_1353	HIMACHAL PRADESH	SOLAN	BILASPUR CIRCLE	KUNIHAR DIVISION	KUTHAR RANGE	PATTA BLOCK	AWAD BEAT	20190528_1353	1
31.0191	76.8775	VF375	28-05-2019 13:53	KUTHAR -1	20190528_1353	HIMACHAL PRADESH	SOLAN	BILASPUR CIRCLE	KUNIHAR DIVISION	KUNIHAR RANGE	CHANDI BLOCK	GOELA BEAT	20190528_1353	1
31.0191	76.8775	VF375	28-05-2019 13:53	KUTHAR -1	20190528_1353	HIMACHAL PRADESH	SOLAN	BILASPUR CIRCLE	KUNIHAR DIVISION	KUTHAR RANGE	PATTA BLOCK	AWAD BEAT	20190528_1353	1
31.3377	77.0782	VF375	28-05-2019 13:53	PANGNA -1	20190528_1353	HIMACHAL PRADESH	MANDI	MANDI CIRCLE	KARSOG DIVISION	PANGNA RANGE	CHINDHI BLOCK	KANDA BEAT	20190528_1353	1
31.3382	77.0842	VF375	28-05-2019 13:53	PANGNA -1	20190528_1353	HIMACHAL PRADESH	MANDI	MANDI CIRCLE	KARSOG DIVISION	PANGNA RANGE	CHINDHI BLOCK	KANDA BEAT	20190528_1353	1
31.341	77.0825	VF375	28-05-2019 13:53	PANGNA -1	20190528_1353	HIMACHAL PRADESH	MANDI	MANDI CIRCLE	KARSOG DIVISION	PANGNA RANGE	CHINDHI BLOCK	KANDA BEAT	20190528_1353	1

EXAMPLE OF LARGE FIRE SMS ALERT



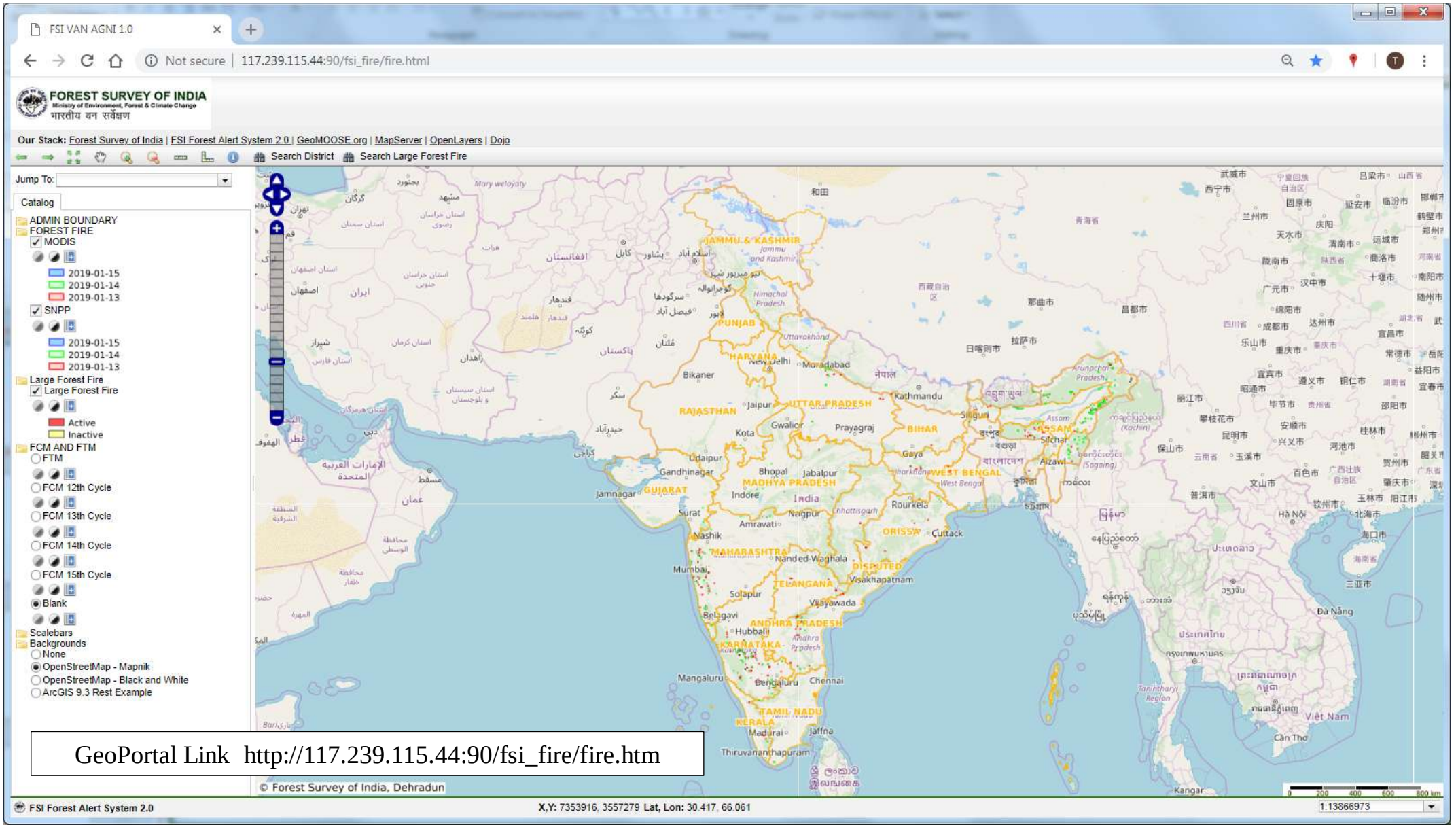
#	Fire Name	Division / District	Active Pixels	Total Pixels	KMZ Link	MAP Link	Portal Link	Fire Status
1.	CHANDGARH -3 First Detection: 21-02-2019 13:53	State: MADHYA PRADESH District: EAST NIMAR Circle: KHANDWA CIRCLE Division: KHANDWA DIVISION Range: CHANDGARH RANGE Block: CHANDGARH RANGE BLOCK Beat: NORTH BHETKEDA BEAT	3	7	Download KMZ	View	View	Active
2.	CHURNA (BHAURA) -1 First Detection: 21-02-2019 13:53	State: MADHYA PRADESH District: HOSHANGABAD Circle: SATPUDA TIGER RESERVE CIRCLE Division: SATPUDA TIGER RESERVE DIVISION Range: CHURNA (BHAURA) RANGE Block: CHURNA (BHAURA) RANGE BLOCK Beat: BANGLAPURA JAL BEAT	7	7	Download KMZ	View	View	Active
3.	GARHI -1 First Detection: 21-02-2019 13:53	State: MADHYA PRADESH District: RAISEN Circle: BHOPAL CIRCLE Division: RAISEN DIVISION Range: GARHI RANGE Block: GARHI RANGE BLOCK Beat: MAHALPURPATHA BEAT	3	3	Download KMZ	View	View	Active

FSI Forest Fire Geo-Portal
Van Agni

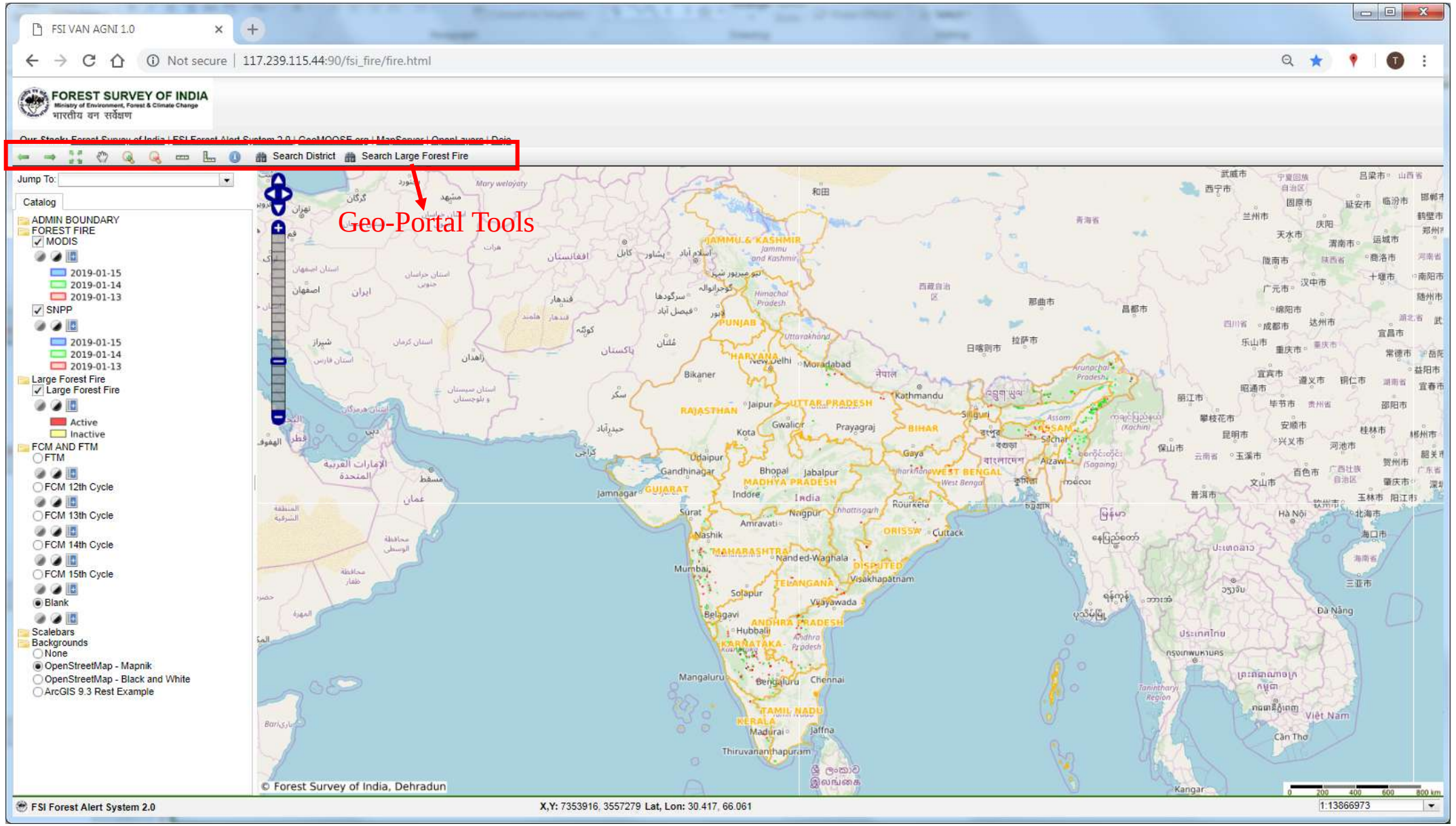
Features in Geoportal

- Created using Opensource Software (MapServer 7.0.7 & GeoMOOSE 2.9)
- Latest Web GIS Technology
- Compatible with OGC standards
- Automated integration of Near Real Time Forest Fire Data & Large Forest Fire Data
- Easy to use simple tools
- Integration of Forest Cover and Forest Type Data in background
- Integration of Open Source Open Street Map Data
- Advance Searching capability

FSI GEOPORTAL



FSI GEOPORTAL



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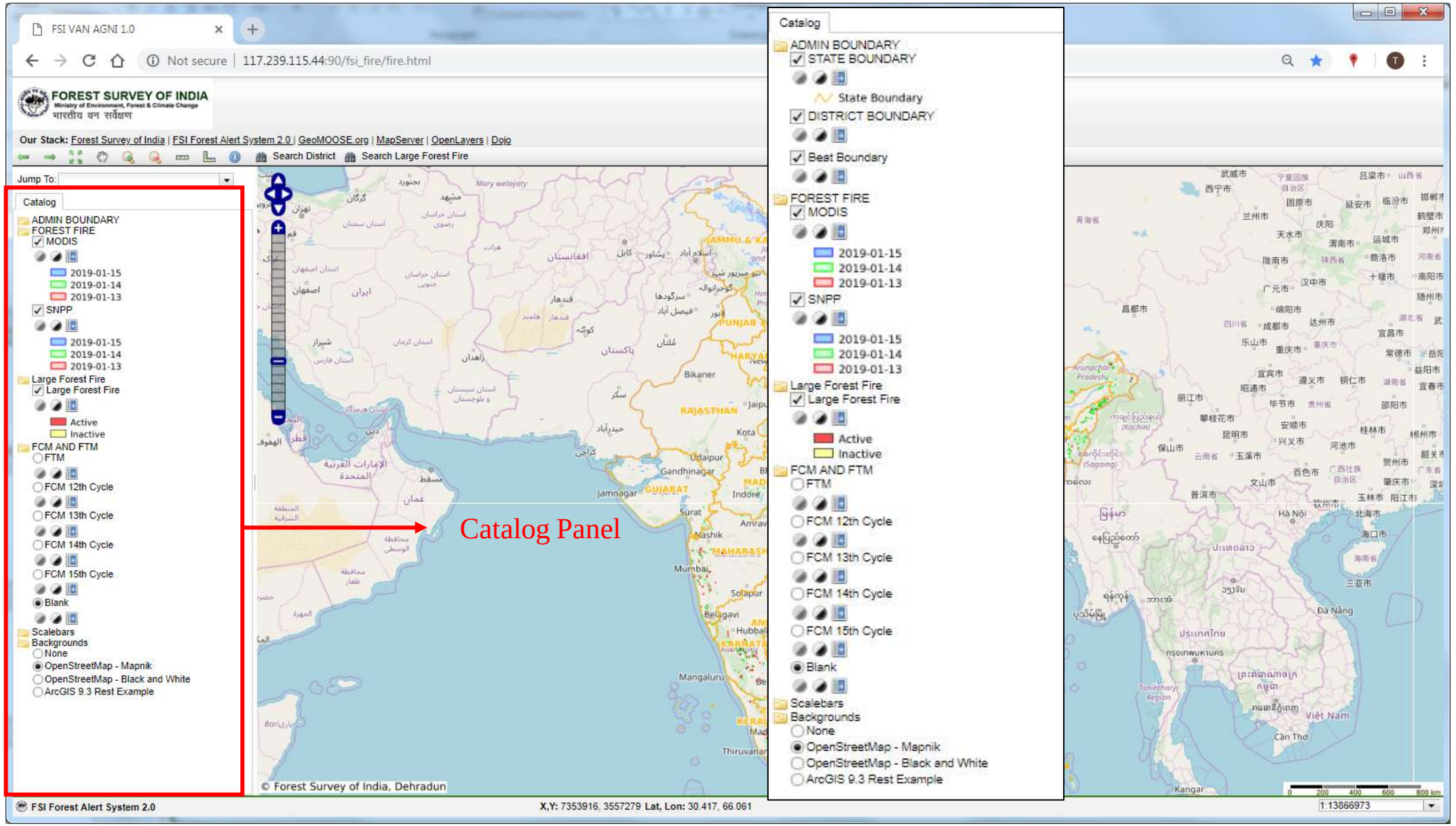
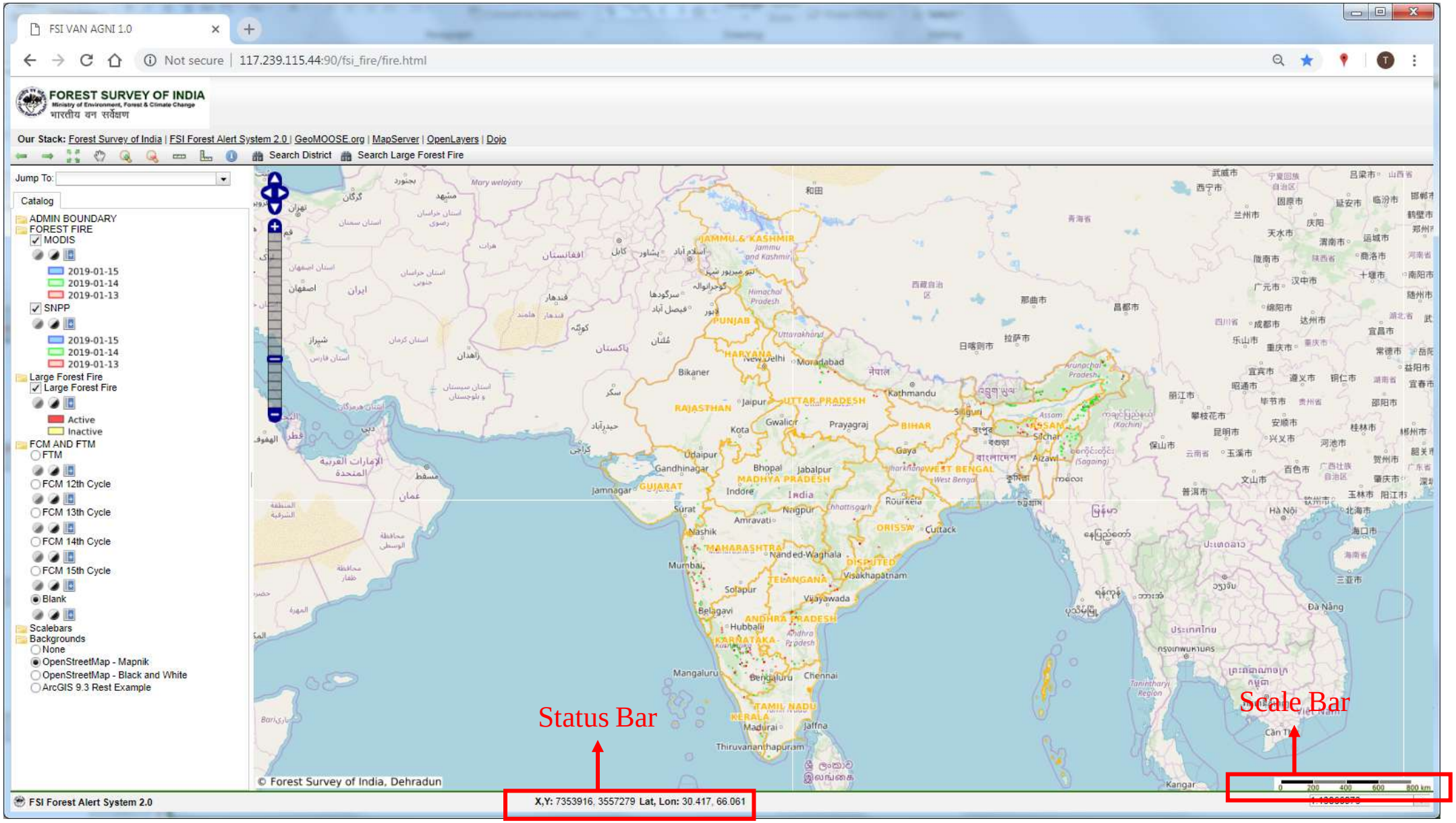
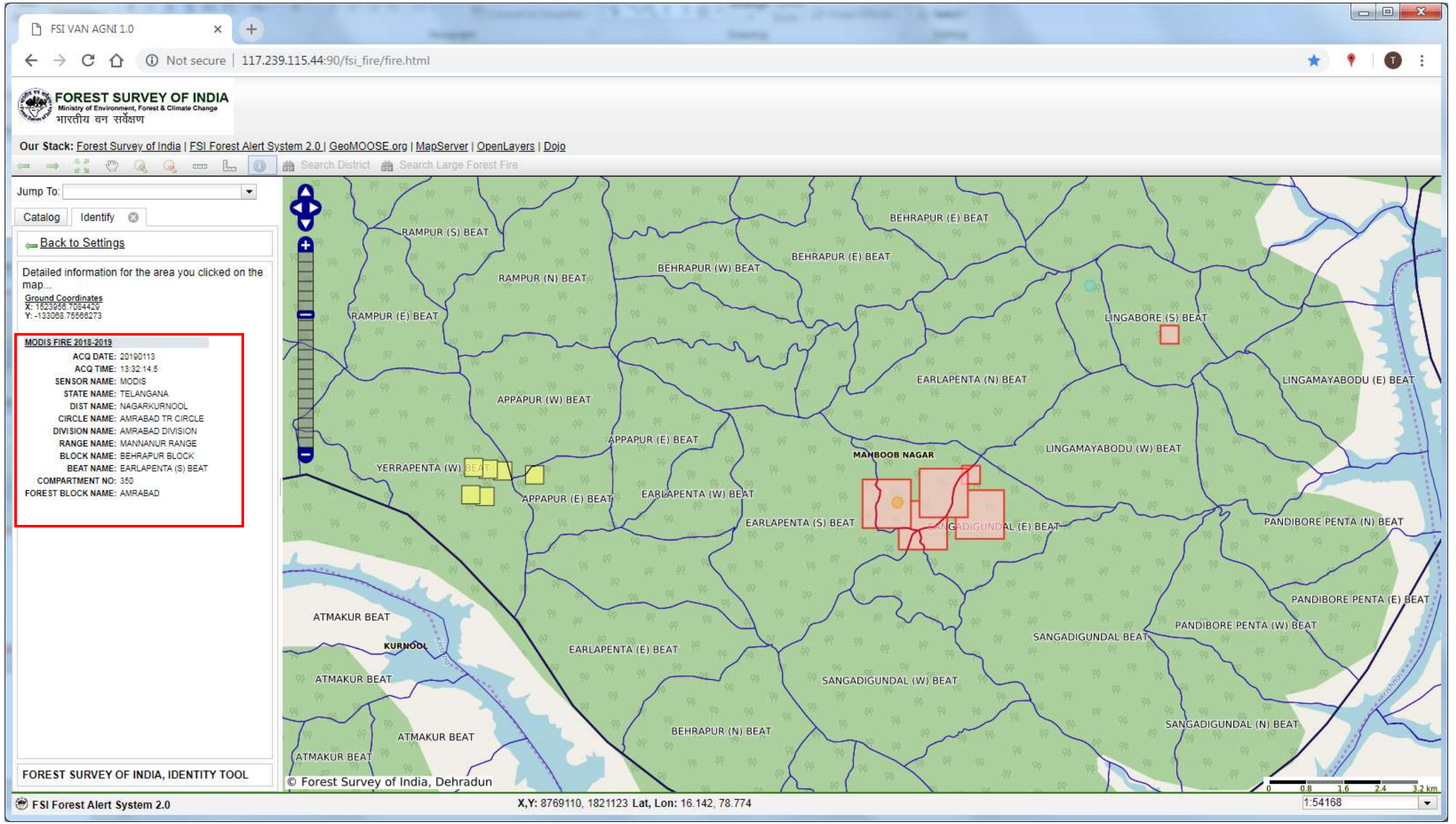


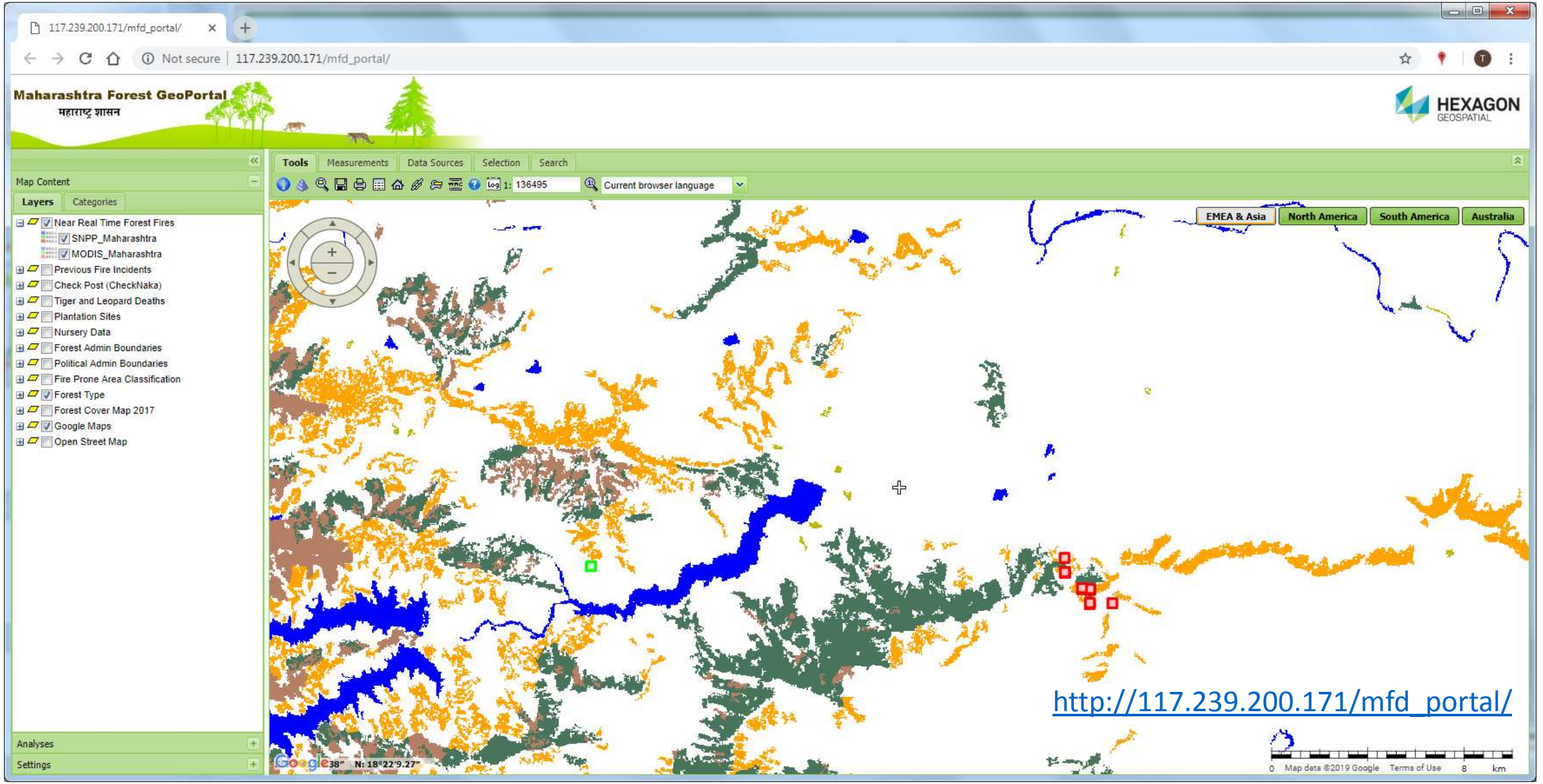
FSI GEOPORTAL




FSI VAN AGNI 1.0
Not secure | 117.239.115.44:90/fsi_fire/fire.html
FOREST SURVEY OF INDIA
Ministry of Environment, Forest & Climate Change
भारतीय वन सर्वेक्षण
Our Stack: Forest Survey of India | FSI Forest Alert System 2.0 | GeoMOOSE.org | MapServer | OpenLayers | Dojo
Search District
Search Large Forest Fire
Jump To:
Catalog
Identify
Back to Settings
Detailed information for the area you clicked on the map...
Ground Coordinates
X: 1523956.7084429
Y: -133068.75666273
MODIS FIRE 2018-2019
ACQ DATE: 20190113
ACQ TIME: 13:32:14.5
SENSOR NAME: MODIS
STATE NAME: TELANGANA
DIST NAME: NAGARKURNOOL
CIRCLE NAME: AMRABAD TR CIRCLE
DIVISION NAME: AMRABAD DIVISION
RANGE NAME: MANNANUR RANGE
BLOCK NAME: BEHRAPUR BLOCK
BEAT NAME: EARLAPENTA (S) BEAT
COMPARTMENT NO: 350
FOREST BLOCK NAME: AMRABAD
FOREST SURVEY OF INDIA, IDENTITY TOOL
RAMPUR (S) BEAT
BEHRAPUR (E) BEAT
BEHRAPUR (W) BEAT
RAMPUR (N) BEAT
RAMPUR (E) BEAT
LINGABORE (S) BEAT
EARLAPENTA (N) BEAT
LINGAMAYABODU (E) BEAT
APPAPUR (W) BEAT
APPAPUR (E) BEAT
MANBOOB NAGAR
LINGAMAYABODU (W) BEAT
YERRAPENTA (W) BEAT
EARLAPENTA (W) BEAT
EARLAPENTA (S) BEAT
PANDIBORE PENTA (N) BEAT
PANDIBORE PENTA (E) BEAT
ATMAKUR BEAT
KURNOOL
PANDIBORE PENTA (W) BEAT
SANGADIGUNDAL BEAT
EARLAPENTA (E) BEAT
SANGADIGUNDAL (W) BEAT
BEHRAPUR (N) BEAT
SANGADIGUNDAL (N) BEAT
© Forest Survey of India, Dehradun
FSI Forest Alert System 2.0
X,Y: 8769110, 1821123 Lat, Lon: 16.142, 78.774
1:54168

Real Time WMS & WFS Service to State

Real Time WMS Service in Maharashtra Forest Geo-Portal



Early-Warning Alert System for Forest Fire

Primary Objectives of Early-Warning Alert System

Identify vulnerable areas on the ground for-

- **Alerting State Forest Department and other agencies**
- **Resource allocation and mobilisation**
- **Risk reduction and mitigation**
- **Develop a scientific approach for identification of highly fire prone areas**
- **Inputs for future planning**

Forest Fire
Pre-Warning Alert System

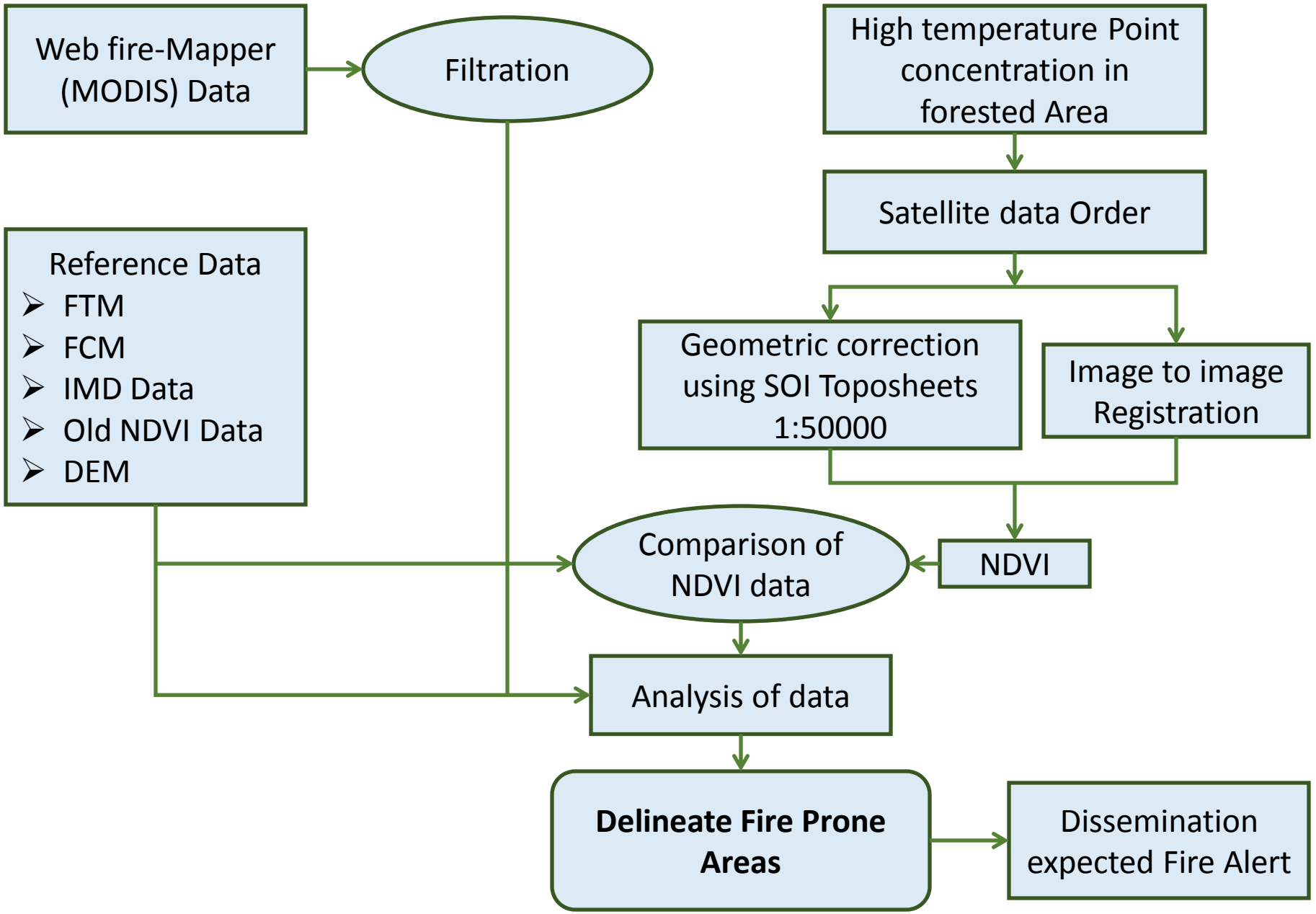
An important component of the study would be to issue alerts in respect of regions where there are enhanced conditions of forest fire outbreaks in terms of the following:

- **Increase in atmospheric temperature leading to leaf stress, yellowing of leaves and lead shedding ultimately resulting in increased dry biomass/fuel load for burning**
- **Dry spells with no rains causing early yellowing of leaves and lead fall**
- **Loss in soil moisture leading to fast spread of ground fires during the outbreaks**

Data used

- Fire Data (from NRSC/ Web Fire Mapper)
- Forest Type Map (FTM)
- Temperature Data (From IMD)

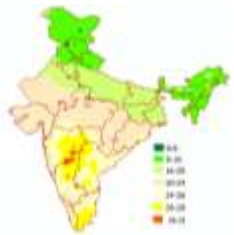
Methodology for Pre-warning Alert system



Work Flow for Pre-Warning Alert System for Forest Fire

MODIS Sensor

Temperature Data from IMD



Temperature Map

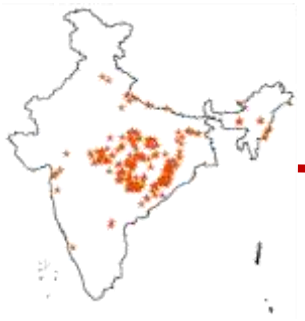
Forest Type Map

Forest Cover Map

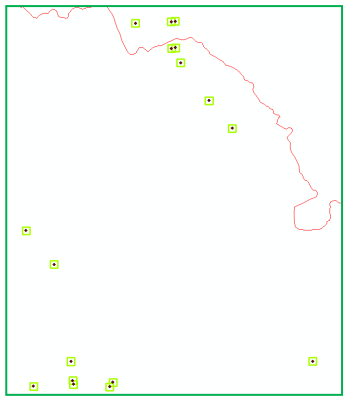
Admin Boundaries

Signals Received at Earth Station

Intersect



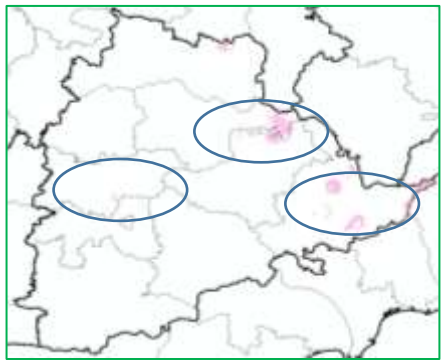
Fire Point Data



Buffer (1Km x 1Km)

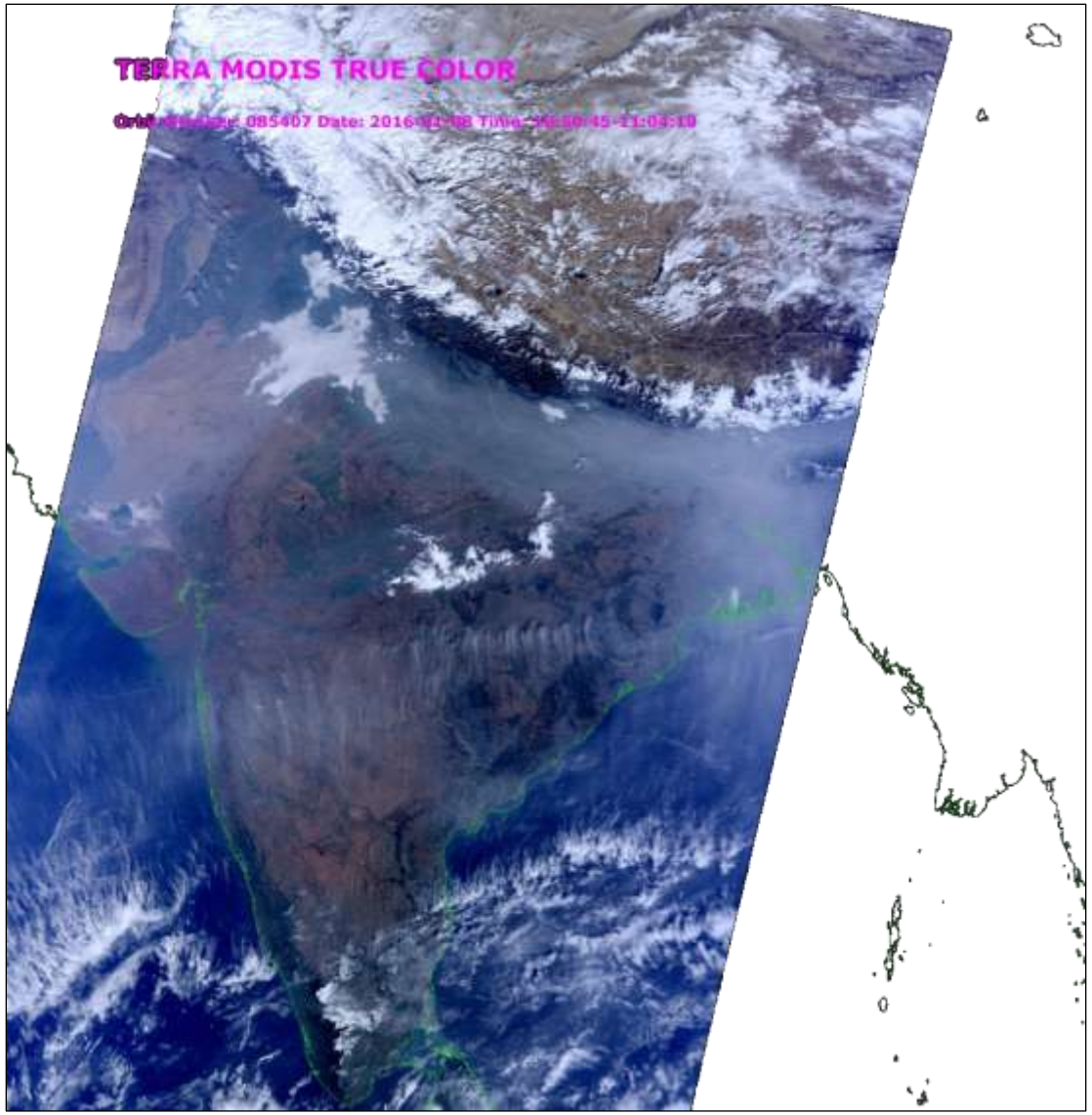
Analysis & Creation of Pre-Warning Alert Polygons

Pre-Warning Polygons

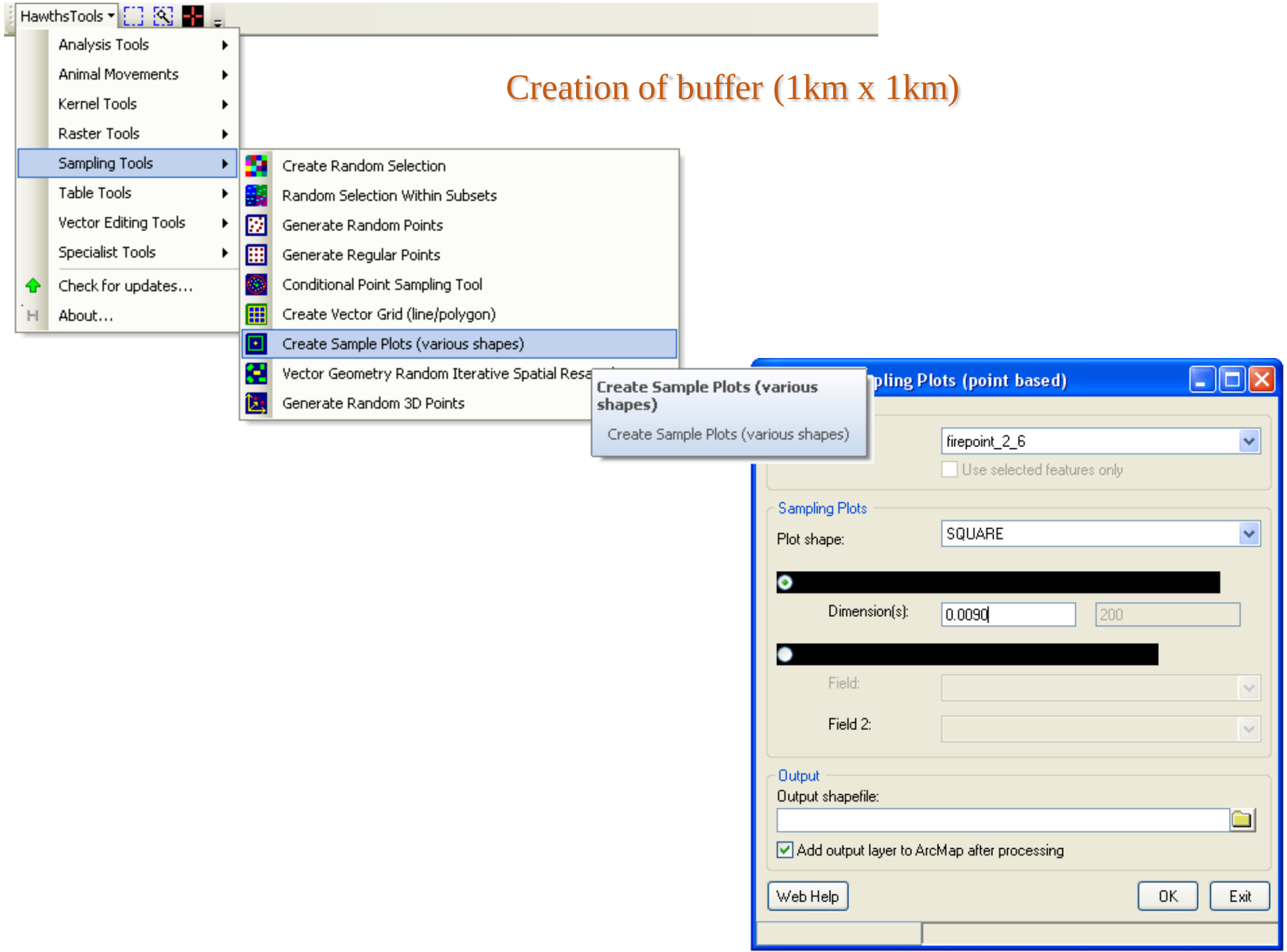


Fire point of 06 Feb. 2016 overlaid on India state boundary

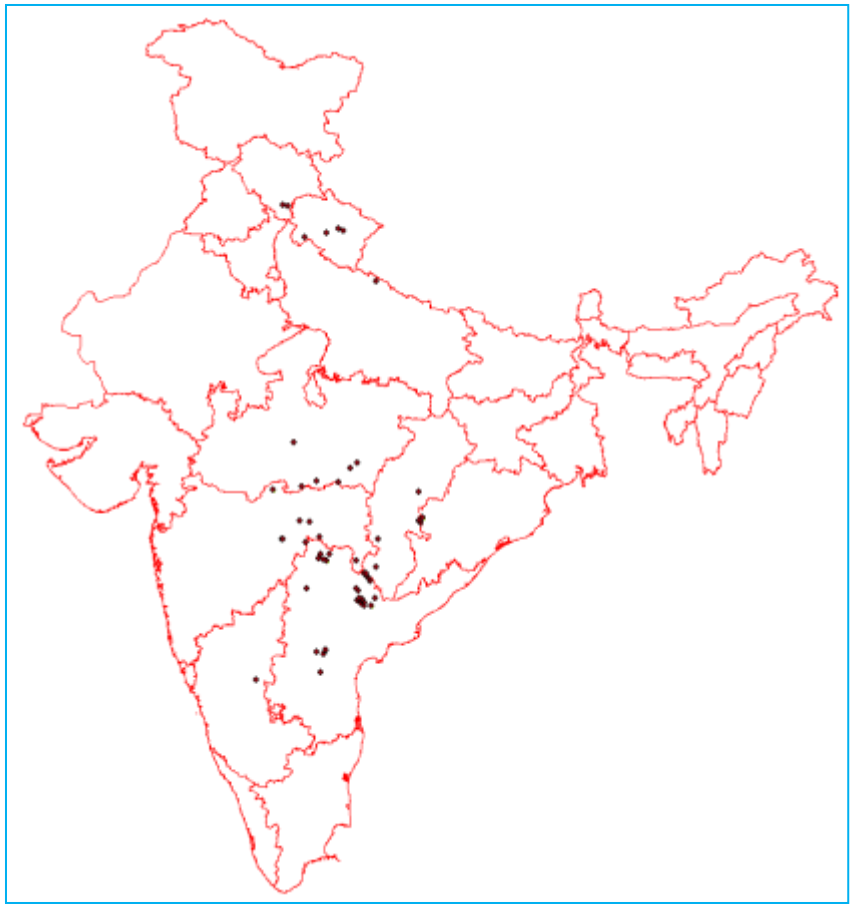
Terra MODIS true color Image

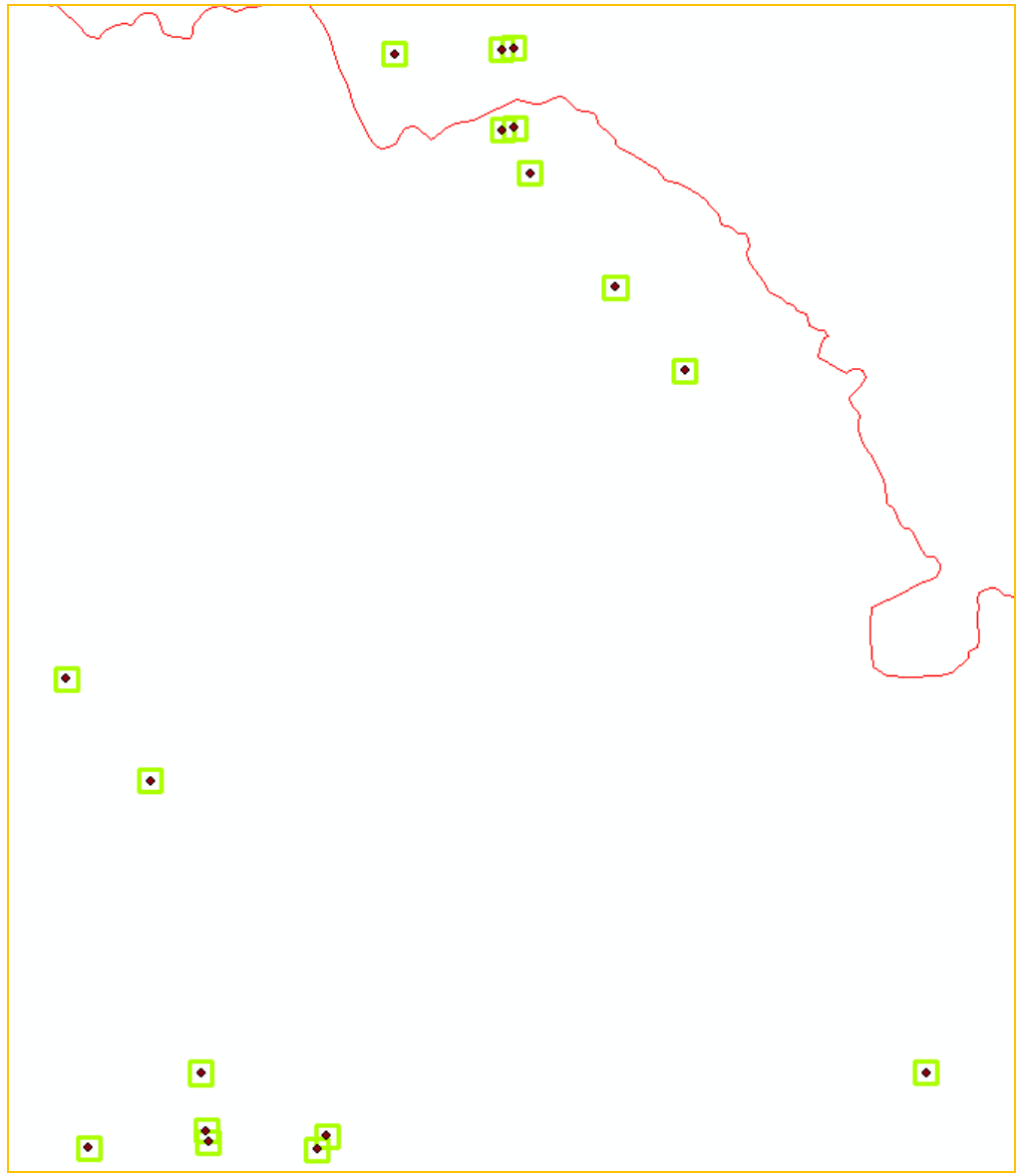


Creation of buffer (1km x 1km)



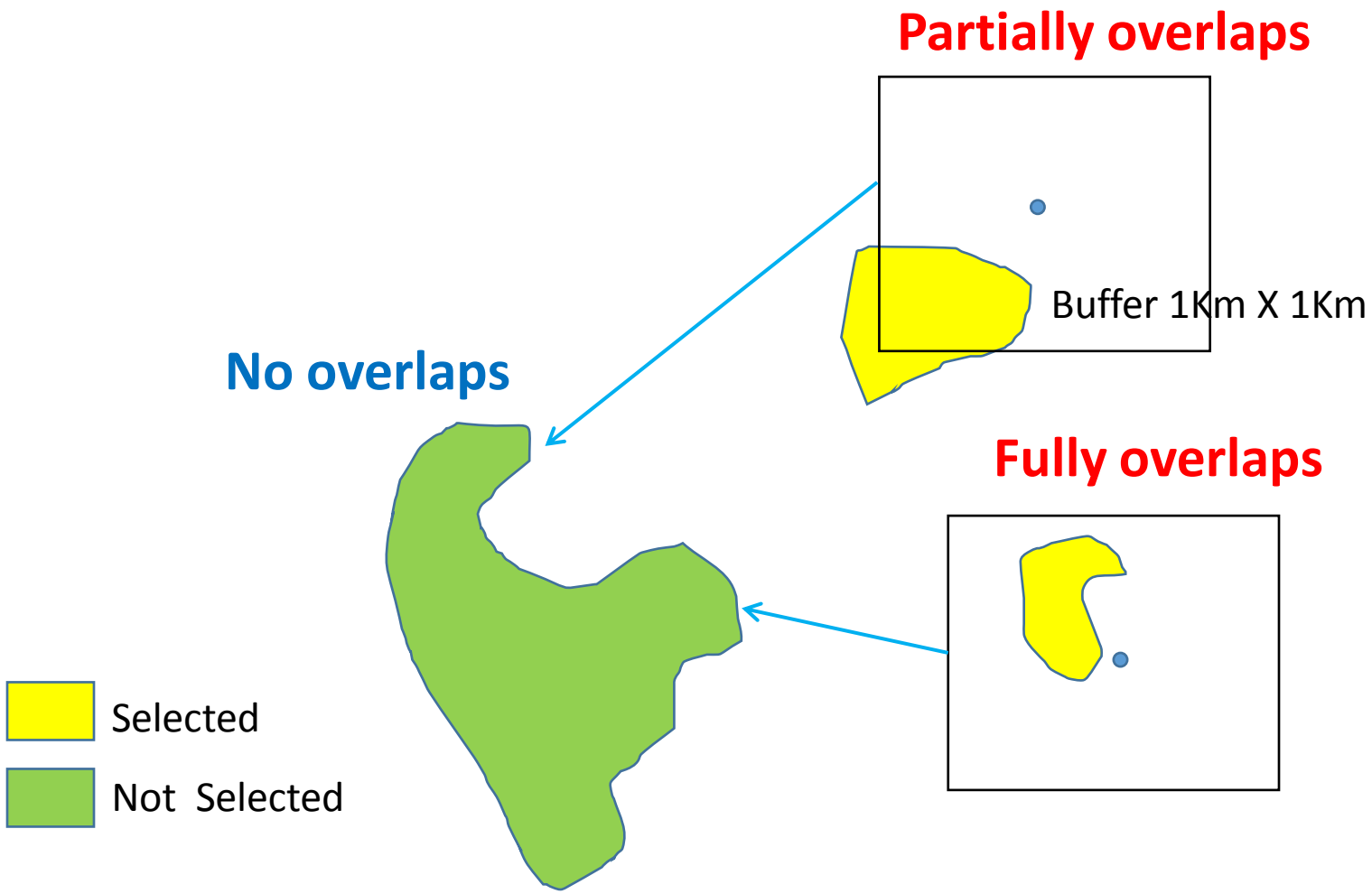
Buffer (1Km x 1Km)



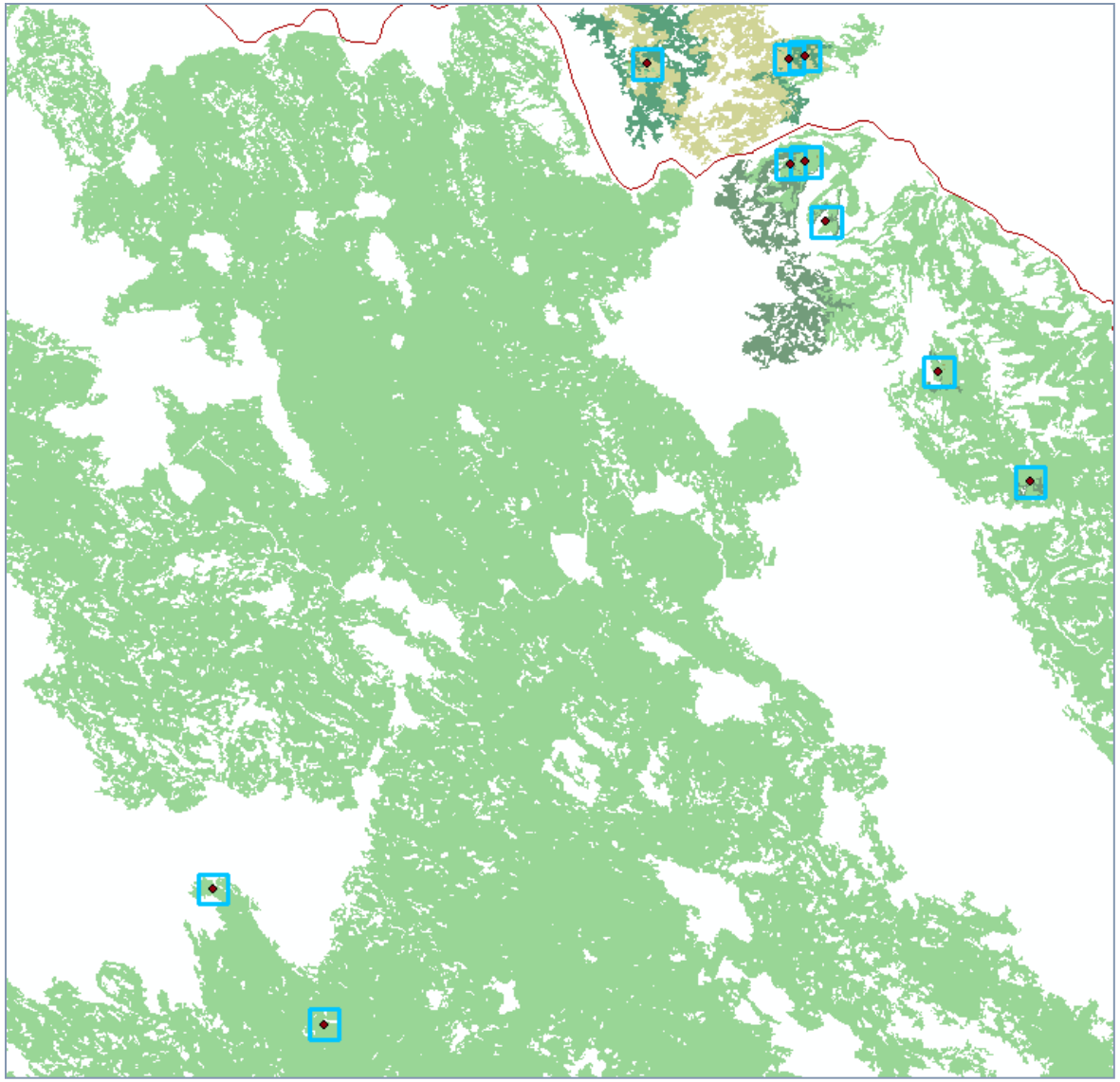


Selection of Forest Types

- ✓ Selection of Forest types based on intersect
- ✓ Intersect returns any feature that either full or partially overlaps the source features



FTM intersected with 1kmx1km buffer polygon

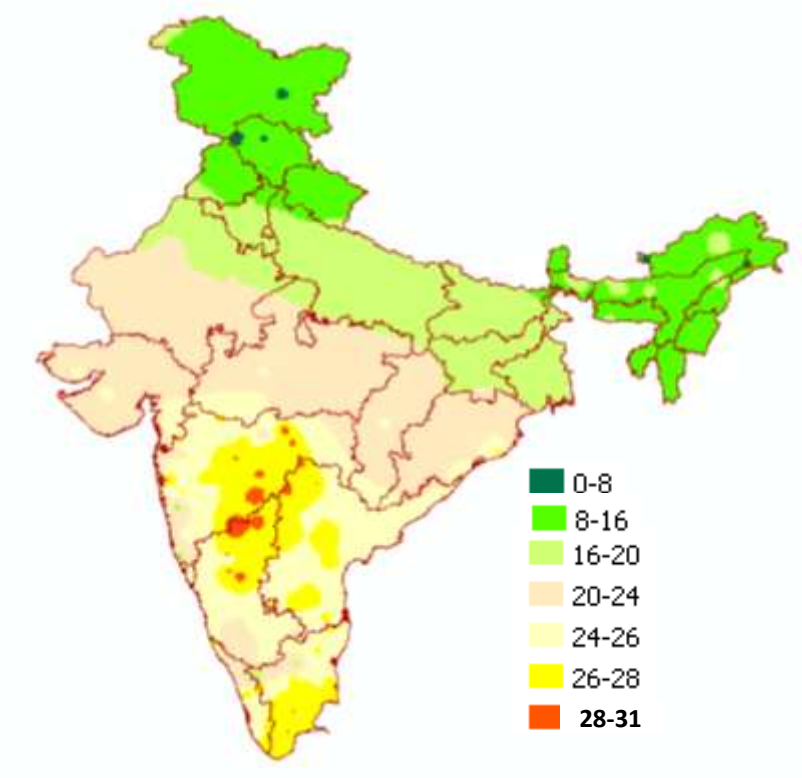


Near real time Temperature
&
Rainfall data from Indian Meteorological Department

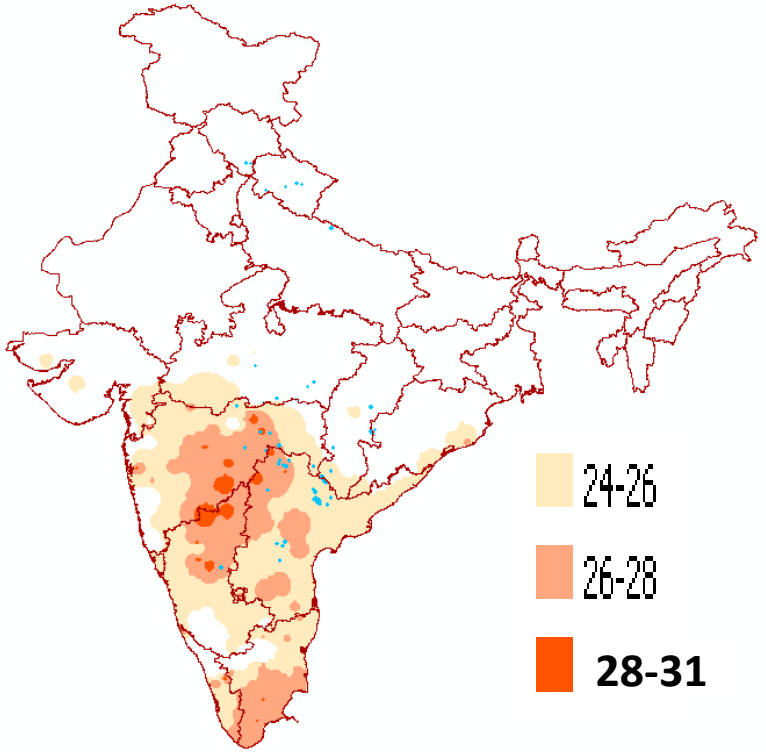
SR.NO.	STATION NAME	DATE	TIME	LATITUDE[N]	LONGITUDE[E]	SLP[hPa]	MSLP	RAINFALL[mm]	TEMPERATURE [Deg C]	POINT DEW [Deg C]	WIND SPEED [Kt]	WIND DIR [Deg]
1	VEDASANDUR	15-Dec-15	12:00:00	10.5	78	986.5	1010.3 hpa	0	26.8	26.8	2	100
2	UTTAR_KASHI	15-Dec-15	12:00:00	30.4	79.4	885.6	1545.3 gpm	0	13		0	60
3	TAWANG	15-Dec-15	12:00:00	27.6	91.9	716.5	3192.6 gpm	0	0.2		1	60
4	TAVANUR	15-Dec-15	12:00:00	10.8	75	1008.8	1011.4 hpa	2	27.9	26.8	1	0
5	THIRUVANANTHAPURAM	15-Dec-15	12:00:00	8.5	77		----	0	28.8		6	320
6	TIRUMALLA	15-Dec-15	12:00:00	13.7	79.4	970.1	1926.9 gpm	0	9.2		1	80
7	THOOTHUKUDI PORT	15-Dec-15	12:00:00	8.8	78.2	1009.8	1010.2 hpa	0	28.6		5	350
8	TIRUCHENDUR	15-Dec-15	12:00:00	8.5	78.1	1009.5	1010 hpa	3	29.3	29.3	6	20
9	SHAR	15-Dec-15	12:00:00	13.7	80.2	1011.5	1012.2 hpa	0	27.4		2	70
10	SAGAR_ISLAND	15-Dec-15	12:00:00	21.8	88	1013.3	1013.6 hpa	0	21.1	21.1	1	350
11	MUMBAI_SANTA_CRUZ	15-Dec-15	12:00:00	19.1	72.8	1007.3	----	0			2	340
12	RAIPUR	15-Dec-15	12:00:00	21.2	81.7	982.5	1016 hpa	0	24.1	8.9		200
13	RAHURI	15-Dec-15	12:00:00	19.4	74.6	951.3	1008.1 hpa	0	29.9		1	0
14	RAJGURUNAGAR	15-Dec-15	12:00:00	18.5	73.8	943.4	1007.4 hpa	0	33.4		5	310
15	PUNE(CAGMO)	15-Dec-15	12:00:00	18.5	73.8	949.6	1010.5 hpa	0	29.6	18.8	2	340
16	PEDDAPURAM	15-Dec-15	12:00:00	17.1	82.2	1007.1	1012.4 hpa	0	25.8	25.8	2	140
17	NEYYOOR	15-Dec-15	12:00:00	8.2	77.3	1005	1010.9 hpa	2	27.3	27.3	1	70
18	NAWAPARA	15-Dec-15	12:00:00	20.8	82.6		----	0	24.6		1	90
19	NASIK	15-Dec-15	12:00:00	20	73.7	944.5	1012.1 hpa	0	26	17.9	2	310
20	NIMAPARA	15-Dec-15	12:00:00	20	86.1	1012.3	1013.9 hpa	0	26.4	26.4	2	80
21	MATHURA	15-Dec-15	12:00:00	27.5	77.7	995.3	1015.6 hpa	0	19		0	

Data Source: IMD Pune, AWS Lab.

Temperature Map interpolated from IMD Data of 06th February 2016



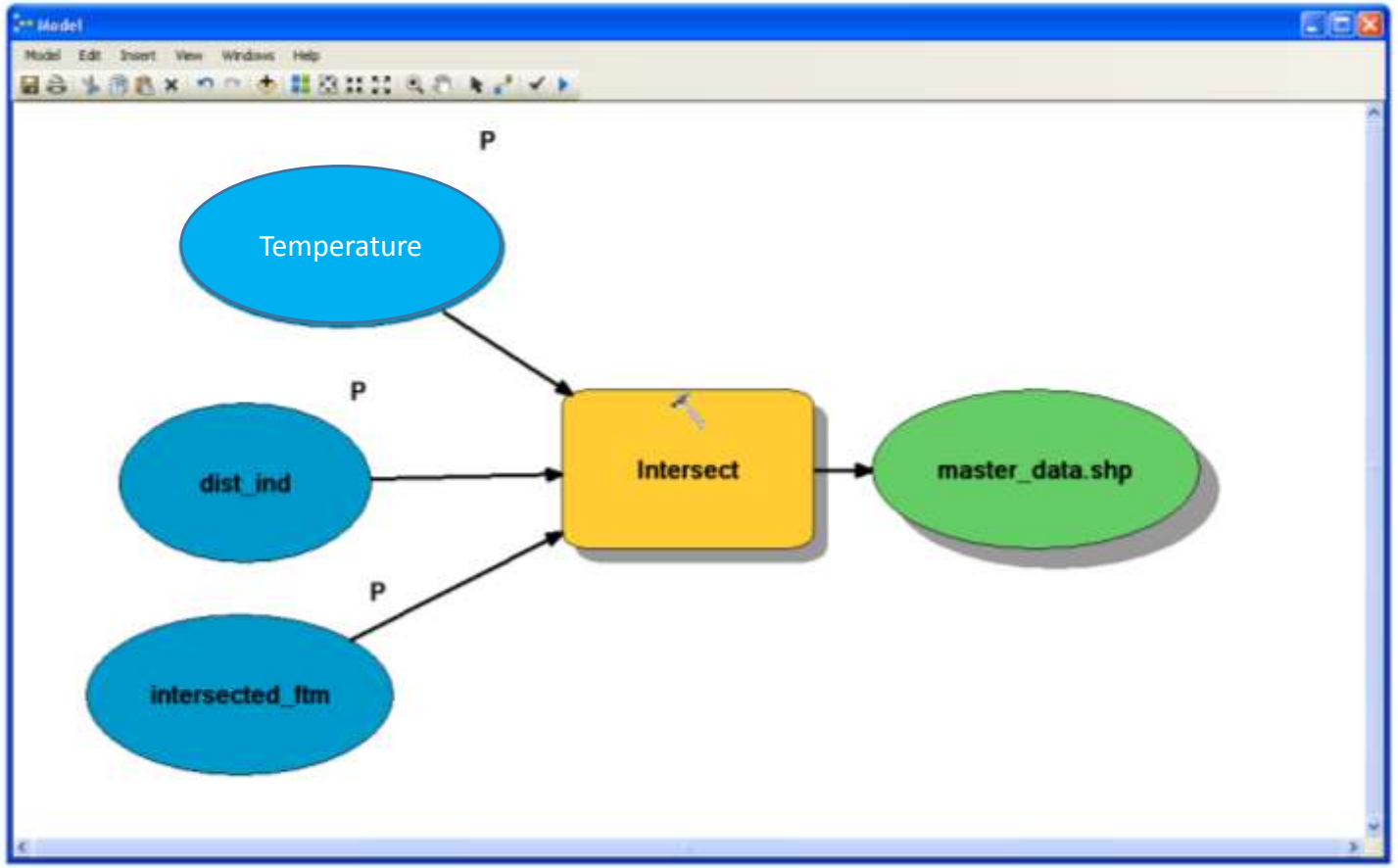
Selected Temperature range for Pre-warning



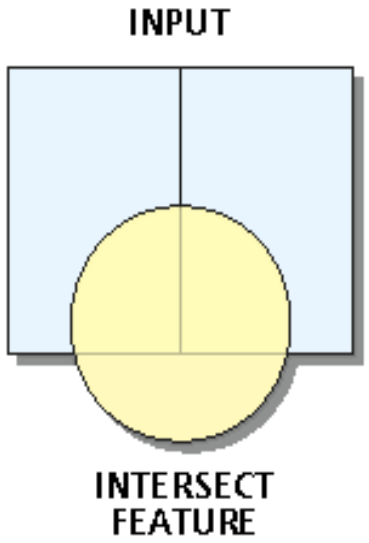
Intersect

- Computes a geometric intersection of the input features(Temperature, District Boundary , and Forest Types)

- Feature or portion of feature which overlap in all layers and /or feature classes will be written to the output feature

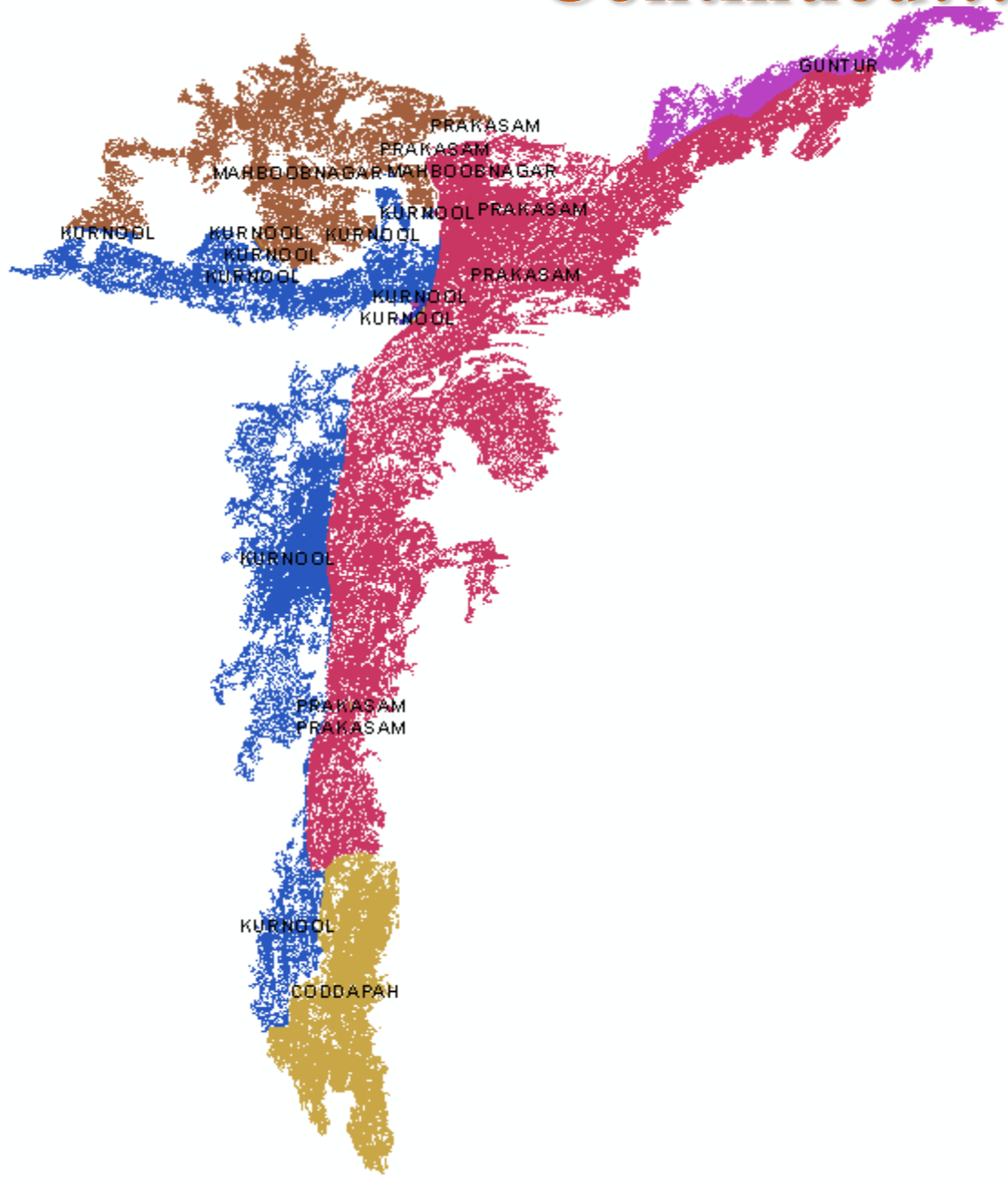


Continued…

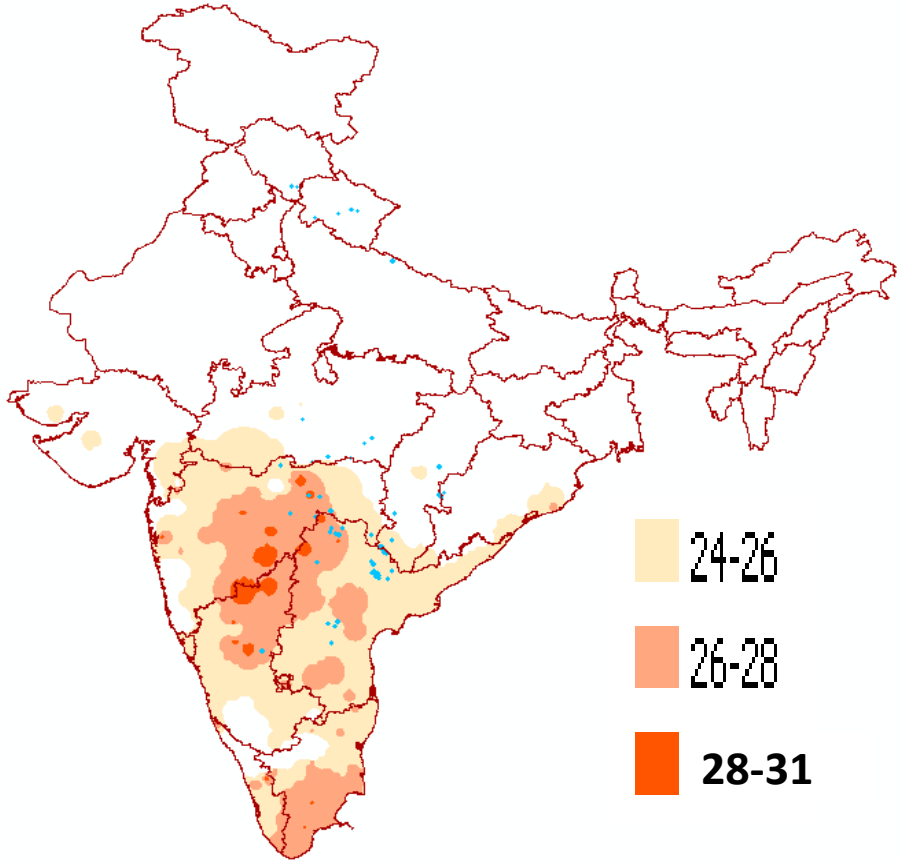


Continued…

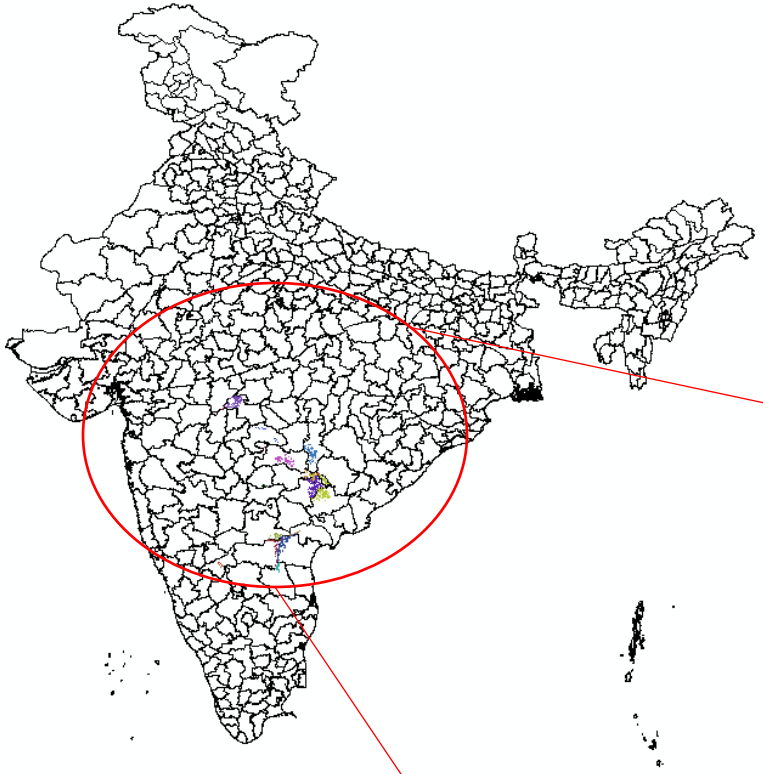
- 3B/C1 b Moist Teak Forest, DANTEWARA
- 3B/C1 b Moist Teak Forest, GARHCHIROLI
- 3B/C1 c Slightly Moist Teak Forest, DANTEWARA
- 3B/C1 c Slightly Moist Teak Forest, KHAMMAM
- 3B/C2 Southern Moist Mixed Deciduous Forest, DANTEWARA
- 3B/C2 Southern Moist Mixed Deciduous Forest, GARHCHIROLI
- 3B/C2 Southern Moist Mixed Deciduous Forest, KHAMMAM
- 3C/2e (ii) Moist Peninsular Low Level Sal Forests, DANTEWARA
- 5/2S1 Secondary Dry Deciduous Forest, ADILABAD
- 5/DS1 Dry Deciduous Scrub, KHAMMAM
- 5/DS1 Dry Deciduous Scrub, KURNOOL
- 5/DS1 Dry Deciduous Scrub, MAHBOOBNAGAR
- 5/DS1 Dry Deciduous Scrub, PRAKASAM
- 5/DS1 Dry Deciduous Scrub, WARANGAL
- 5/E9 Dry Bamboo Brake, KURNOOL
- 5/E9 Dry Bamboo Brake, PRAKASAM
- 5A/C1 a Very Dry Teak Forest, AKOLA
- 5A/C1 a Very Dry Teak Forest, AMRAVATI
- 5A/C1 a Very Dry Teak Forest, BETUL
- 5A/C1 a Very Dry Teak Forest, BULDANA
- 5A/C1 a Very Dry Teak Forest, EAST NIMAR
- 5A/C1 a Very Dry Teak Forest, NANDED
- 5A/C1 a Very Dry Teak Forest, YAVATMAL
- 5A/C1 b Dry Teak Forest, ADILABAD
- 5A/C1 b Dry Teak Forest, BETUL
- 5A/C1 b Dry Teak Forest, KHAMMAM
- 5A/C1 b Dry Teak Forest, KURNOOL
- 5A/C1 b Dry Teak Forest, PRAKASAM
- 5A/C1 b Dry Teak Forest, WARANGAL
- 5A/C3 Southern Dry Mixed Deciduous Forest, ADILABAD
- 5A/C3 Southern Dry Mixed Deciduous Forest, AMRAVATI
- 5A/C3 Southern Dry Mixed Deciduous Forest, BELLARY
- 5A/C3 Southern Dry Mixed Deciduous Forest, CHITRADURG
- 5A/C3 Southern Dry Mixed Deciduous Forest, CODDAPAH
- 5A/C3 Southern Dry Mixed Deciduous Forest, DANTEWARA
- 5A/C3 Southern Dry Mixed Deciduous Forest, GUNTUR
- 5A/C3 Southern Dry Mixed Deciduous Forest, KARIMNAGAR
- 5A/C3 Southern Dry Mixed Deciduous Forest, KHAMMAM
- 5A/C3 Southern Dry Mixed Deciduous Forest, KURNOOL
- 5A/C3 Southern Dry Mixed Deciduous Forest, MAHBOOBNAGAR
- 5A/C3 Southern Dry Mixed Deciduous Forest, MEDAK
- 5A/C3 Southern Dry Mixed Deciduous Forest, NANDED
- 5A/C3 Southern Dry Mixed Deciduous Forest, NIZAMABAD
- 5A/C3 Southern Dry Mixed Deciduous Forest, PRAKASAM
- 5A/C3 Southern Dry Mixed Deciduous Forest, WARANGAL
- 5A/C3 Southern Dry Mixed Deciduous Forest, YAVATMAL
- 6A/C1 Southern Thorn Forest, PRAKASAM

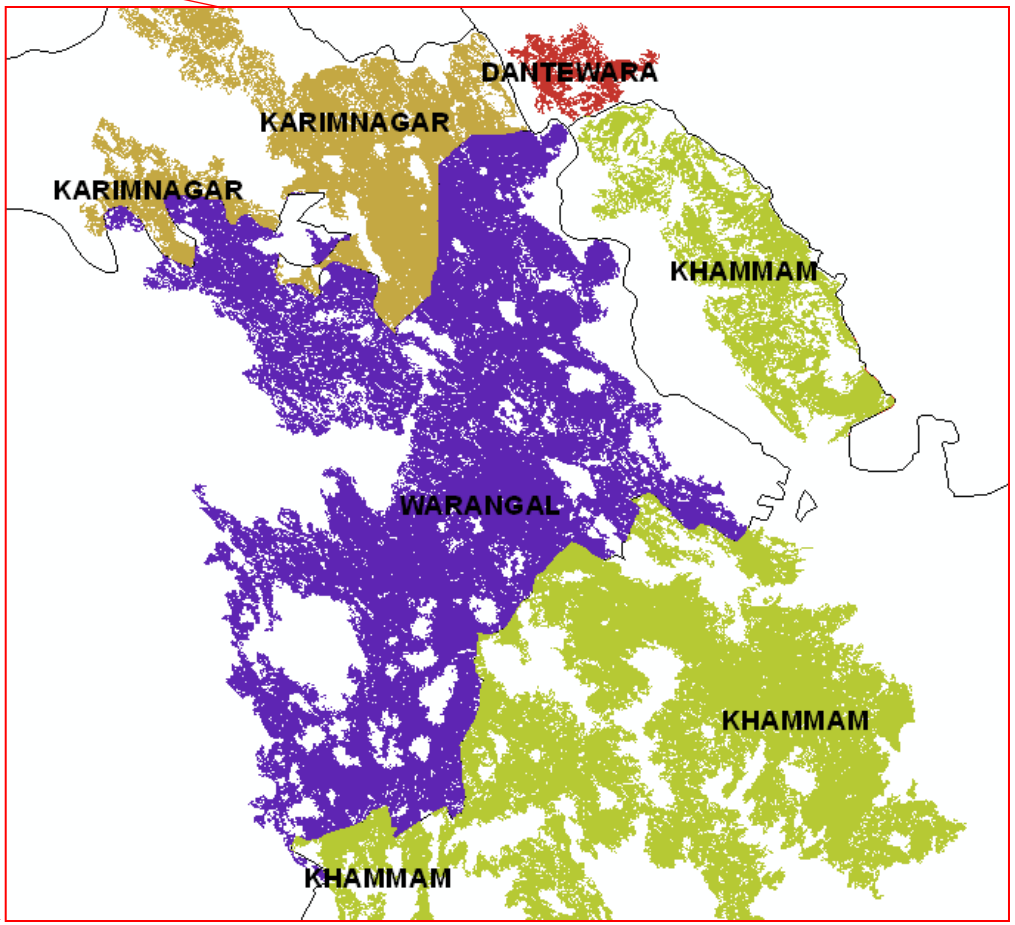


Selected Temperature range for Pre-warning



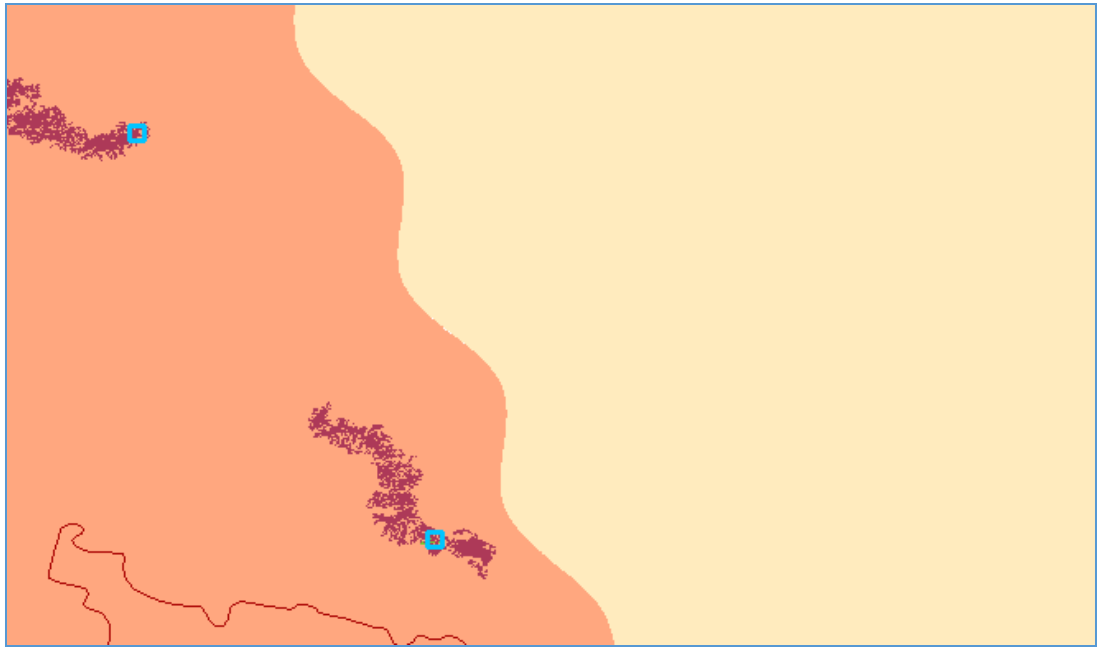
Pre-warning polygons District wise





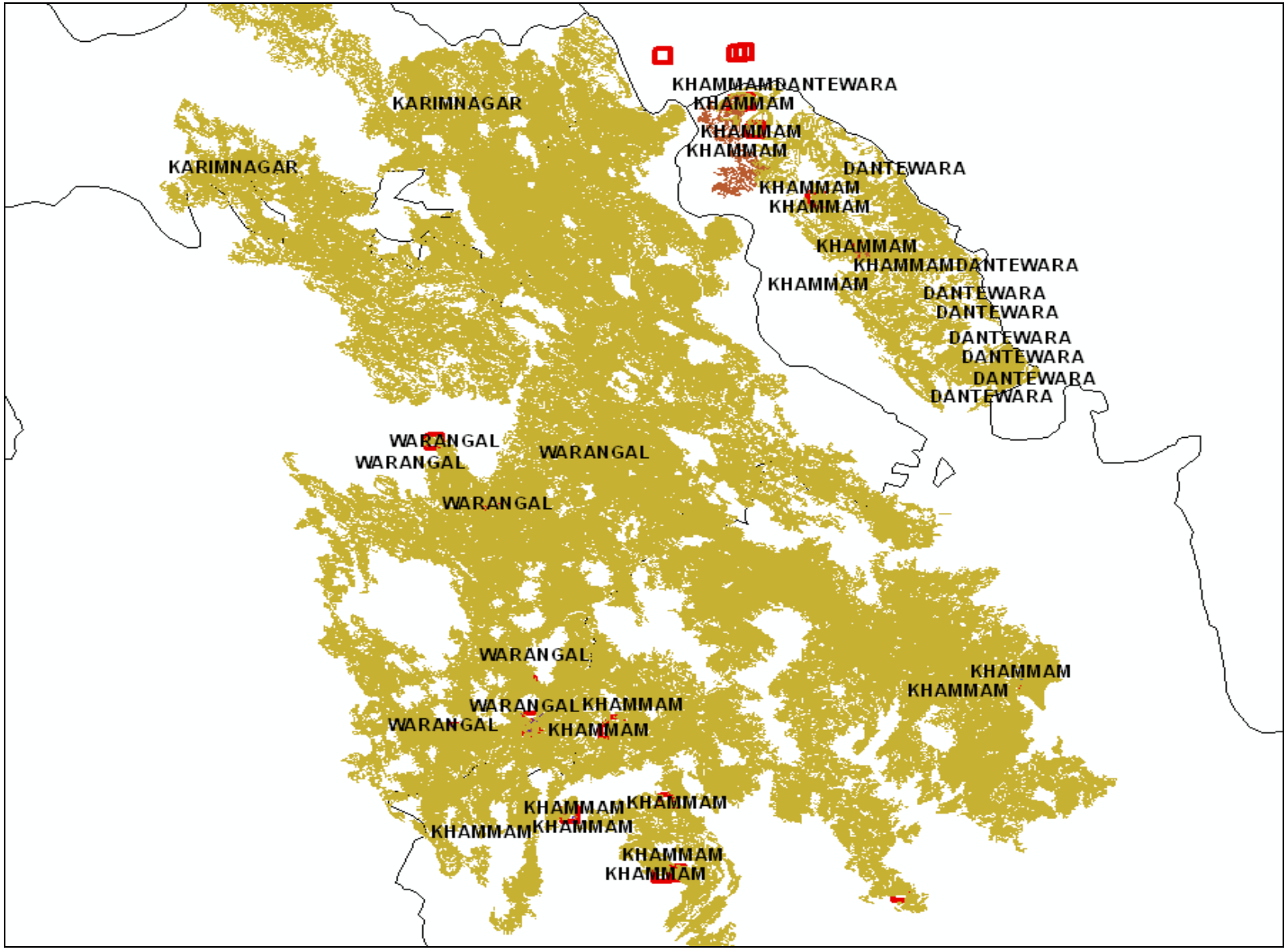
Intersected forest types

- 3B/C1 b Moist Teak Forest
- 3B/C1 c Slightly Moist Teak Forest
- 3B/C2 Southern Moist Mixed Deciduous Forest
- 3C/2e (ii) Moist Peninsular Low Level Sal Forests
- 5/2S1 Secondary Dry Deciduous Forest
- 5/DS1 Dry Deciduous Scrub
- 5/E9 Dry Bamboo Brake
- 5A/C1 a Very Dry Teak Forest
- 5A/C1 b Dry Teak Forest
- 5A/C3 Southern Dry Mixed Deciduous Forest
- 6A/C1 Southern Thorn Forest



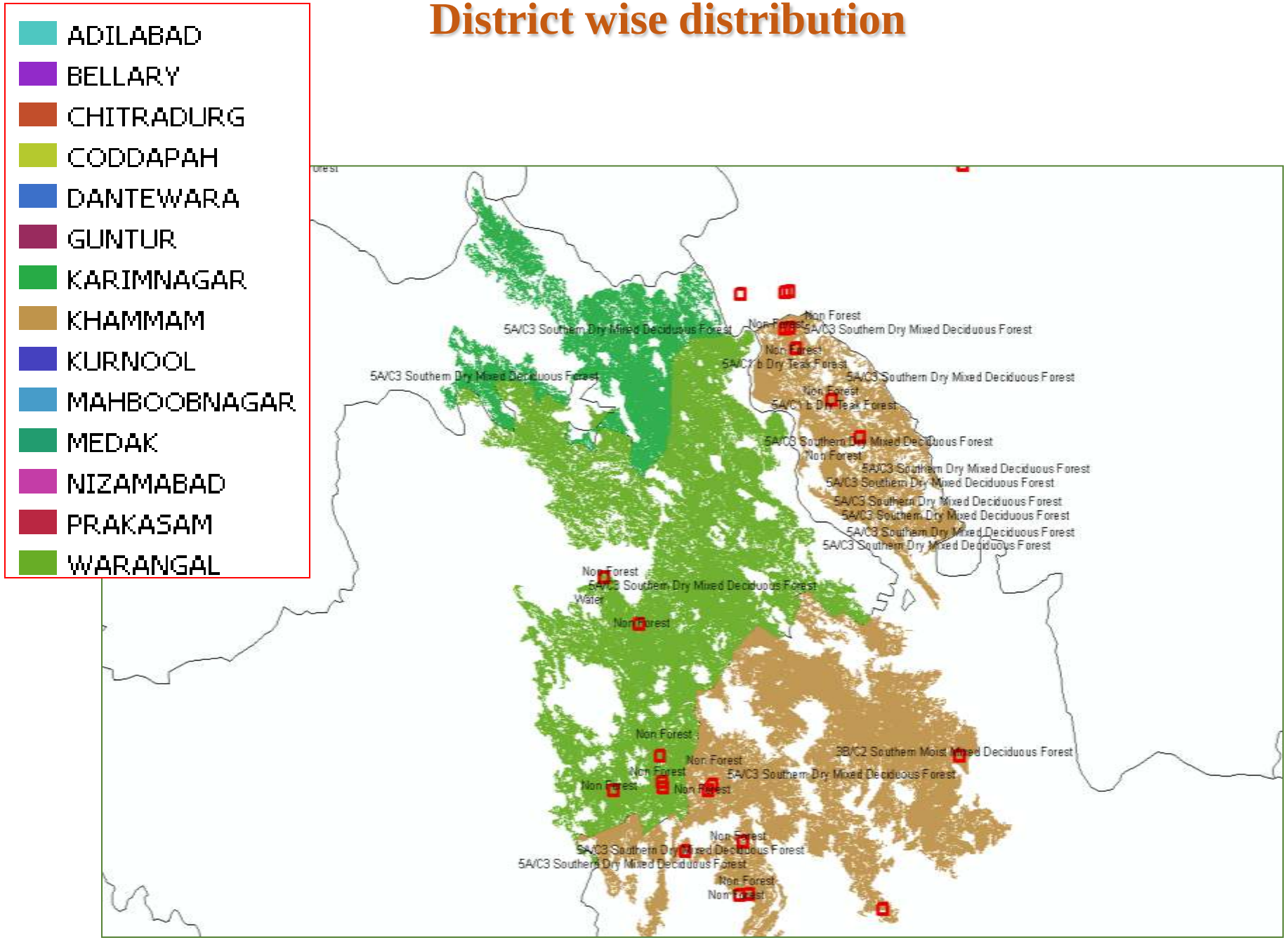
- 24-26 °C
- >26 °C

Forest type wise Distribution

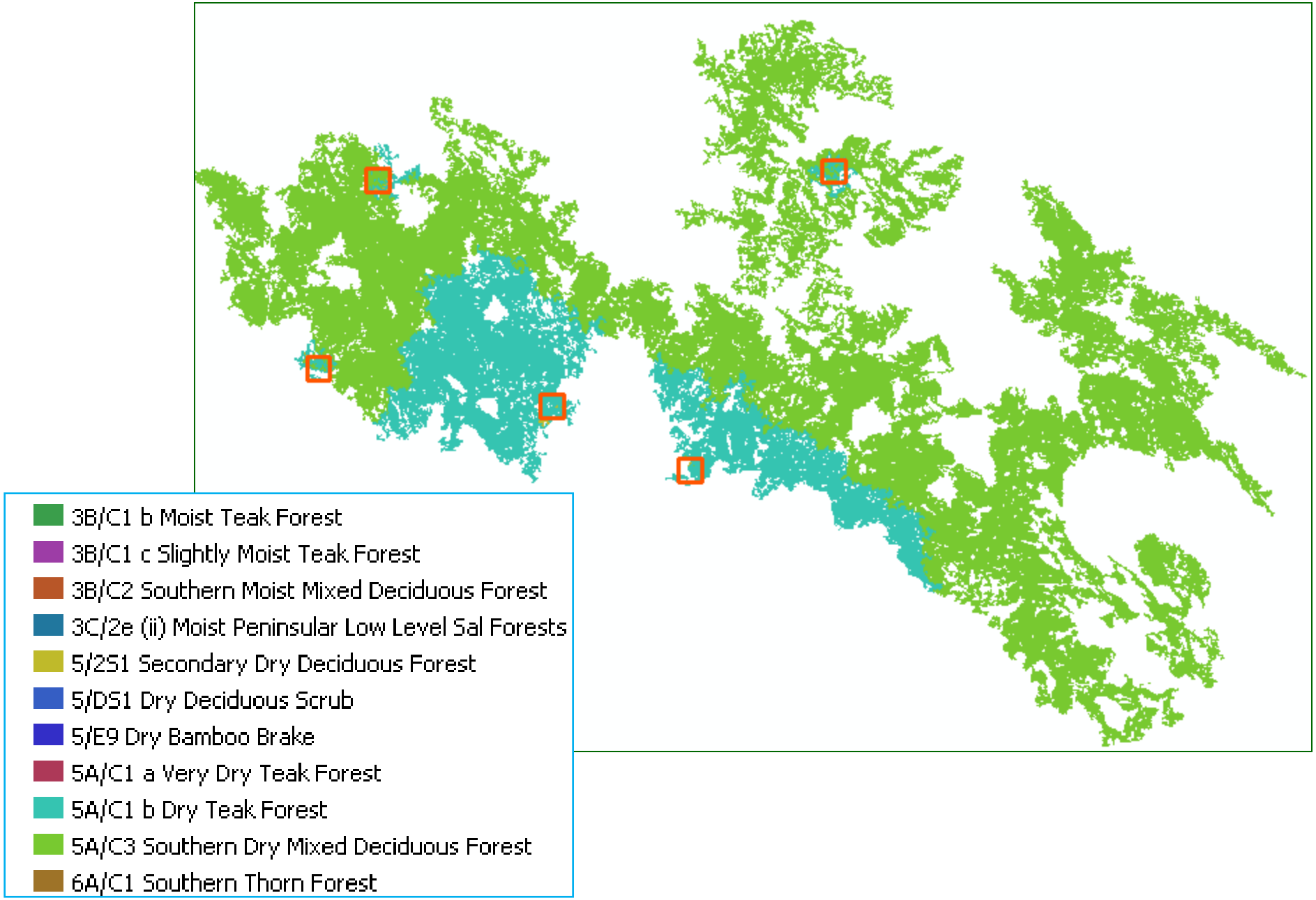


- 3B/C2 Southern Moist Mixed Deciduous Forest
- 5/2S1 Secondary Dry Deciduous Forest
- 5/DS1 Dry Deciduous Scrub
- 5/E9 Dry Bamboo Brake
- 5A/C1 b Dry Teak Forest
- 5A/C3 Southern Dry Mixed Deciduous Forest
- 6A/C1 Southern Thorn Forest

District wise distribution



Continued..


3B/C1 b Moist Teak Forest
3B/C1 c Slightly Moist Teak Forest
3B/C2 Southern Moist Mixed Deciduous Forest
3C/2e (ii) Moist Peninsular Low Level Sal Forests
5/2S1 Secondary Dry Deciduous Forest
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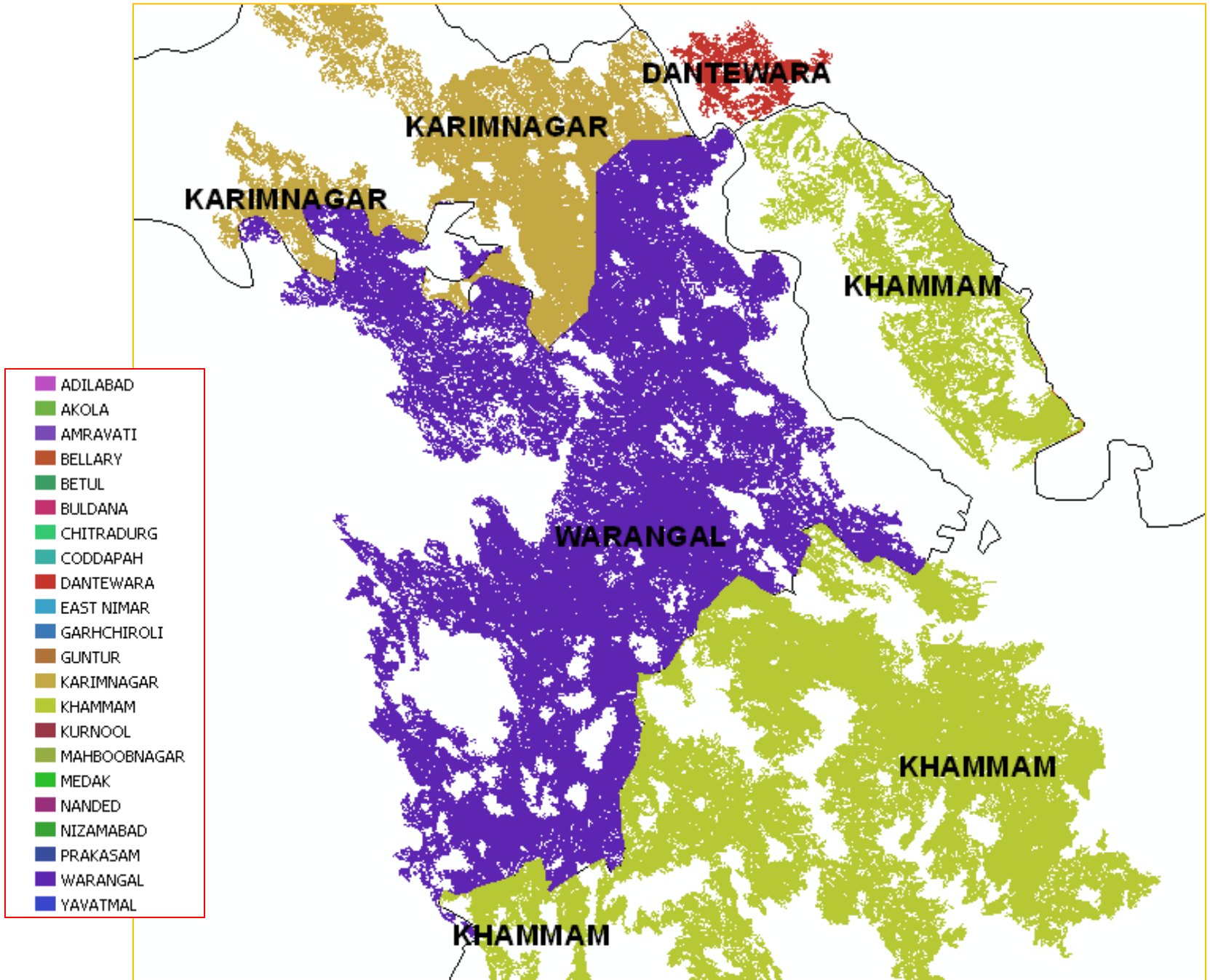
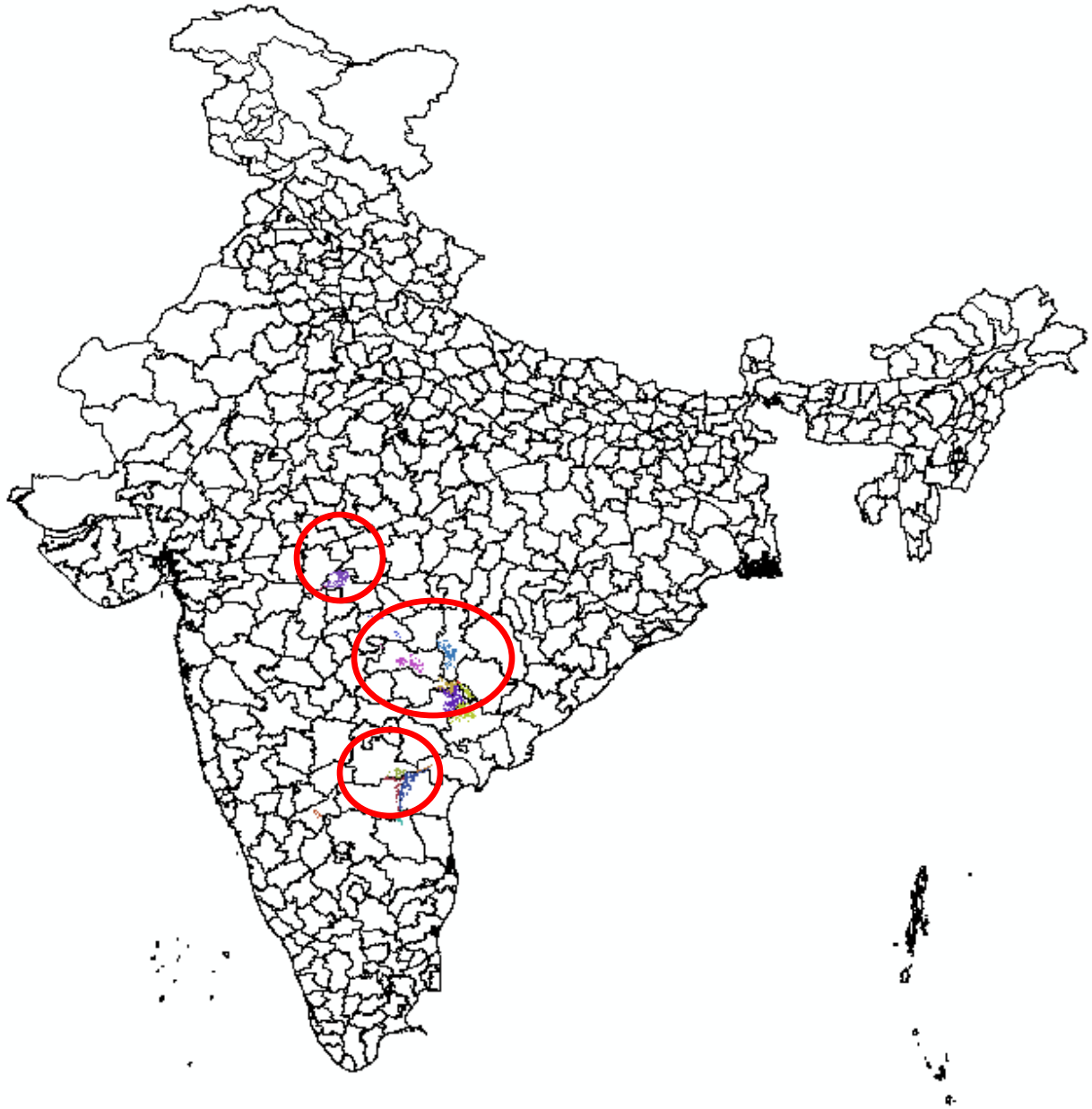
5A/C1 a Very Dry Teak Forest
5A/C1 b Dry Teak Forest
5A/C3 Southern Dry Mixed Deciduous Forest
6A/C1 Southern Thorn Forest

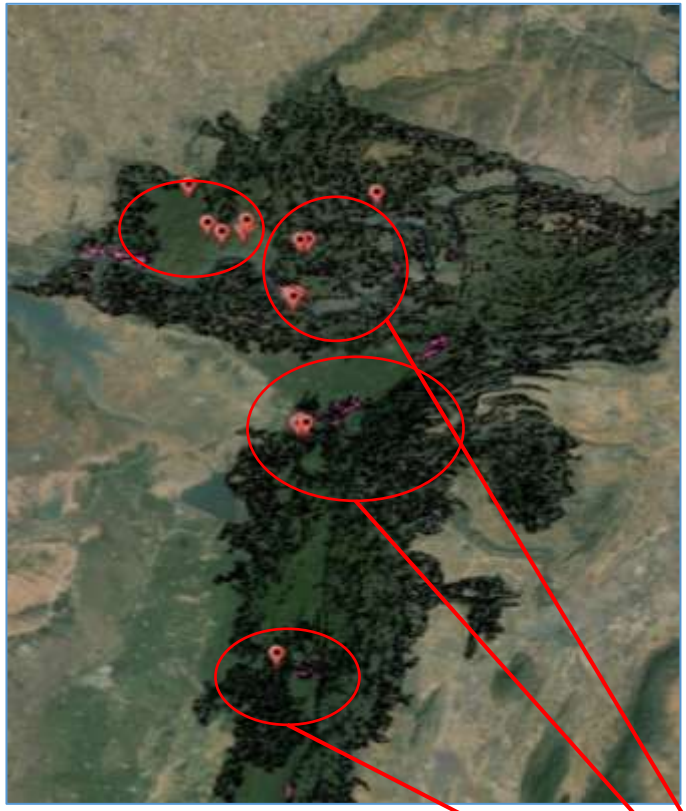
Continued …

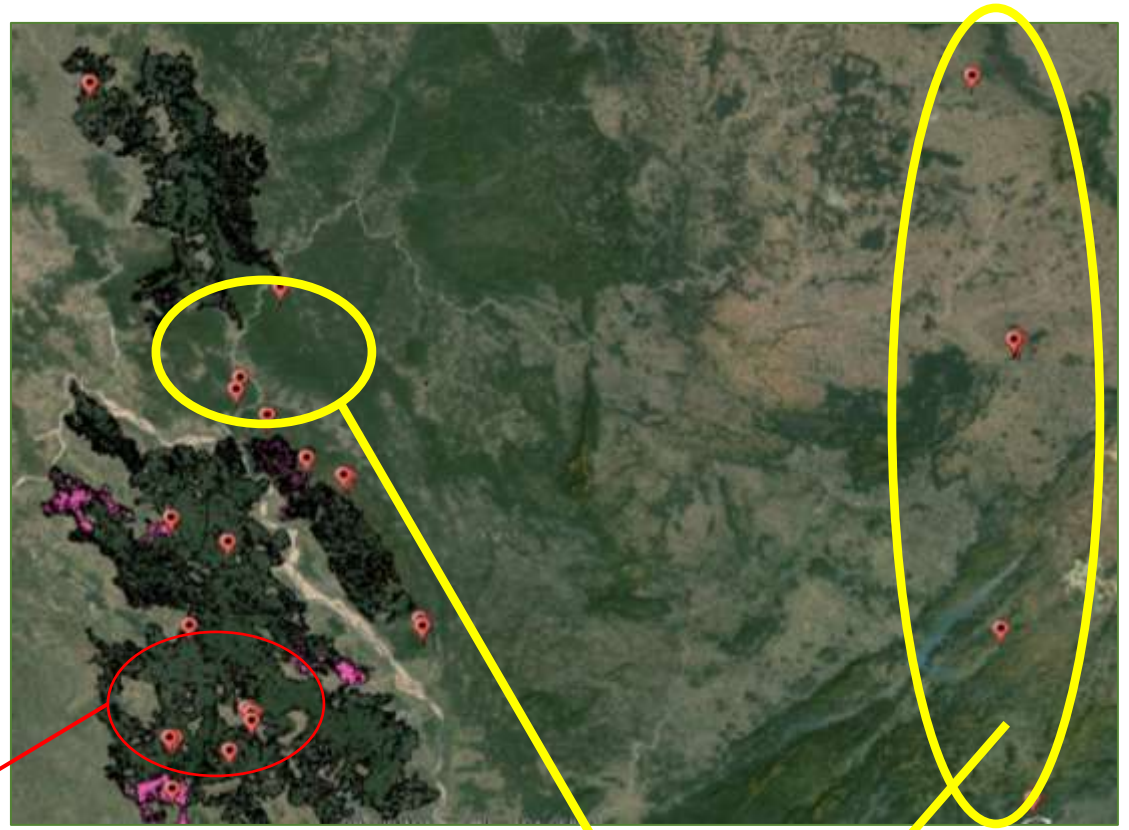

DANTEWARA
KARIMNAGAR
KARIMNAGAR
KHAMMAM
WARANGAL
KHAMMAM
KHAMMAM
ADILABAD
AKOLA
AMRAVATI
BELLARY
BETUL
BULDANA
CHITRADURG
CODDAPAH
DANTEWARA
EAST NIMAR
GARHCHIROLI
GUNTUR
KARIMNAGAR
KHAMMAM
KURNOOL
MAHBOOBNAGAR
MEDAK
NANDED
NIZAMABAD
PRAKASAM
WARANGAL
YAVATMAL

Regions selected for Pre-Warning Alerts



Fire Points overlaid on previous day Pre-Warning Alert layer (Visualised on Google Earth)

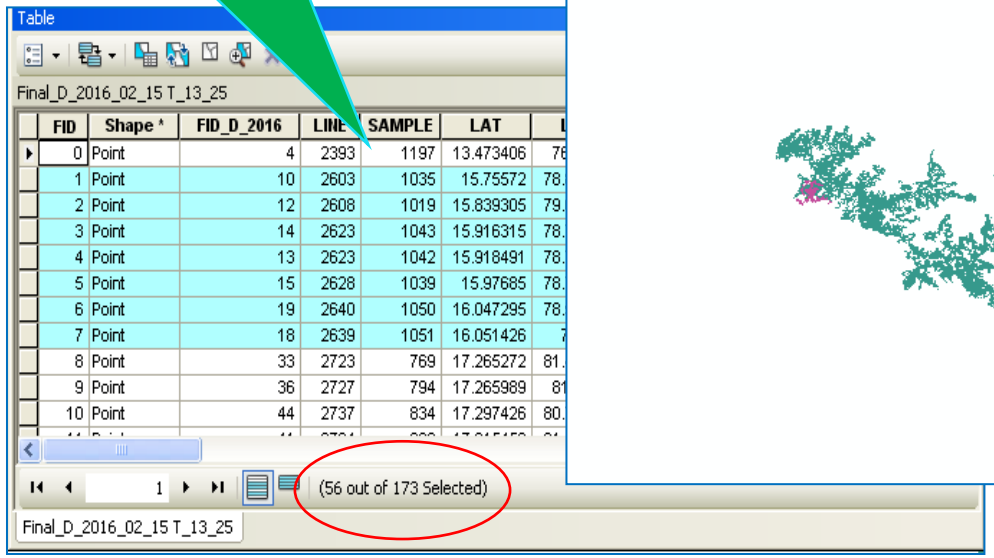


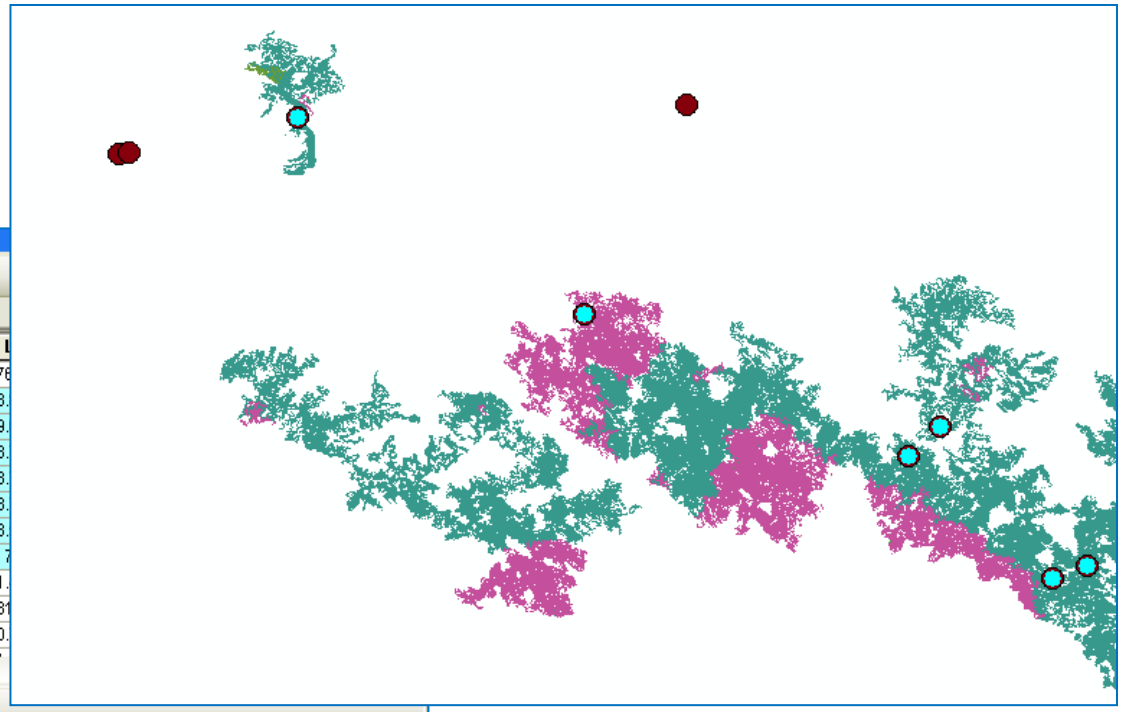


Inside

Out side

56 points out of 173 fall within the pre-warning alert region





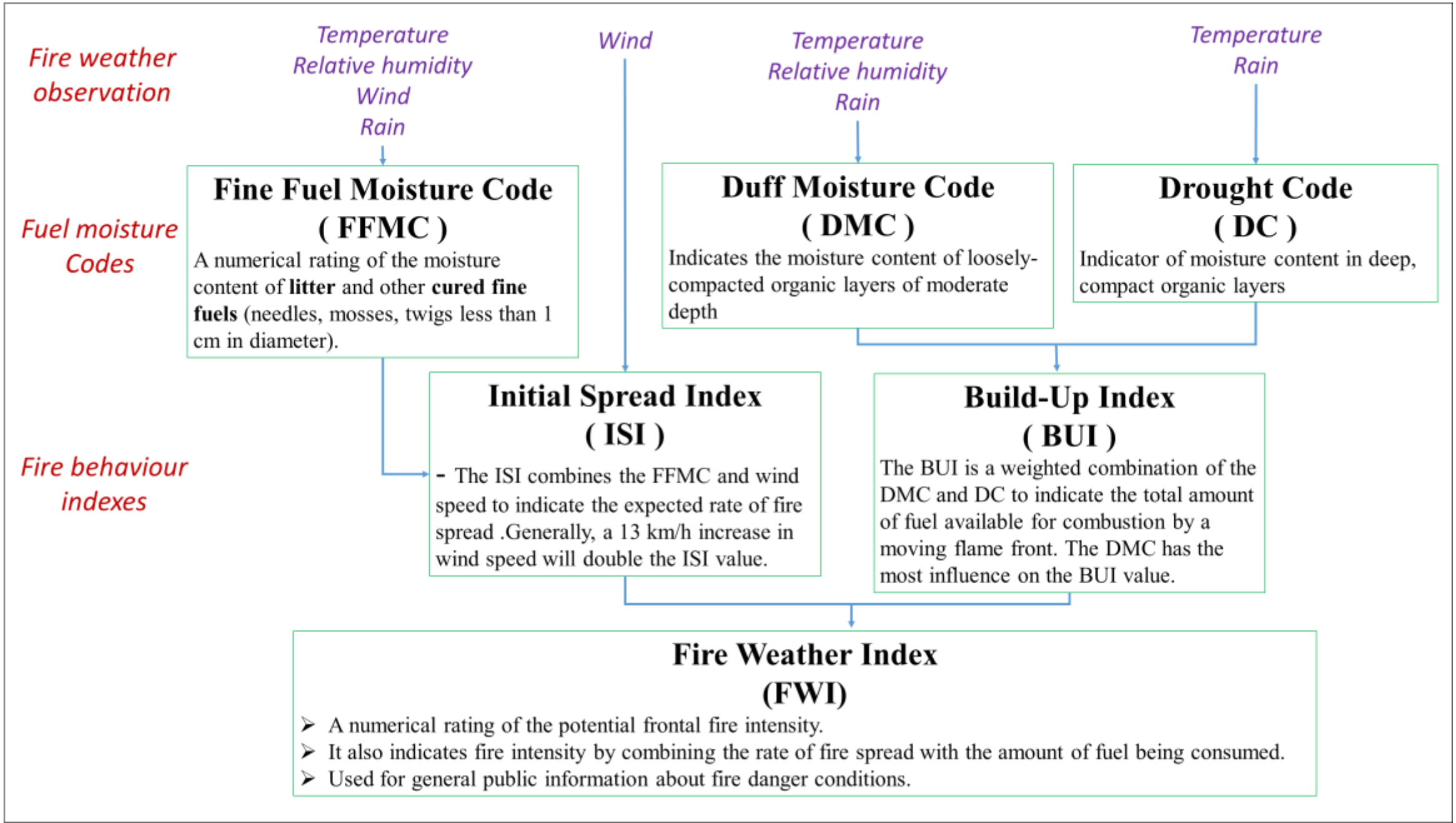
- Forest fire points falling within pre-warning alert region for forest fire layer disseminated on 15th February

- Forest fire points falling outside pre-warning alert region for forest fire layer disseminated on 15th February

Results of Pre-warning Alert

- ✓ **Based on the analysis, around 33% of the forest fire points fall over the Pre-Warning alert layer**
- ✓ **Warning for 49 districts falling in 9 states and comprising 17,837 sq km area have been alerted for pre-warning of forest fires**
- ✓ **Most of the fires have been observed within the RFA boundaries provided by the states**

Over view of fire weather index



FWI calculation model an example

LATITUDE	23
MONTH	01

Today's 12:00 Weather

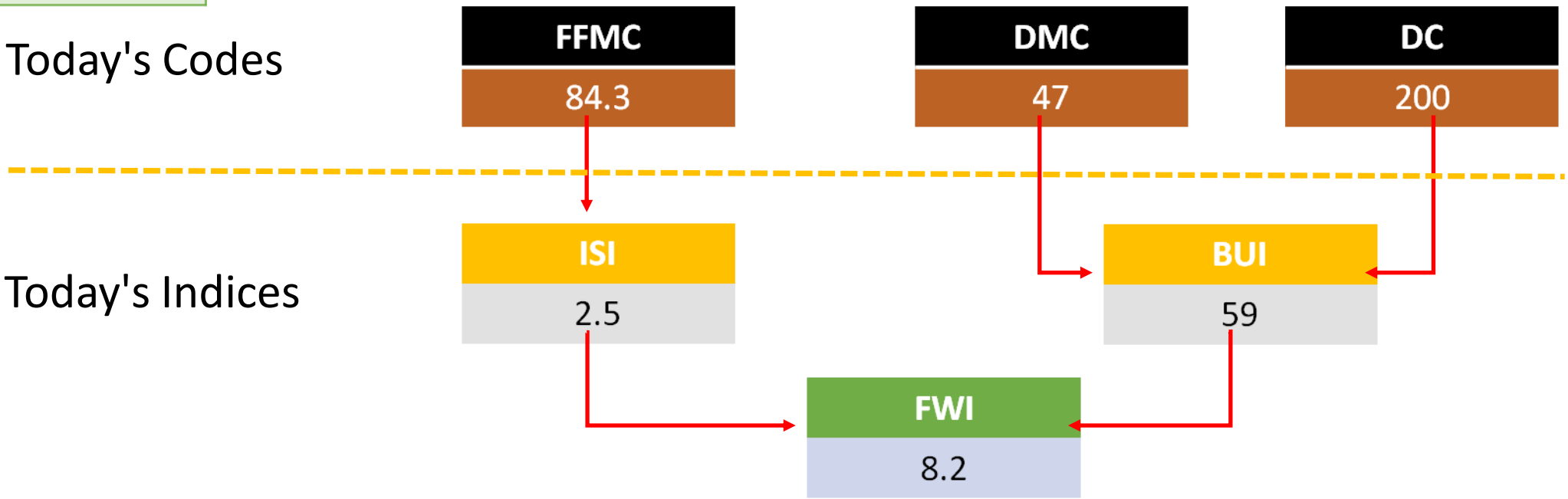
TEMP	30.0
WIND	5.0
RH	60.0
24 hr RAIN	1.0

Yesterday's Moisture Codes

FFMC	85
DMC	45
DC	195

Today's Codes

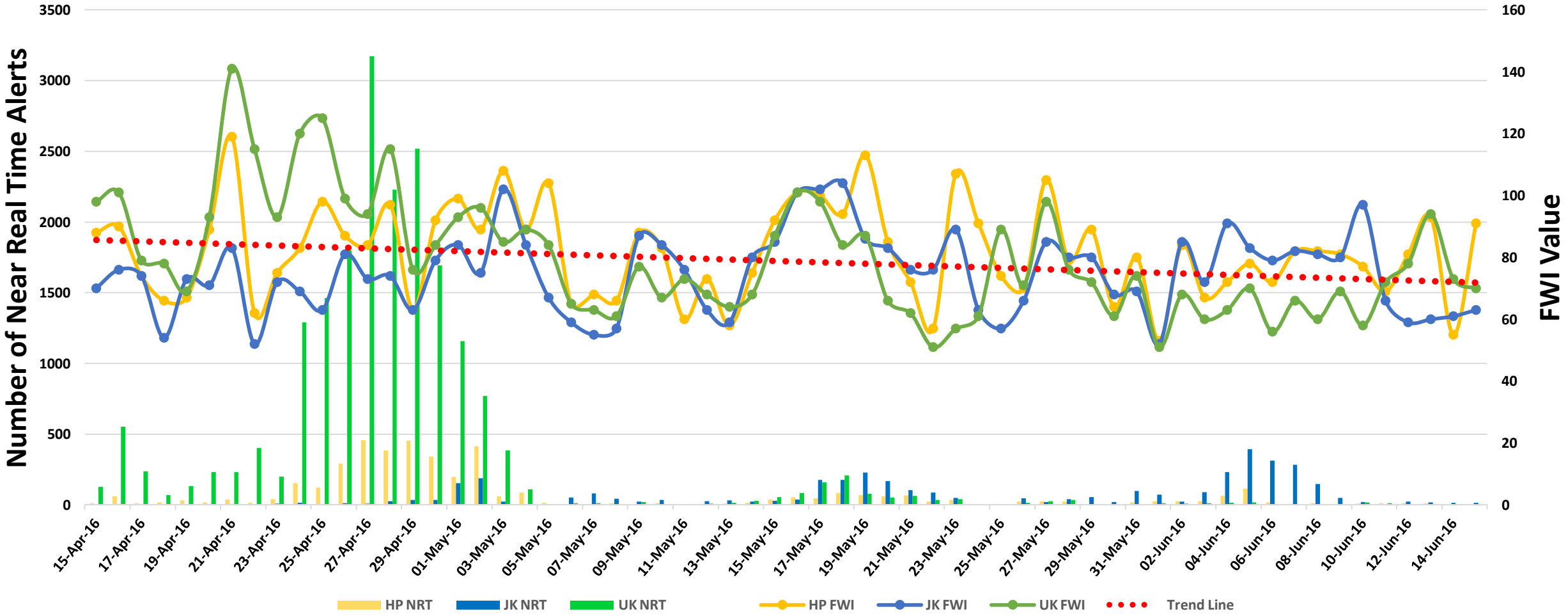
Today's Indices



Customised Fire Danger Rating System (FDRS) based on Fire Weather Index (FWI) for Pilot States of India

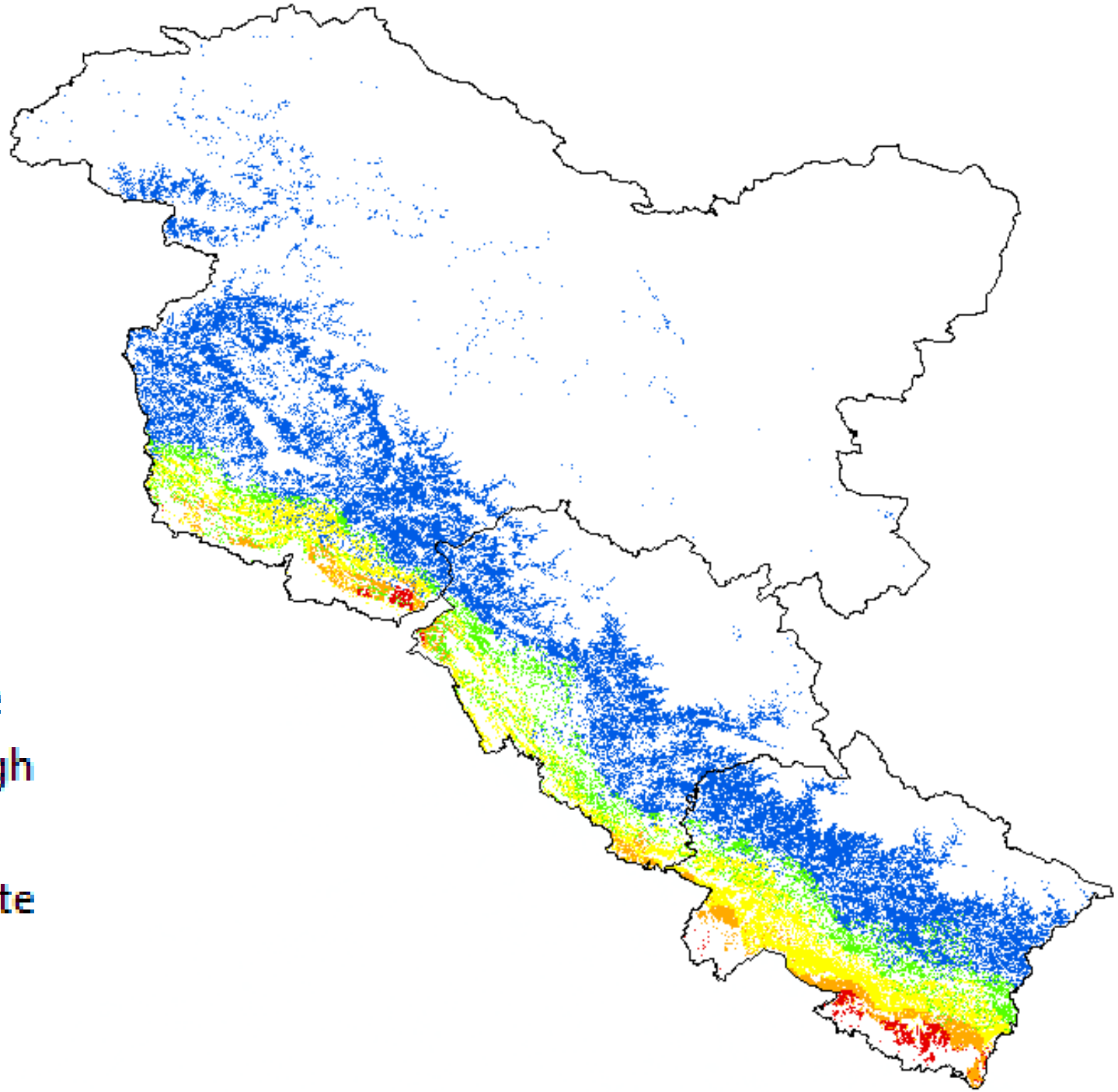
Western Himalayan States

1 Himachal Pradesh(HP) 2 Jammu and Kashmir(JK) 3 Uttarakhand(UK)



Western Himalaya

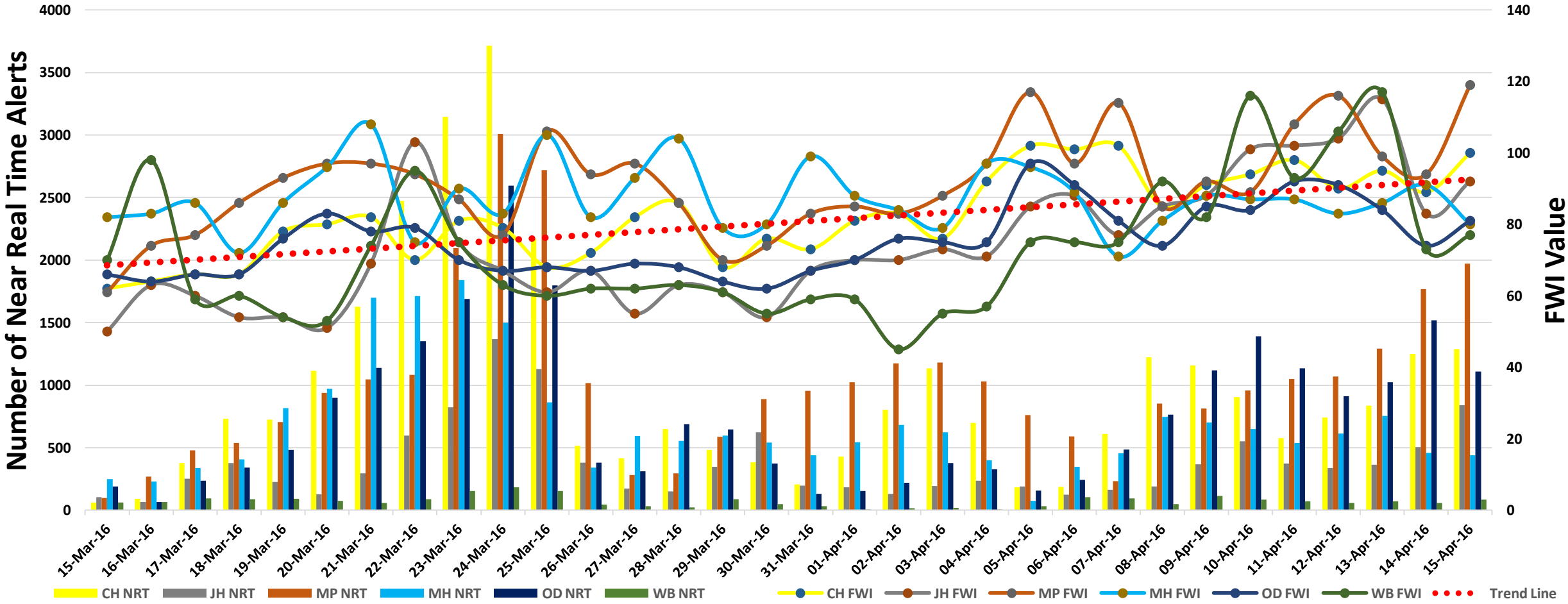
FDRS
02 May 2019 -10 May 2019



Central Indian States

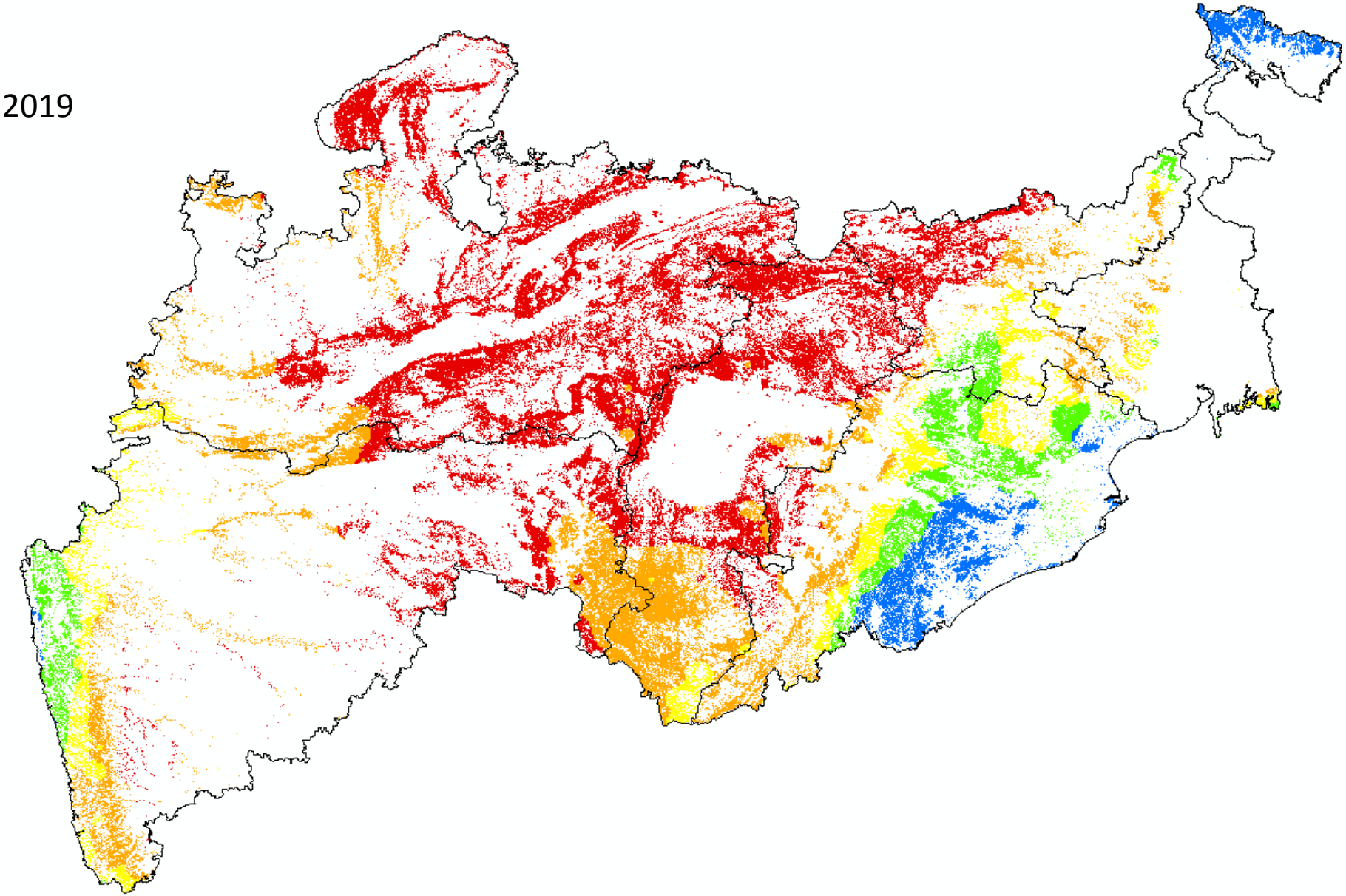
1 Chhattisgarh 2 Jharkhand 3 Madhya Pradesh 4 Maharashtra

5 Odisha 6 West Bengal



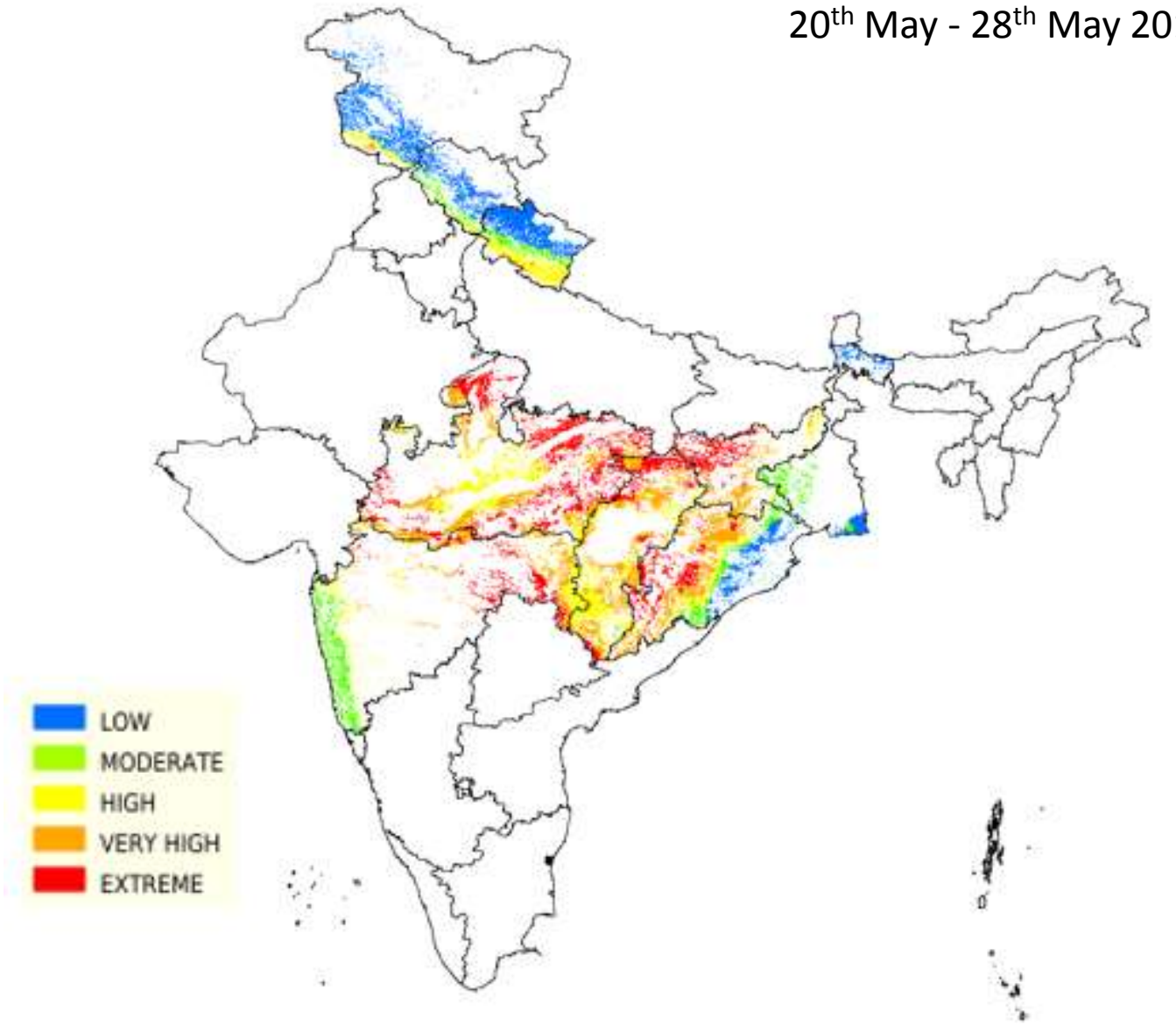
Central India

FDRS
02 May 2019 -10 May 2019

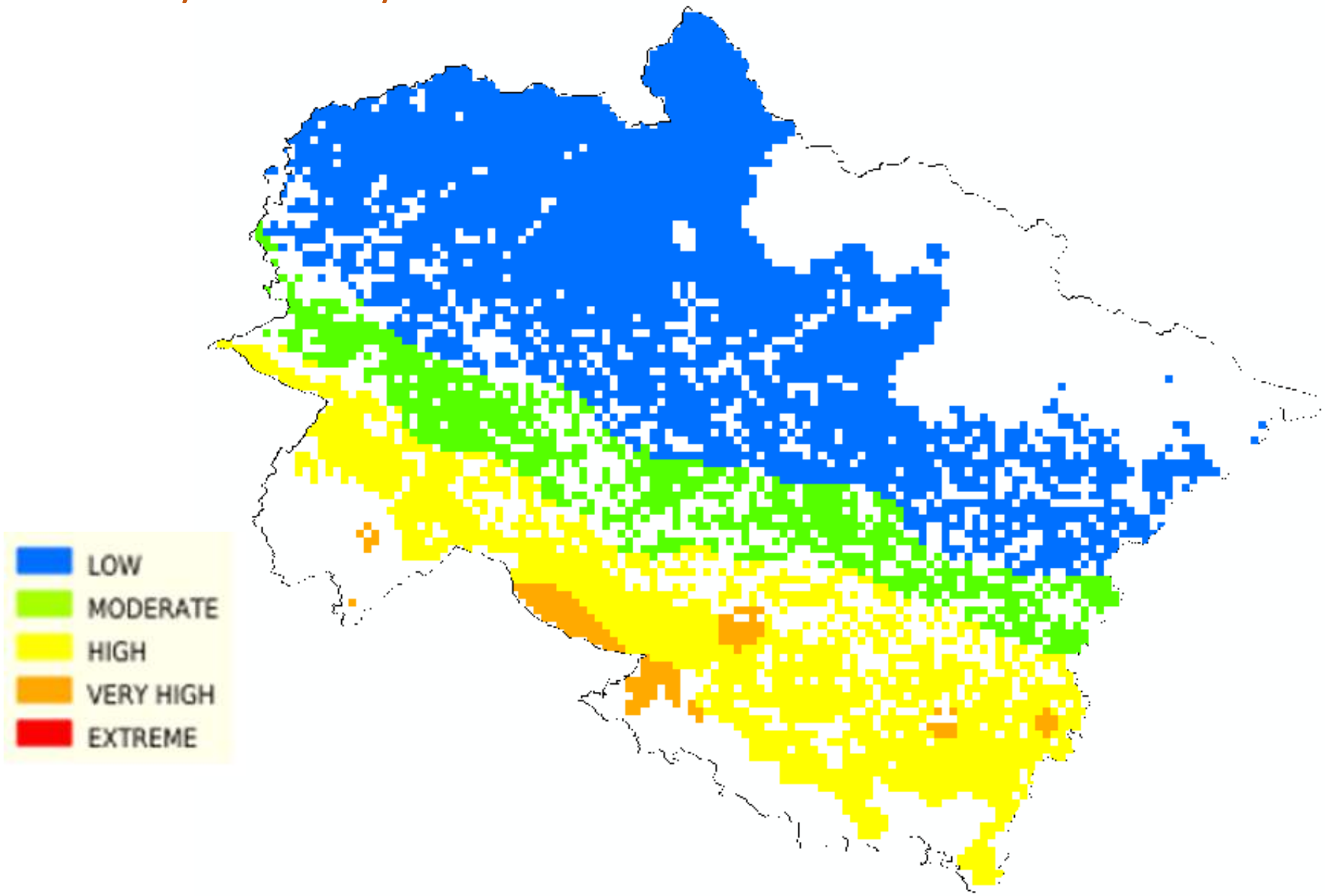


FWI based Basic FDRS of India

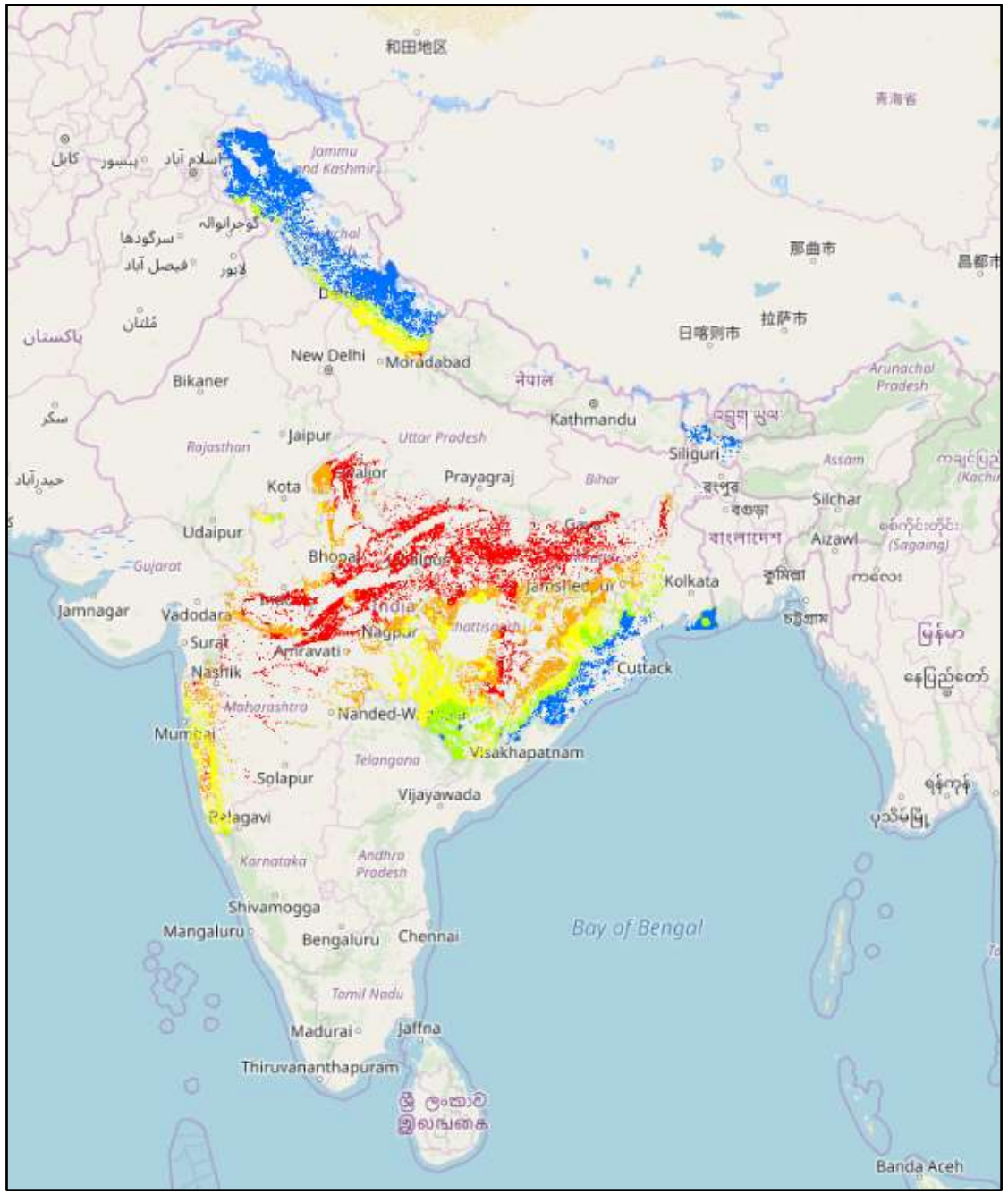
20th May - 28th May 2019



20th May - 28th May 2019



Van-Agni Geo portal of FSI



Uploaded on FSI Van Agni-geo Portal two times in a week

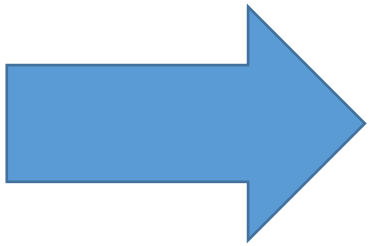
Forest Fire Vulnerability Assessment

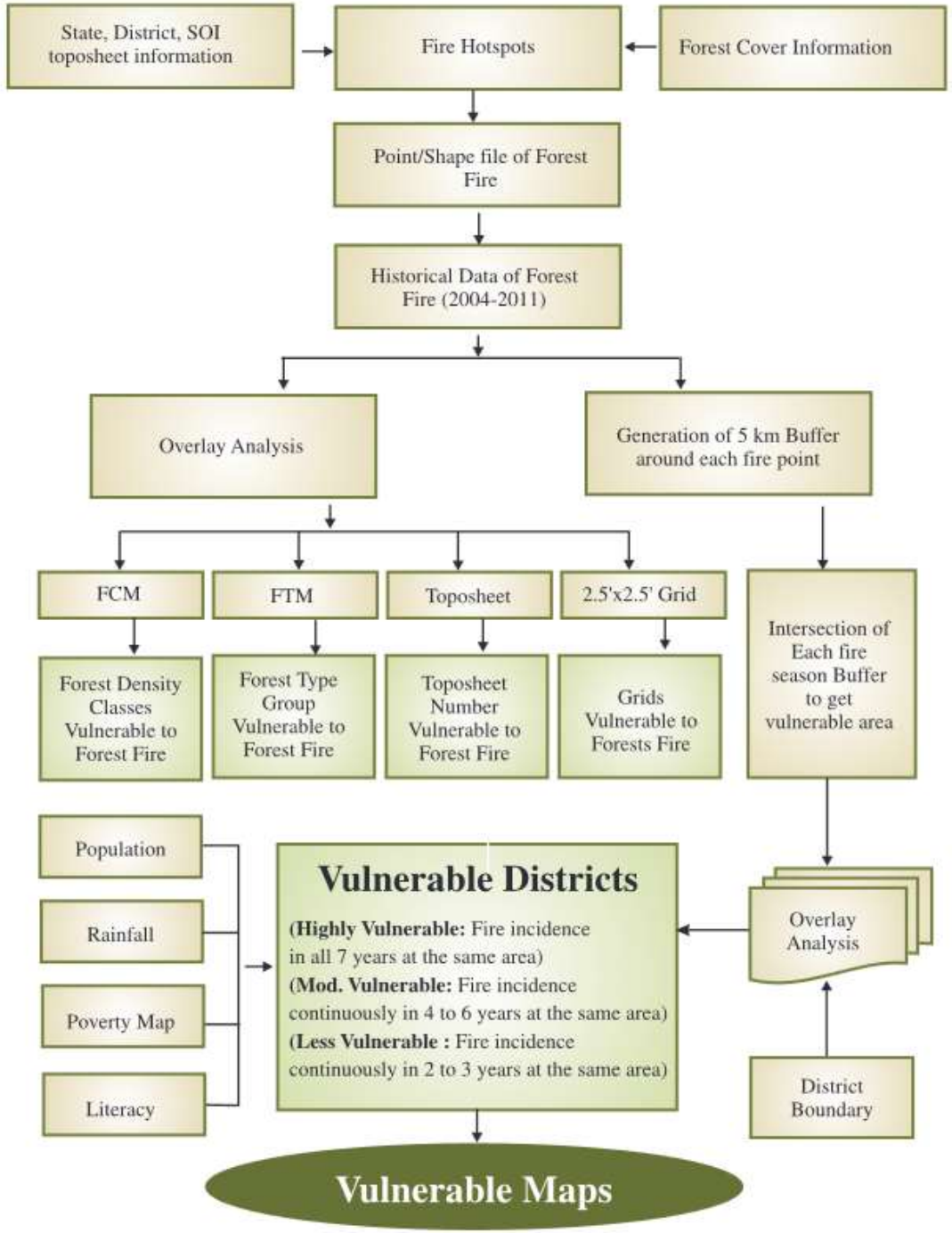
Specific Objectives

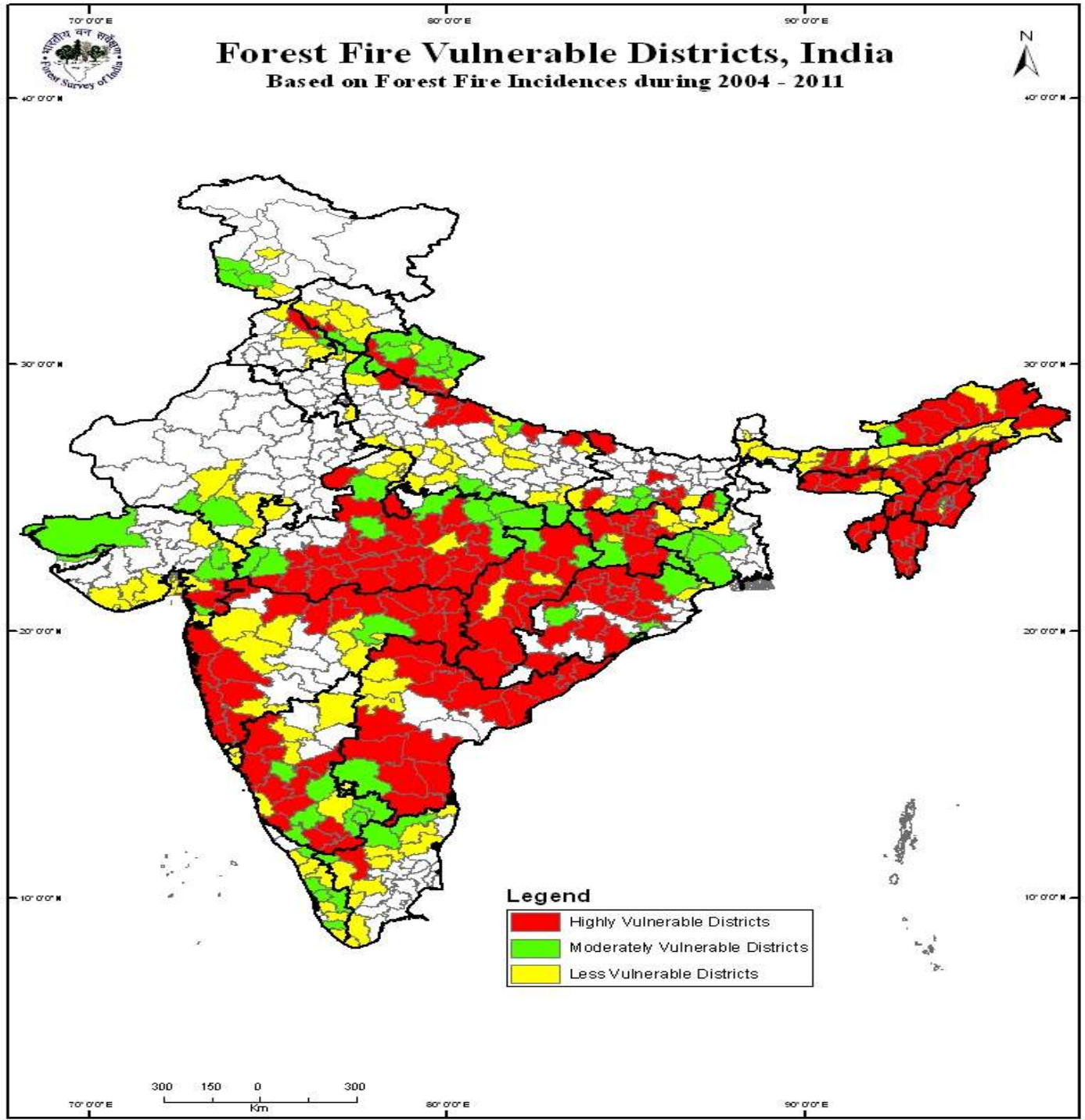
1. Study the forest fire vulnerability using the time series data and other causative factors.
2. Study the vulnerability based on the forest types and forest density classes.
3. Identify and categorized the grids/district based on the degree of severity.
4. Study the socioeconomic parameters and relate the vulnerable area with these parameters.

Vulnerability of India's Forest to Fire

Methodology






Forest Fire Vulnerable Districts, India
Based on Forest Fire Incidences during 2004 - 2011
N
70° 0'0"E
80° 0'0"E
90° 0'0"E
40° 0'0"N
30° 0'0"N
20° 0'0"N
10° 0'0"N
Legend
Highly Vulnerable Districts
Moderately Vulnerable Districts
Less Vulnerable Districts
300 150 0 300
Km

States having Vulnerable Districts

S.No	State	No. of Districts
1	ANDHRA PRADESH	15
2	ARUNACHAL PRADESH	8
3	ASSAM	12
4	BIHAR	5
5	CHHATTISGARH	10
6	GUJARAT	3
7	JHARKHAND	5
8	KARNATAKA	10
9	MADHYA PRADESH	22
10	MAHARASHTRA	16
11	MANIPUR	9
12	MEGHALAYA	5
13	MIZORAM	6
14	NAGALAND	8
15	ORISSA	10
16	TAMIL NADU	1
17	TRIPURA	3
18	UTTAR PRADESH	7
19	UTTARAKHAND	3
	Total	**158**

Salient Features

1. Forest fire vulnerability has been estimated in terms of forest cover, forest type 2.5 ' × 2.5 ', Toposheets, time periods.
2. Attempt has been made to correlate the vulnerability with different factors such as socioeconomic, anthropogenic, climatological etc.
3. Vulnerability in terms of spatial extent has been assessed.
4. It has been further studied to find the state level crucial period of fire occurrences.

Findings

1. A total of 8645 forest fire incidences have been reported during 2004-2005; 20567 during 2005-2006; 16779 during 2006-2007; 17264 during 2007-2008; 26180 during 2008-2009; 30892 during 2009-2010; and 13898 during 2010-11 respectively.
2. A total of 57063 forest fire incidence were observed in moderately dense forest which is total 43% of the total fire incidences. A total of 53779 forest fire incidence have been observed in open forest which is total 40% of the total fire incidences. However, only 9% fire incidences have been reported in very dense forest during the last 7 years.
3. The maximum forest fire incidences have been reported in dry deciduous forest followed by tropical moist deciduous forest and tropical semi-evergreen forests.

Major Findings

1. **Subtropical pine forest is the 5th forest type vulnerable to forest fires. Although the % of this forest type group is 2.63% in the country yet total forest fire incidences reported in this type group during past 7 years is 2062.**
2. **In north-eastern part of the country a total of 1057, 1032 and 999 fire incidences have been reported following in toposheet numbers 84B09, 84A05 and 84A12 respectively, whereas in other parts of the country 702,667 and 608 forest fire incidences have been reported in 65A15,65E03 and 65A14 toposheets respectively during the past 7 years.**
3. **Most of the vulnerable areas have been observed in the border district of the states of central and southern central India viz., Madhya Pradesh, Chhatisgarh, Andhra Pradesh and Odisha.**

Major Findings

4. 29 out of 35 states and UTs have been reported with the continuous forest fire in two or more consecutive years. 348 district of the country are vulnerable to forest fire out of which 168 districts are highly vulnerable, 96 are moderately vulnerable whereas 111 are less vulnerable.
5. As per analysis carried out in every 2.5' × 2.5' grid, 15% area of the country is vulnerable to forest fire.
6. States such as Delhi and the UTs except Dadra and Nagar Haveli, repetition of forest fire in the same area in the consecutive years have not been reported.
7. In the north-eastern states main reason for the larger being vulnerable may be attributed to the general practice of shifting cultivation.

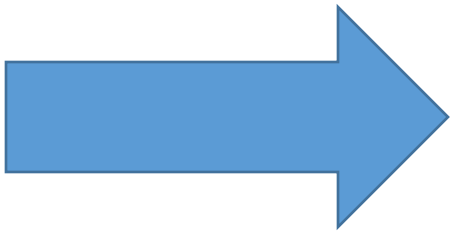
Major Findings

8. At country level, the state of Madhya Pradesh is having highest number of highly vulnerable districts followed by Maharashtra, Chhattisgarh and Odisha.
9. Out of 348 identified vulnerable districts of the country, 83 districts are having literacy rate less than 60%.
10. 32 districts of the central India area highly prone to forest fire with average poverty level between 41-80% (Census of India -2011). This districts comprise 35.16% forest cover area of the total geographical area of these districts.

Forest fire incidences in different forest density classes of forest cover map

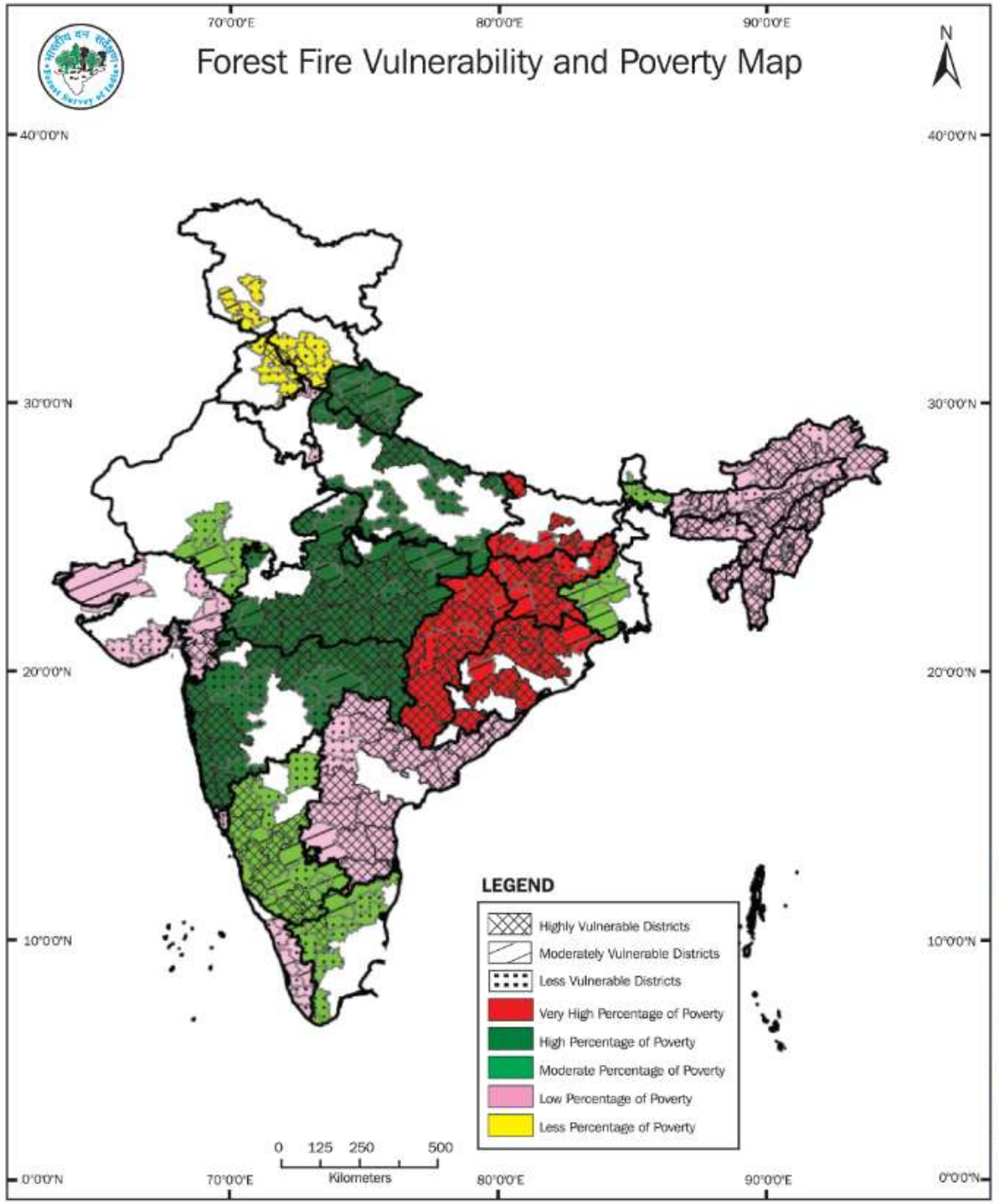
Forest Density	Year 2004-05	Year 2005-06	Year 2006-07	Year 2007-08	Year 2008-09	Year 2009-10	Year 2010-11	Total
Very Dense Forest	827	1139	1456	1563	2574	2804	1105	**11468**
Moderately Dense Forest	3646	8140	7173	7570	11497	13196	5841	**57063**
Open Forest	3032	8910	6675	6758	10008	12711	5685	**53779**
Scrub	82	137	77	61	84	100	39	**580**
Non Forest	1058	2241	1398	1312	2017	2081	1228	**11335**
Total	**8645**	**20567**	**16779**	**17264**	**26180**	**30892**	**13898**	**134225**

States with No. of districts under different vulnerability zones

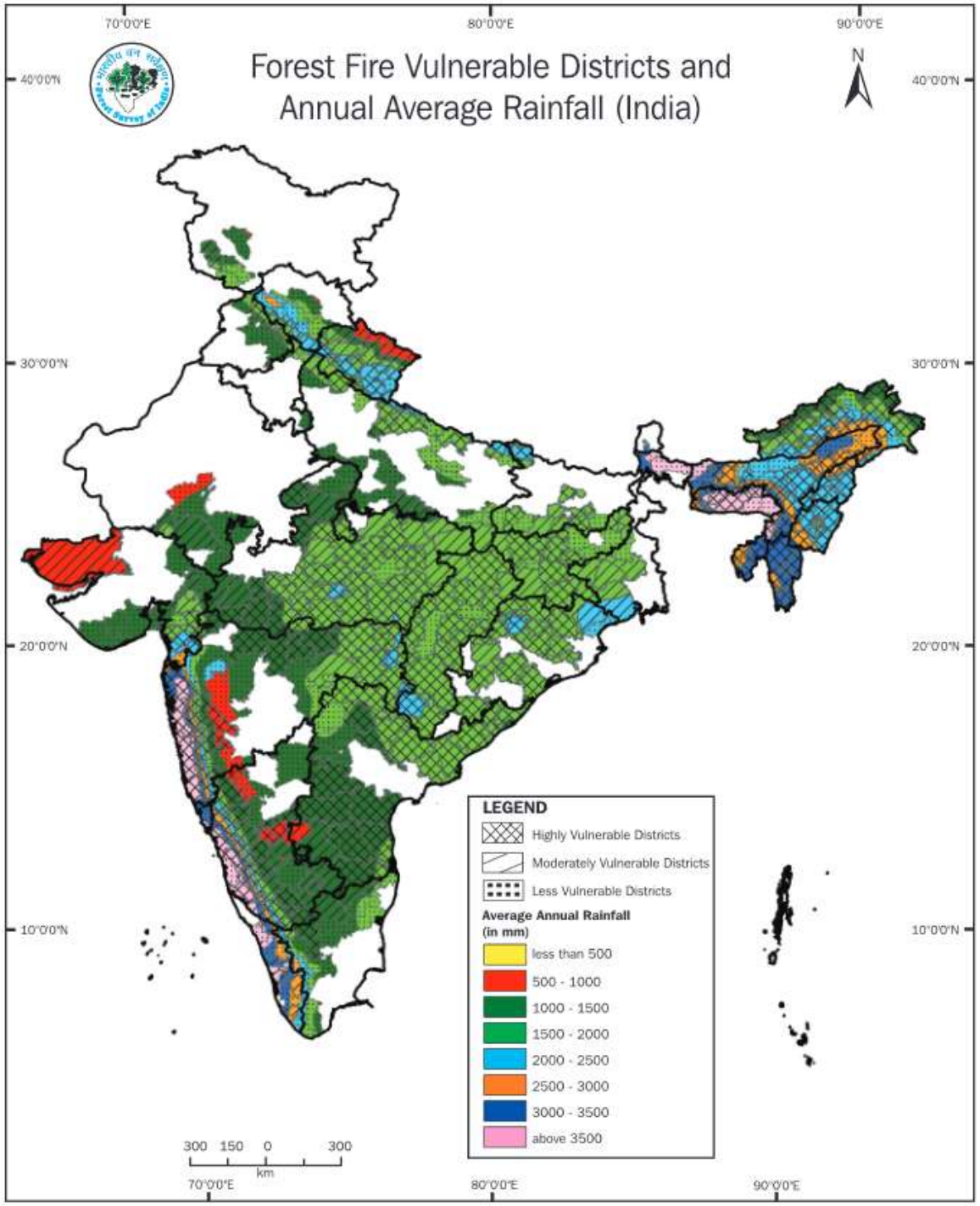


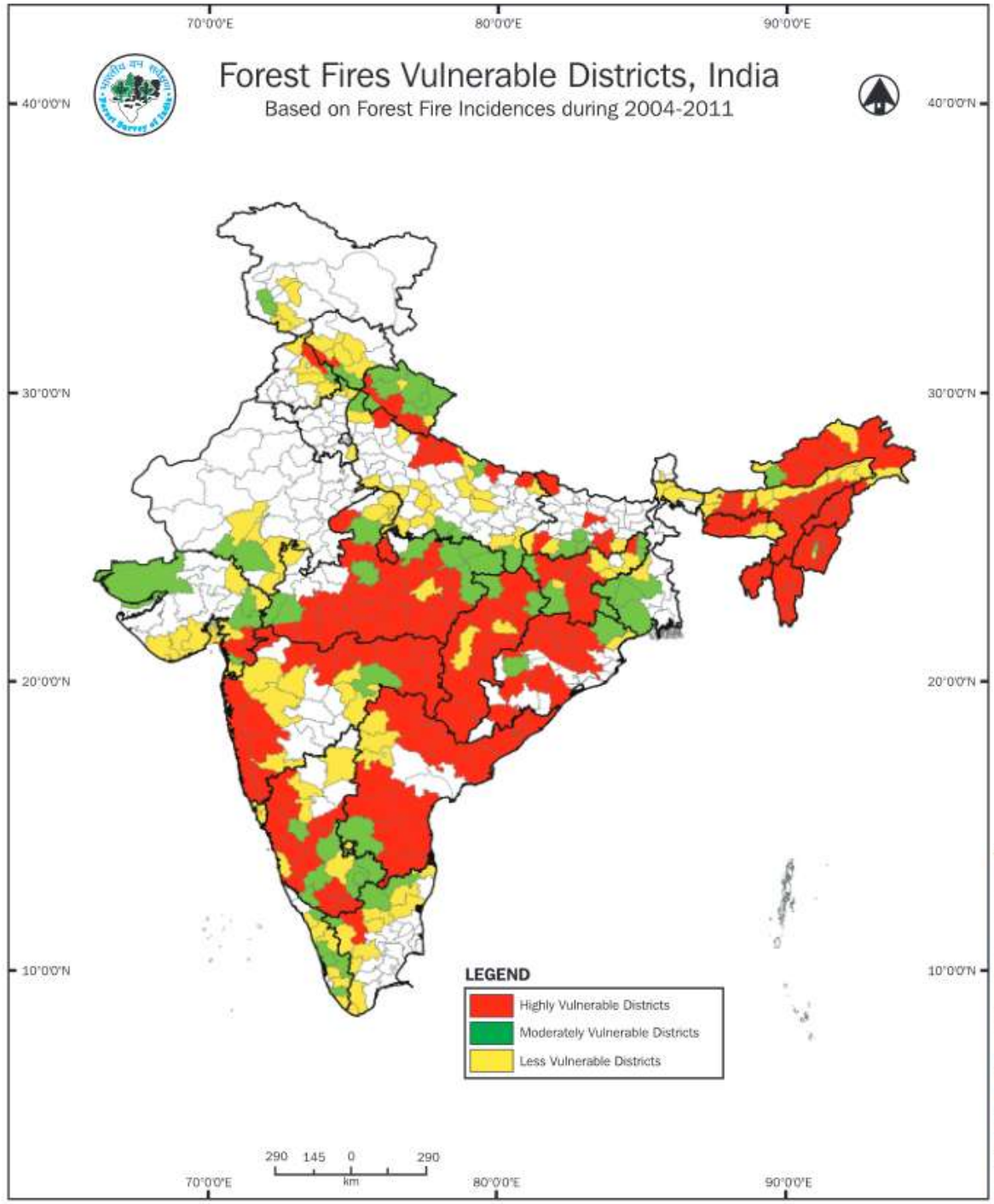
Sl. No.	State	No. of Highly Vulnerable District	No. of Moderately Vulnerable District	No. of Less Vulnerable District	Total No. of Vulnerable District
1.	Andhra Pradesh	15	1	3	19
2.	Arunachal Pradesh	9	1	3	13
3.	Assam	12	0	9	21
4.	Bihar	5	3	3	11
5.	Chhattisgarh	11	2	2	15
6.	Gujarat	3	4	7	14
7.	Goa	0	0	2	2
9.	Haryana	0	1	1	2
10.	Himachal Pradesh	1	2	5	8
11.	Jammu & Kashmir	0	2	4	6
12.	Jharkhand	8	5	4	17
13.	Karnataka	11	7	5	23
14.	Kerala	0	5	6	11
15.	Madhya Pradesh	24	9	5	38
16.	Maharashtra	18	1	7	26
17.	Manipur	7	1	1	9
18.	Meghalaya	5	0	2	7
19.	Mizoram	6	0	0	6
20.	Nagaland	8	0	0	8
22	Odisha	9	3	1	13
23	Punjab	1	1	4	6
24.	Rajasthan	0	2	4	6
25.	Sikkim	0	0	1	1

Vulnerability of India's Forest to Fire



Vulnerability of India's Forest to Fire




Forest Fires Vulnerable Districts, India
Based on Forest Fire Incidences during 2004-2011
70°0'0"E
80°0'0"E
90°0'0"E
40°0'0"N
30°0'0"N
20°0'0"N
10°0'0"N
LEGEND
Highly Vulnerable Districts
Moderately Vulnerable Districts
Less Vulnerable Districts
290 145 0 290
km

States With The Districts Under Different Vulnerability Zones

State	No. of Highly Vulnerable Districts	No. of Moderately Vulnerable Districts	No. of Less Vulnerable Districts	Total No. of Vulnerable Districts
Andhra Pradesh	15	1	3	19
Arunachal Pradesh	9	1	3	13
Assam	12	0	9	21
Bihar	5	3	3	11
Chhattisgarh	11	2	2	15
Gujarat	3	4	7	14
Goa	0	0	2	2
Haryana	0	1	1	2
Himachal Pradesh	1	2	5	8
Jammu & Kashmir	0	3	3	6
Jharkhand	8	5	4	17
Karnataka	11	7	5	23
Kerala	0	5	6	11
Madhya Pradesh	24	9	5	38
Maharashtra	18	1	7	26
Manipur	7	1	1	9
Meghalaya	5	0	2	7
Mizoram	6	0	0	6
Nagaland	8	0	0	8
Orissa	9	3	1	13
Punjab	1	1	4	6
Rajasthan	0	2	4	6
Sikkim	0	0	1	1
Tamil Nadu	1	3	10	14
Tripura	3	0	0	3
Uttar Pradesh	7	5	16	28
Uttarakhand	4	7	2	13
West Bengal	0	4	3	7
Dadra & Nagar Haveli	0	0	1	1
Total	**168**	**70**	**110**	**348**

Percentage of Vulnerable Districts in the State

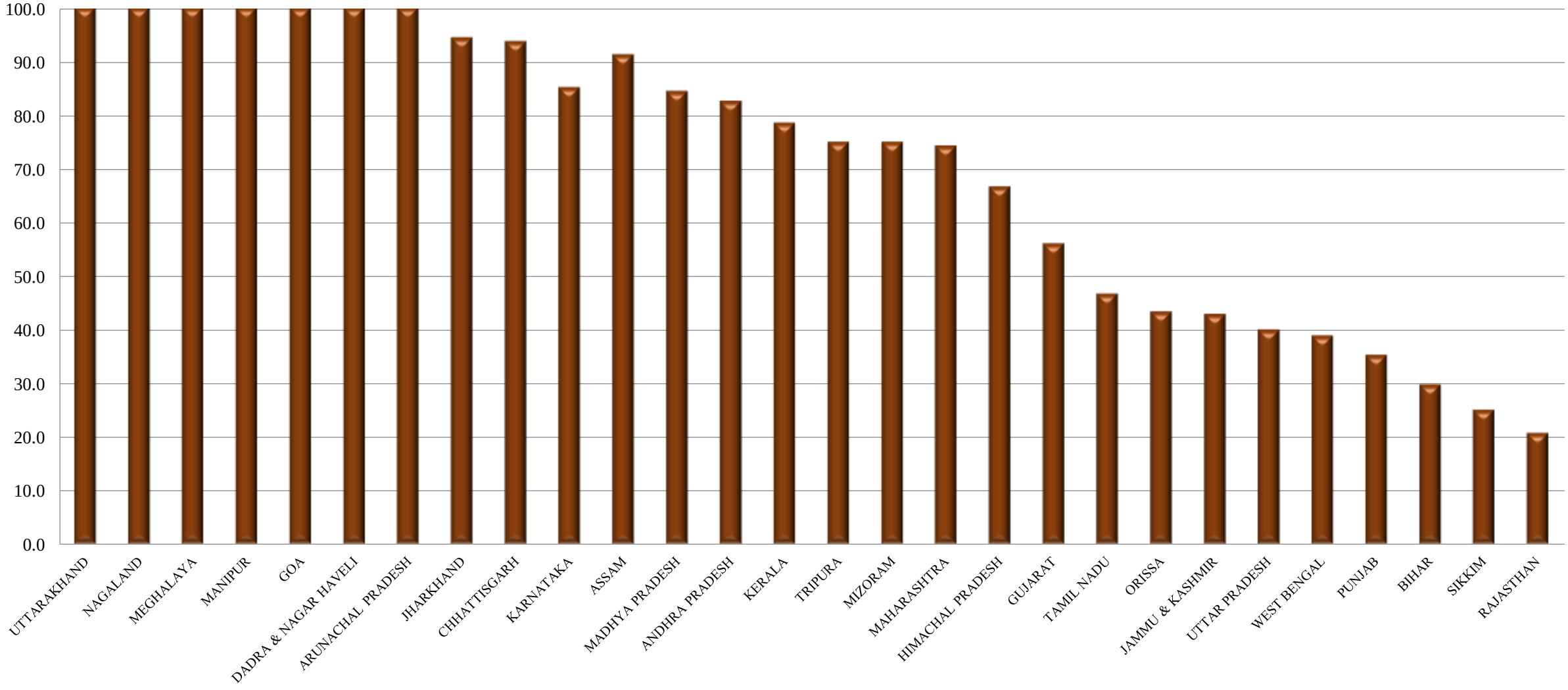


Chart representing the number of forest fire vulnerable districts in states at national level having 31-47% of population below poverty line

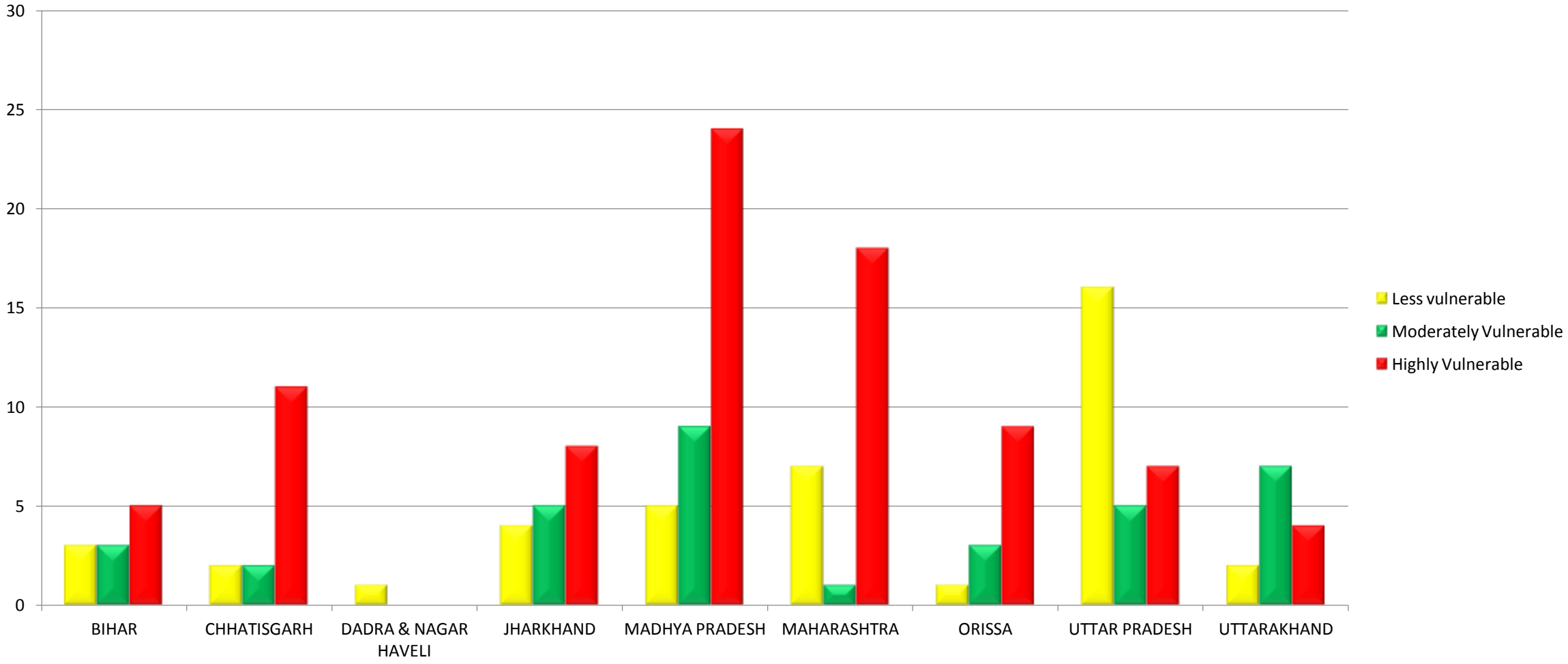
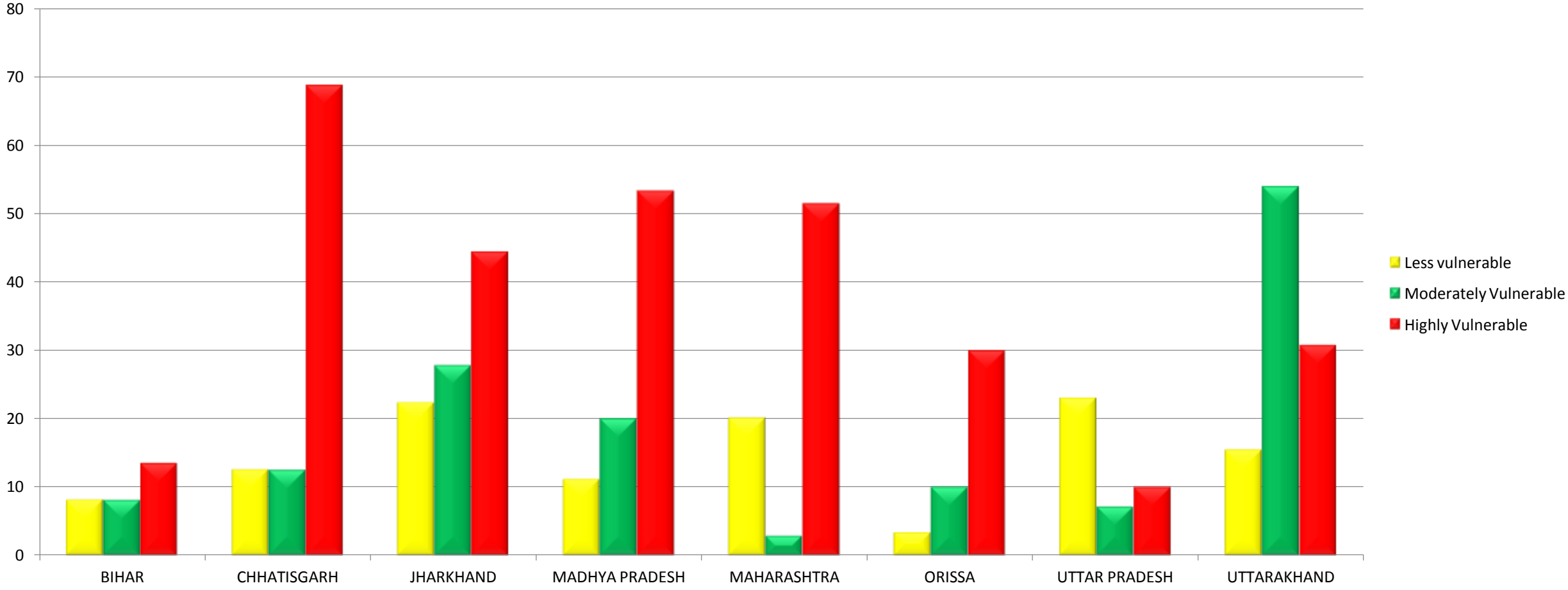
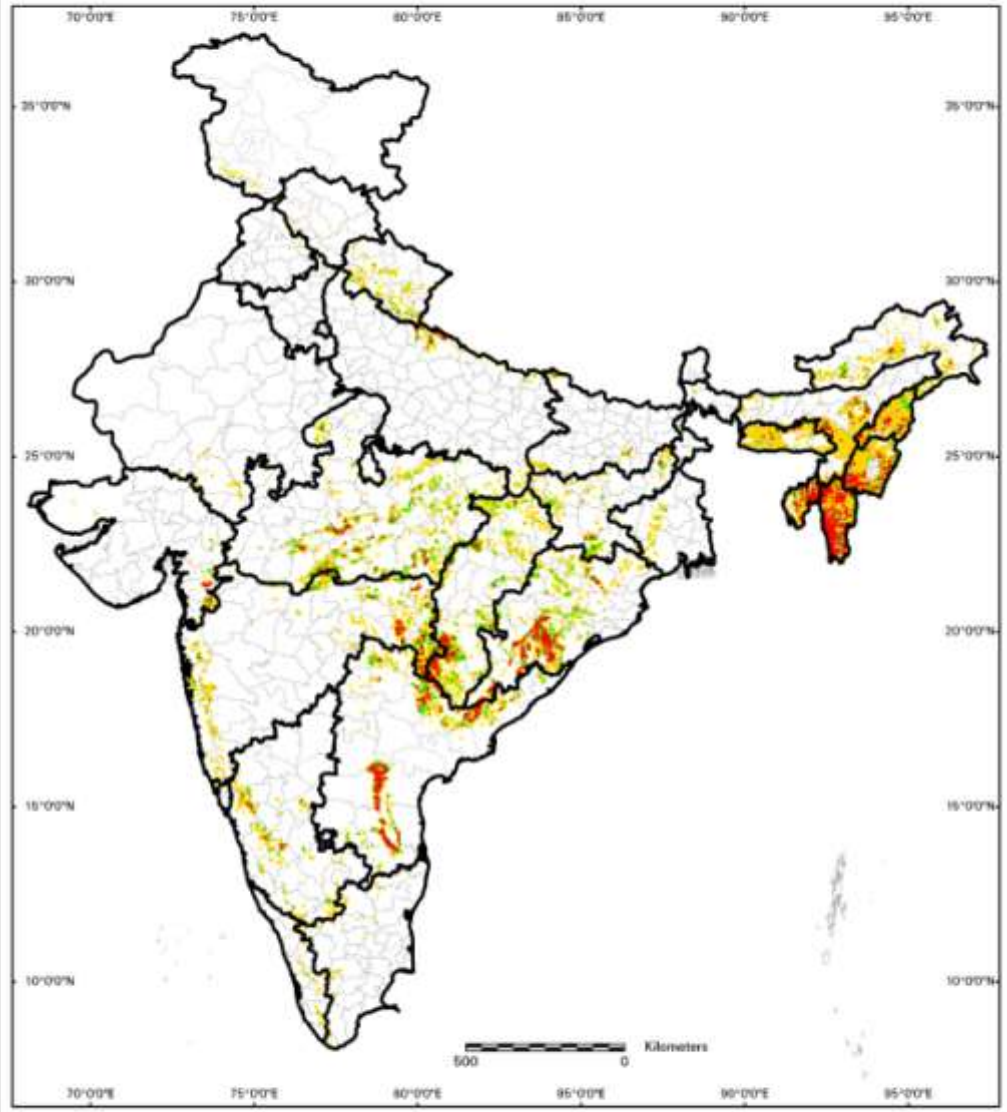


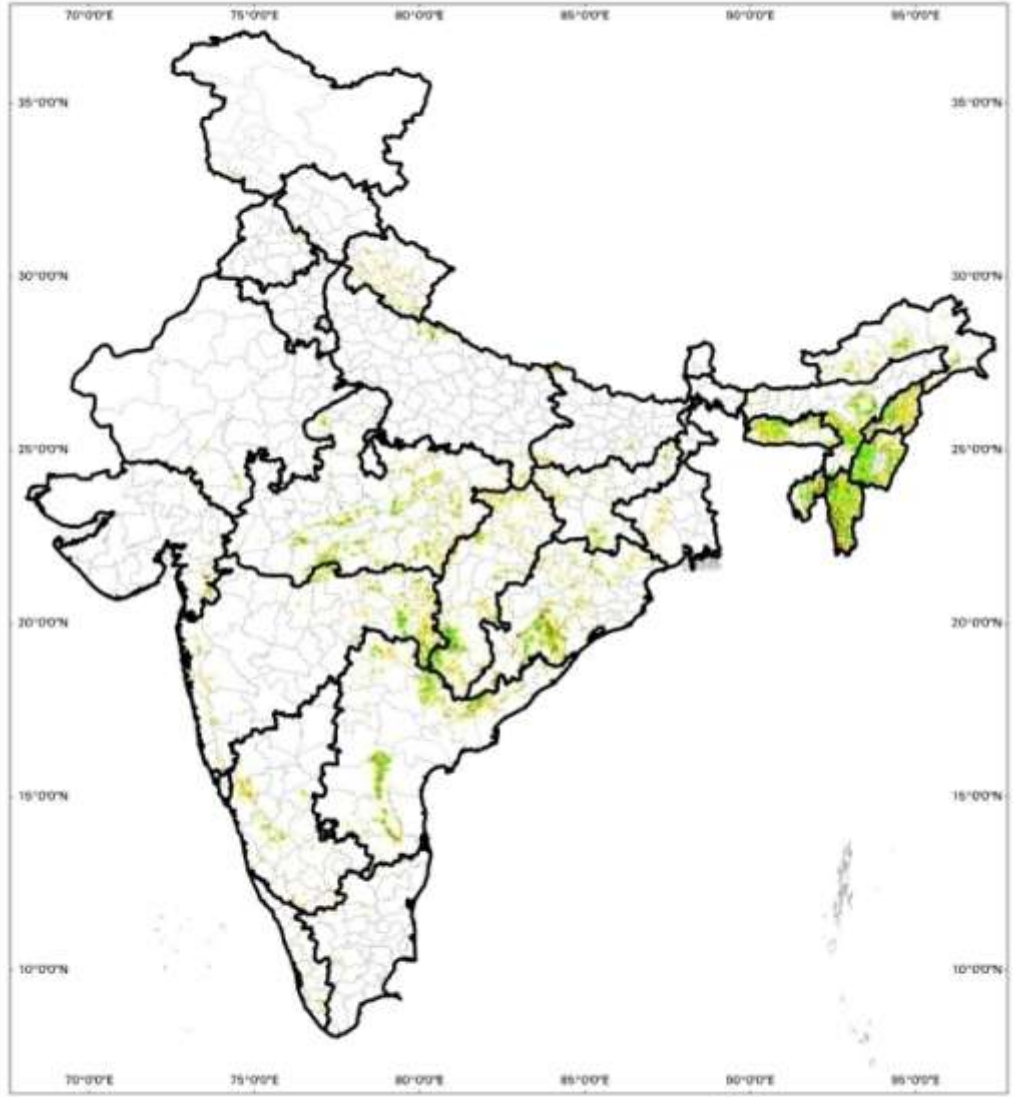
Chart representing the number of forest fire vulnerable districts in states having 31-47% of population below poverty line



Forest Fires Vulnerable Areas



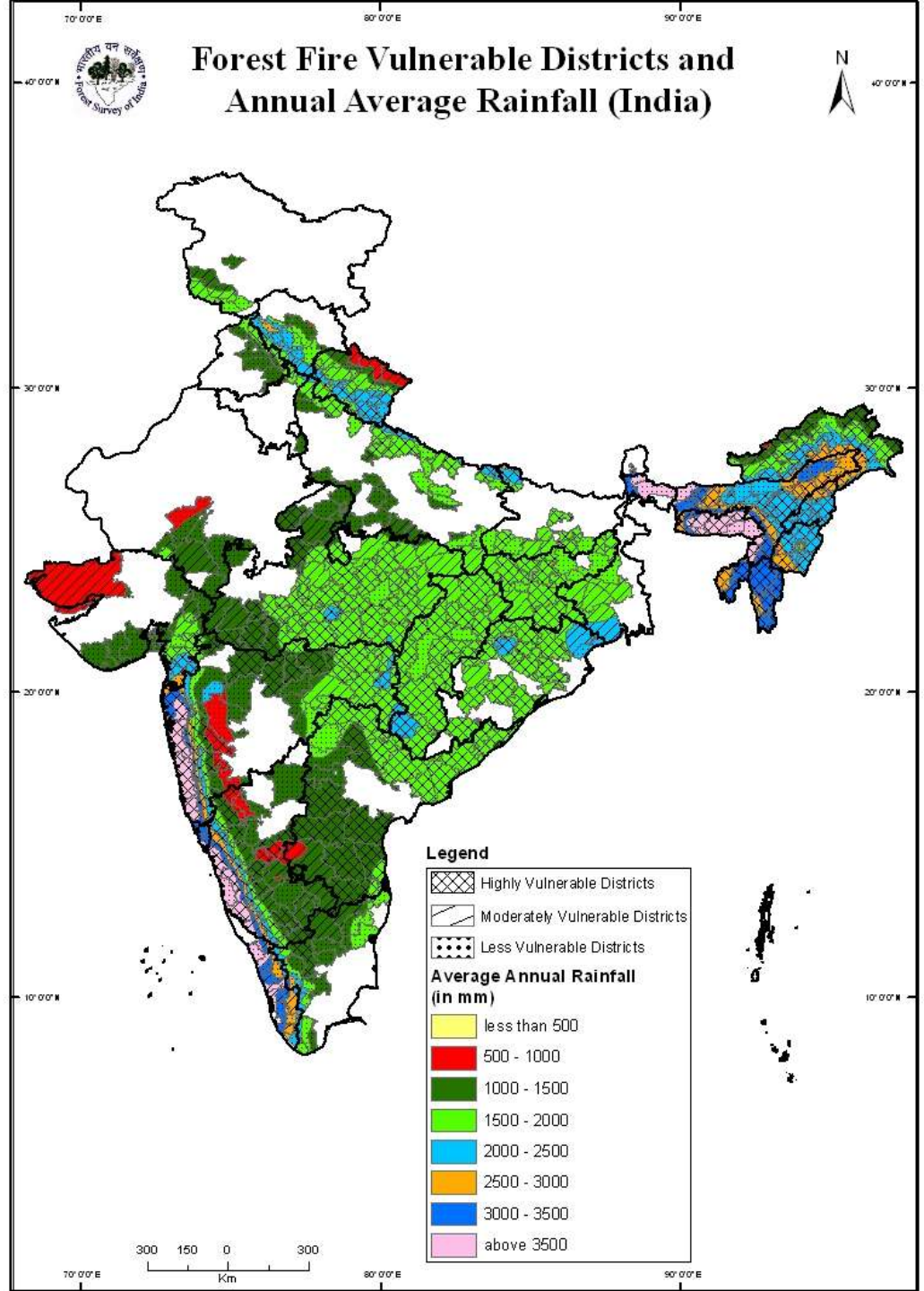
Forest Fires Vulnerable Grids



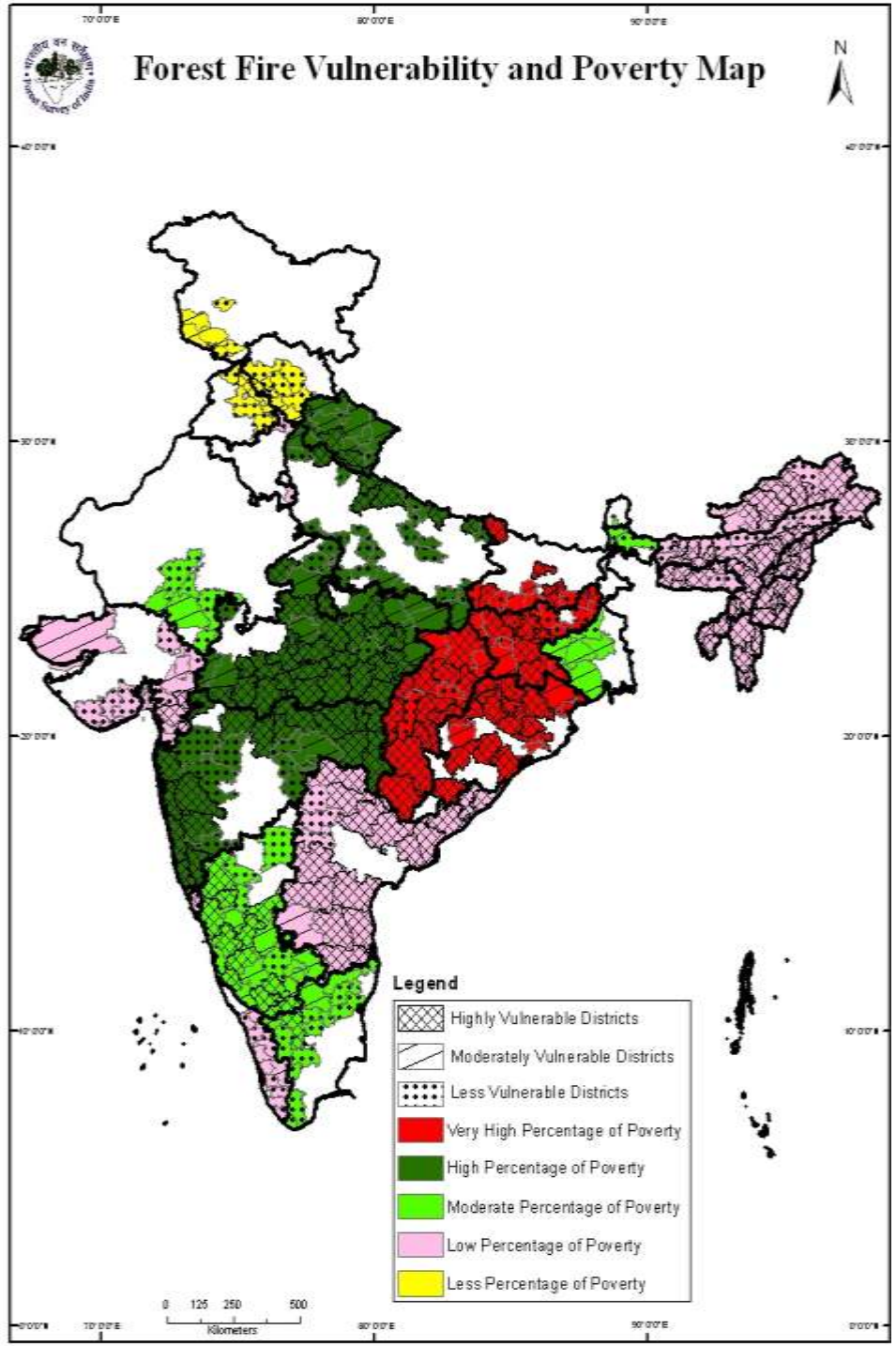
LEGEND

- Highly Vulnerable Areas
- Moderately Vulnerable Areas
- Low Vulnerable Areas
- State Boundary
- District Boundary

500 0 Kilometers


Forest Fire Vulnerable Districts and
Annual Average Rainfall (India)
N
70° 0'0" E
80° 0'0" E
90° 0'0" E
40° 0'0" N
30° 0'0" N
20° 0'0" N
10° 0'0" N
Legend
Highly Vulnerable Districts
Moderately Vulnerable Districts
Less Vulnerable Districts
Average Annual Rainfall
(in mm)
less than 500
500 - 1000
1000 - 1500
1500 - 2000
2000 - 2500
2500 - 3000
3000 - 3500
above 3500
300 150 0 300
Km

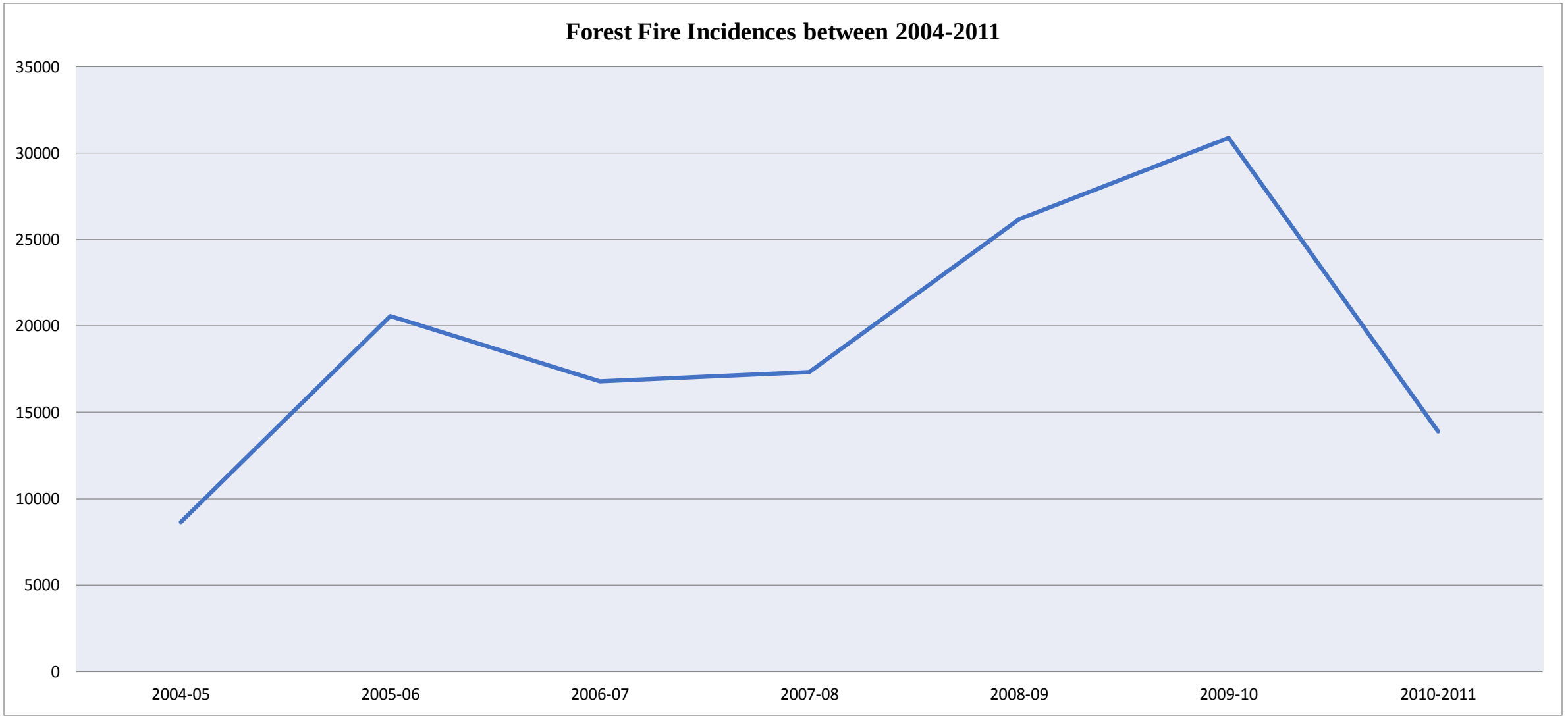
Forest Fire Vulnerability and Poverty Map



Forest Fire Incidences Communicated To State Forest Department During Different Fire Seasons

State	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	Total
Andaman & Nicobar	0	7	1	0	6	1	0	**15**
Andhra Pradesh	1119	1837	2442	1454	1931	1569	1108	**11460**
Arunachal Pradesh	485	576	786	349	627	514	97	**3434**
Assam	1321	2511	1901	1020	902	1369	210	**9234**
Bihar	81	397	143	84	84	126	67	**982**
Chandigarh	0	0	0	0	0	0	0	**0**
Chhattisgarh	1074	2835	2849	1389	1762	848	784	**11541**
Dadra & Nagar Haveli	0	0	0	3	1	0	0	**4**
Daman & Diu	0	0	0	0	0	0	0	**0**
Delhi	1	0	0	0	0	0	0	**1**
Goa	3	0	2	0	1	9	6	**21**
Gujarat	101	179	182	131	100	208	140	**1041**
Haryana	5	29	21	75	14	11	7	**162**
Himachal Pradesh	6	125	168	104	48	12	9	**472**
Jammu & Kashmir	7	30	117	54	92	81	29	**410**
Jharkhand	192	1314	430	394	140	548	151	**3169**
Karnataka	370	428	604	275	414	631	417	**3139**
Kerala	10	106	166	19	130	51	90	**572**
Lakshadweep	0	0	0	0	0	0	0	**0**
Madhya Pradesh	1451	2386	2894	2705	871	1101	900	**12308**
Maharashtra	882	1789	2257	1426	1243	1009	534	**9140**
Manipur	1275	2487	1477	1415	1223	1666	295	**9838**
Meghalaya	879	1743	1010	699	504	1285	69	**6189**
Mizoram	1691	4675	3434	2095	2733	4479	1513	**20620**
Nagaland	919	1654	984	568	851	1200	131	**6307**
Odisha	780	2515	2080	1184	1587	1646	1127	**10919**
Puducherry	0	0	0	0	0	0	0	**0**
Punjab	10	56	41	147	18	33	21	**326**
Rajasthan	87	117	96	118	53	47	14	**532**
Sikkim	1	5	1	0	0	7	0	**14**
Tamil Nadu	34	148	276	40	123	109	193	**923**
Tripura	634	1127	717	358	788	1421	324	**5369**
Uttar Pradesh	198	737	370	379	305	253	235	**2477**
Uttarakhand	85	855	631	717	222	165	143	**2818**
West Bengal	197	224	100	62	6	168	31	**788**
Total	**13898**	**30892**	**26180**	**17264**	**16779**	**20567**	**8645**	**134225**

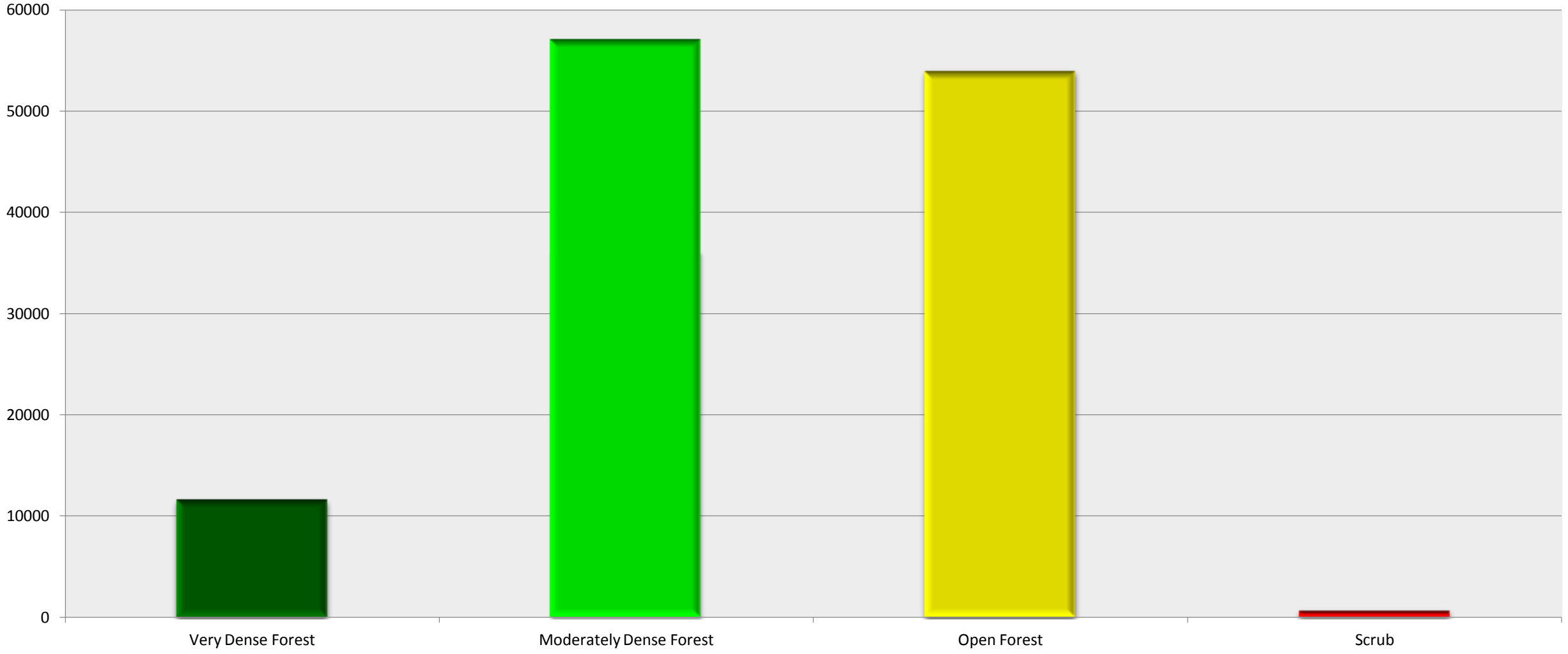
Forest Fire Incidences Communicated To State Forest Department During Different Fire Seasons



Forest Fire Incidences In Different Forest Density Classes Of Forest Cover Map

Forest Density	Year 2004-05	Year 2005-06	Year 2006-07	Year 2007-08	Year 2008-09	Year 2009-10	Year 2010-11	Total
Very Dense Forest	827	1139	1456	1563	2574	2804	1105	**11468**
Moderately Dense Forest	3646	8140	7173	7570	11497	13196	5841	**57063**
Open Forest	3032	8910	6675	6758	10008	12711	5685	**53779**
Scrub	82	137	77	61	84	100	39	**580**
Non Forest	1058	2241	1398	1312	2017	2081	1228	**11335**
Total	**8645**	**20567**	**16779**	**17264**	**26180**	**30892**	**13898**	**134225**

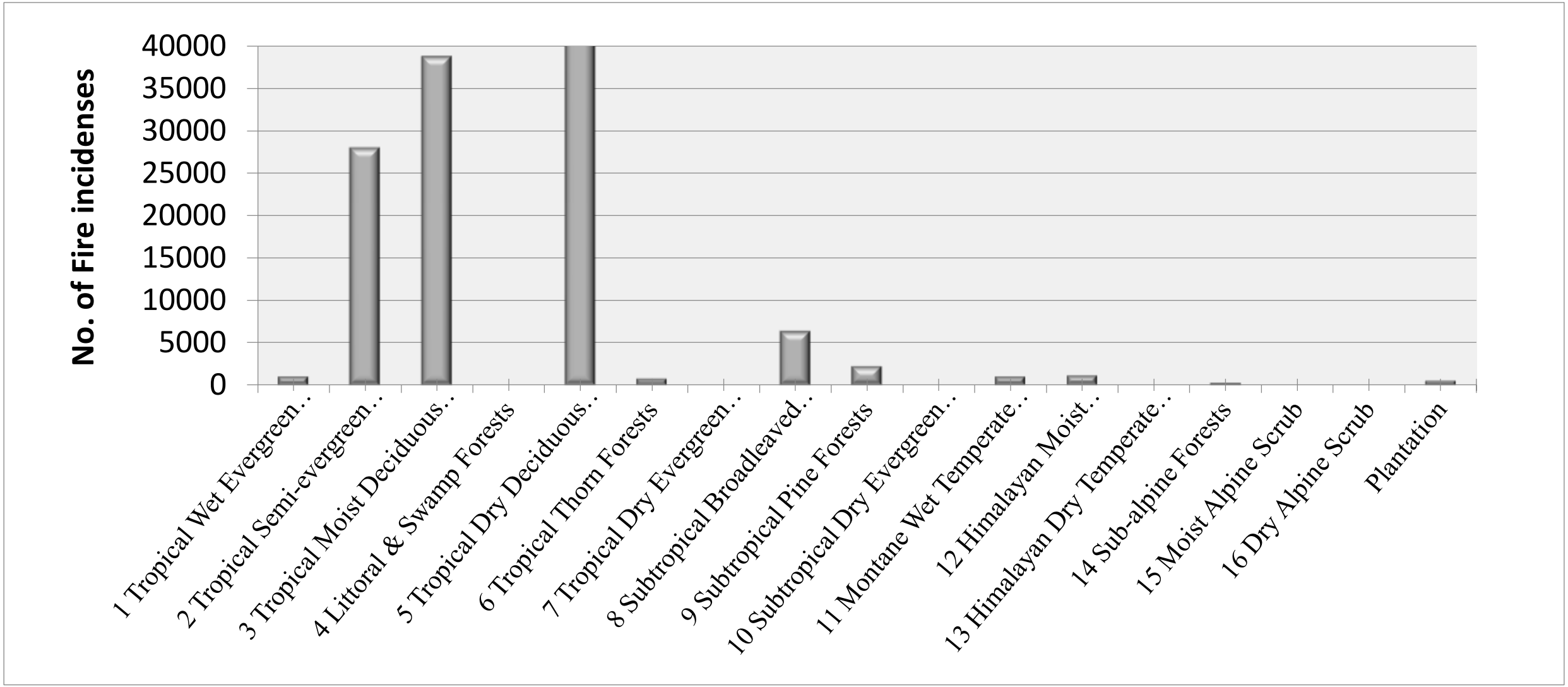
Number of Fire incidences in Different Forest Density Classes



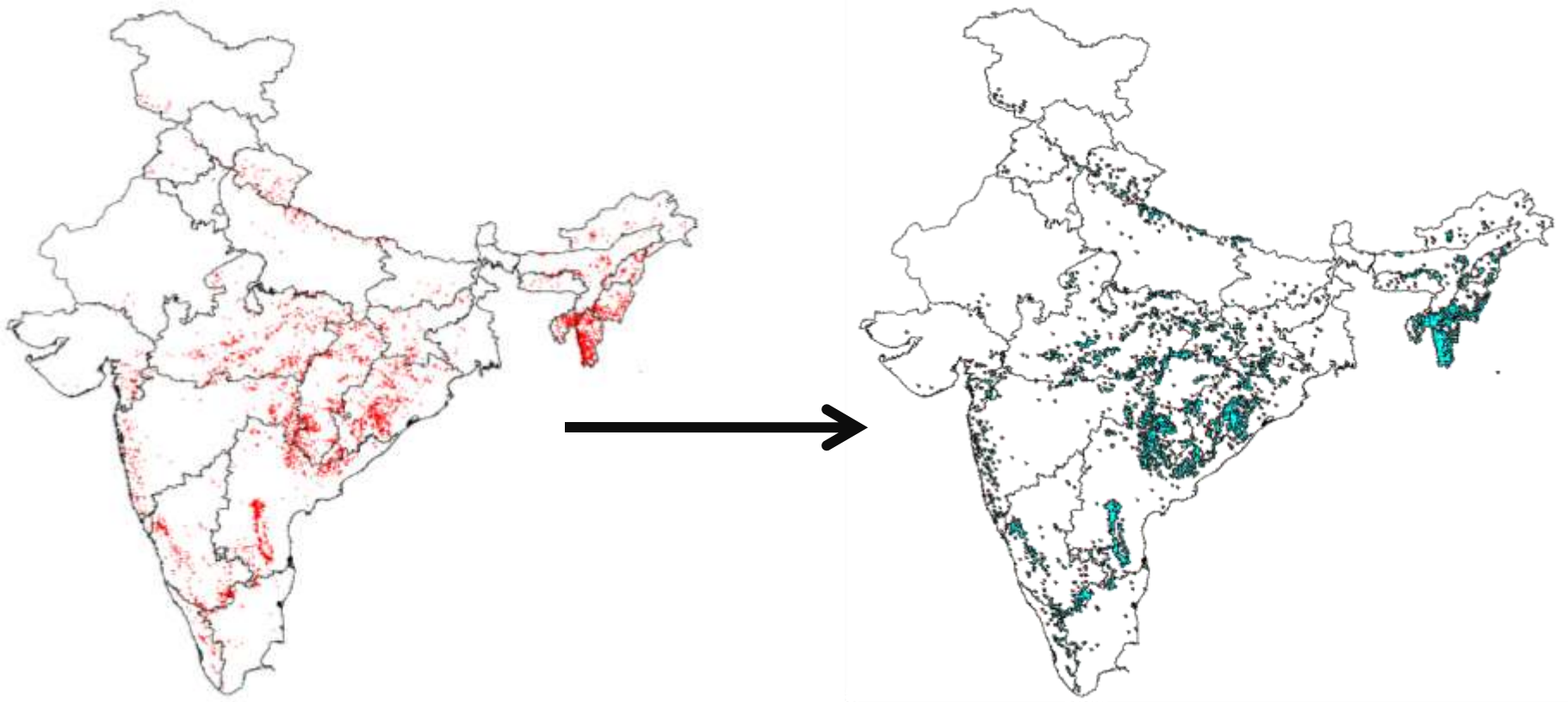
Forest Fire Incidences In Different Forest Type Groups During Period 2004-11 (Year Wise) As Per Champion And Seth's Classification

Type Group	No of fire incidence							
	04-05	05-06	06-07	07-08	08-09	09-10	10-11	Total
1 Tropical Wet Evergreen Forests	32	144	93	50	182	184	107	**792**
2 Tropical Semi-evergreen Forests	1447	5274	3705	3007	5121	6324	2999	**27877**
3 Tropical Moist Deciduous Forests	2316	6079	5239	4367	7113	9514	3997	**38625**
4 Littoral & Swamp Forests	8	9	3	11	18	16	1	**66**
5 Tropical Dry Deciduous Forests	3281	5111	5116	6700	9120	9583	4260	**43171**
6 Tropical Thorn Forests	70	109	96	75	90	81	71	**592**
7 Tropical Dry Evergreen Forests	5	6	10	2	9	7	0	**39**
8 Subtropical Broadleaved Hill Forests	167	1093	773	822	987	1633	780	**6255**
9 Subtropical Pine Forests	64	272	247	325	479	531	144	**2062**
10 Subtropical Dry Evergreen Forests	0	0	0	0	0	0	0	**0**
11 Montane Wet Temperate Forests	8	139	79	96	132	227	109	**790**
12 Himalayan Moist Temperate Forests	53	48	113	136	410	156	64	**980**
13 Himalayan Dry Temperate Forests	0	0	1	13	12	4	1	**31**
14 Sub-Alpine Forests	0	18	16	14	35	23	17	**123**
15 Moist Alpine Scrub	0	2	0	3	6	3	0	**14**
16 Dry Alpine Scrub	0	0	1	3	1	0	0	**5**
Plantation	28	50	35	64	64	93	30	**364**
Non Forest	1166	2213	1252	1576	2401	2513	1318	**12439**
Total	**8645**	**20567**	**16779**	**17264**	**26180**	**30892**	**13898**	**134225**

Forest fire incidences in different forest types from 2004 to 2011



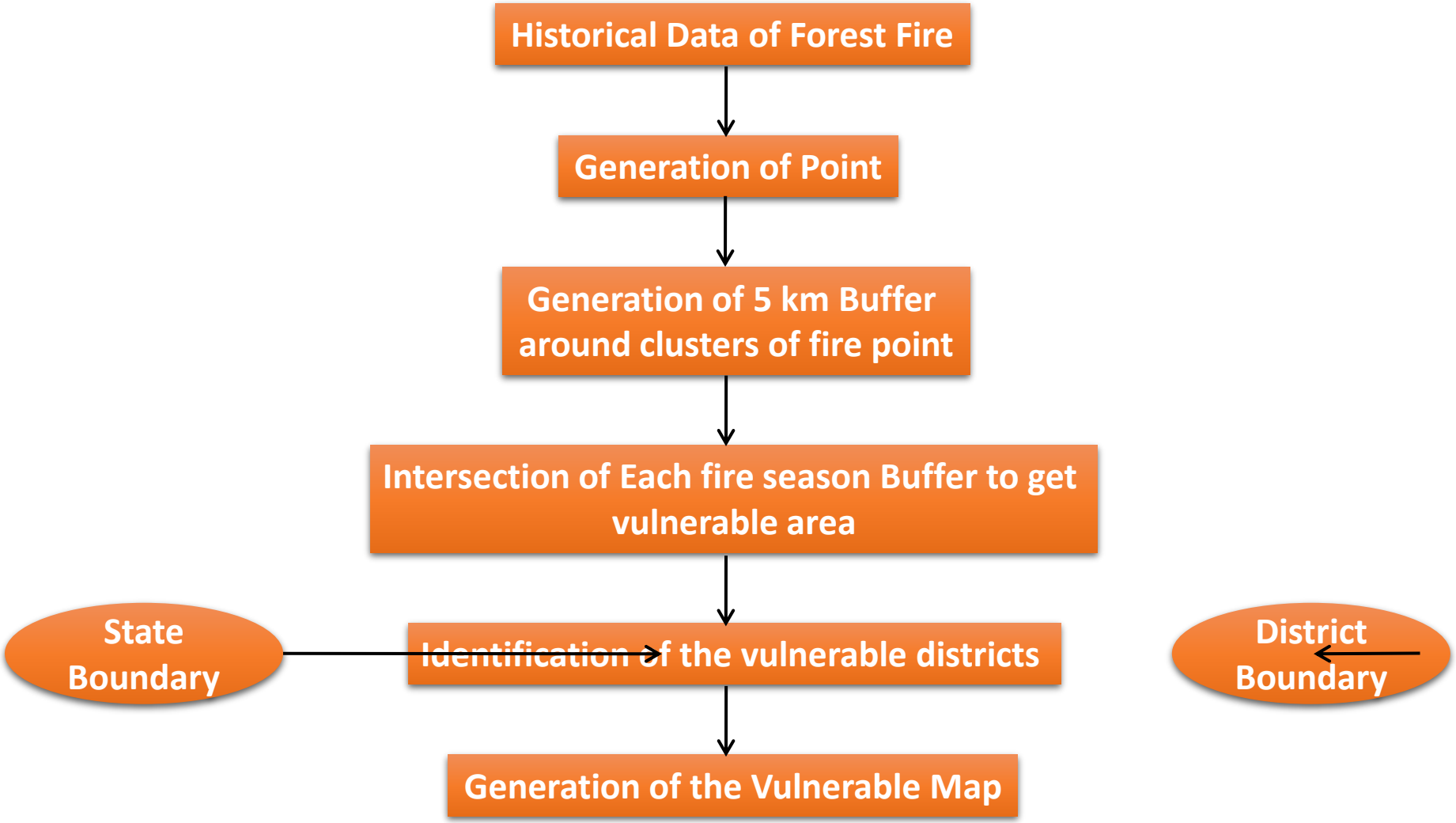
Vulnerability Mapping



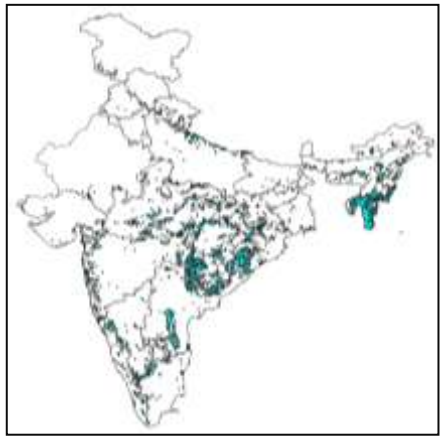
Point Location of Forest Fire incidence

5km Buffer Area around cluster of fire locations

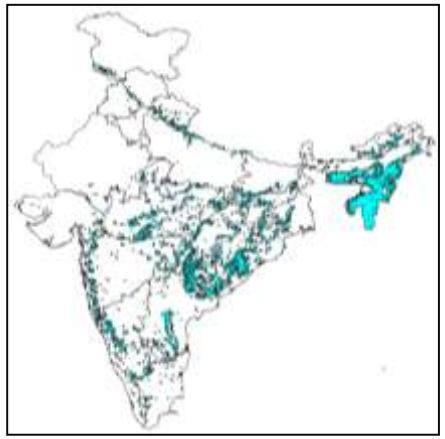
Flow chart for creation of Vulnerability Map



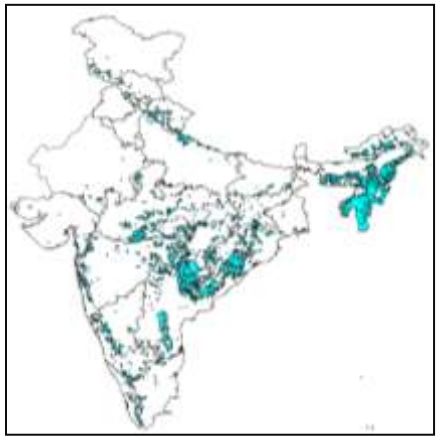
Buffer of Each Fire Season



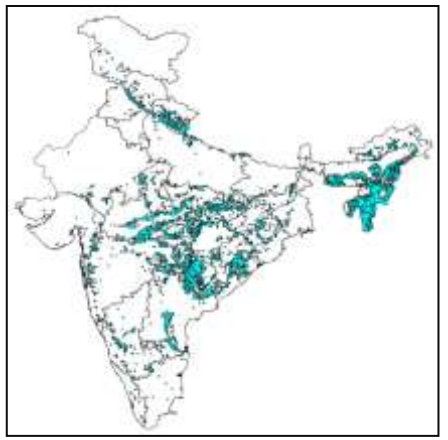
Year - 2004-2005



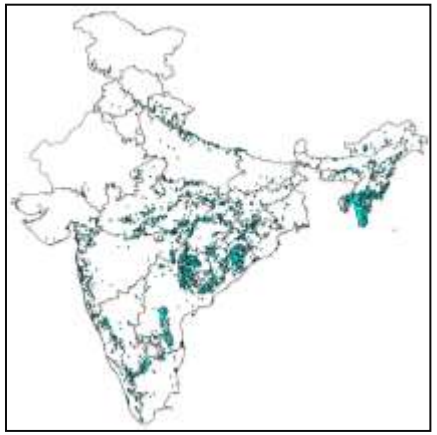
Year - 2005-2006



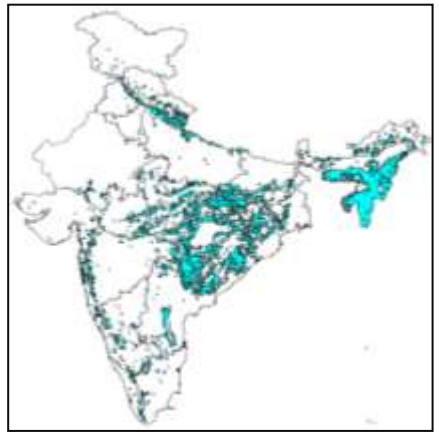
Year - 2006-2007



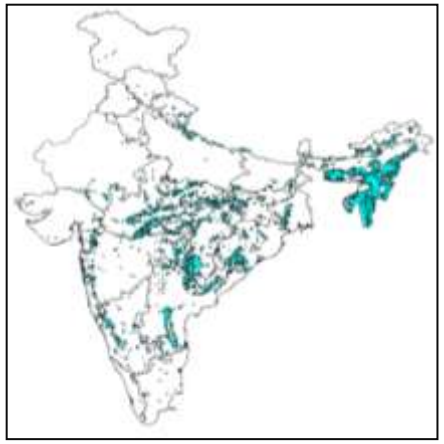
Year - 2007-2008



Year - 2008-2009

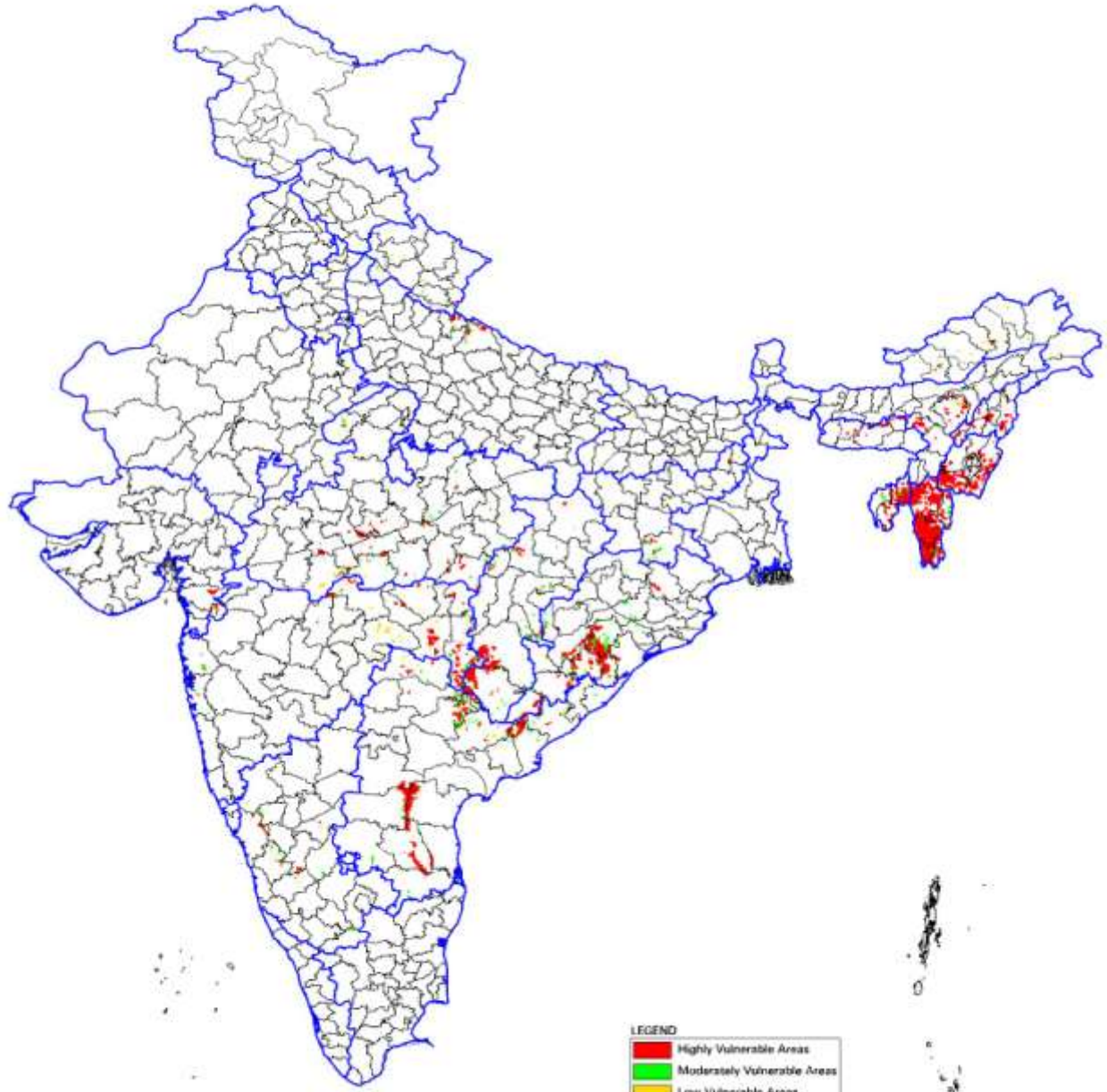


Year - 2009-2010



Year - 2010-2011

Forest Fires Vulnerable Areas



Forest Fire Burnt Scar Assessment

Methodology and Materials Used

Materials used

- ✓IRS Resourcesat-2/P6- AWiFS Satellite data(Resolution-56mts)
- ✓Digital data on fire occurrences
- ✓Digital Elevation Model (DEM)
- ✓Forest Type Map (FTM)
- ✓Forest Cover Map (FCM)
- ✓Historical forest Fire Archival data
- ✓GPS
- ✓SOI-toposheets
- ✓Monthly Temperature Data from IMD

Methodology Used

Reference Data

- Forest Cover Map
- Forest Type Map
- Archival forest fire points
- Monthly Temperature Data
- Digital Elevation model (DEM)

Satellite Data

Geometric correction using SOI Toposheets (1:50,000)

Image to Image Registration

Image Interpretation using Ratio indices and contextual approach (assigning burnt severity classes)

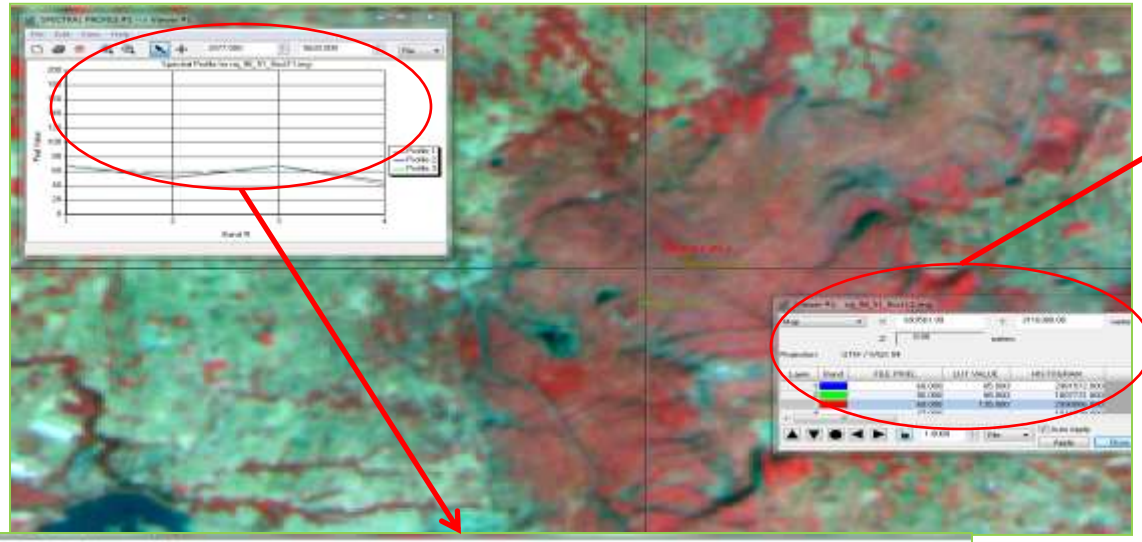
Extraction of geo-coordinates from the center of the polygon

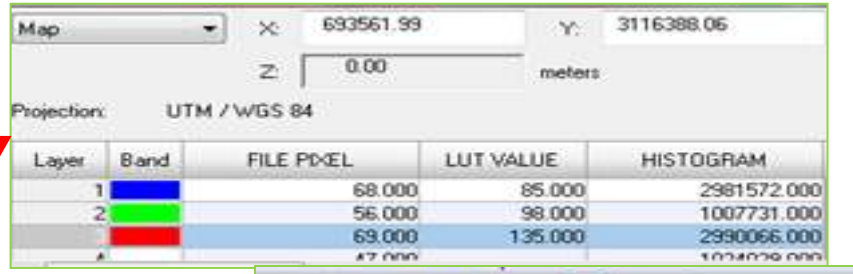
Value addition of attributes (State, District, SOI Toposheet, Area burnt, Severity class)

Map composition and Report writing

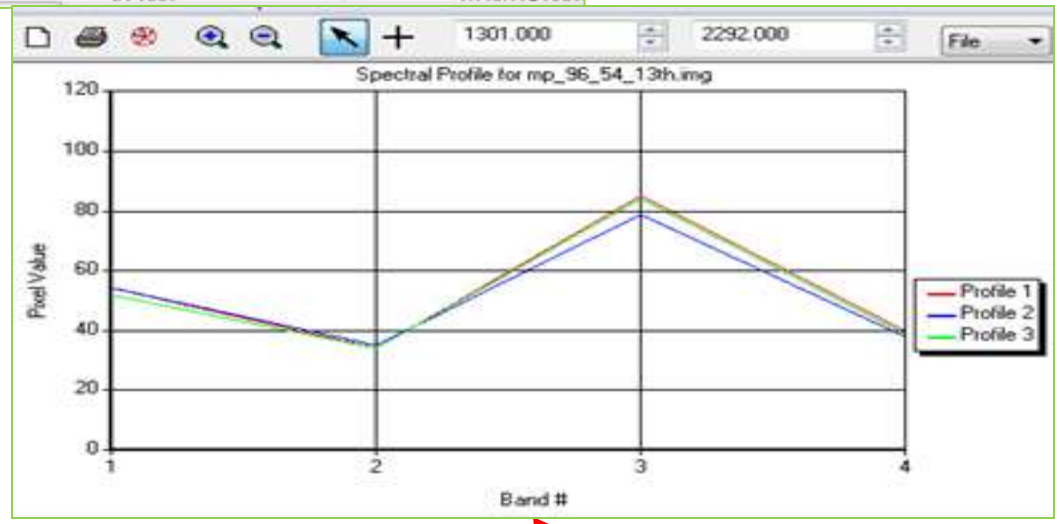
Dissemination of the polygons for ground verification

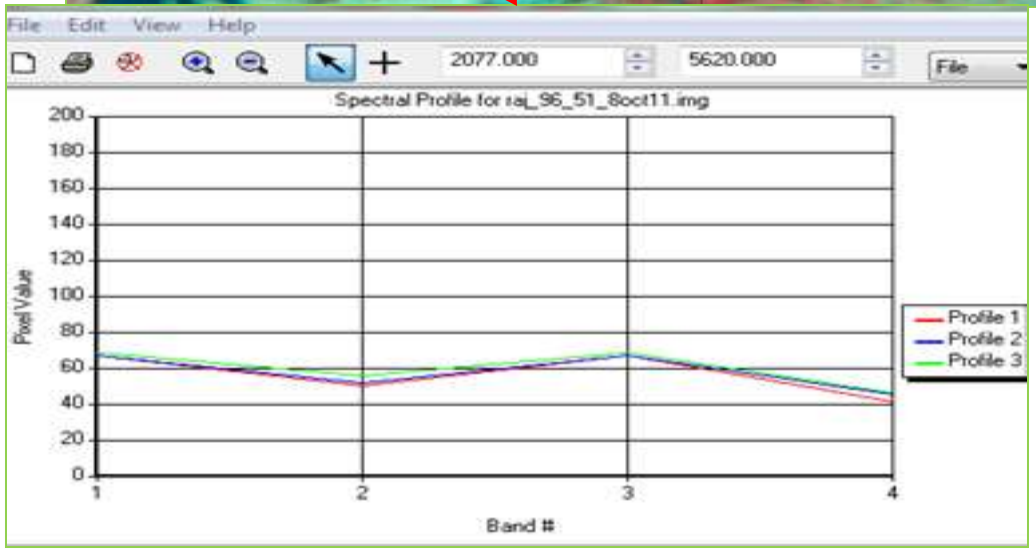
Area calculation under different severity classes

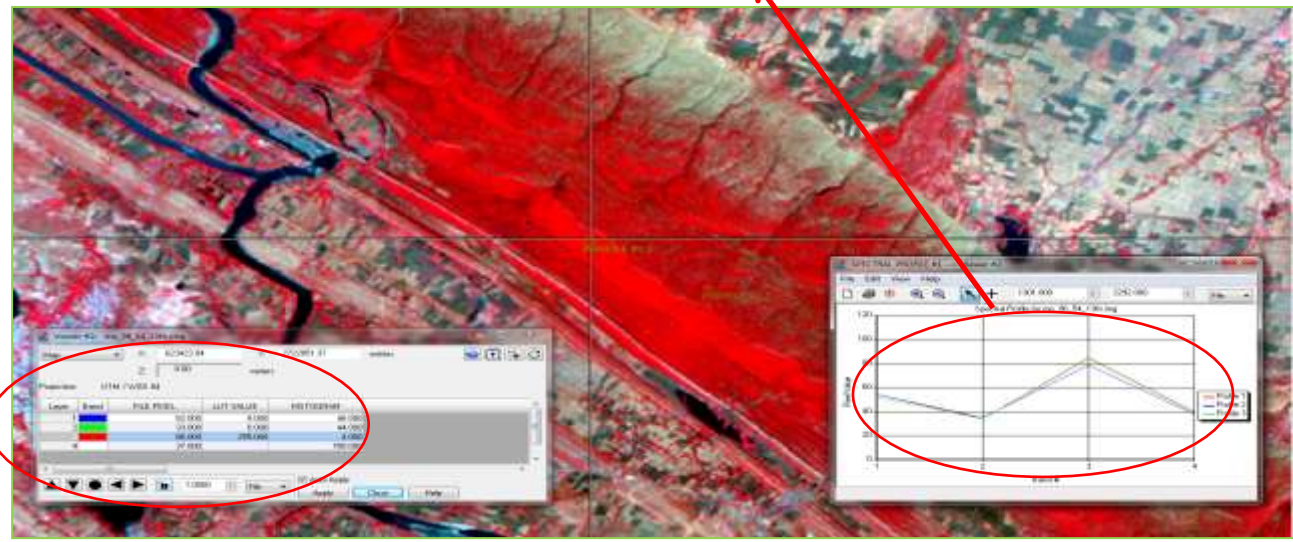


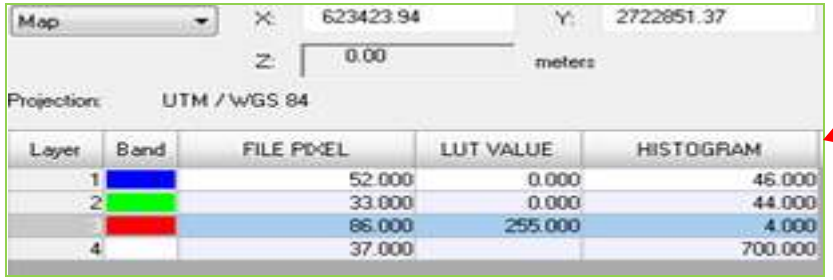


Layer	Band	FILE PIXEL	LUT VALUE	HISTOGRAM
1		68.000	85.000	2981572.000
2		56.000	98.000	1007731.000
		69.000	135.000	2990066.000







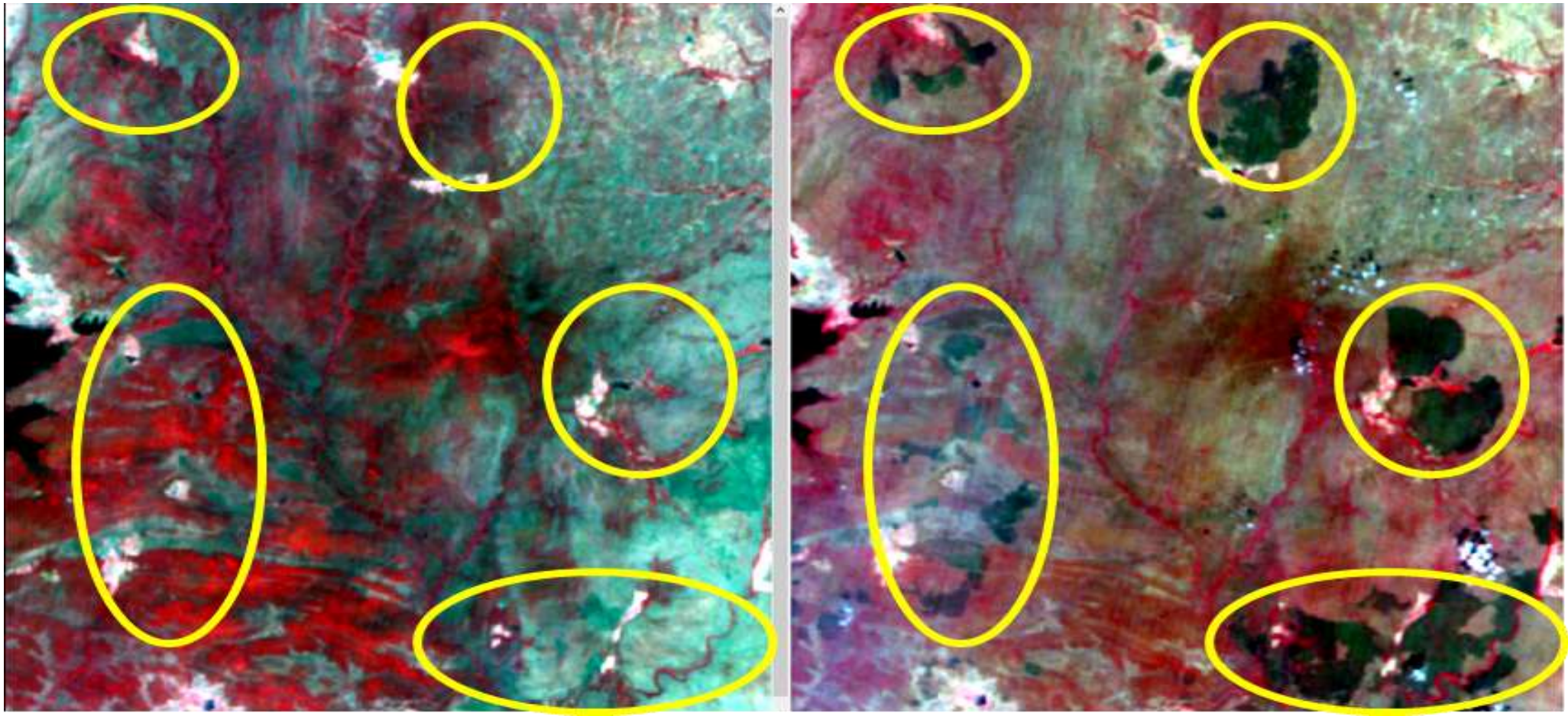


Layer	Band	FILE PIXEL	LUT VALUE	HISTOGRAM
1		52.000	0.000	46.000
2		33.000	0.000	44.000
		86.000	255.000	4.000
4		37.000		700.000

IRS-AWiFS data of pre and post fire season

AWiFS data of 26 February 2016
(Pre-Fire Date)

AWiFS data of 01 April 2016
(Post-Fire Date)



Burnt Area Index (BAI)

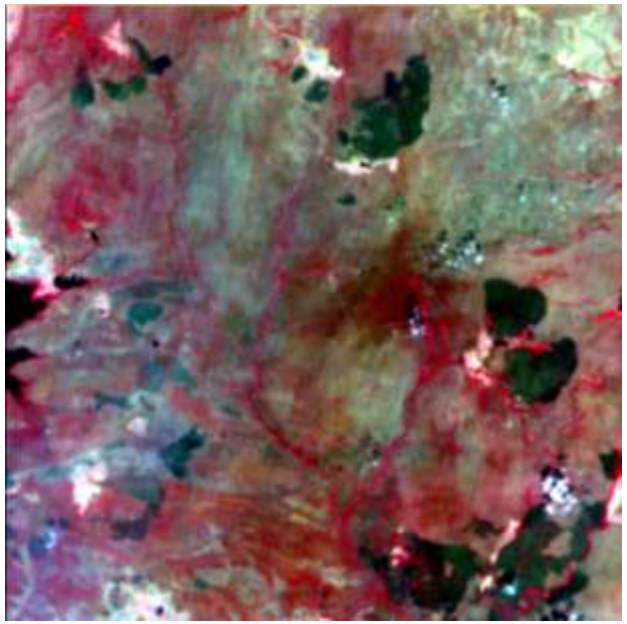
$$BAI = \frac{1}{(\rho cNIR - \rho NIR)^2 + (\rho cSWIR - \rho SWIR)^2}$$

Where $\rho cNIR$ = Reference Reflectance in NIR Band

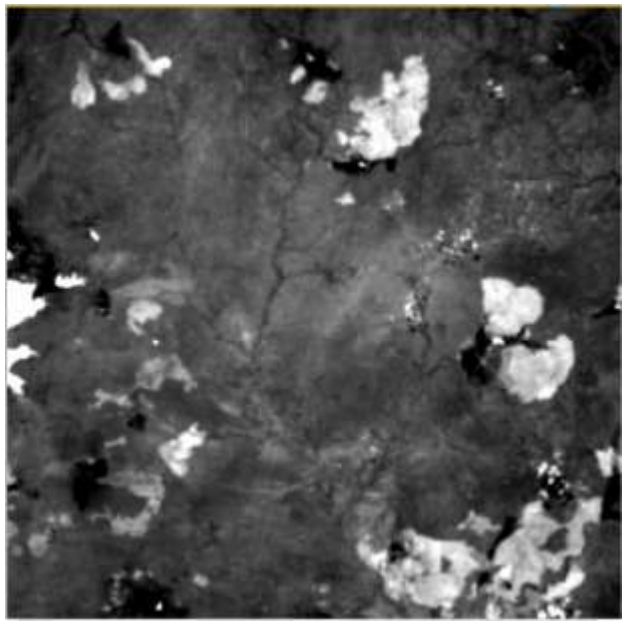
$\rho cSWIR$ = Reference Reflectance in SWIR Band

ρNIR = Reflectance in NIR Band

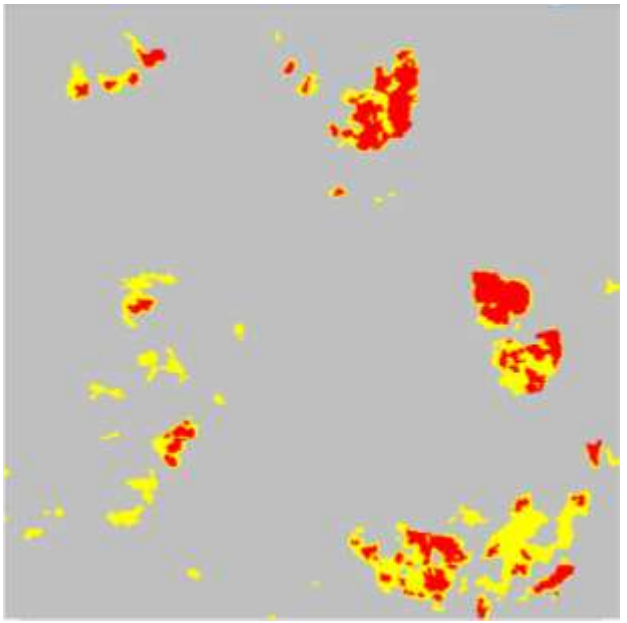
$\rho SWIR$ = Reflectance in SWIR Band



AWiFS Data

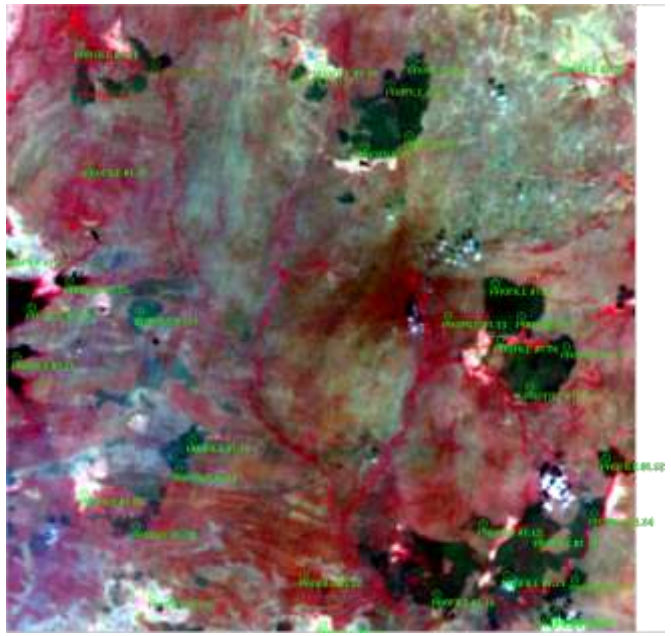


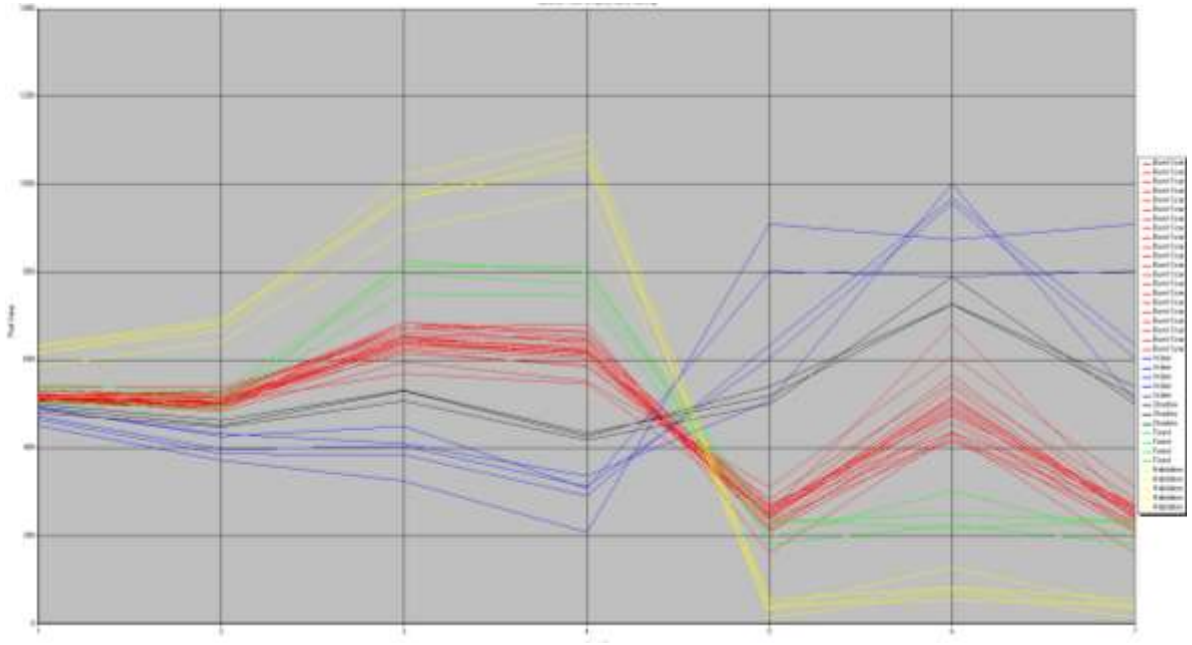
Burned Area Index



Classified BAI

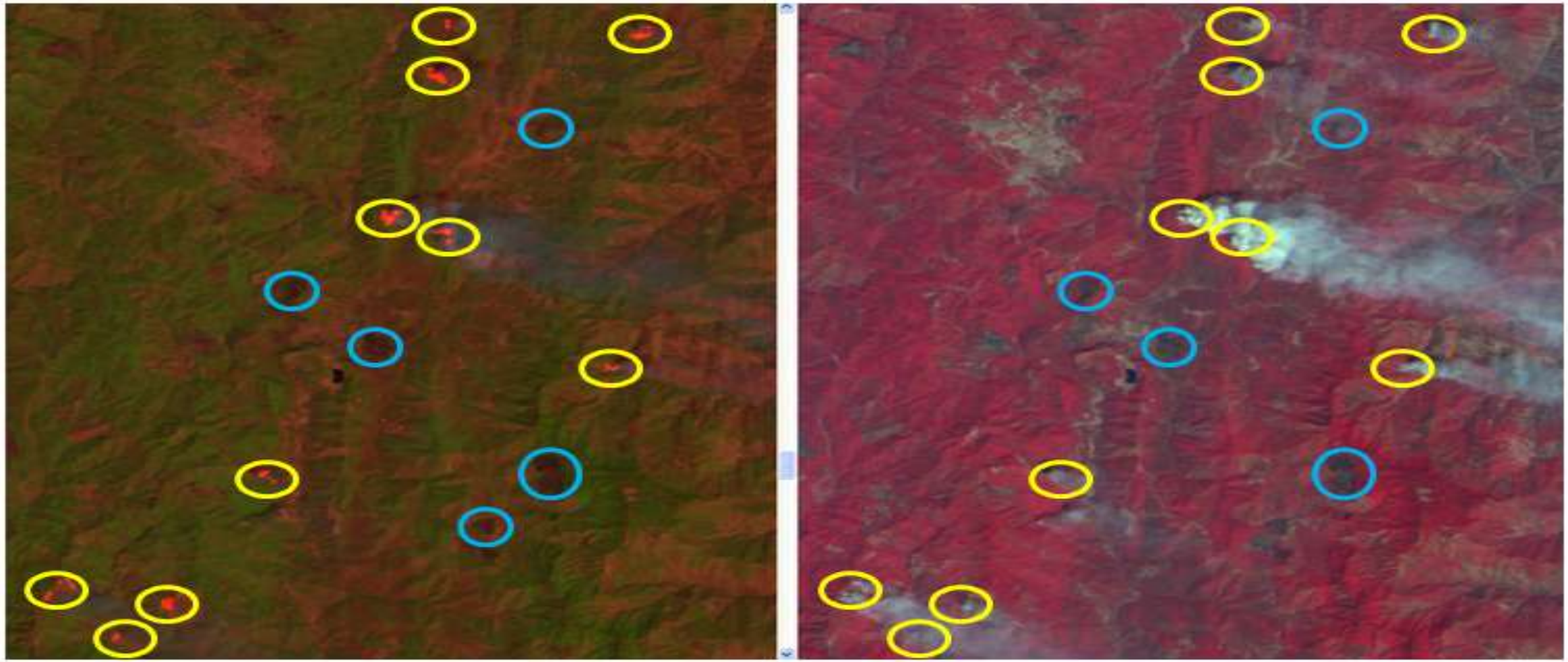
Spectral curve of the different classes





- Spectral Curve of Habitation
- Spectral Curve of Forest
- Spectral Curve of Burnt Scar
- Spectral Curve of Shadow
- Spectral Curve of Water

AWiFS Image Showing Active fire Locations and Burnt Scars using Different Band Combinations



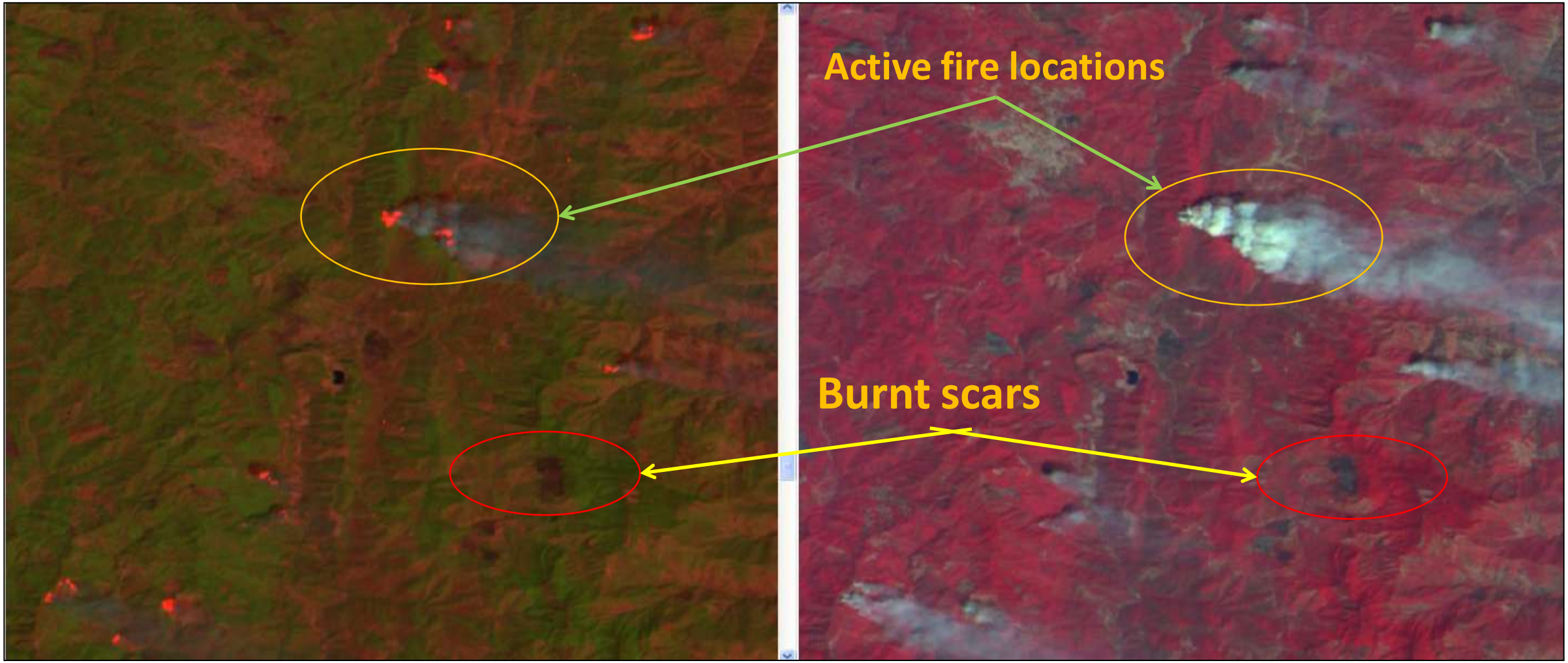
FCC Band Combination 432

FCC Band Combination 321

Active Fire Locations

Burnt Scar

AWiFS Imagery of 17 March 2015

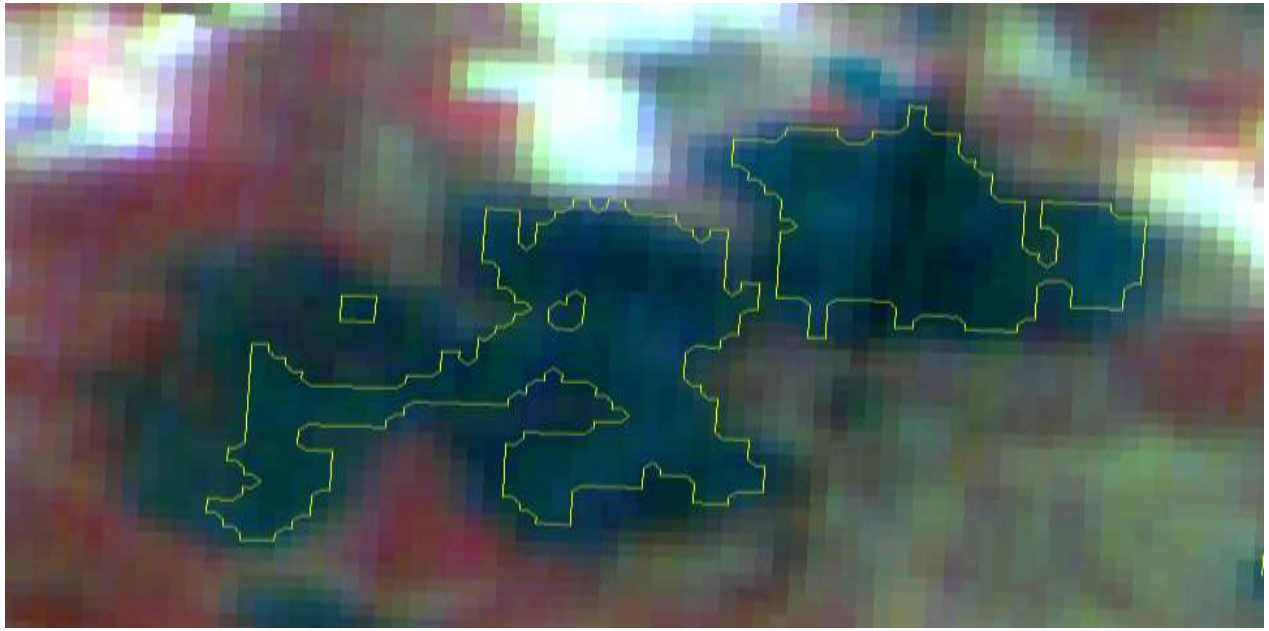


FCC Band Combination 432

FCC Band Combination 321

Burnt Area Polygon as KML overlaid on Google Earth

Burnt Area Polygon as Shape File overlaid on AWiFS Image

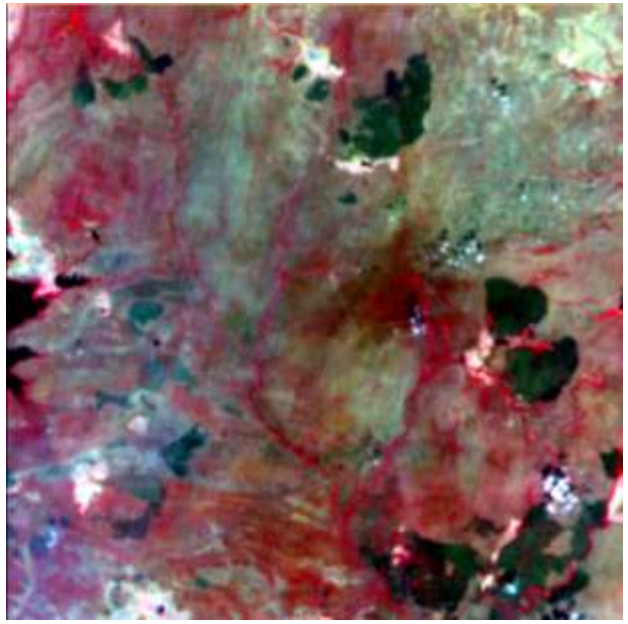


Normalized Differential Vegetation Index (NDVI)

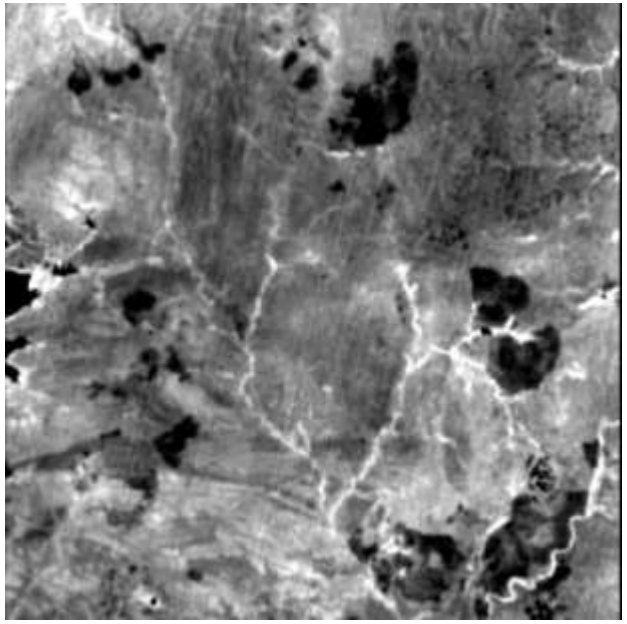
$$NDVI = \frac{\rho NIR - \rho R}{\rho NIR + \rho R}$$

Where ρNIR = Reflectance in NIR Band

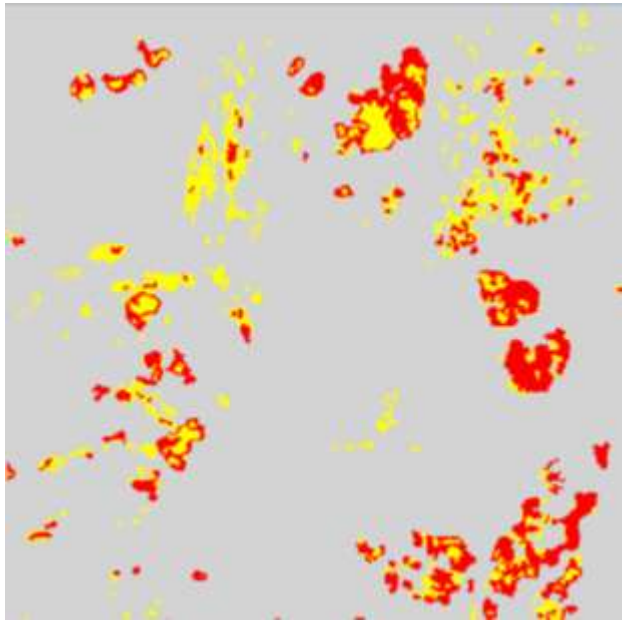
ρR = Reflectance in RED Band



AWiFS Data

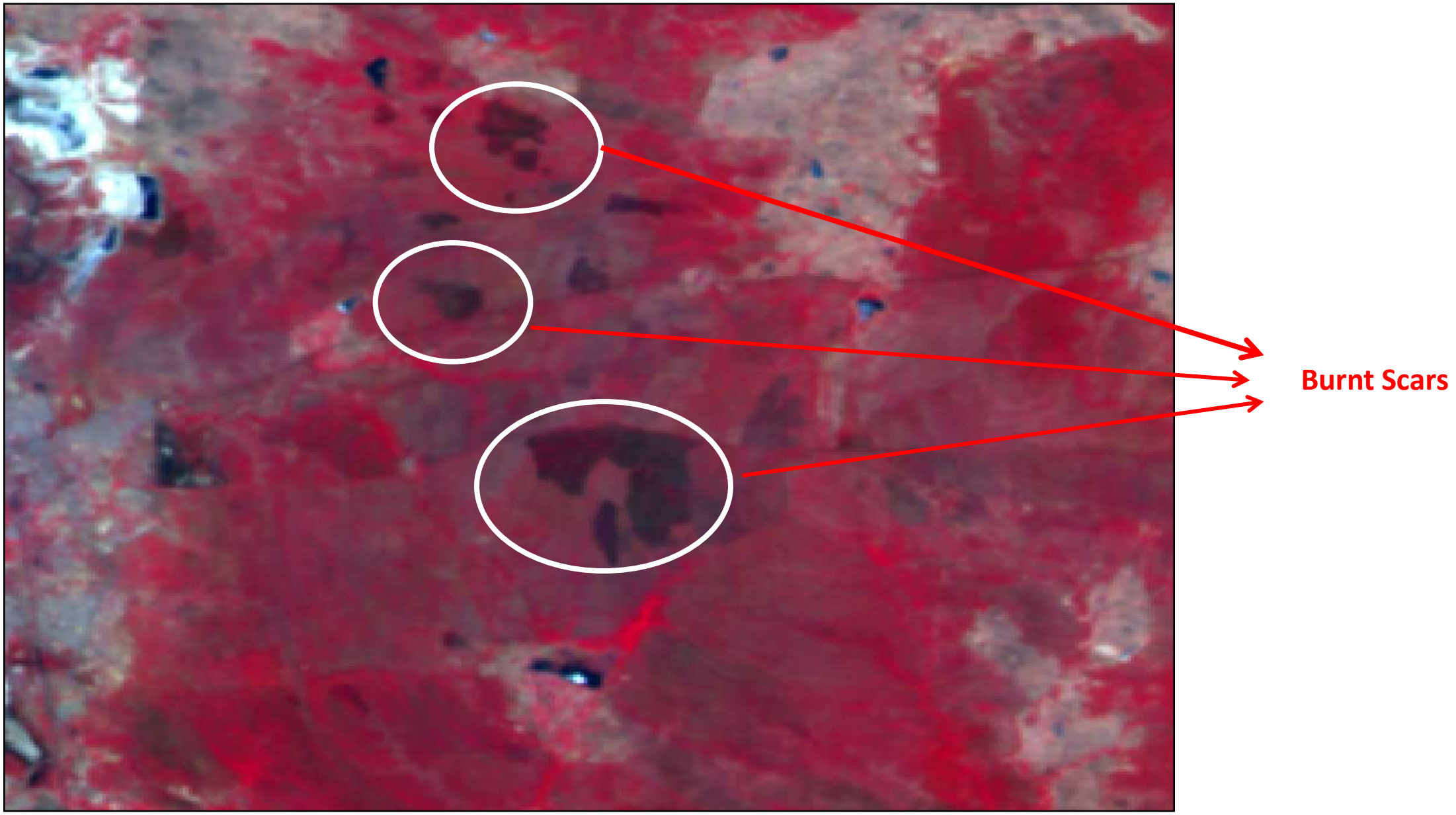


Normalized Differential Vegetation Index



Classified NDVI

Burnt scars observed using AWiFS scene of Maharashtra on 28 May 2014



Conclusion

- Forest Fire is a natural calaimity and requires holistics efforts by Government and People
- Satellite Technology can play an important role in managment and mitigation of forest fires
- Factors from local to regional scale needs to be identified using suitable statistical methods
- Suitable algorithms with image classifiers can be effectively used in monitoring , generation of pre-warning alerts and assessment of damage

Thank you

Forest Fire Team

Forest Survey of India

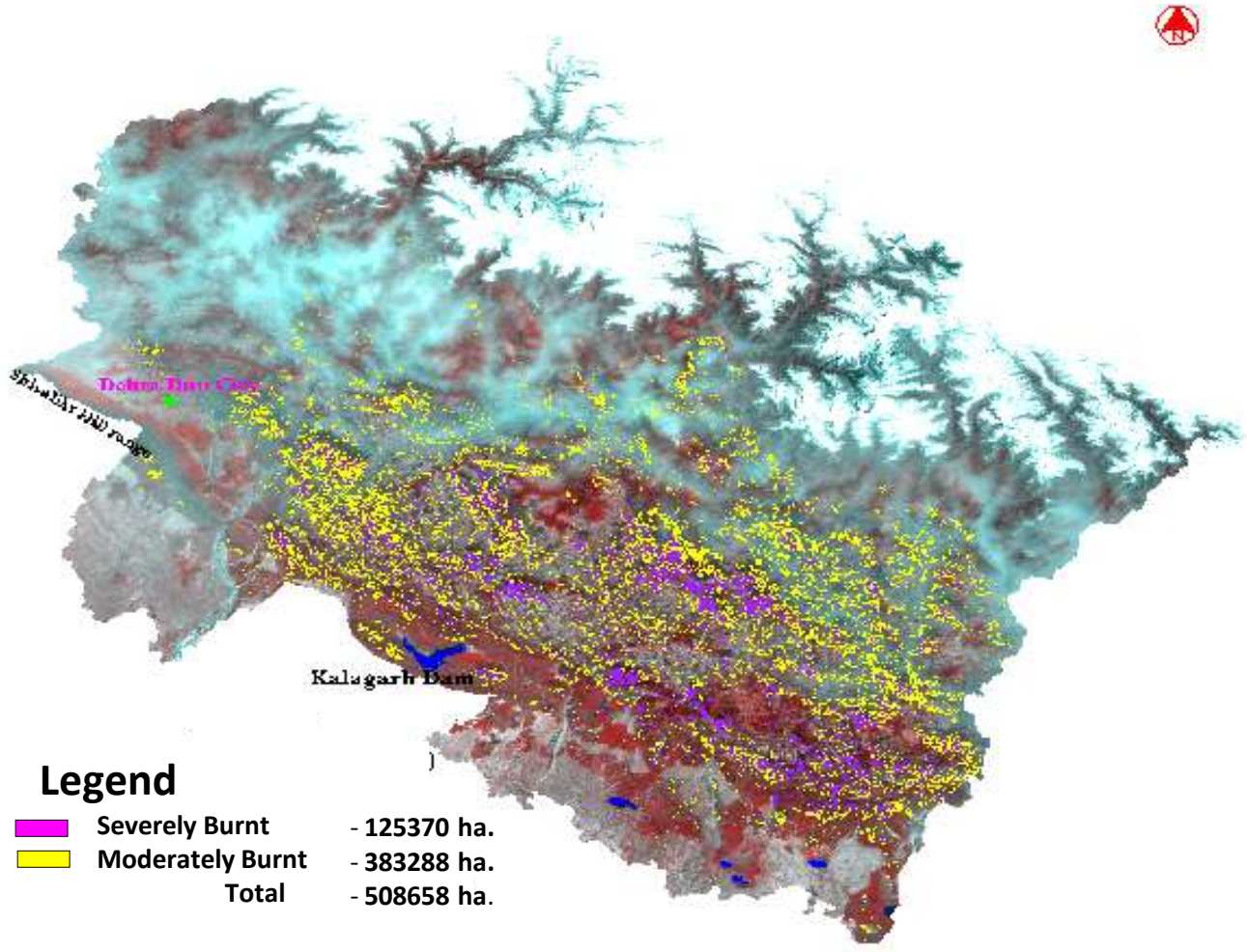
Ministry of Environment, Forest and Climate change

Kaulagarh road Dehradun -248195

www.fsi.nic.in

E-mail forestfiremonitoring@gmail.com

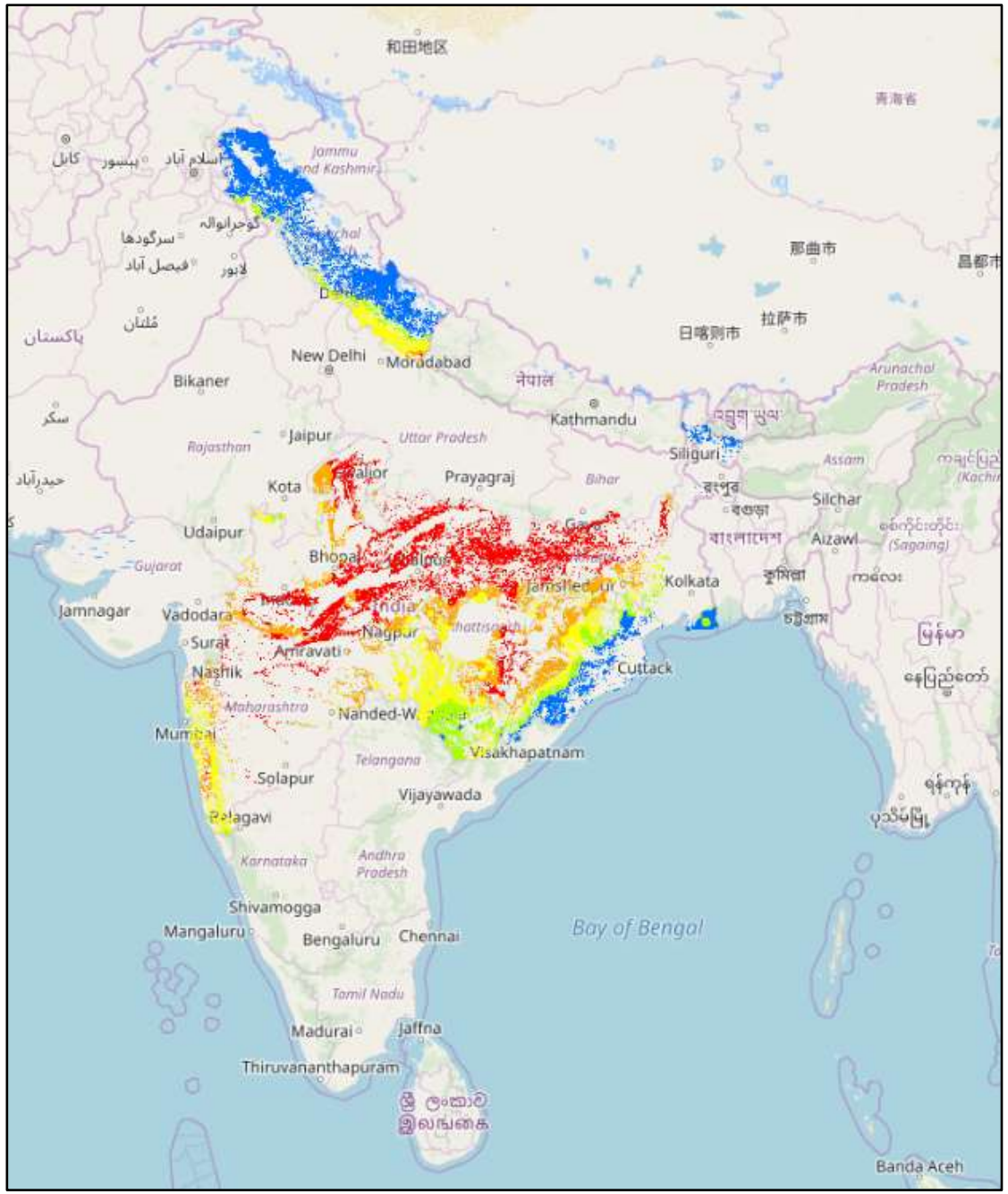
Fire Affected are of Uttarakhand during April, 1999 (WiFS)



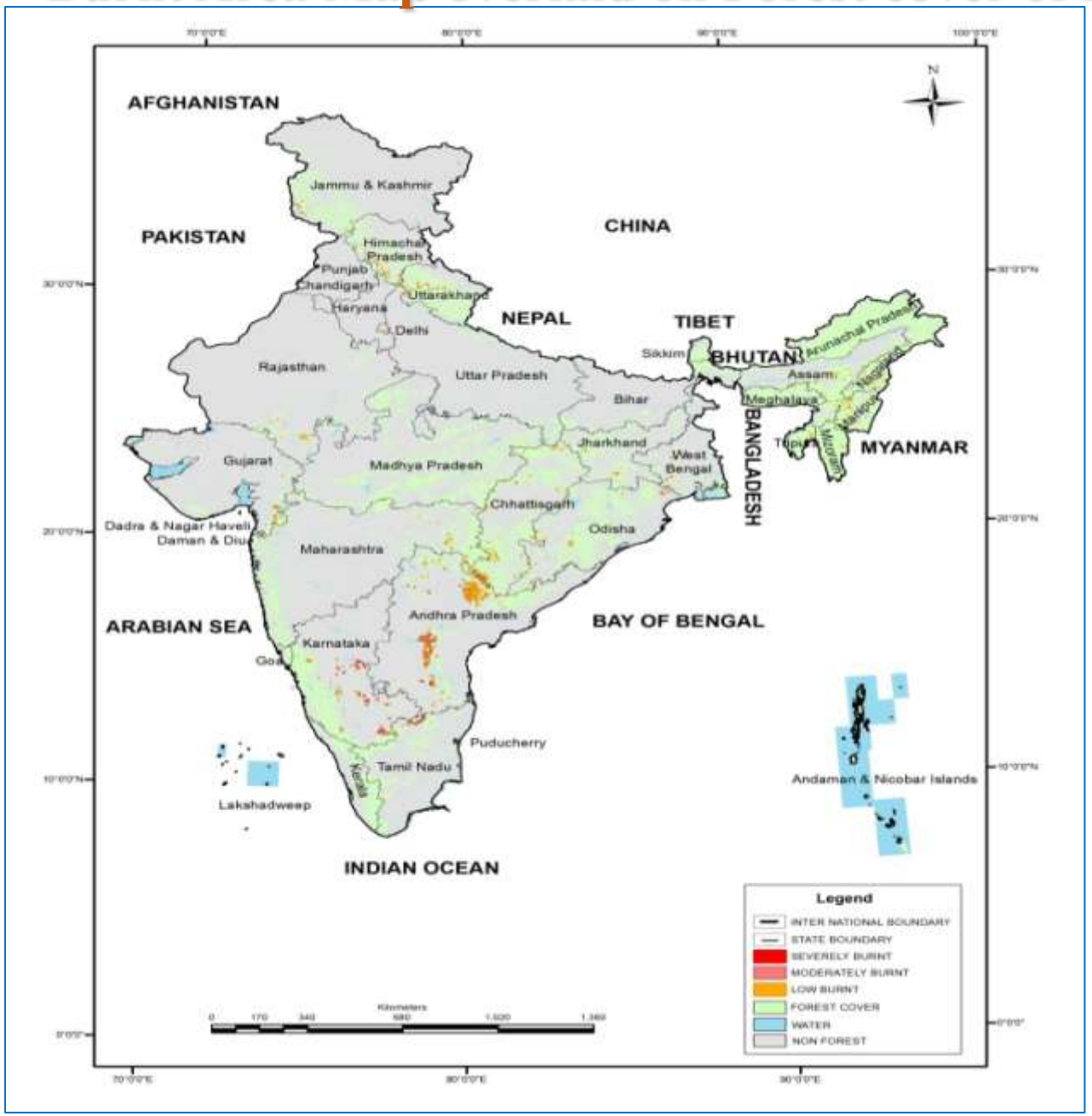
Early-warning

FW Based Early-warning Uploaded on FSI Van Agni-geo Portal two times in a week

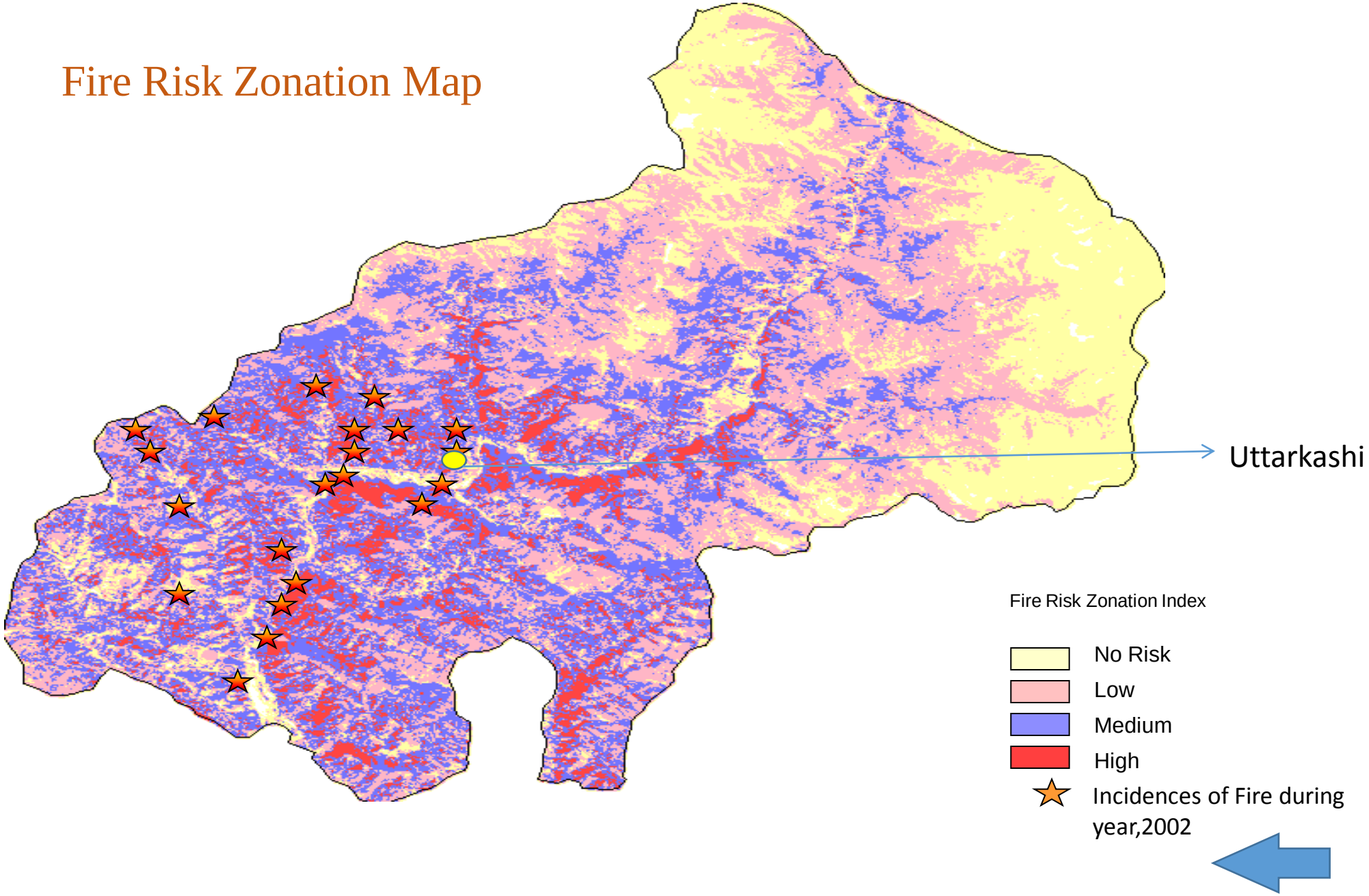
Van-Agni Geo portal of FSI

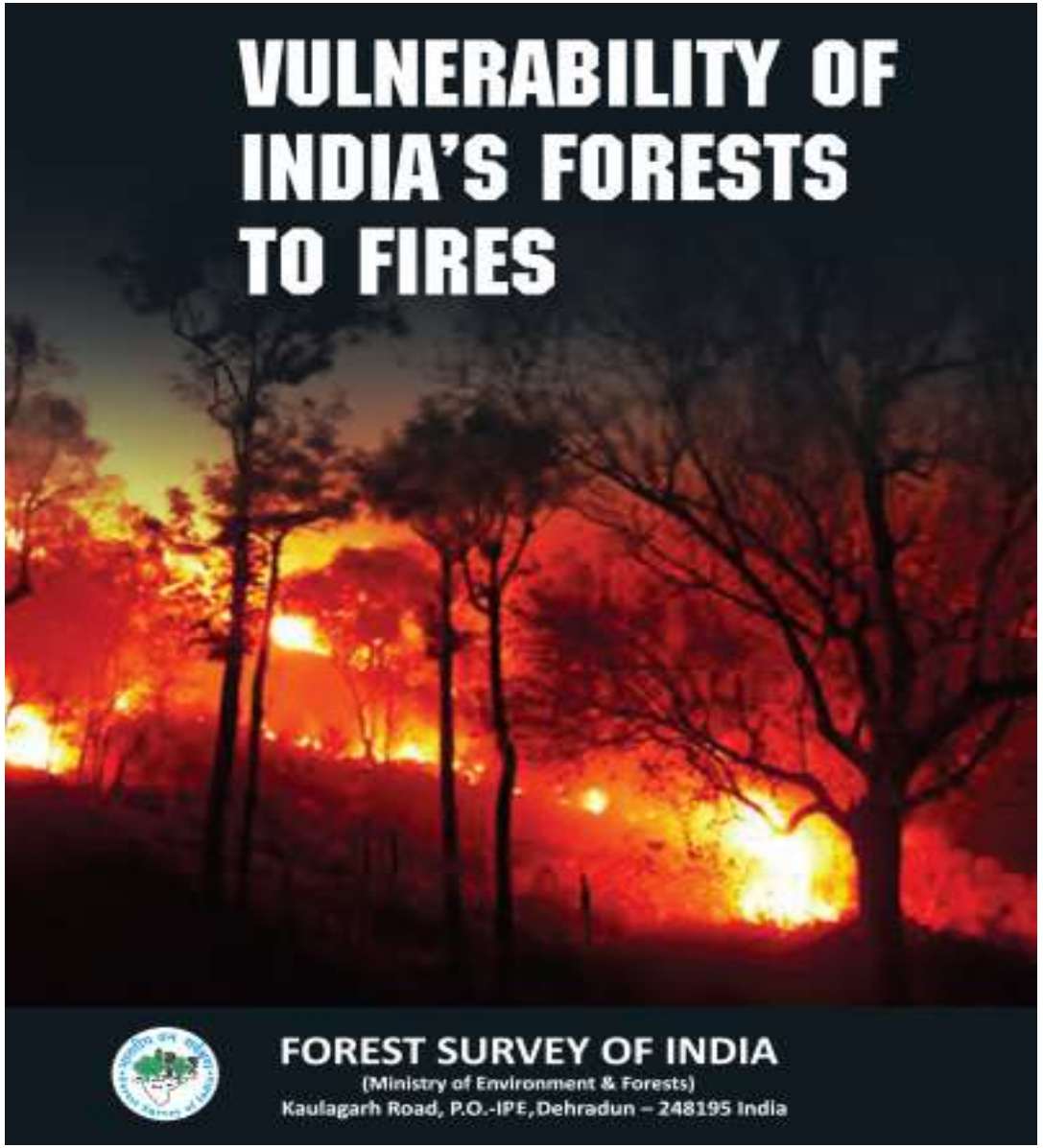


Burnt Area Map overlaid on Forest cover of India



Fire Risk Zonation Map




VULNERABILITY OF
INDIA'S FORESTS
TO FIRES
FOREST SURVEY OF INDIA
(Ministry of Environment & Forests)
Kaulagarh Road, P.O.-IPE, Dehradun – 248195 India

Regions selected for Pre-Warning Alerts