

Automated monitoring of large forest fires using near-real time satellite data- Experience from India

**E. Vikram^{1*}, Anupam Pal¹, Harshi Jain¹, Tanay Das¹, Tapas Biswas¹,
Abhishek Chowdhary¹**

¹Forest Survey of India, Dehradun, Uttarakhand, India

**Corresponding author: evforester@gmail.com*

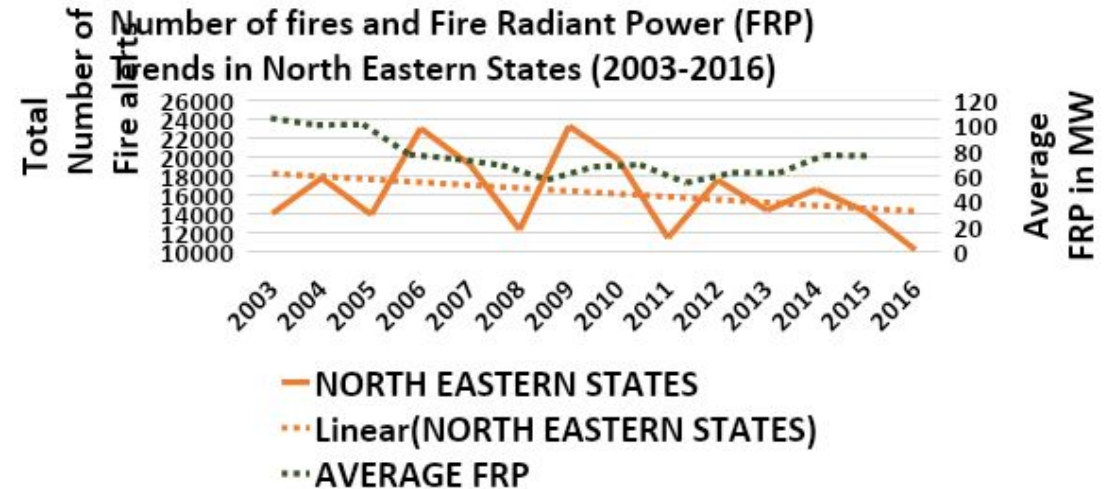
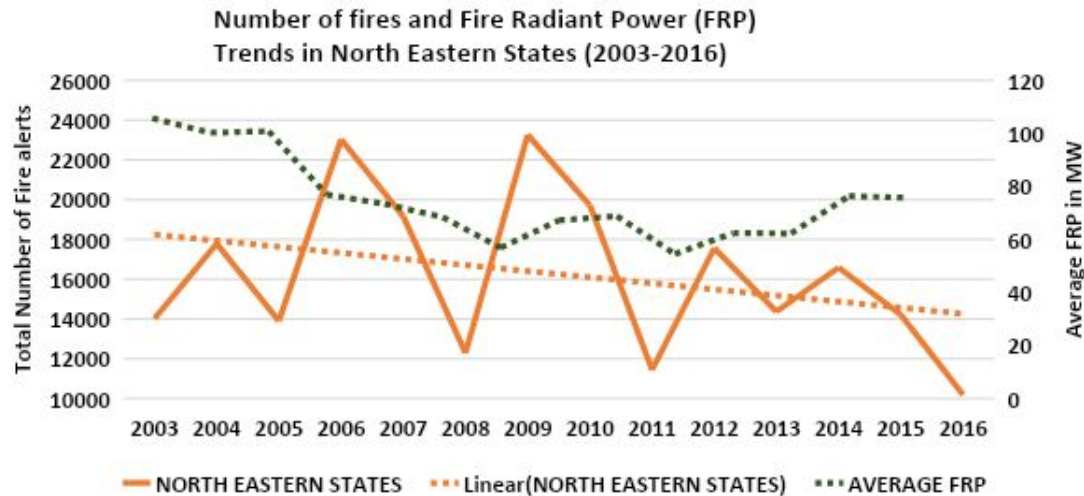
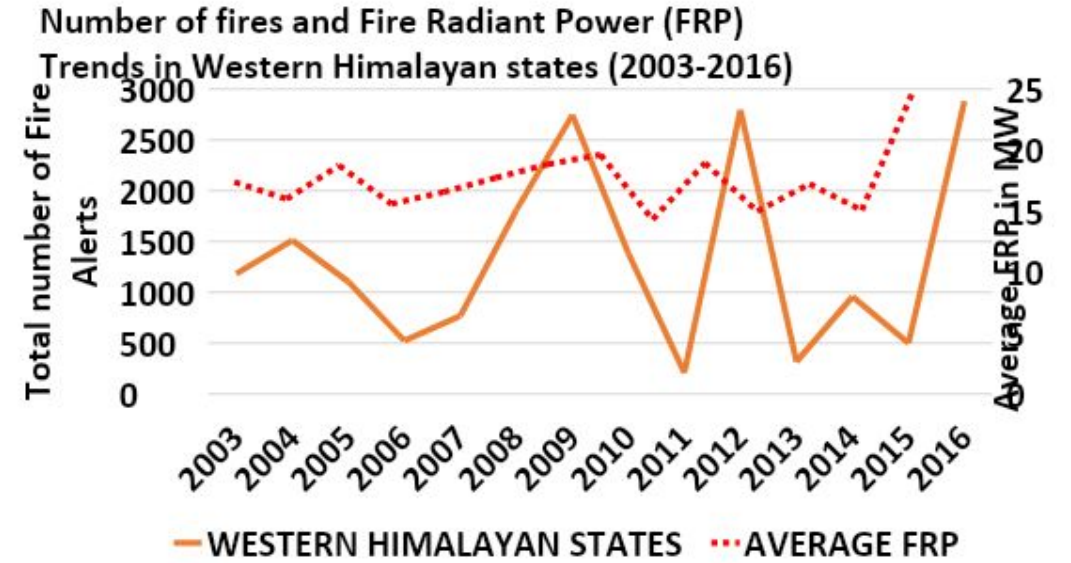
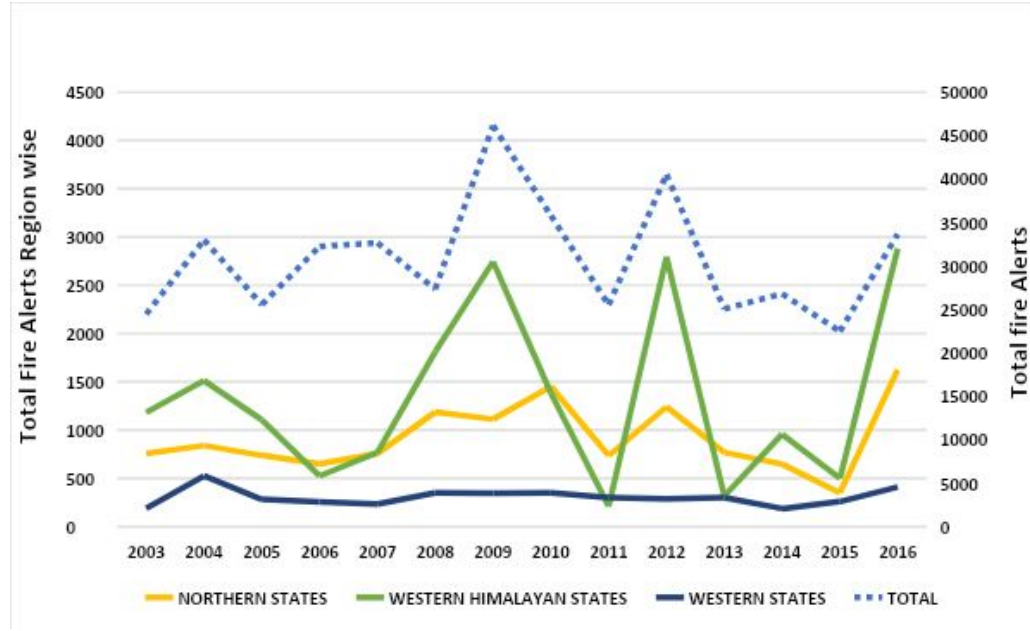
Forests and Forestry in India

- 76.74 million hectares of forest area (23.34% of land area)
- 1.3 billion people; 27% rely partly or wholly on forests for livelihood
- Rich diversity- Alpine to mangroves; rain forests to desert scrub
- More than 200 forest types
- Conservation oriented forestry
- Lesser Government control and larger devolution of rights to individuals and local community
- Forestry contributes around 1% to GDP

Forest Fire scenario in India

- Man made, recurrent annual phenomenon closely linked with traditional, subsistence economic practices like shifting cultivation, non wood forest produce harvest etc
- Fewer large fires due to dense population, forest fragmentation and recurrent annual burning
- Forest fires numbers, density and in some regions severity is closely linked to drought conditions
- Increasing number of larger and more serious forest fires closely linked to changing climate
- High reliance on local communities for fire control; use of traditional fire fighting practices

Forest Fire scenario in India



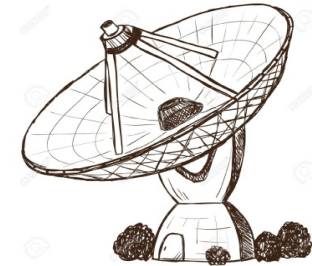
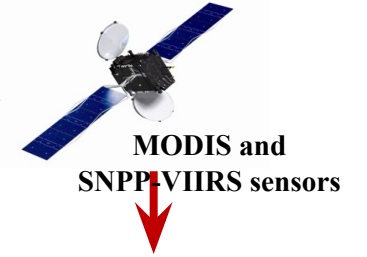
Forest Fire monitoring in India



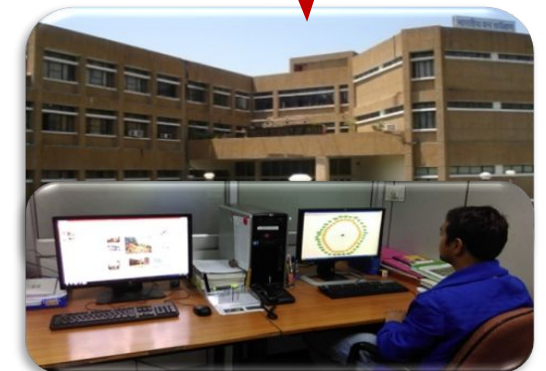
Suppression and Mitigation of Forest



Thermal Anomalies detected

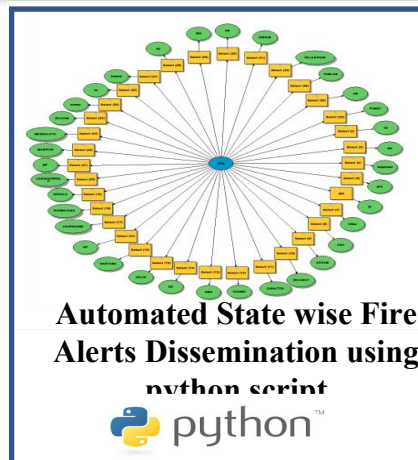


Data processed at Earth Station (NRSC)



Centre for Forest Fire Studies, Forest Survey of India

Processing

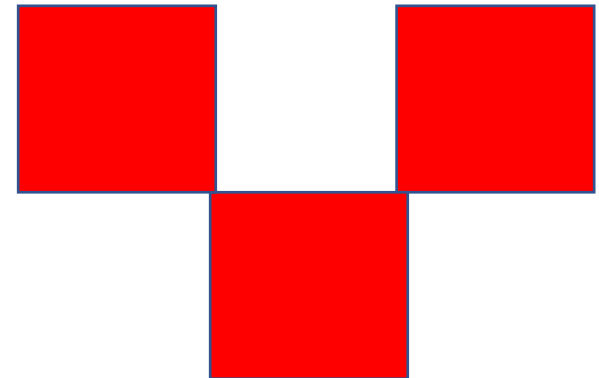
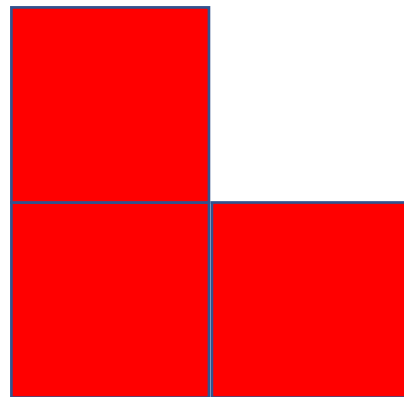
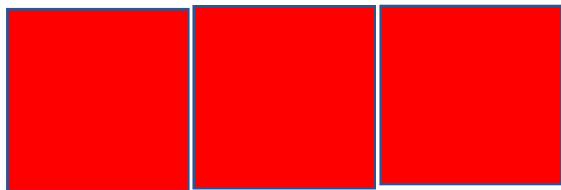


Email Alerts to states nodal officers

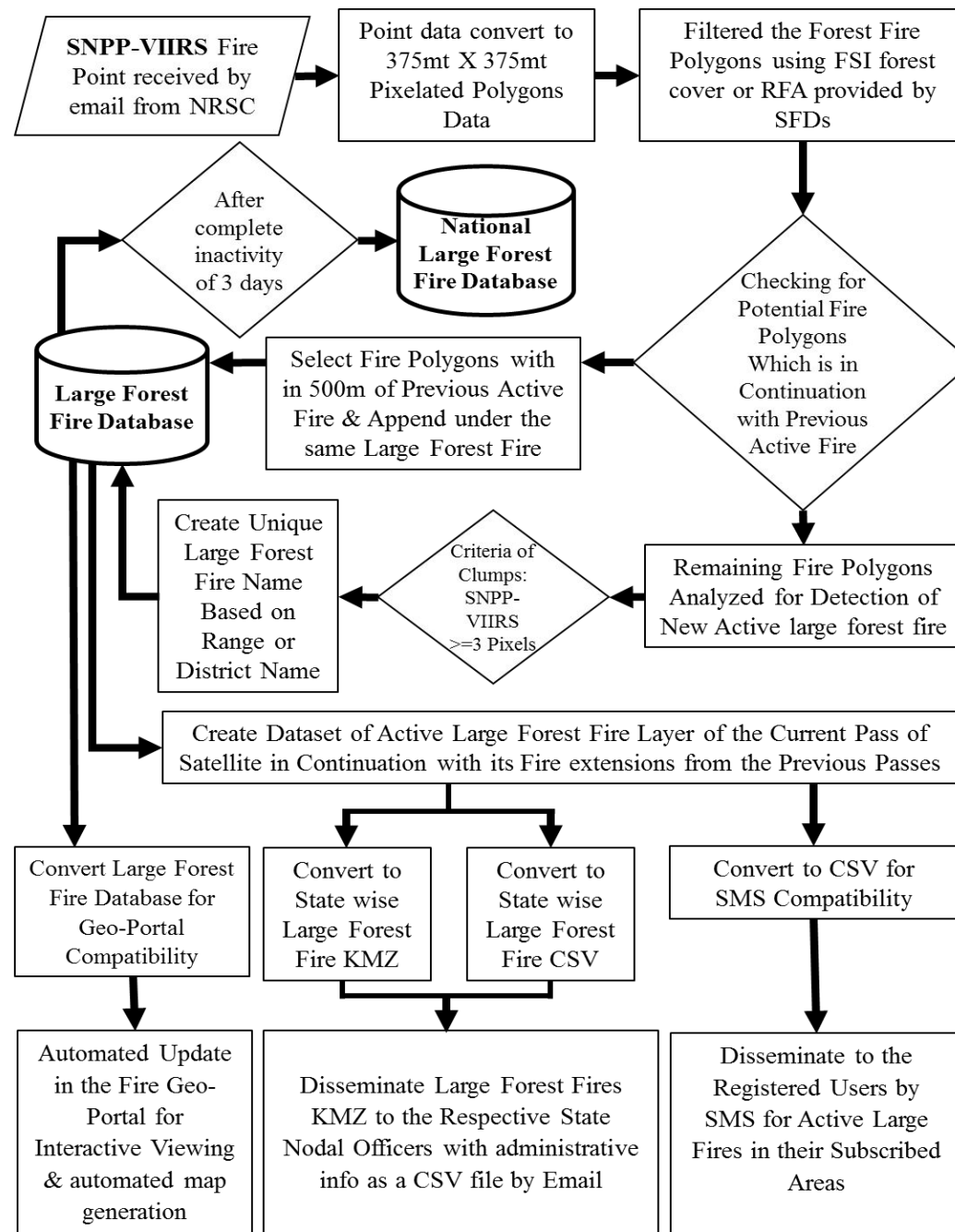
SMS alerts to other users

Large Fire Monitoring System (Transition from Fire Pixel to Fire Event)

- Automated identification of large fire events based on proximity of fire alerts (pixels) in a given satellite pass (SNPP-VIIRS)
- Automated tracking across satellite passes within the estimated fire boundary till the event is alive
- World's first satellite alert based large forest fire monitoring system
- First National large fire database of the country



**AUTOMATIC SELF DETECTION & GROWTH MONITORING MODEL
FOR LARGE FOREST FIRE USING PYTHON SCRIPT**



Flow Chart-
LFF
Programme

Firetracker™ software

- First Detection- thresholds- evaluation
- Subsequent detections
 - Estimated max Fire Boundary EFB (500m) around LFF detection- EFB automatically grows with additional detections @500m
 - All activity within EFB attributed to the same LFF
 - When two LFF boundary collides? Multiple starts of a fire complex..
- Wait period of three days since last detection in the latest EFB to account for fire recurring within the same area again
- Archived after expiry of 3 day wait period

Software and tools used

Python 2.7 on Arc GIS software 10.3.4

- Clump detection- Buffer tool, select by attributes for 3 pixel clumps
- Buffer creation and continuous updation- Buffer tool
- Large fire nomenclature and append pixels
- Extract details such as First detection, latest detection, active pixels, total pixels of the Large Fire
- Overlaid with admin area data and is appended to it
- SMS generation based on user admin area preference

Python libraries used

arcpy, OS, time, shutil, csv, numpy, glob, email, mimetypes, traceback, sys, smtplib, re, arcpy.mapping, email, dbfpy, datetime, etc.

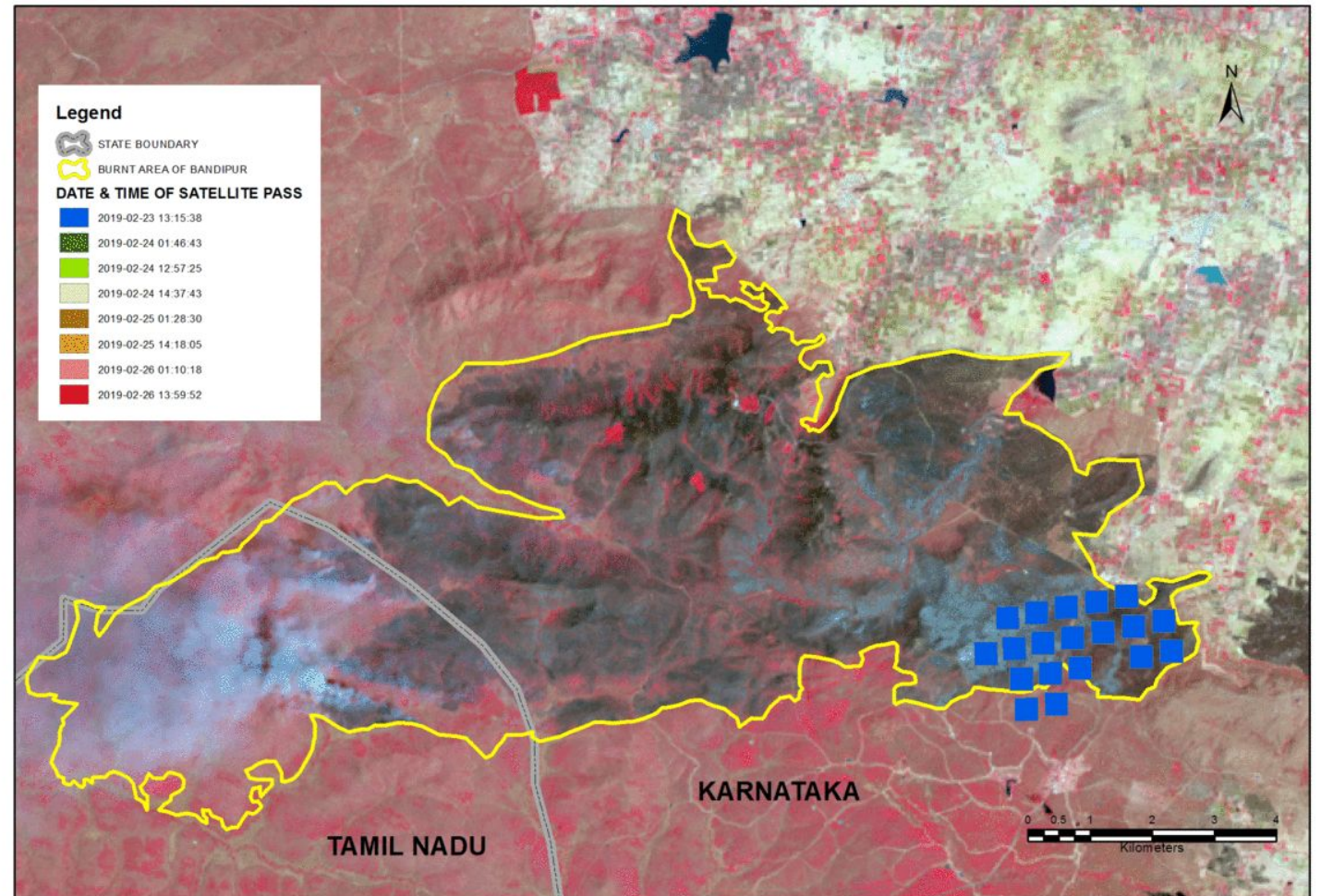
Case Studies

- Firetracker™ capabilities (Size and rate of spread)
 - Large slow moving fires
 - Large fast spreading grassland fires
 - Smaller slow moving and fast moving fires
- First detection thresholds (3 pixels Vs 5 pixels)
 - Advantages and Disadvantages

Large & Slow (Bandipur forest fire complex – Karnataka & TamilNadu) 23rd to 26th

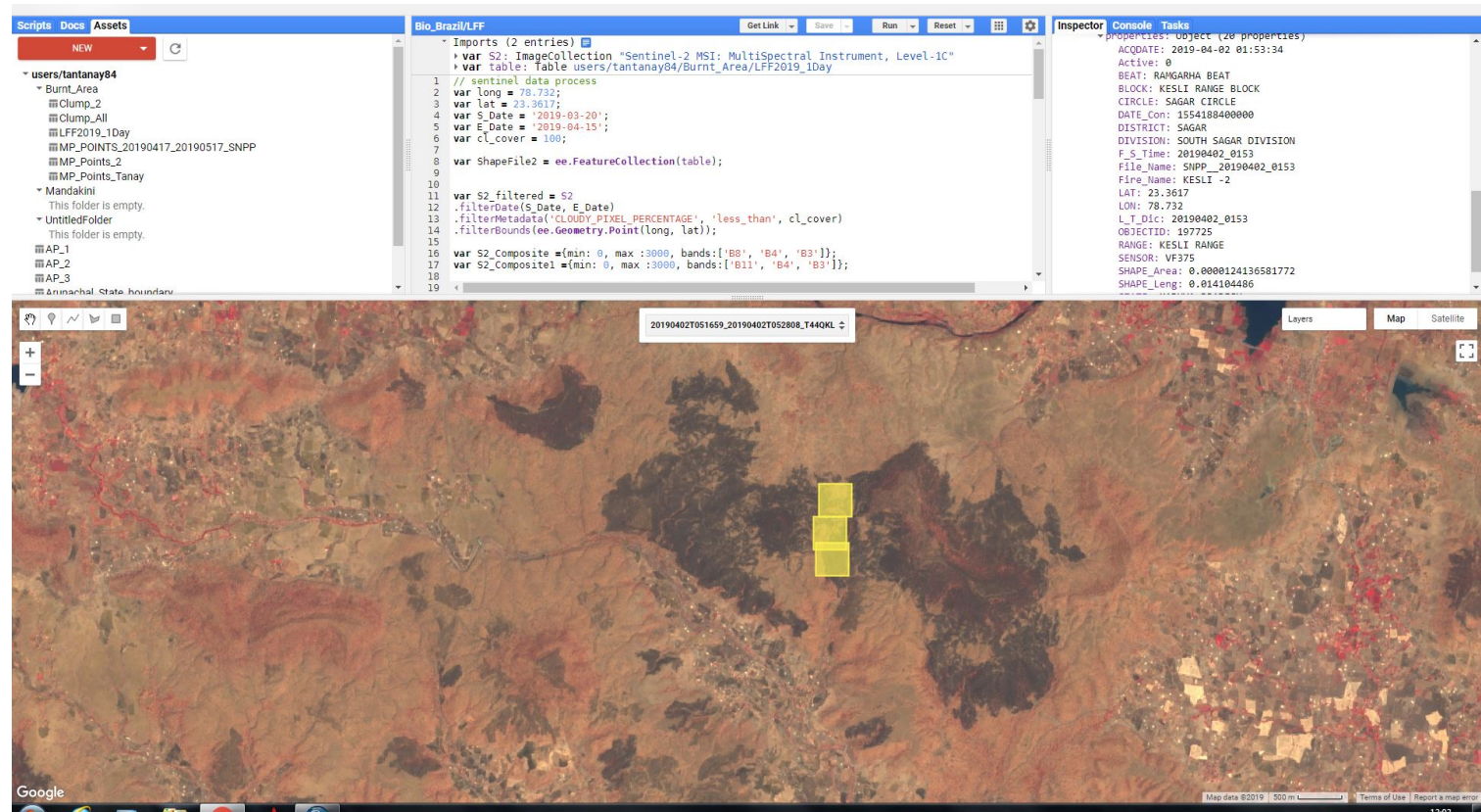
Date & Time of Pass	No of SNPP-VIIRS Pixels detected by Large Forest Fire
23 rd Feb 13:15	19
24 th Feb 1:46	38
24 th Feb 12:57	31
24 th Feb 14:37	42
25 th Feb 1:28	47
25 th Feb 14:18	39
26 th Feb 1:10	1
26 th Feb 13:59	15
Total	232

SNPP VIIRS Pass wise Fire Progression at Bandipur Tiger Reserve



Large & Fast (Kesli-2 forest fire – Madhya Pradesh) 2nd April- 0153 hrs

Date & Time of Pass	No of SNPP-VIIRS Pixels detected by Large Forest Fire
2 nd April 2019 01:53	3



Estimated fire affected area 8.36 sq kms

Sentinel 2 MSI Satellite DoP 2nd Apr 2019

Small & Fast

(Abdullahganj-1 forest fire – Uttar Pradesh) 2nd May- 0230hrs

Date & Time of Pass	No of SNPP-VIIRS Pixels detected by Large Forest Fire
2 nd May 2019 02:30	3

Area affected 1.189 sq kms

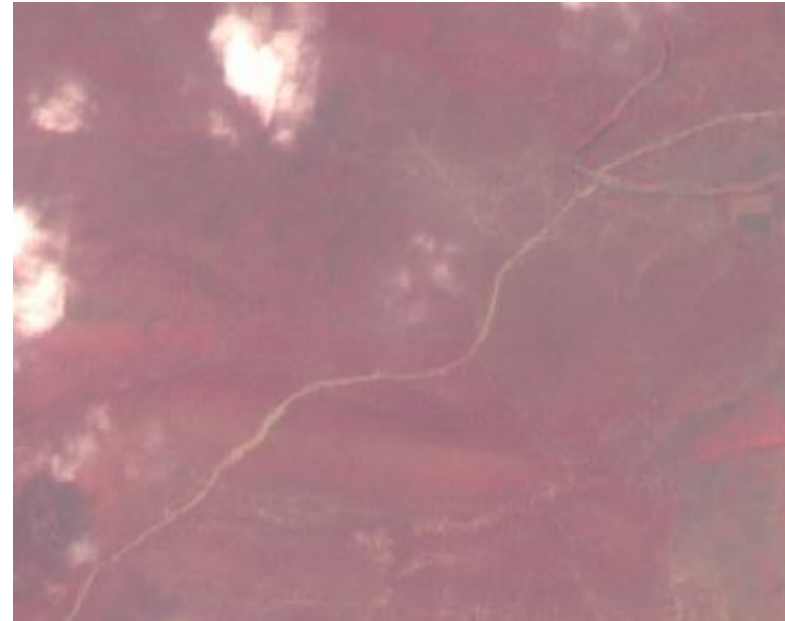
The screenshot displays the Google Earth Engine web interface. The top navigation bar includes the search bar and user profile. The left sidebar shows the 'Assets' panel with a folder structure for 'users/tantanay84'. The main panel is split into three sections: 'Scripts', 'Inspector', and 'Map'. The 'Scripts' panel shows a JavaScript code snippet for processing Sentinel-2 data, including filtering by date and cloud cover. The 'Inspector' panel shows metadata for the selected area, including acquisition date, location, and file name. The 'Map' panel shows a satellite image of the forest fire area with a red overlay and three yellow rectangular markers.

Sentinel 2 MSI Satellite DoP 9th May 2019.

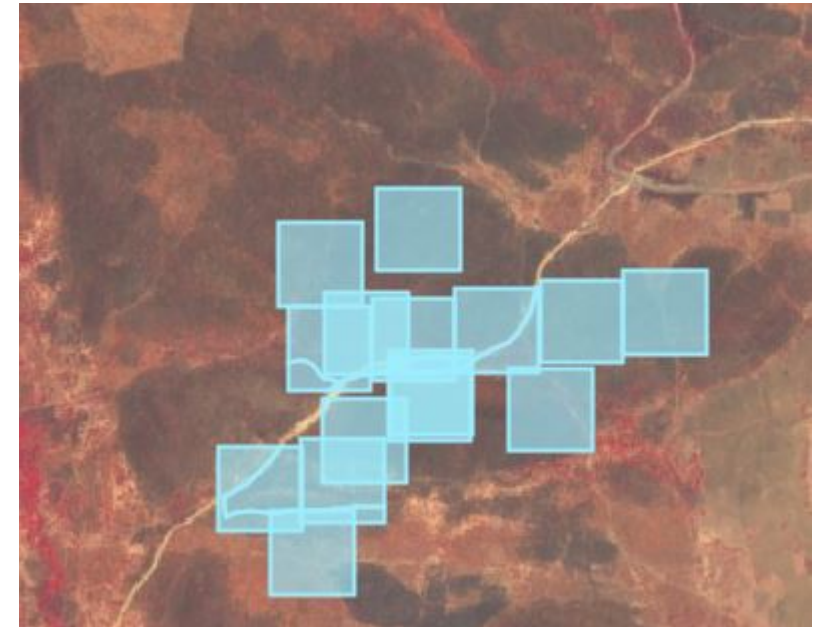
Small & Slow

(Asaralli forest fire – Maharashtra) 20th and 22nd March, 2016

Date & Time of Pass	No of SNPP-VIIRS Pixels detected by Large Forest Fire
20 th March, 2016	3
21 st March, 2016	9
22 nd March, 2016	3
Total	15



Pre Fire Sentinel 2A Satellite Image dated 09-02-2016 showing healthy vegetation

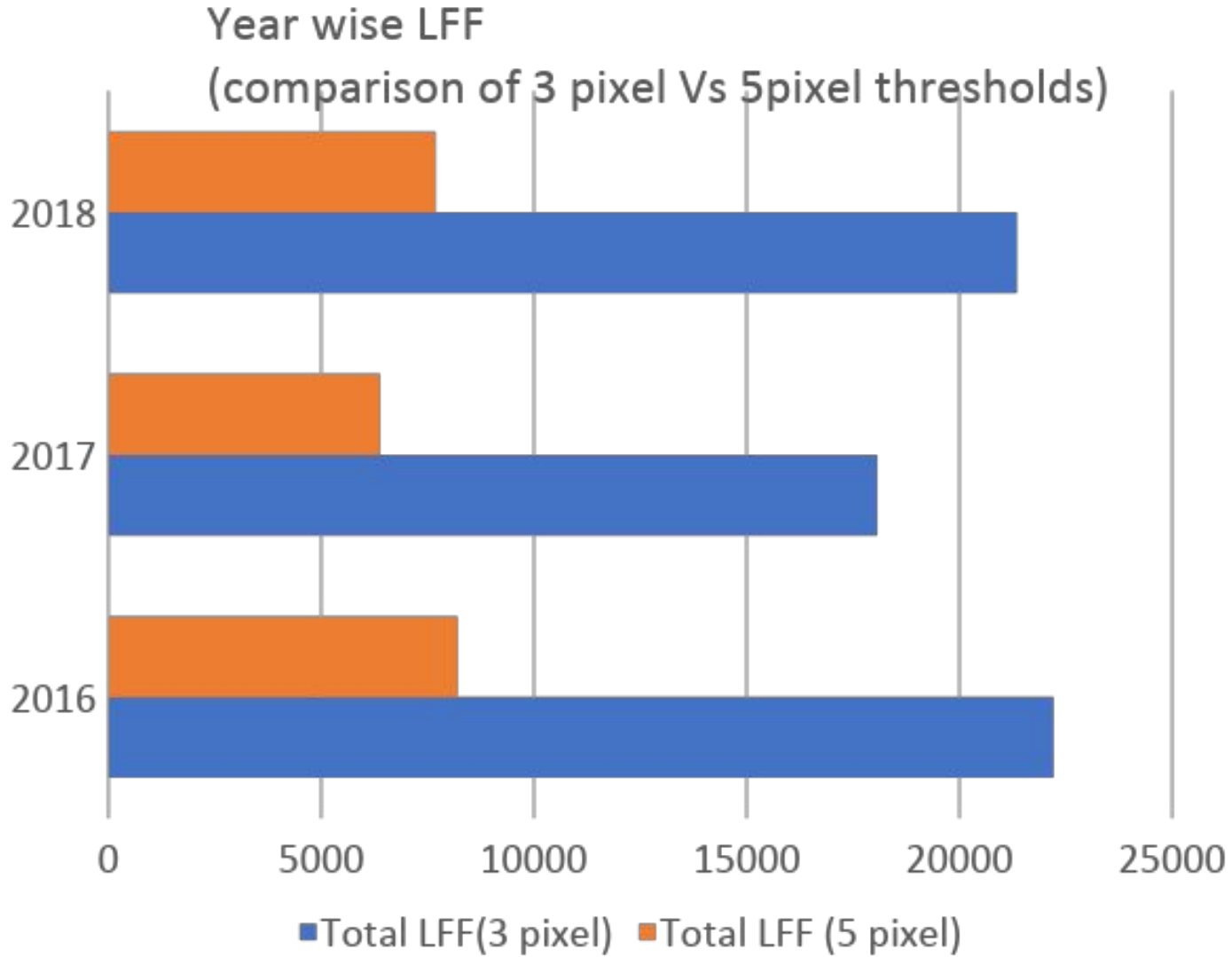


Sentinel 2A of 9th April, 2016 showing fire affected vegetation; 12 LFF SNPP-VIIRS pixels overlaid

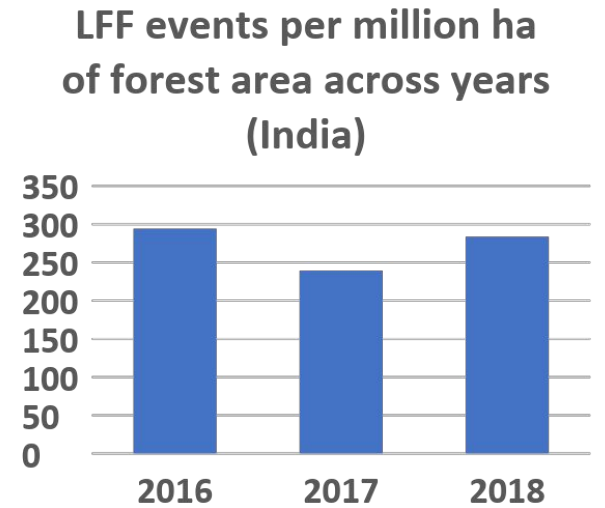
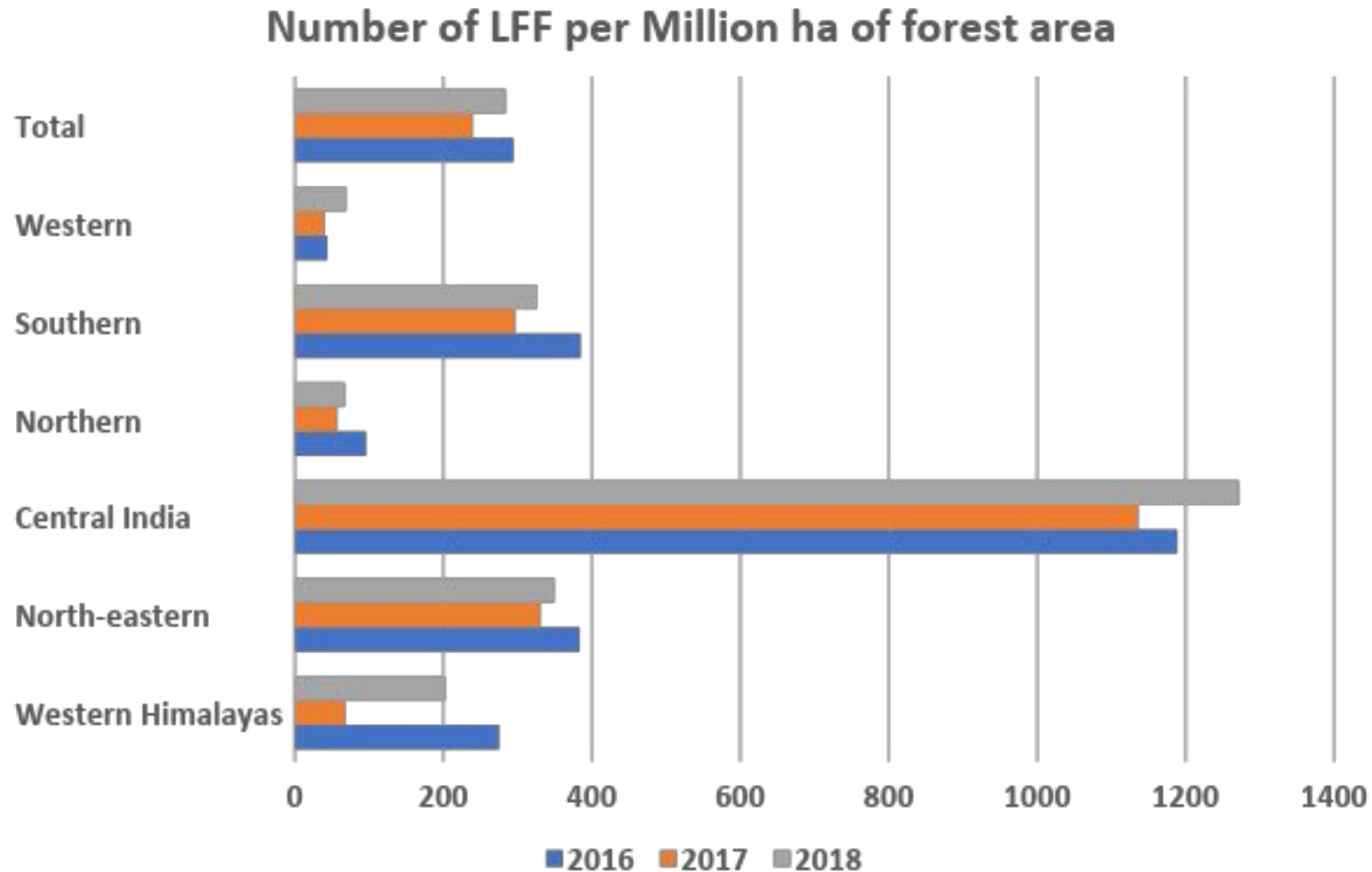
Fire affected Area- 471 ha

Medium Term Trends in LFF (2016 to 2018) using VNP14IMGTDL_NRT

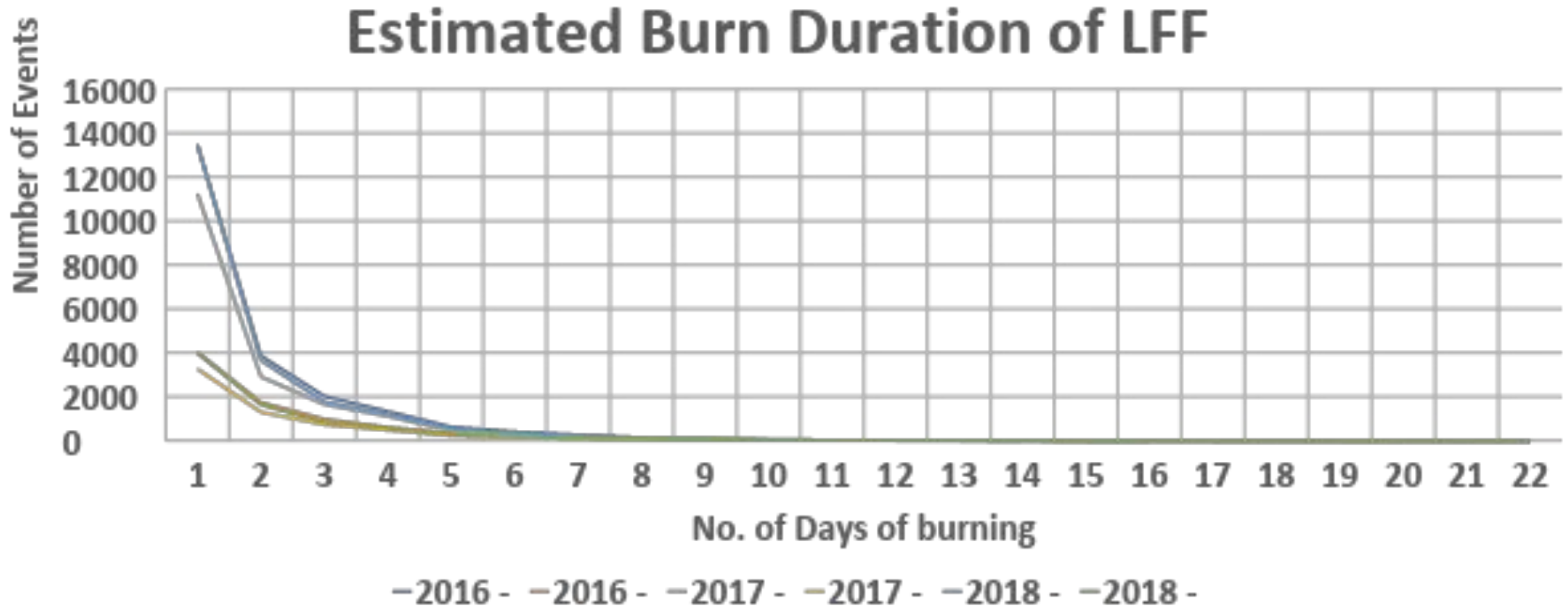
Year	NRT Fire Alert pixel count	LFF Pixel Count	%
2017	245783	134081	54.6
2018	258480	151967	58.8



LFF density in Regions (2016 to 2018)



Comparison of Duration of Burn in 3 & 5 pixel thresholds



LFF monitoring in 2019 (January- June 2019)

- 12480 candidate LFF events monitored; 7523 were only single detections;
- 2333 events with more than 2 day duration
- 361 more than 5 day duration
- 47 events more than 10 duration

Major Lessons

- Alerts too frequent- Are we raising too many large fire alarms?
- Subsequent detection could added as a criteria for LFF in 2020

LFF NRT dissemination

Active Large Fire Events of Today - 14-01-2019

* Click on the Numbers for more details

Search by State:

States	No. of Fire(s) *
ANDAMAN AND NICOBAR ISLANDS	0
ANDHRA PRADESH	3
ARUNACHAL PRADESH	6
ASSAM	1
BIHAR	0
CHANDIGARH	0

Click on the Number for details →

Large Forest Fire

1 Large Fire Events - 14-01-2019

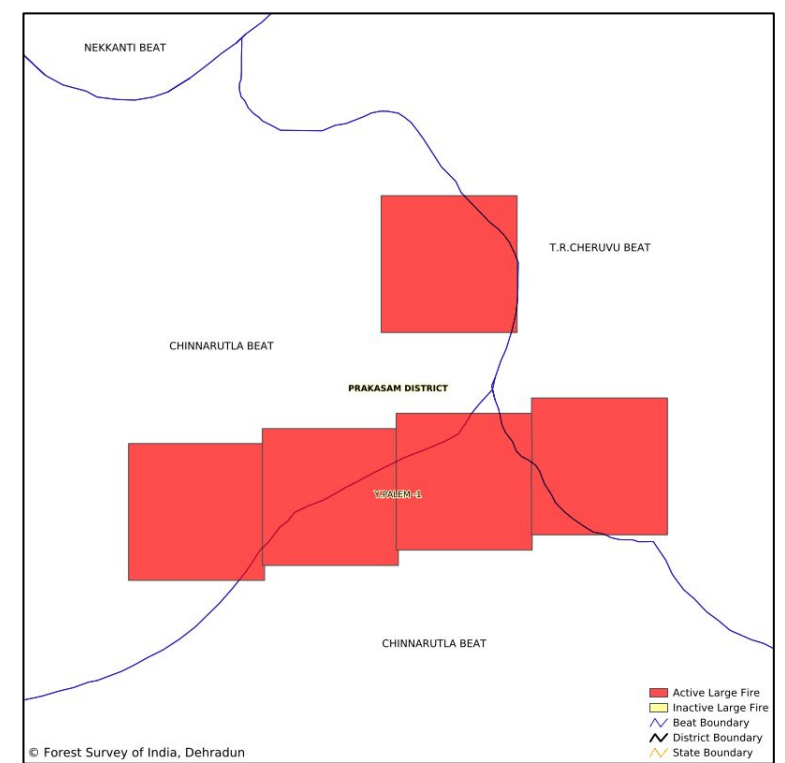
#	Fire Name	Division / District	Active Pixels	Total Pixels	First Detection	KMZ Link	MAP Link	Fire Status
1.	Y.PALEM -1	State: ANDHRA PRADESH District: PRAKASHAM Circle: FDPT SRISAILAM CIRCLE Division: MARKAPUR DIVISION Range: DORNAL RANGE Block: CHINTALA BLOCK Beat: CHINNARUTLA BEAT	5	5	14-01-2019 14:06	Download KMZ	View	Active

LFF NRT dissemination

Large Forest Fire

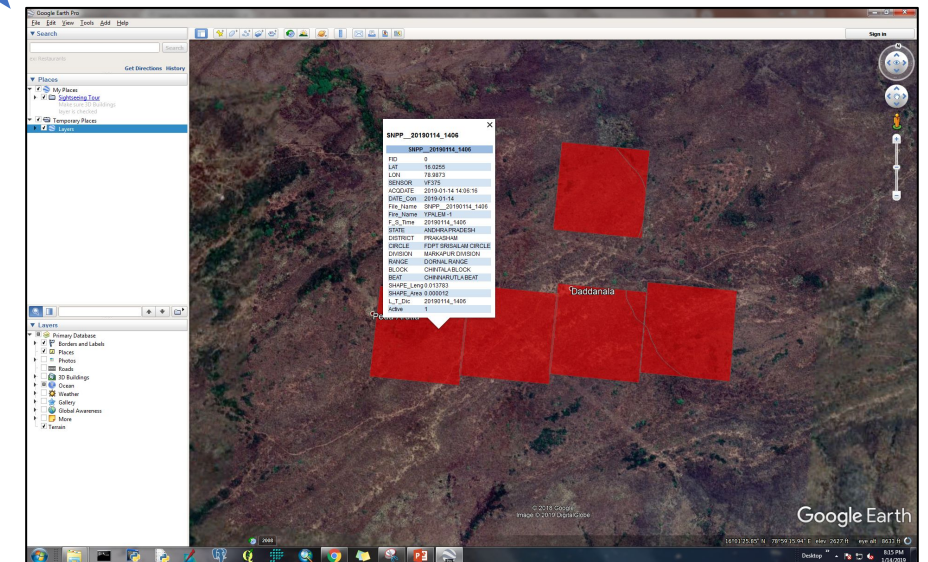
1 Large Fire Events - 14-01-2019

#	Fire Name	Division / District	Active Pixels	Total Pixels	First Detection	KMZ Link	MAP Link	Fire Status
1.	Y.PALEM -1	State: ANDHRA PRADESH District: PRAKASHAM	5	5	14-01-2019 14:06	Download KMZ	View	Active



Fire Name: Y.PALEM -1 View on Map First detected at 14-01-2019 14:06 hrs., 5 of 5 pixels are active.

1.	14-01-2019	14:06:16	16.0255 N	78.9873 E	SNPP	State: ANDHRA PRADESH District: PRAKASHAM Circle: FDPT SRISAILAM CIRCLE Division: MARKAPUR DIVISION Range: DORNAL RANGE Block: CHINTALA BLOCK Beat: CHINNARUTLA BEAT	Active
2.	14-01-2019	14:06:16	16.0259 N	78.9907 E	SNPP	State: ANDHRA PRADESH District: PRAKASHAM Circle: FDPT SRISAILAM CIRCLE Division: MARKAPUR DIVISION Range: DORNAL RANGE Block: CHINTALA BLOCK Beat: CHINNARUTLA BEAT	Active
3.	14-01-2019	14:06:16	16.0317 N	78.9938 E	SNPP	State: ANDHRA PRADESH District: PRAKASHAM Circle: FDPT SRISAILAM CIRCLE Division: MARKAPUR DIVISION Range: DORNAL RANGE Block: CHINTALA BLOCK Beat: CHINNARUTLA BEAT	Active
4.	14-01-2019	14:06:16	16.0263 N	78.9942 E	SNPP	State: ANDHRA PRADESH District: PRAKASHAM	Active



LFF NRT dissemination

Fire Name: Y.PALEM -1 [View on Map](#)

First detected at 14-01-2019 1406 hrs., 5 of 5 pixels are active.

1. 14-01-2019 14:06:16 16.0255 N 78.9873 E SNPP State: ANDHRA PRADESH District: PRAKASHAM Circle: FDPT SRISAILAM CIRCLE Division: MARKAPUR DIVISION Range: DORNAL RANGE Block: CHINTALA BLOCK Beat: CHINNARUTLA BEAT **Active**

FSI VAN AGNI 1.0

FOREST SURVEY OF INDIA
Ministry of Environment, Forest & Climate Change
भारतीय वन सर्वेक्षण

Our Stack: Forest Survey of India | FSI Forest Alert S

Jump To: [Dropdown]

Catalog Identify

Back to Settings

Detailed information for the area you clicked on the map...

Ground Coordinates
X: 78.987005001236
Y: 16.027488035619

LARGE FOREST FIRE 2018-2019

LARGE FOREST FIRE NAME: Y.PALEM -1
ACQUIRED DATE: 2019-01-14 14:06:16
SENSOR NAME: VF375
FIRST DETECTION: 20190114_1406
LATEST DETECTION: 20190114_1406
STATE NAME: ANDHRA PRADESH
DIST NAME: PRAKASHAM
CIRCLE NAME: FDPT SRISAILAM CIRCLE
DIVISION NAME: MARKAPUR DIVISION
RANGE NAME: Y.PALEM RANGE
BLOCK NAME: KOLUKULA BLOCK
BEAT NAME: T.R.CHERUVU BEAT

FSI VAN AGNI 1.0

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

Jump To: [Dropdown]

Catalog

- ADMIN BOUNDARY
- FOREST FIRE
 - MODIS
 - SNPP
 - Large Forest Fire
 - Large Forest Fire
- FCM AND FTM
 - FTM
 - FCM 12th Cycle
 - FCM 13th Cycle
 - FCM 14th Cycle
 - FCM 15th Cycle

Legend:

- Active (Red)
- Inactive (Yellow)
- VDF (Green)
- MDF (Light Green)
- OF (Orange)
- SCRUB (Blue)
- WATER (Blue)

Scalebars

Backgrounds

- None
- OpenStreetMap - Mapnik
- OpenStreetMap - Black and White
- ArcGIS 9.3 Rest Example

© Forest Survey of India, Dehradun

FSI Forest Alert System 2.0 X,Y: 8792877, 1807335 Lat, Lon: 16.023, 78.988 1:6771

Advantages

- Enables Fire managers to monitor large forest fire events and provide special emphasis in fire control of these events
- Provides disaster escalation support in order to bring in timely additional support from other agencies such as District Administration, SDMA, NDMA, Armed forces etc
- Supports rehabilitation of fire affected areas
- Enables building up of a National Large Forest Fire Database for planning especially in development of State Crisis Management Plans, Working Plans

Replicability and Adaptability

- Low cost solution for NRT of Large Fire events
- Transparency in Data
- Based on Open source technology
- Forest Survey of India is open to collaboration
- Versatile scalable Platform – It can include data from new sensors in future
- Easy to integrate with communication technologies
- Provides crucial data for medium to long term scientific analysis

THANKS FOR THE OPPORTUNITY !

CONTACT DETAILS
VIKRAM ELAVARSAN
DEPUTY DIRECTOR
FOREST SURVEY OF INDIA
evforester@gmail.com