

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

**E. Vikram<sup>1\*</sup>, Anupam Pal<sup>1</sup>, Harshi Jain<sup>1</sup>, Tanay Das<sup>1</sup>, Tapas Biswas<sup>1</sup>,  
Abhishek Chowdhary<sup>1</sup>**

*<sup>1</sup>Forest Survey of India, MoEFCC, Dehradun, Uttarakhand, India*

*\*Corresponding author: [evforester@gmail.com](mailto:evforester@gmail.com)*

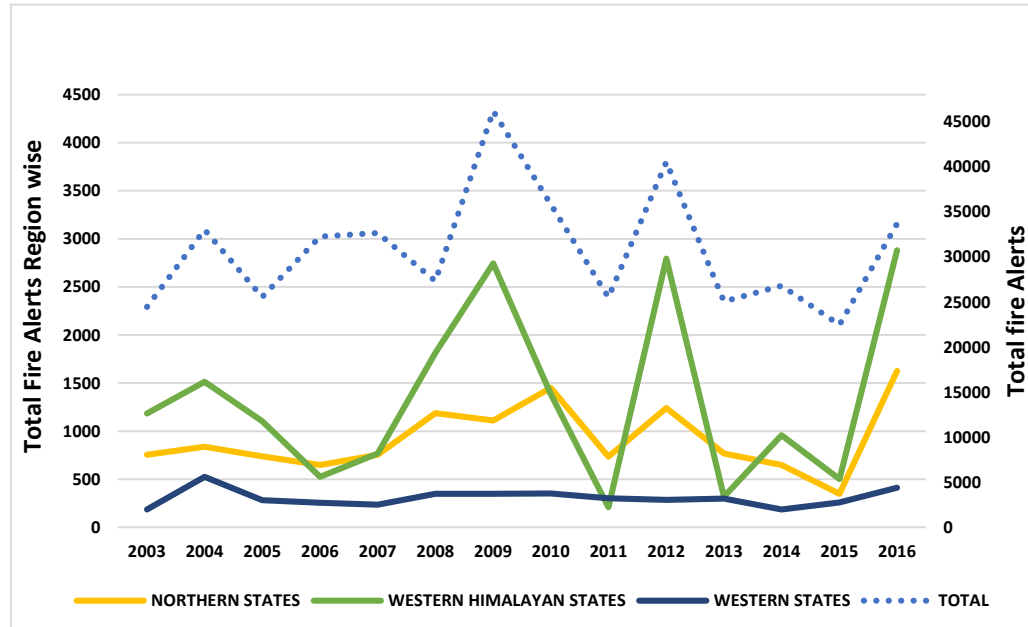
# Forests and Forestry in India

- 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

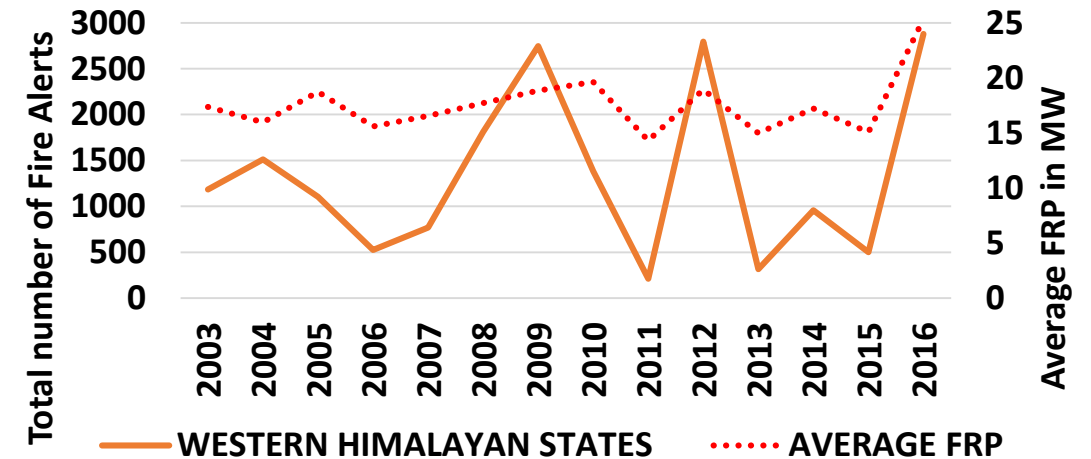
# Forest Fire scenario in India

- 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

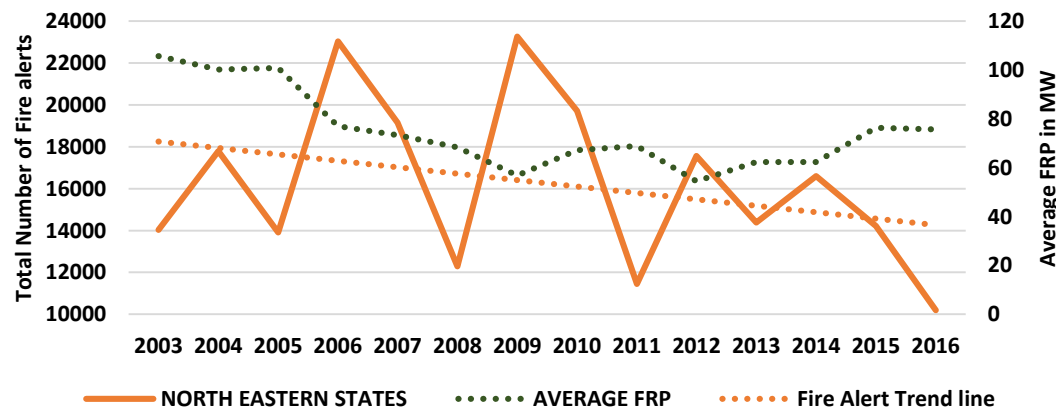
# Forest Fire scenario in India



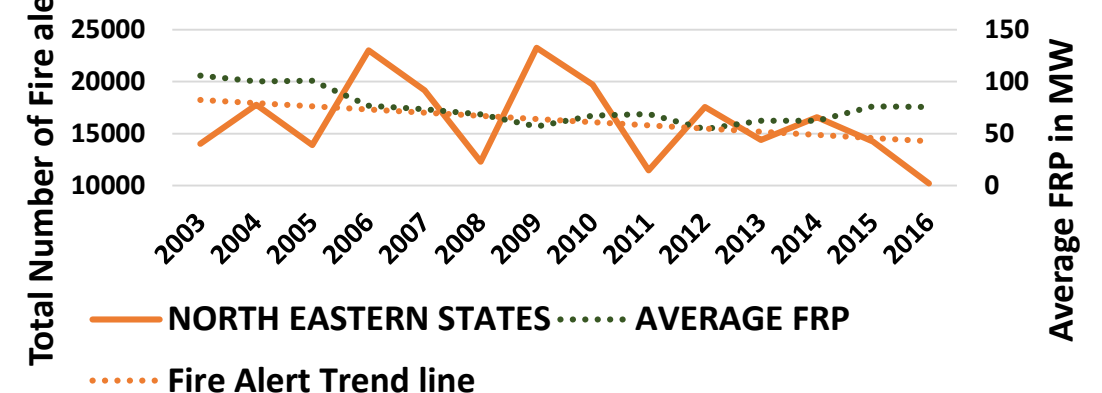
Number of fires and Fire Radiant Power (FRP)  
Trends in Western Himalayan states (2003-2016)



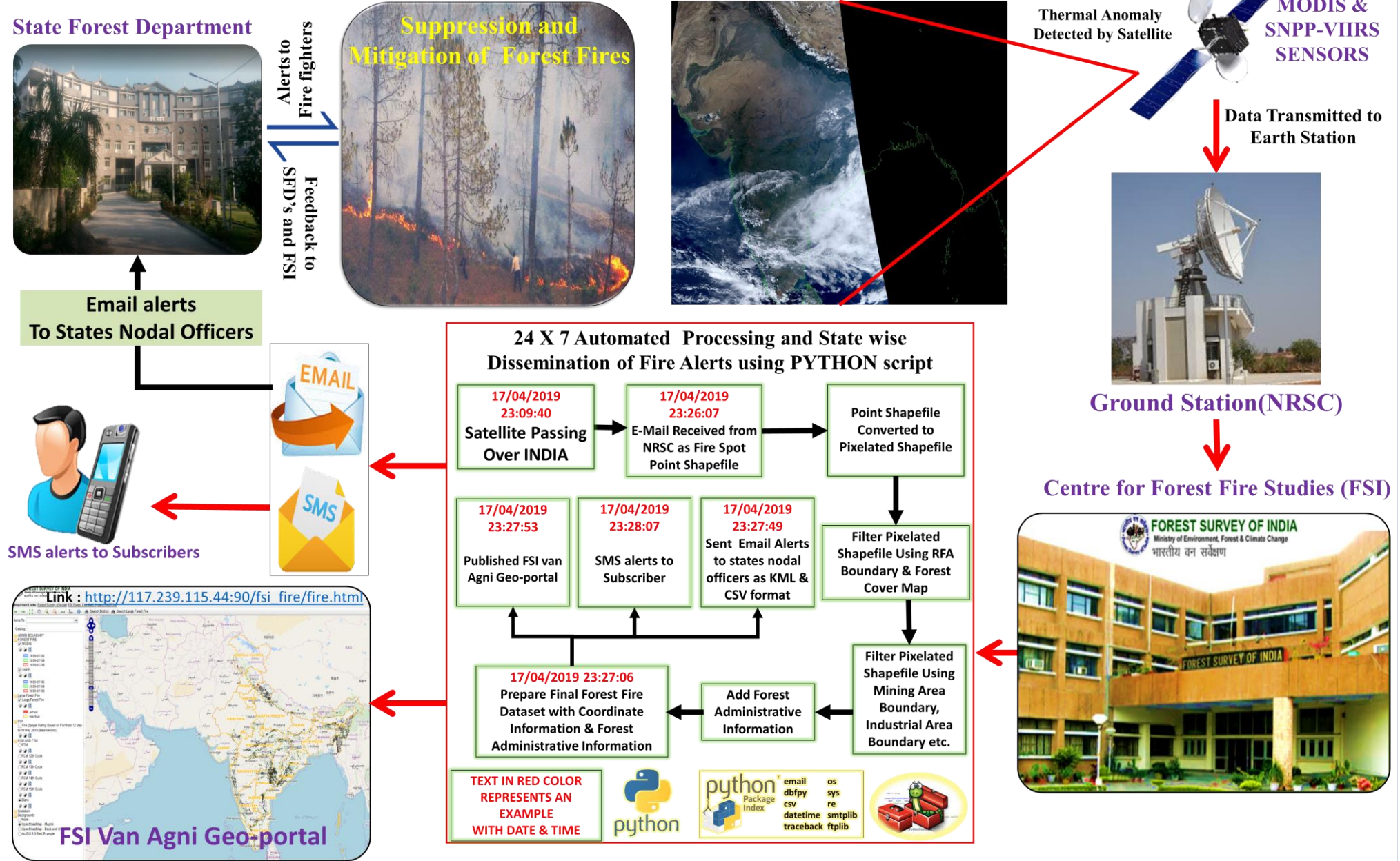
Number of fires and Fire Radiant Power (FRP)  
Trends in North Eastern States (2003-2016)



Number of fires and Fire Radiant Power (FRP)  
Trends in North Eastern States (2003-2016)



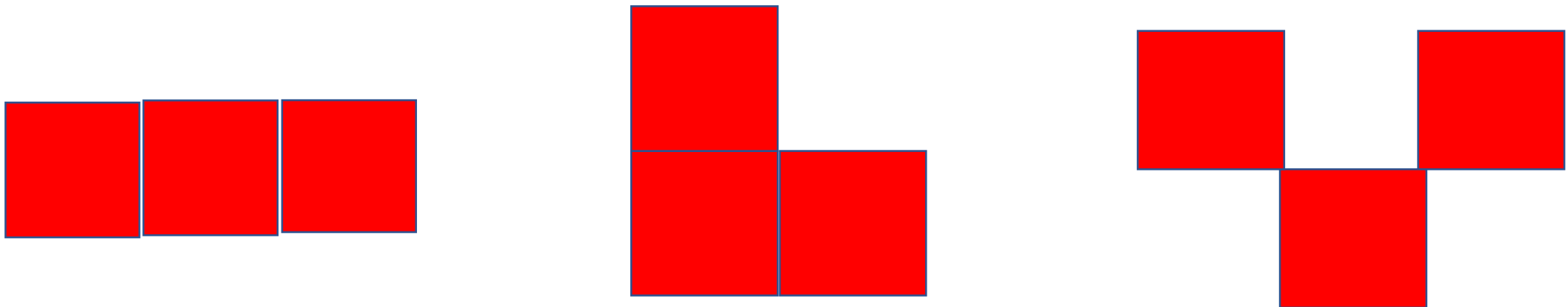
# Near Real Time Monitoring of Forest Fires



# Large Fire Monitoring System

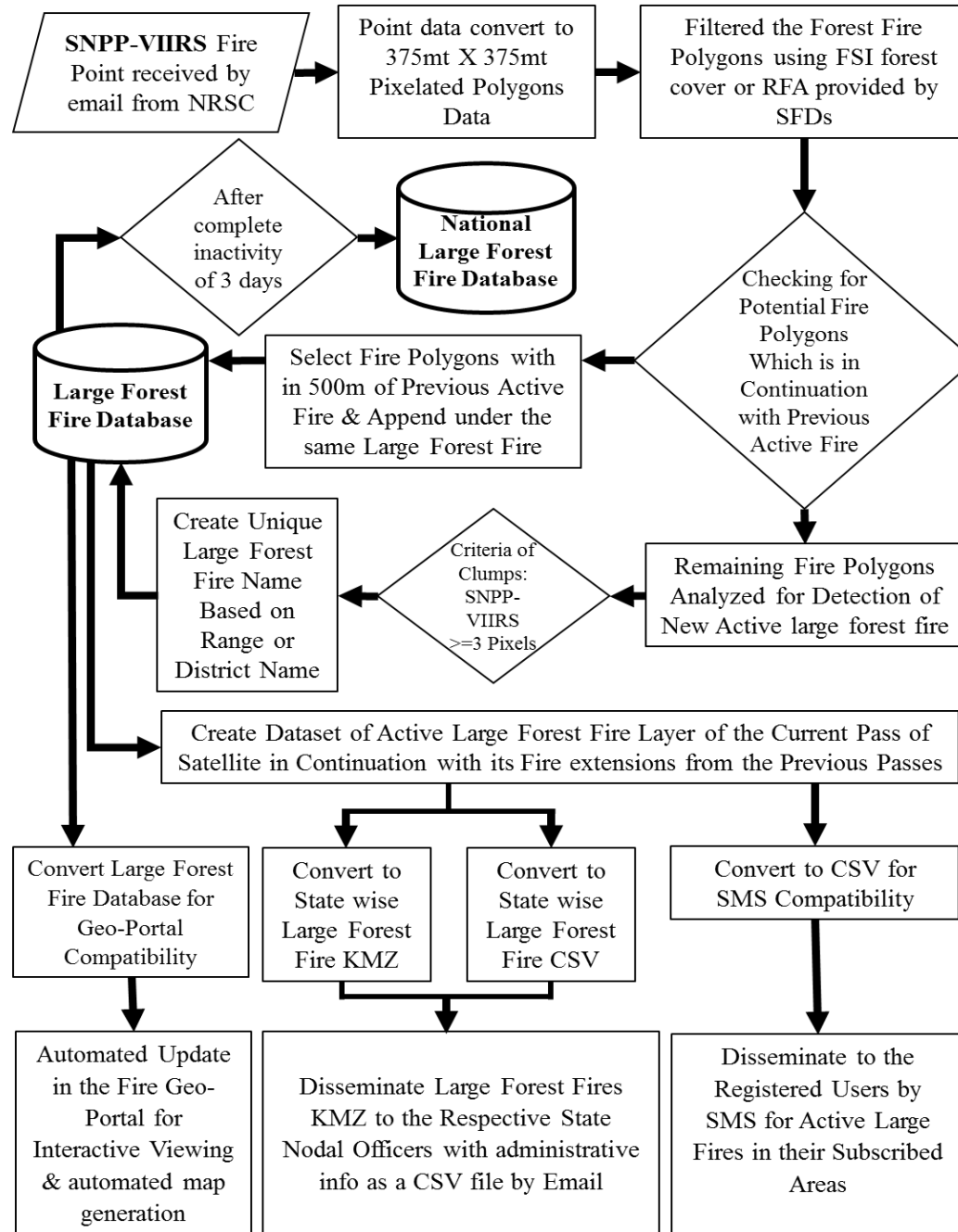
## (Transition from Fire Pixel to Fire Event)

- 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



# Flow Chart- LFF Programme

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



# *Firetracker* <sup>TM</sup> 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* <sup>TM</sup> 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

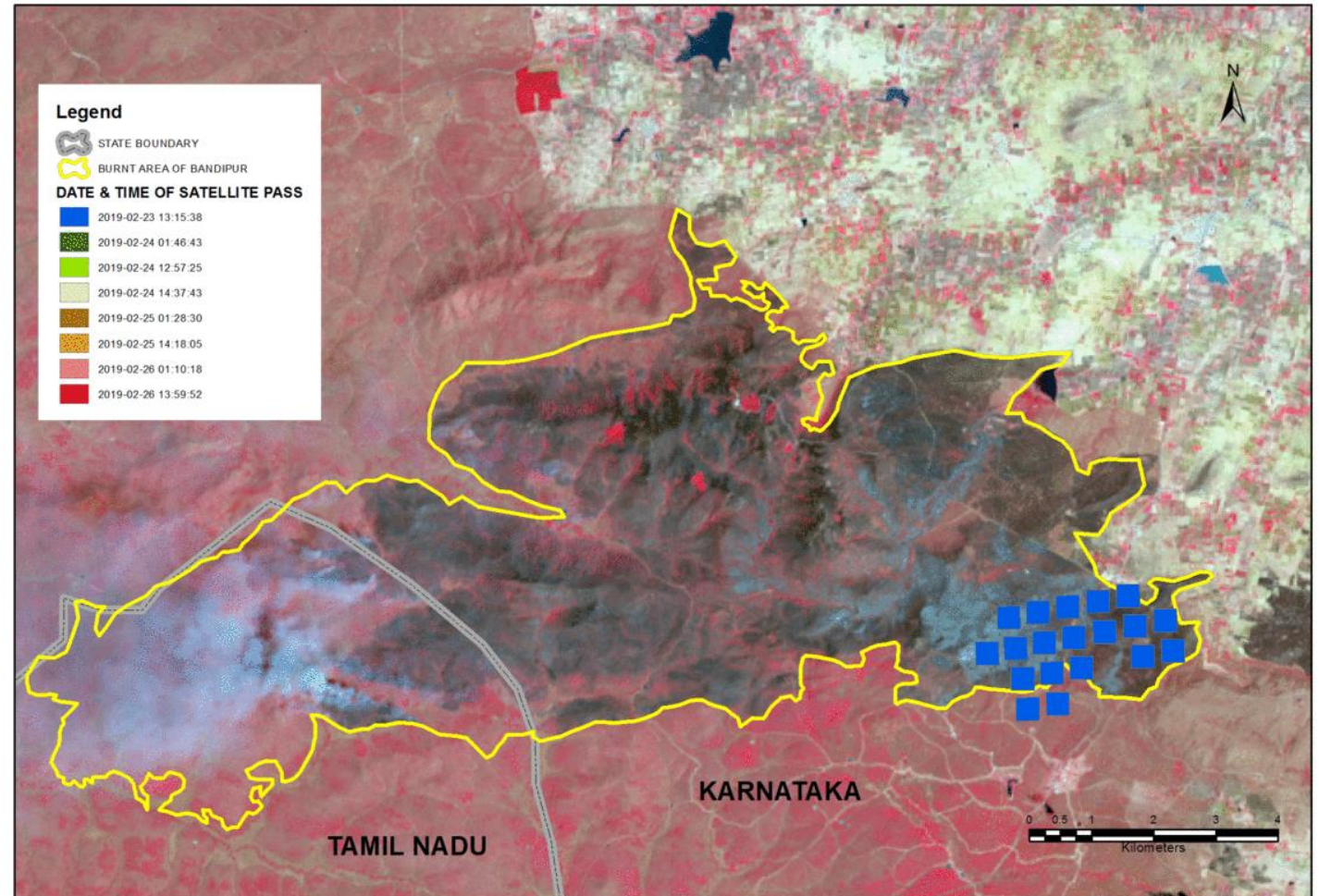
# Large & Slow

## (Bandipur forest fire complex – Karnataka & TamilNadu)

### 23<sup>rd</sup> to 26<sup>th</sup> Feb, 2019

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

SNPP VIIRS Pass wise Fire Progression at Bandipur Tiger Reserve



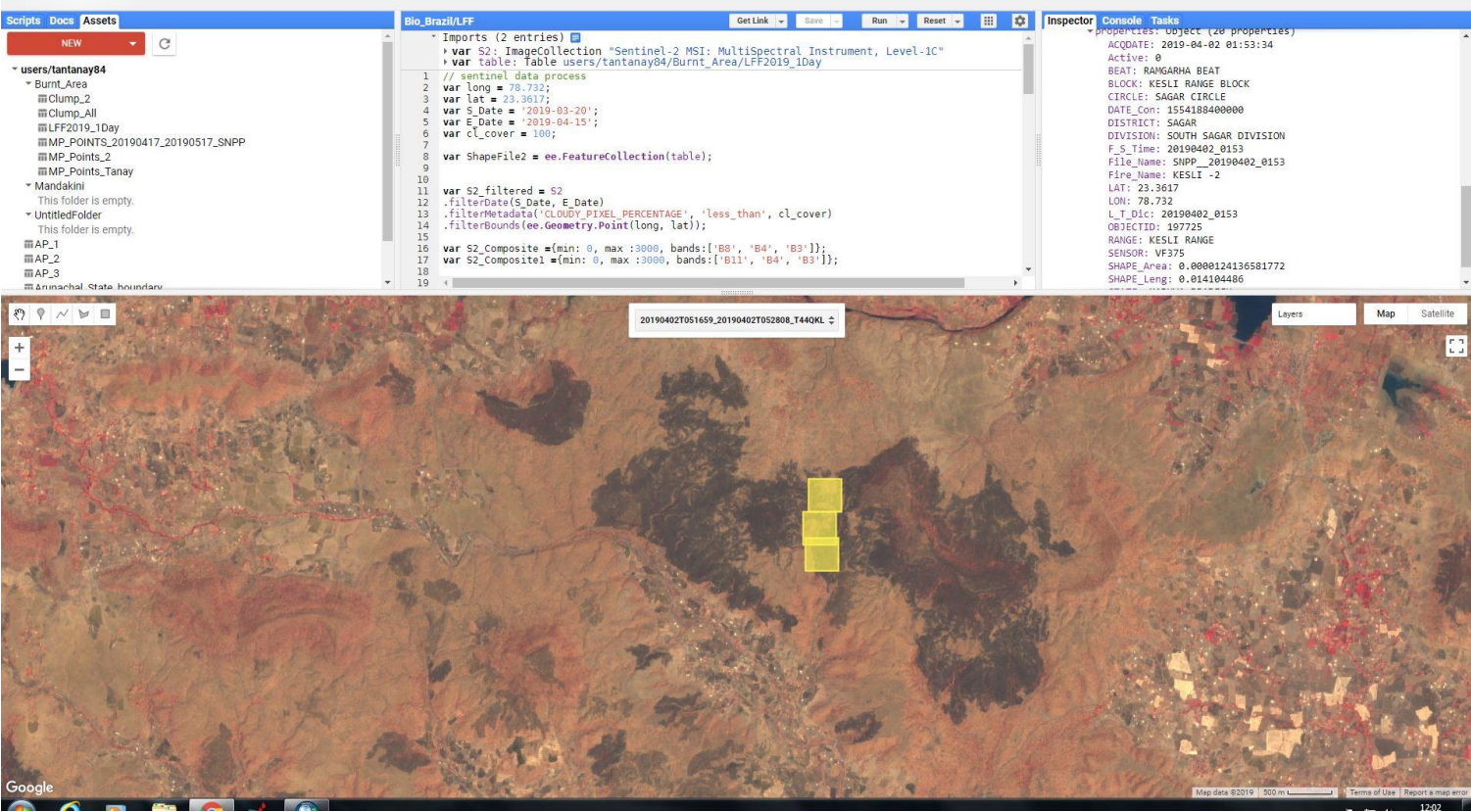


# Large & Fast

## (Kesli-2 forest fire – Madhya Pradesh) 2<sup>nd</sup> April, 2019- 0153 hrs

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

Estimated fire affected area 8.36 sq kms



Sentinel 2 MSI Satellite DoP 2nd Apr 2019

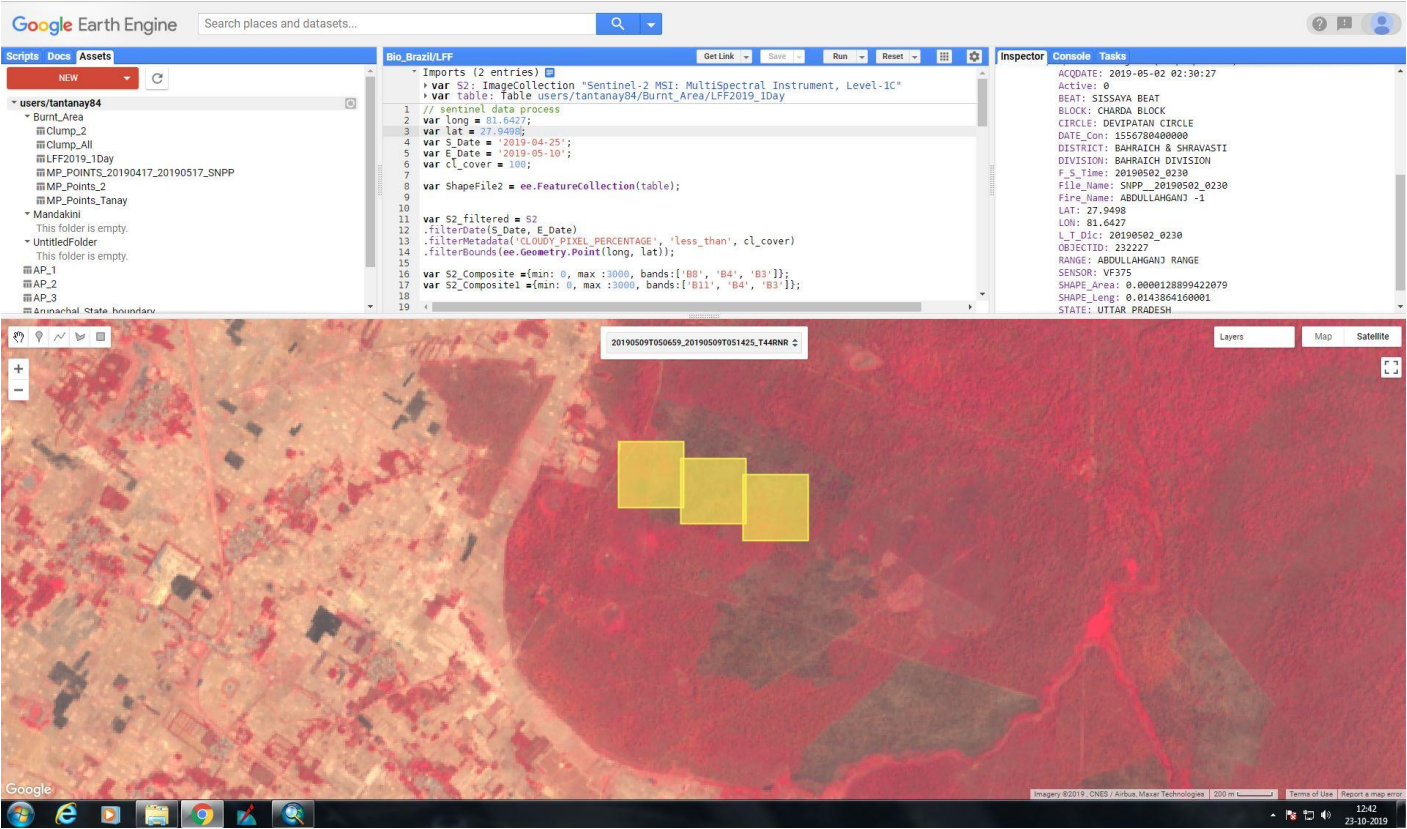
# Small & Fast

## (Abdullahganj-1 forest fire – Uttar Pradesh) 2<sup>nd</sup> May 2019

0230hrs

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

Area affected 1.189 sq kms

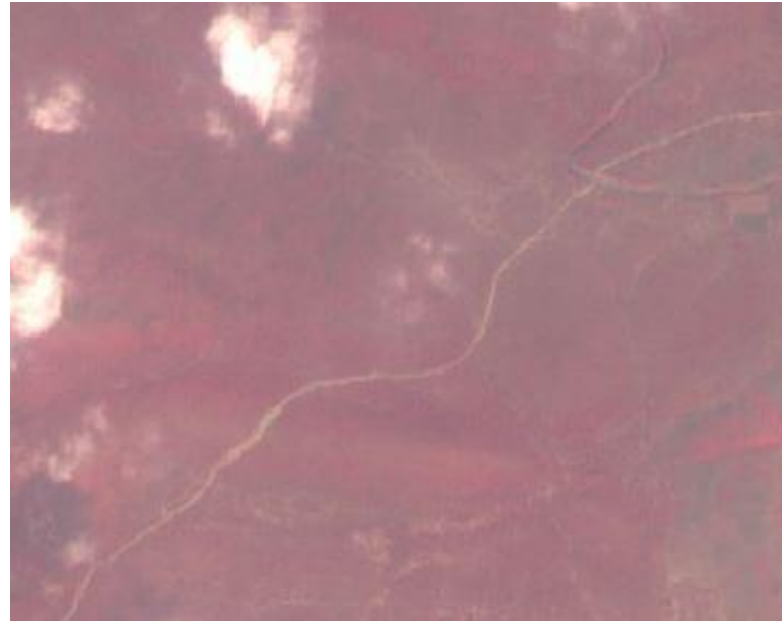


Sentinel 2 MSI Satellite DoP 9th May 2019.

# Small & Slow

## (Asaralli forest fire – Maharashtra) 20<sup>th</sup> and 22<sup>nd</sup> March, 2016

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



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



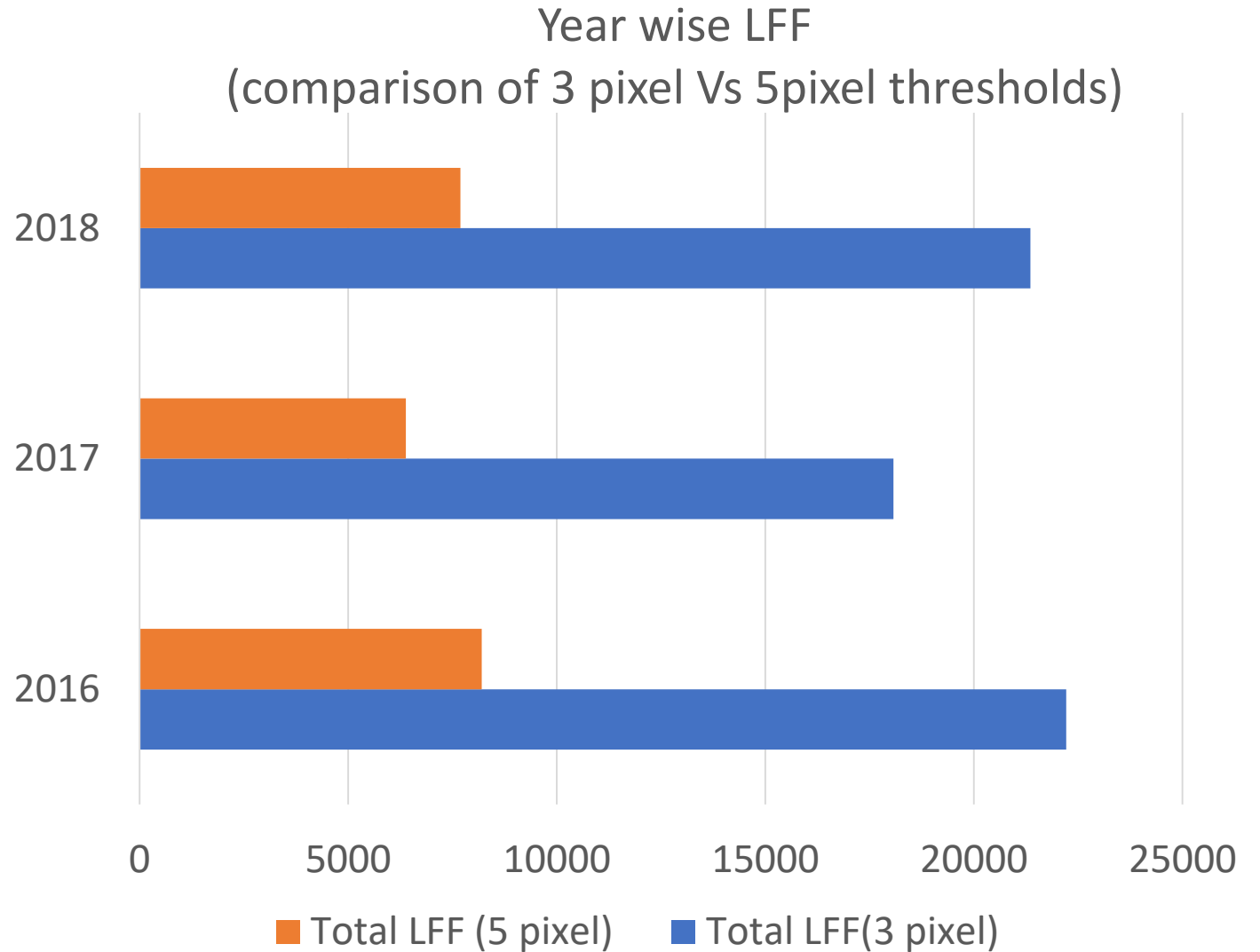
Sentinel 2A of 9<sup>th</sup> April, 2016 showing fire affected vegetation; 12 LFF SNPP-VIIRS pixels overlaid

Fire affected Area- 471 ha

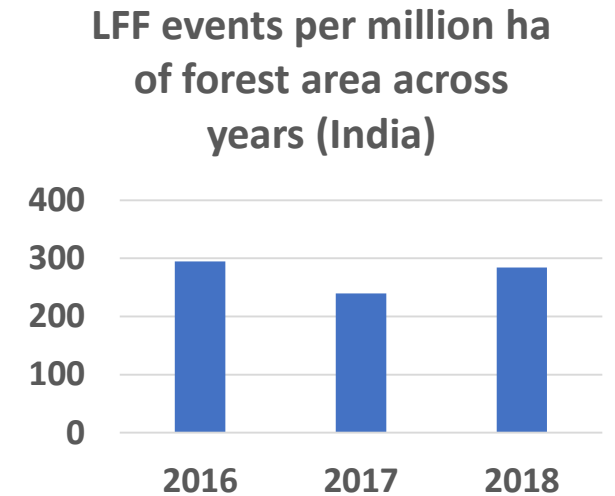
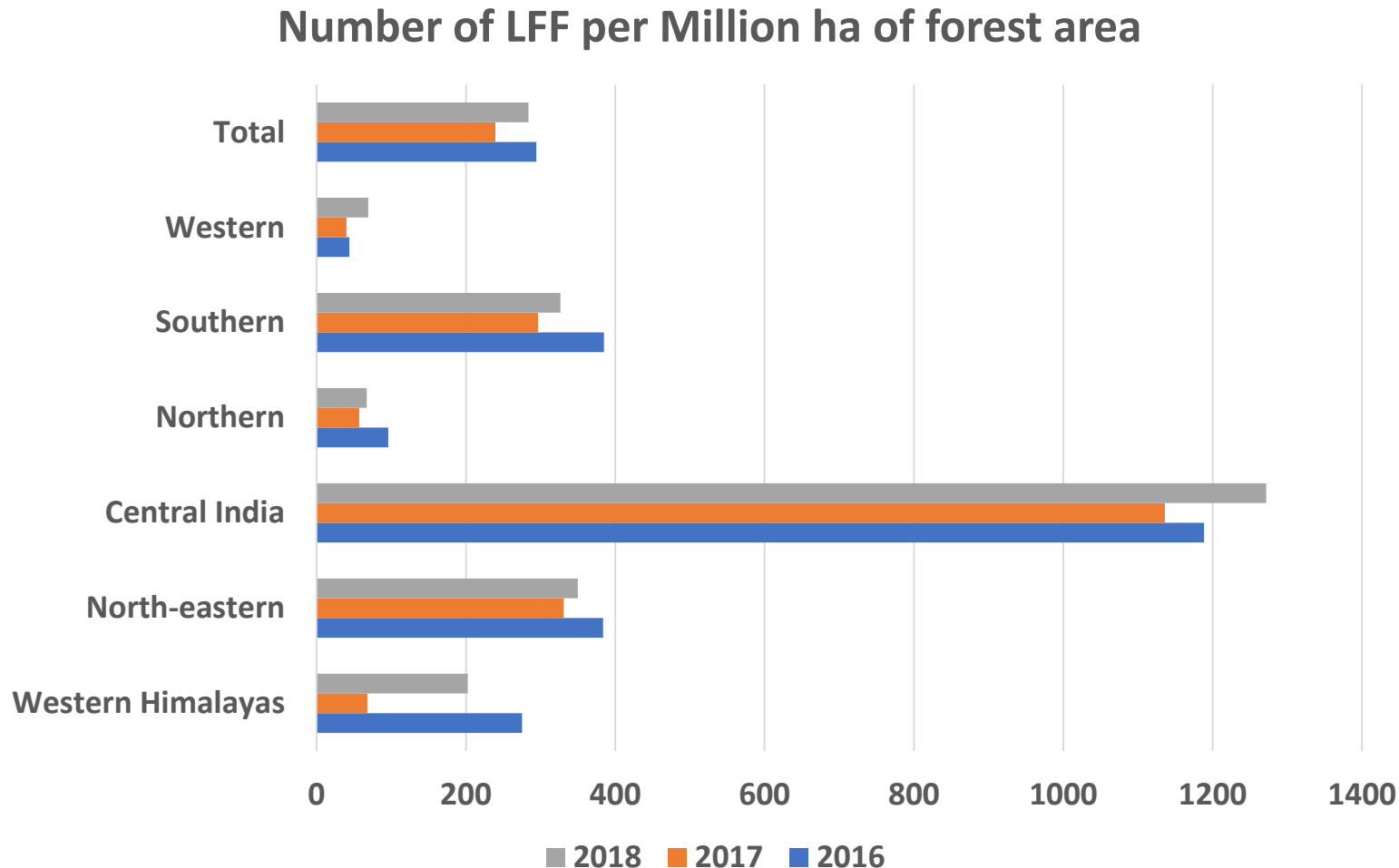


# Medium Term Trends in LFF (2016 to 2018) using VNP14IMGTDL\_NRT

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

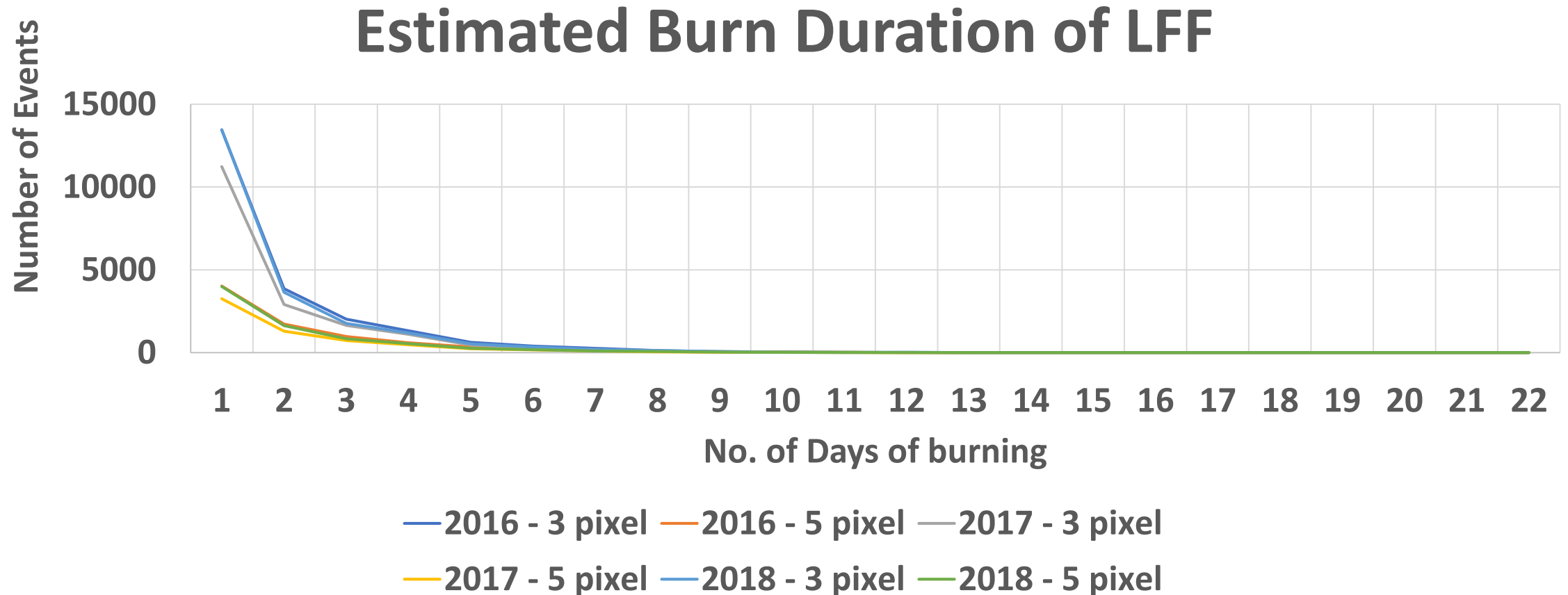


# LFF density in Regions (2016 to 2018)





# 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

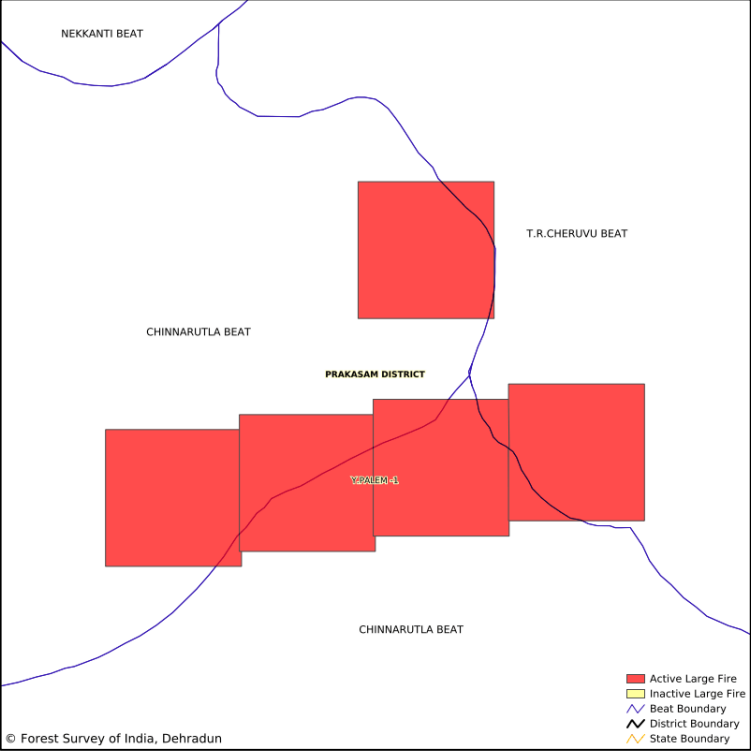
#	Fire Name	Division / District	Active Pixels	Total Pixels	First Detection	KMZ Link	MAP Link	Fire Status
1.	Y.PALEM -1	State: ANDHRA PRADESH District: PRAKASHAM Circle: FDPT SRISAILAM CIRCLE Division: MARKAPUR DIVISION Range: DORNAL RANGE Block: CHINTALA BLOCK Beat: CHINNARUTLA BEAT	5	5	14-01-2019 14:06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

# LFF NRT dissemination

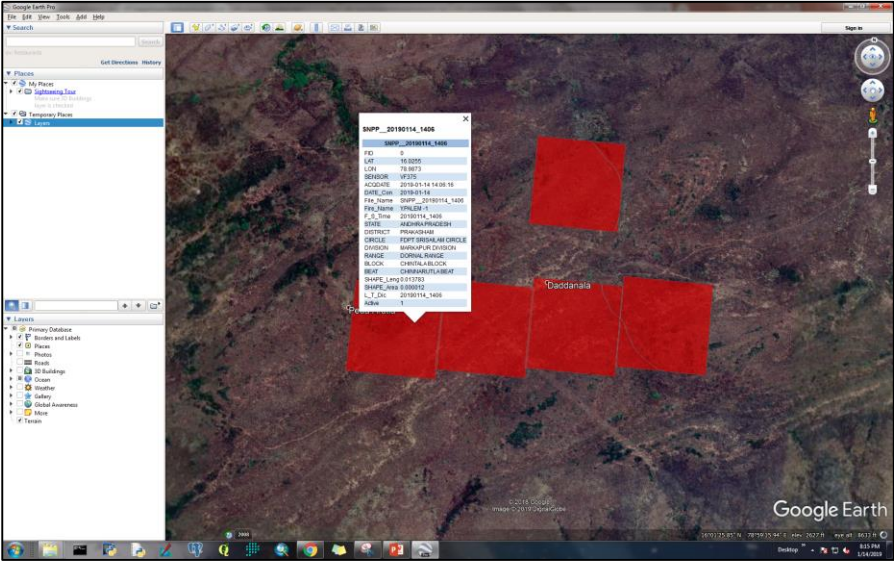
## Large Forest Fire

### 1 Large Fire Events - 14-01-2019

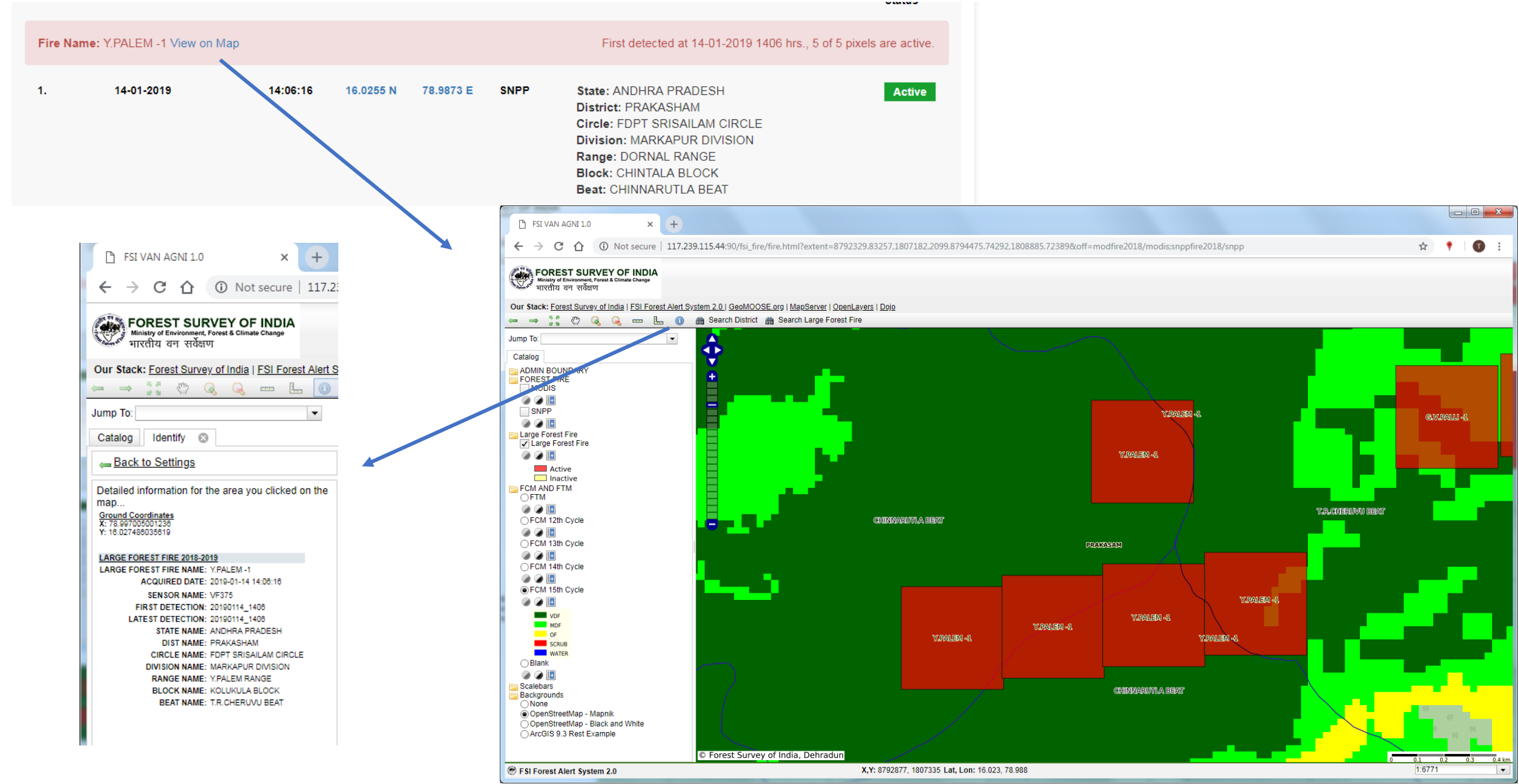
#	Fire Name	Division / District	Active Pixels	Total Pixels	First Detection	KMZ Link	MAP Link	Fire Status
1.	Y.PALEM -1	State: ANDHRA PRADESH District: PRAKASHAM	5	5	14-01-2019 14:06	<a href="#">Download KMZ</a>	<a href="#">View</a>	Active



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	
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 Circle: FDPT SRISAILAM CIRCLE Division: MARKAPUR DIVISION Range: DORNAL RANGE Block: CHINTALA BLOCK Beat: CHINNARUTLA BEAT	Active	



# LFF NRT dissemination



# 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**