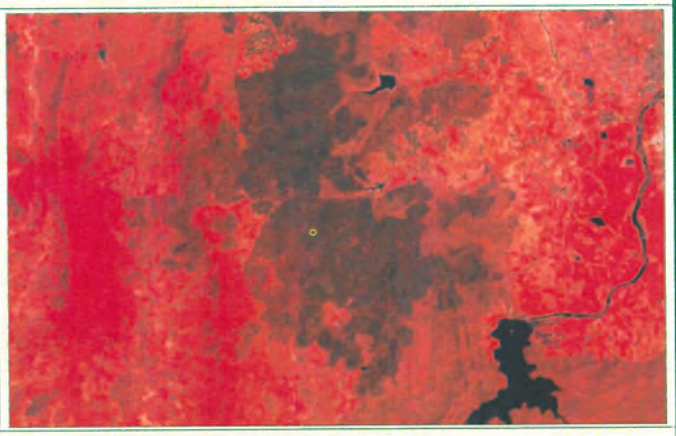
सत्यमेव जयते

TECHNICAL INFORMATION SERIES

Volume I No. 2 2019

FSI FOREST FIRE ALERT SYSTEM (FAST 3.0)



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

TECHNICAL INFORMATION SERIES

Volume I No. 2 2019

FSI Forest Fire Alert System (FAST 3.0)

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1. Background

Forest fires are a recurrent annual phenomenon in India. Almost all the fires in forest areas are manmade and usually the forest dependent communities are known to use fire for various purposes ranging from clearing community forests for shifting cultivation to clearing the forest floor to encourage grass growth. However, uncontrolled and unmanaged fires cause tremendous adverse impact on the environment and the society. In recent years, there have been spurts in the number of forest fire incidents which is a cause of serious concern for all. In past few months, grave wildfires have been observed in different parts of the globe such as California, Tasmania, Cape Town, Melbourne, United Kingdom etc. In one of the major wildfire outbreaks in California, about 60,000Ha of forest was burned resulting in 86 deaths and destruction of approximately 19,000 structures.

Forest fire disaster of 2016 in Uttarakhand and Himachal Pradesh, Kurangani fire incident of Tamil Nadu, Mt. Abu and Vaishnodevi fires of 2018 are some of the recent examples from our country.

Forest fires are one of the most important causes of land degradation that lead to biodiversity loss, deforestation and desertification processes. In India, most forest fires are restricted to the forest floor and are well controlled by beating the fire with the help of the local community. But, the intensity and number of fires vary greatly across the years and are dependent on mostly the moisture conditions in the forest areas. Drier winters, late monsoon onset cause fire season to aggravate and also extent which resulted in large scale damage in western Himalayan region in the year 2016.

2. Forest Fire scenario in the country

As per the data from the National Forest Inventory program of FSI, 9.89% of forest areas are heavily affected and 54.40% mildly affected due to forest fires. Therefore, almost two thirds of our forest areas are vulnerable to forest fires. According to the ISFR 2017, an approximate 33,000 fires alerts from MODIS sensor were generated by FSI all over India in the year 2016. In the year 2018, 37059 fire alerts from MODIS sensor were generated by FSI all over India.

3. Forest Fire related interventions of FSI

The FSI Forest Fire Alerts system has undergone periodic changes to facilitate not only foresters but also common people in a better way. Fully automated Forest Fire Alert System 3.0 disseminates its alert system for 20 states at beat level and 2 states at Range level. In case of the rest of the States/UT's, alerts are sent up to District level in the absence of Administrative boundary information from State Forest Departments.

Forest Survey of India has also launched the **Large Forest Fire Monitoring Programme** using near real time SNPP-VIIRS data on 16th January, 2019. With the launch of Large Forest Fire Monitoring System under FAST 3.0 (FSI Fire Alerts System), FSI aims to track large fire events across the country and disseminate specific Large 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.

Improved Custom Filter, rationalized Trees outside Forests layer, custom masking have boosted its accuracy level. Integration with visualization WMS, Map links in SMS etc. such type of facilities are available for convenient the users' end. Database is enriched with Science quality database and Map server based web portal (open source) for dynamic display of alerts. Feedback system is revamped via SMS and state nodal page. State Nodal Officer pages are also improved to get feedback from their end.

The process of generation and dissemination of forest fire alerts (Fig. 1) is described below.

i. After a satellite overpass, the active fire spots or hotspots are received by NRSC (National Remote Sensing Centre), Hyderabad in their ground station at Shadnagar, Telangana and are shared through email by NRSC to FSI.

ii. The fire alerts provided by NRSC include all thermal anomalies detected by the sensors irrespective of whether these fall within or outside forests. FSI filters out all fires other than forest fires using a custom filter which is a combination of Recorded Forest Area boundaries as well as forest cover data. Enrichment of the forest fire information is carried out by adding attributes like State, District, Division, Range, Beat, Compartment boundaries etc. to the forest fire locations.

iii. This information is then disseminated to State Nodal Officers, registered users and also uploaded on the website of FSI in the form of Table and Maps.

iv. Users who have specified their areas of interest are also notified of the fires therein through SMS as shown in Fig.2.

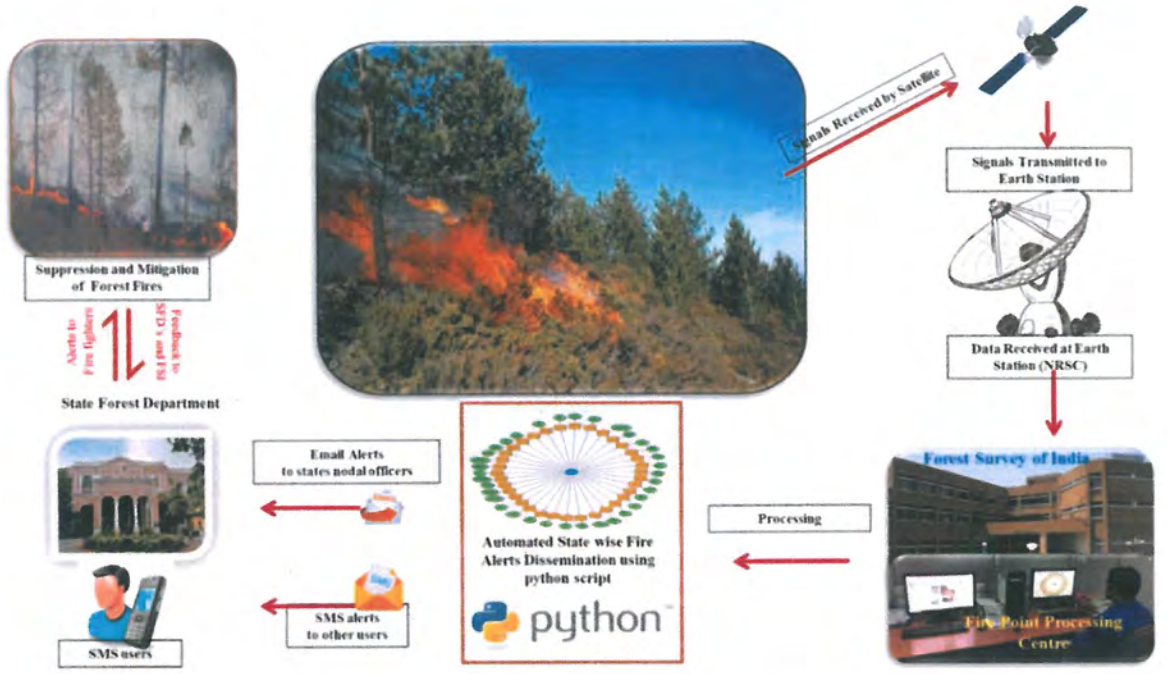


Fig. 1 Generation and dissemination of forest fire alerts

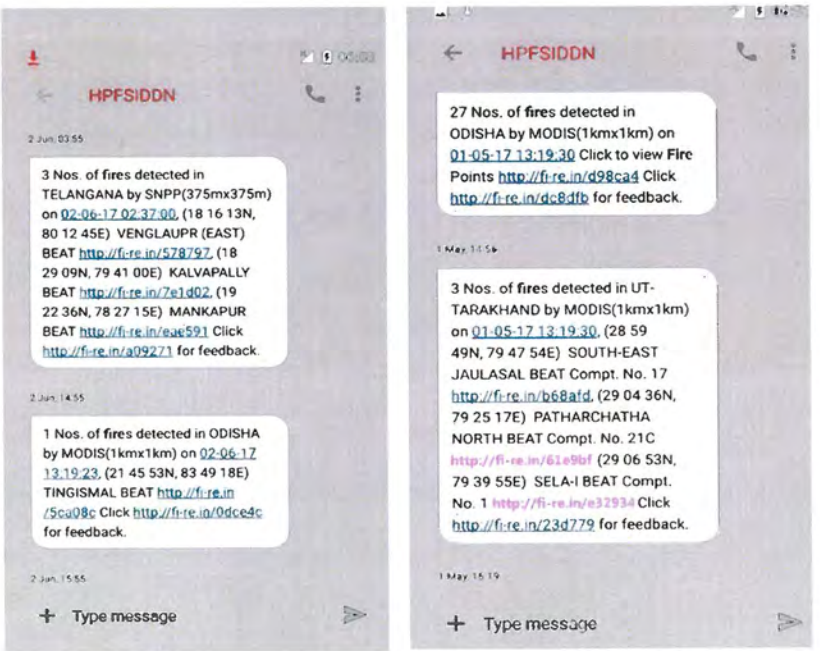


Fig. 2 Example of Fire Alert SMS

4. Recent Developments on Forest Fire management at National level

4.1 National Action Plan on Forest Fires

The Ministry of Environment, Forest and Climate Change has recently come up with a National Action Plan on Forest Fires (NAPFF). The National Action Plan on Forest Fires (NAPFF) owes its origin to the recommendations of the Parliamentary Standing Committee on Science, Technology and Environment & Forests which asked the ministry to prepare a comprehensive action plan in its 293rd report. This was also further stressed by the National Green Tribunal in the case OA No.216 of 2016 in the matter of Rajiv Dutta Vs Union of India & Others in its ruling in August 2017. The NAPFF focuses on holistic management of forest fire scenario in the country including fire prevention, fire control, post fire activities, community mobilization etc. The framework for preparation of State Crisis Management Plan and funding provisions from Central schemes, coordination of various agencies are also a part of the Plan.

4.2 World Bank Study on Forest Fire scenario in the country

The World Bank and MoEFCC jointly conducted a study on forest fire prevention and management in India in the year 2017-18 and came out with a report recently. The report concluded that just 20 districts, representing 3 percent of the India's land area and 16 percent of the country's forest cover in 2000, accounted for 44 percent of all forest fire detections from 2003 to 2016. Similarly, the top-20 districts in terms of area affected by fire from 2003 to 2016 account for 48 percent of the total fire-affected area, despite having just 12 percent of the nation's forest cover in 2000 and 7 percent of its land area. The top-20 districts in terms of fire frequency mainly located in the Northeast, while the top-20 districts in terms of burnt area are mainly in Central India.

The major recommendations of the report include:

i. Preparation and implementation of a National Action Plan
ii. Review of Working Plan code.
iii. Continued development of systems for early warning and fire danger rating.
iv. More systematic use of silvicultural practices for fire prevention.
v. Working with communities to modify how fire is used and prevent unwanted fire.
vi. Modernizing the forest fire fighting and response system.
vii. Strengthening the assessment of the economic impacts of fire.
viii. Silvicultural practices for restoring and rehabilitating fire-degraded forests.

5. Current Focus areas of FSI

The current work areas and achievements of FSI in the area of forest fires are briefly described below.

5.1 Evolution of Near Real Time Forest Fire alerts

Forest Survey of India has been using spatial information (MODIS and SNPP-VIIRS) to find and report forest fires in the nascent stage and provide quick and reliable signals to SFDs and general public to initiate preventive measures at their end.

5.1.1 Forest Fire Alert System Ver. 1.0 (2004-2017)

Forest Survey of India has been alerting State Forest Departments of forest fire locations detected by the MODIS (Moderate Resolution Imaging Spectro-radiometer) sensor on-board Aqua and Terra Satellites of NASA since 2004. As each of the MODIS satellites has two passes over the country daily, fire alerts of 1km X 1km resolution pertaining to 10.30 am, 1.30 pm, 10.30 pm and 1.30 am are sent to the users. During the initial years, fires detected by the satellites were transmitted through Fax and later through SMS and email with improvement in communication technology.

This initiative which started exclusively for the State Forest Departments (SFD), was extended to the general public also since 2010. A registered user who is registered on the FSI website can avail forest fire alerts as SMS for their chosen district/s or State or even for the whole country. Since 2012, alerts were also disseminated together with Google Earth compatible KML files through email to the nodal officers of State Forest Departments.

5.1.2 Forest Fire Alert System Ver. 2.0 (2017-2018)

During the year 2017, the system of forest fire alerts underwent a complete revamp in order to serve the interests of the users in a better way.

The revamped fire alert system which was launched on 23rd January 2017 has been christened as "Forest Fire Alert System 2.0". The main features and advantages of this system are given below.

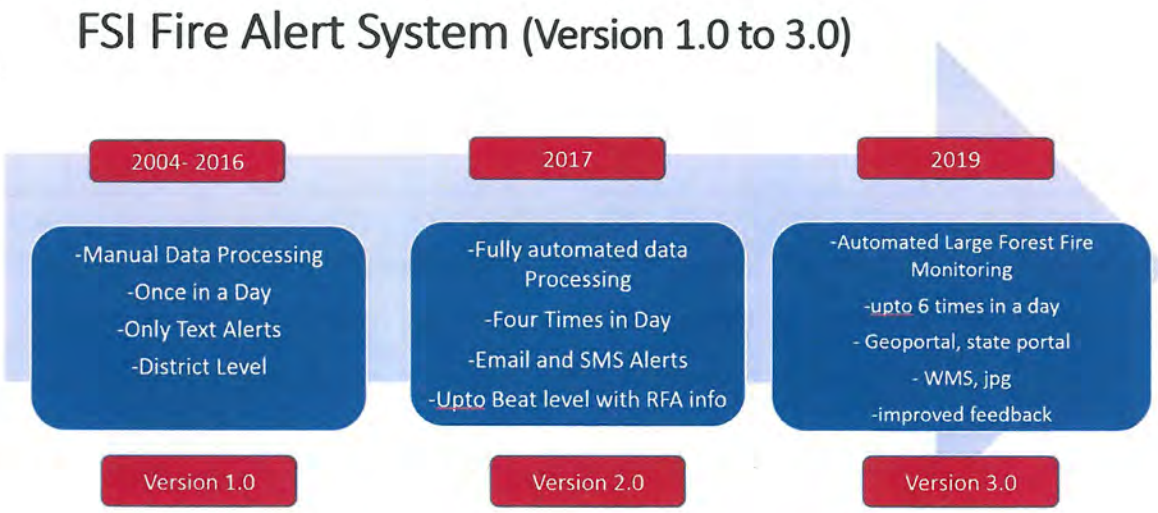
1. Inclusion of Forest Fire Alerts from SNPP-VIIRS (Visible Infrared Imaging Radiometer Suite) Sensor with higher resolution of 375m x 375m. A comparison of the two sensors is given in Table 1.
2. Automation of the process
3. Customized Alerts
4. Improved users experience
5. Control Panel for State Nodal Officers

Table 1 Comparison of MODIS and VIIRS sensors

	MODIS (Moderate resolution Imaging spectro-radiometer)	SNPP-VIIRS Suomi National Polar-orbiting Partnership (NPP) satellite
Sensor	36 spectral bands (channel 21,22,31)	5 HR Imagery channels (I-bands), 16 moderate resolution channels (M-bands) and a D/N Band (M13 and M15)
Satellite	Aqua & Terra	Suomi National Polar-orbiting Partnership (NPP) satellite
Launch	Dec 99 & May 2002	Oct-11
Algorithm	Contextual	Thresholding and Contextual (Hybrid)
Equatorial Pass	Terra- 10:30 am and 10:30 pm ; Aqua - 1:30 pm and 1:30 am	1:30pm and 1:30am
Resolution	1 km X 1km	375mx 375m &750m x 750m
Night time performance	Poor	Good
Mapping small fires	No (ideally 1000 sq m)	Yes
Accuracy of mapping large fire boundaries	Poor	Good
Under Canopy Fires detection	Poor	Good

5.1.3 Forest Fire Alert System Ver. 3.0 (FAST 3.0)

The FSI Forest Fire Alert has undergone a refurbishment yet again in January, 2019. A faster, quicker and more robust version of Fire Alert System viz. FAST Ver. 3.0 was launched by Dr. Harak Singh Rawat, Hon'ble Minister, Forest and Environment, Government of Uttarakhand on 16-17th January, 2019 during the pre-fire season workshop on forest fires for State Nodal Officers held at FSI, Dehradun.



Features in FAST 3.0 (FSI Fire Alert System)

i. Large Forest Fire Monitoring Programme: It is based on satellite data (SNPP-VIIRS) to automatically identify and track large forest fire events

ii. FSI Forest Fire Geoportal: to view forest fire related data along with other thematic layers

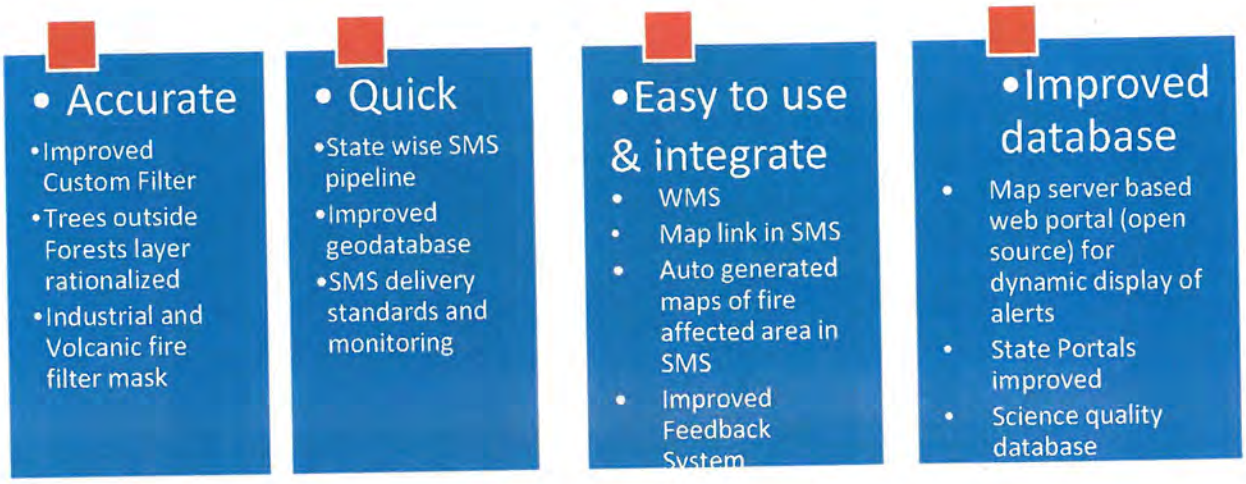
iii. Web Map Service (WMS): available for integration to State Forest Departments

iv. Customized alerts for 20 states at beat level and 2 states at Range level

v. Improved feedback system (via SMS and nodal officer page)

vi. Improved Nodal officer page

Advancements in FAST Ver. 3.0 from Ver 2.0



a. Large Forest Fire Monitoring Programme using near real time SNPP-VIIRS data:

Forest Survey of India has launched the Large Forest Fire Monitoring Programme using near real time SNPP-VIIRS data.

A Large Forest Fire is defined as a fire event comprising of at least 3 proximate VIIRS pixels. The programme detects minimum of 3 SNPP pixels in close proximity to identify a Large Forest Fire. Once detected, it is continuously monitored until it is put off. The programme scans the fire for additional 3 days after its inactivity to detect dormant fires, if any.

FSI disseminates 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

Scope of Large Fire Monitoring Programme

i. To monitor continuous, large forest fires using near-real time basis
ii. To enable SFDs to monitor large forest fire events and provide special emphasis in fire control of these events
iii. 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.
iv. National Large Forest Fire Database would help in future planning especially in development of State Crisis Management Plans, Working Plans.
v. To support rehabilitation of fire affected areas.

Spin-offs

i. Creation of Large Fire Database at National Level.

ii. Development of National Forest Fire Database.

iii. Continuous monitoring of fire affected areas for planning, research etc.

The following procedure (depicted in Fig. 3) is followed for generation and dissemination of large forest fire alerts:

i. 'Large Forest Fires' are identified by carrying out the clumping of fire polygons with criteria being atleast 3 SNPP forest fire polygons to be detected in close proximity. This one clump is considered as a single 'large forest' fire event.

ii. Unique large fire nomenclature is assigned to every large forest fire based on its range/district name.

iii. If any fire in the subsequent satellite passes is within a pre-defined vicinity range of any of the previous continuing large fire, then it's continued under the same name of the previously continuing fire.

iv. Such continuous monitoring is done until the fire douses and for additional 3 days after the inactivity of the fire.

v. Based on steps 1 – 4, a 'Large Forest Fire Database' is generated.

vi. Dataset of active large fire layer of the current pass of satellite in continuation with its fire extensions from the previous passes is created.

vii. Enrichment of the forest fire information is carried out by adding attributes like State, District, Division, Range, Beat, etc. to the large forest fire polygons.

viii. This information is then disseminated to State Nodal Officers as kmz through e-mail, to registered users through SMS and also uploaded on the FSI fire geo-portal for interactive viewing.

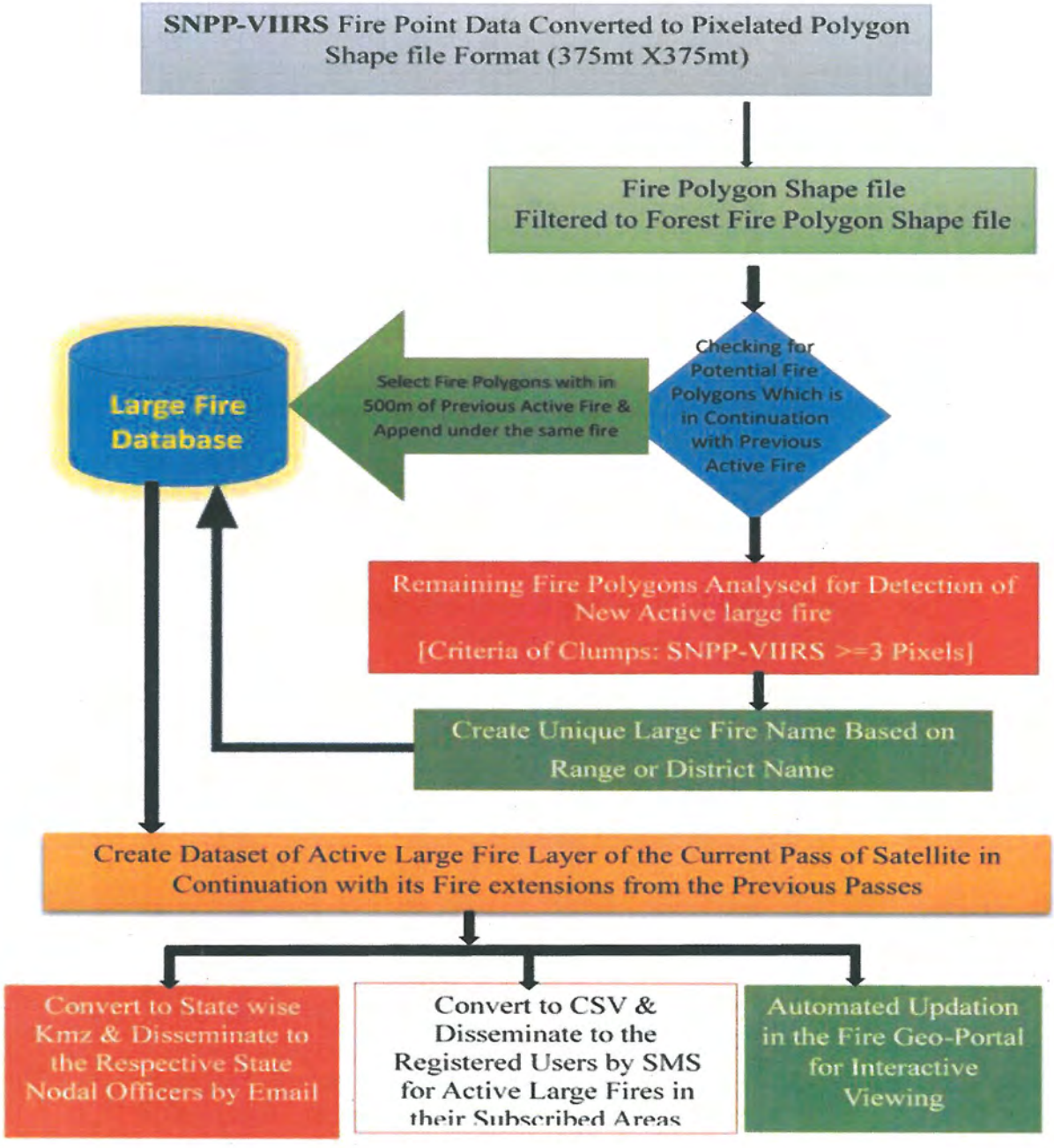
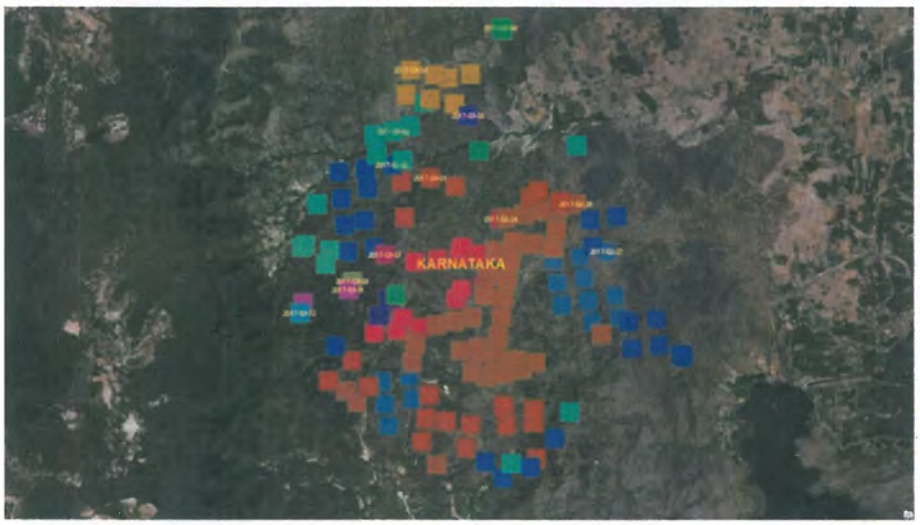


Fig. 3 Generation and dissemination of large forest fire alerts

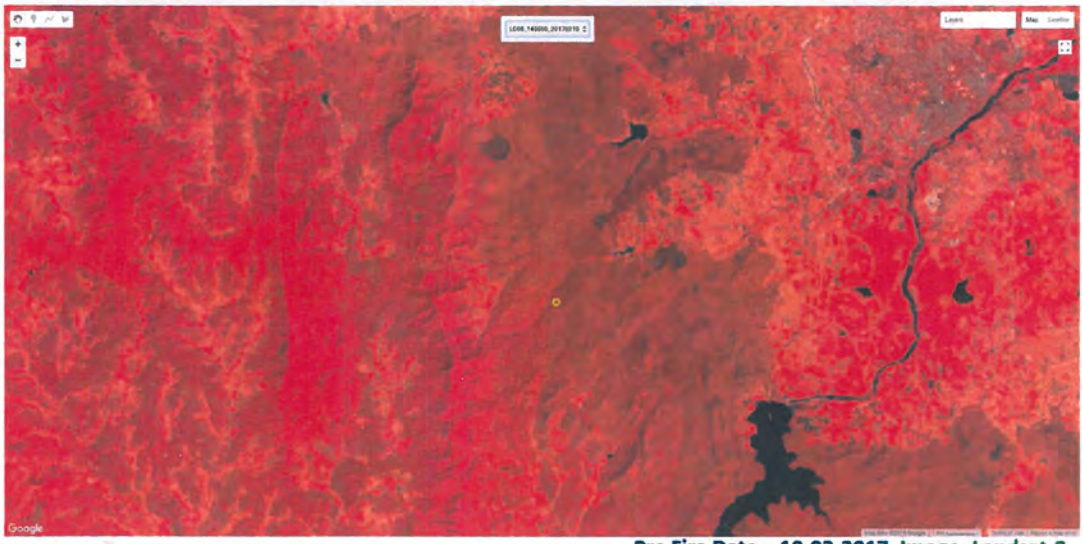
An example of a Large Forest Fire event named, 'Sacre Byle – 3' in Karnataka which remained active for an extended period of 16 days has been depicted below in Fig.4.

Fire Name	State	First Detection Time	Last Detection Time	No. of Days fire remained active
SACRE BYLE -3	KARNATAKA	24-02-2017	12-03-2017	16



Satellite Image Validation By Google Earth Engine

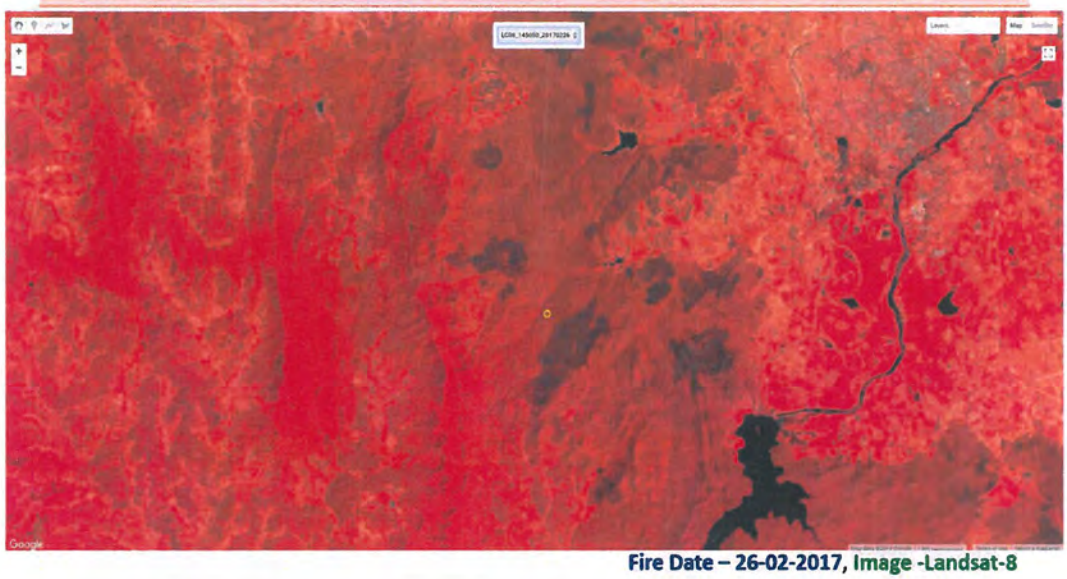
Fire Name	State	First Detection Time	Last Detection Time	No. of Days fire remained active
SACRE BYLE -3	KARNATAKA	24-02-2017	12-03-2017	16



Pre Fire Date – 10-02-2017, Image -Landsat-8

Satellite Image Validation By Google Earth Engine

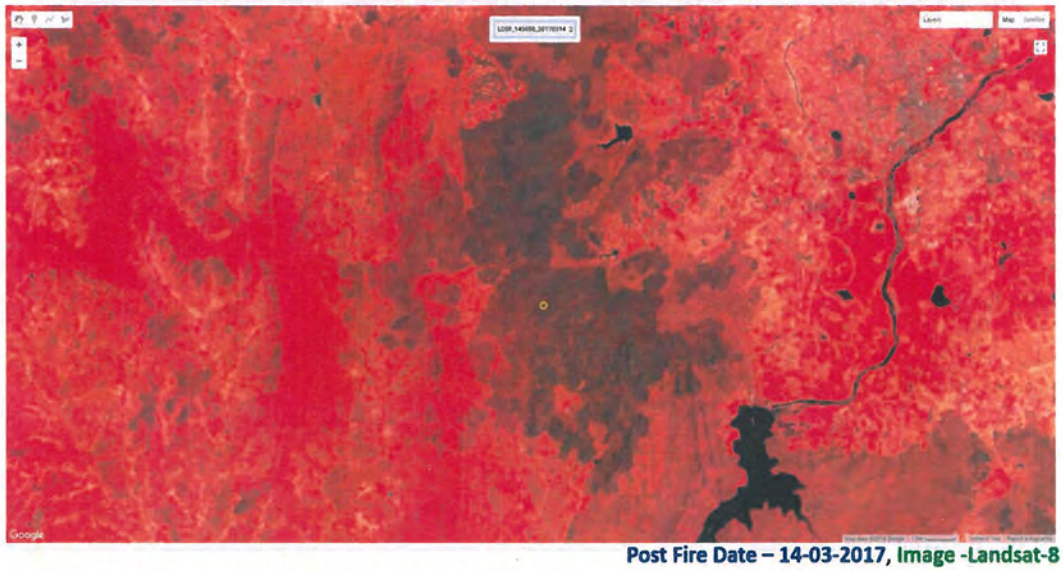
Fire Name	State	First Detection Time	Last Detection Time	No. of Days fire remained active
SACRE BYLE -3	KARNATAKA	24-02-2017	12-03-2017	16



Fire Date – 26-02-2017, 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
SACRE BYLE -3	KARNATAKA	24-02-2017	12-03-2017	16

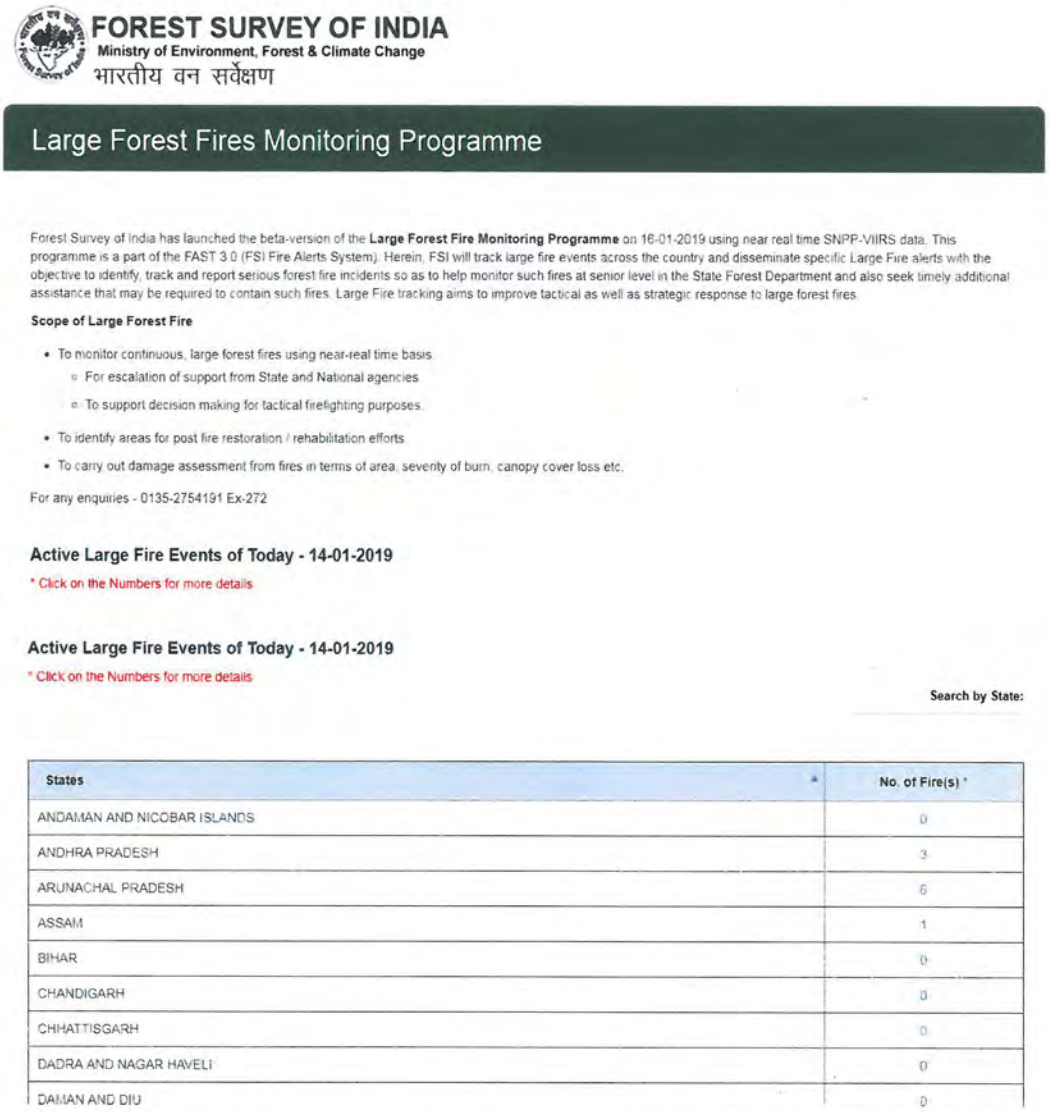


Post Fire Date – 14-03-2017, Image -Landsat-8

Fig. 4 An example of Large Forest Fire event detection and monitoring

Large Forest Fire Dashboard in FSI website

A Large Forest Fire Monitoring programme dashboard, as shown in Fig. 5-6, has been provided on Forest Fire Portal of FSI (fsi.nic.in) for the forest officers and staff as well as the general public to monitor the large forest fire status in their state. The fire events details are enriched with its related information such as Administrative boundary details, date of first detection of the fire event, status of the fire along with provision of .kml links (google earth compatible), geo-portal link and the map link for easier tracing and tracking.



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Large Forest Fires Monitoring Programme

Forest Survey of India has launched the beta-version of the **Large Forest Fire Monitoring Programme** on 16-01-2019 using near real time SNPP-VIIRS data. This programme is a part of the FAST 3.0 (FSI Fire Alerts System). Herein, FSI will track large fire events across the country and disseminate specific Large 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. Large Fire tracking aims to improve tactical as well as strategic response to large forest fires.

Scope of Large Forest Fire

- To monitor continuous, large forest fires using near-real time basis.
  - For escalation of support from State and National agencies.
  - To support decision making for tactical firefighting purposes.
- To identify areas for post fire restoration / rehabilitation efforts.
- To carry out damage assessment from fires in terms of area, severity of burn, canopy cover loss etc.

For any enquiries - 0135-2754191 Ex-272

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

* Click on the Numbers for more details

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
CHHATTISGARH	0
DADRA AND NAGAR HAVELI	0
DAMAN AND DIU	0

Fig. 5 Large Forest Fire Dashboard in FSI Website

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Large Forest Fire

1 Large Fire Events - 05-02-2019

#	Fire Name	Division / District	Active Pixels	Total Pixels	KMZ Link	MAP Link	Portal Link	Fire Status
1.	KANKAVALI -6 First Detection: 05-02-2019 13:53	State: MAHARASHTRA District: SINDHUDURG Circle: KOLHAPUR CIRCLE Division: SAWANTWADI DIVISION Range: KANKAVALI RANGE Block: BHIRWANDE BLOCK Beat: BHIRWANDE BEAT	5	5	Download KMZ	View	View	Active
2.	BHAMBURDA -3 First Detection: 05-02-2019 13:53	State: MAHARASHTRA District: PUNE Circle: PUNE CIRCLE Division: PUNE DIVISION Range: BHAMBURDA RANGE Block: BHAMBURDA BLOCK Beat: BAVDHAN BEAT	5	5	Download KMZ	View	View	Active

Fig. 6.1

Large Forest Fire Detection shared as .kmz file via e-mail

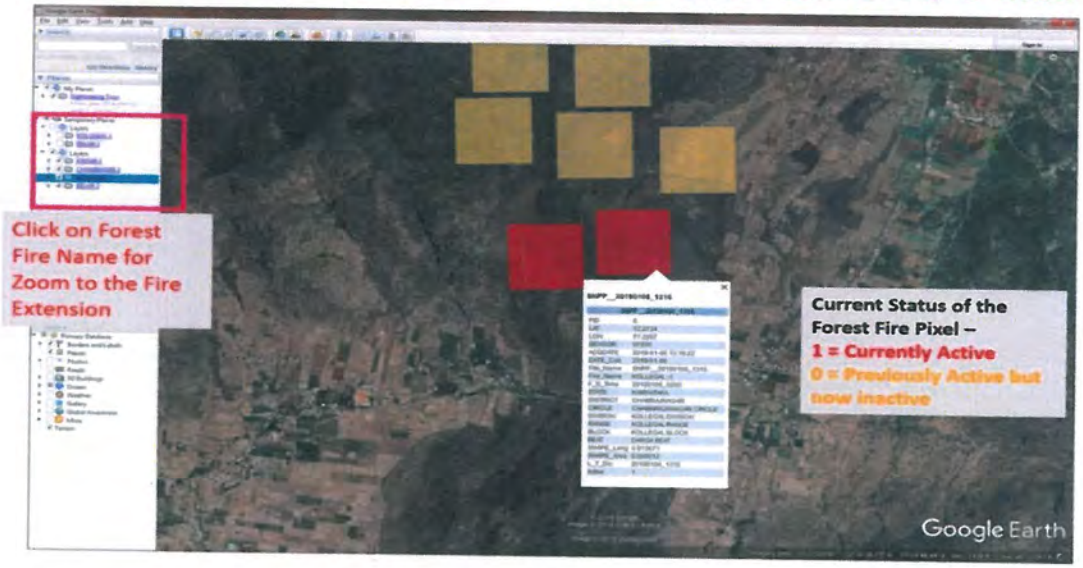

Fig. 6.2

Fig. 6.1. Details of Large Forest Fire Event as shown in dashboard
Fig. 6.2. .kmz file in Google Earth
Fig. 6.3. Map view of Large Forest Fire

ig. 6.3

b. FSI Forest Fire Geoportal

FSI Forest Fire Geo-portal, VAN AGNI 1.0 (http://117.239.115.44:90/fsi_fire/fire.html) is an in-house development of FSI which has been created using Opensource Softwares viz. MapServer 7.0.7 & GeoMOOSE 2.9.

It has been developed for user-friendly interactive viewing where the user can view forest fire related data inter alia, forest fires, large forest fire events tracking etc. along with other thematic layers such as Forest admin boundaries, Forest and Forest cover, forest type etc.

A snapshot view of the geo-portal is been shown in Fig.7.

Key features are:

i. Latest Web GIS Technology
ii. Automation with python script
iii. Automated integration of Near Real Time Forest Fire Data & Large Forest Fire Data
iv. Easy to use simple tools
v. Integration of FCM & FTM Data in background
vi. Integration of Open Source Open Street Map Data as background map
vii. Advance Searching capability

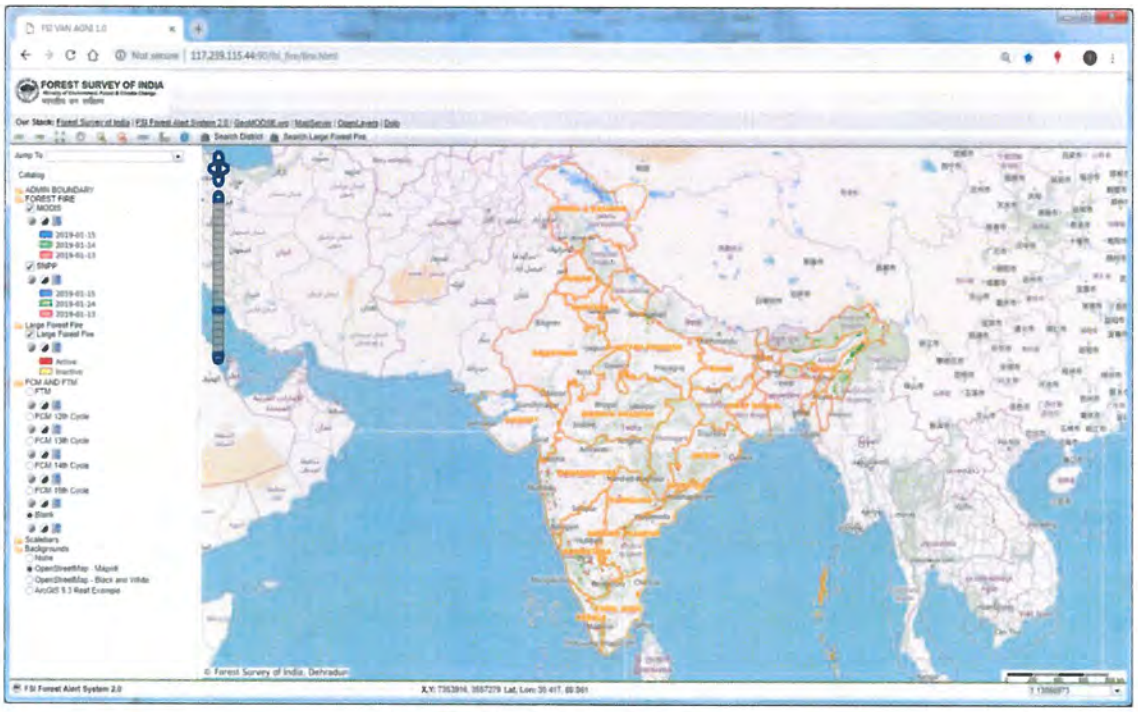

Fig. 7 FSI Fire Geo-portal view

c. WMS Service

WMS (Web-Map Service) is another development in FAST Ver. 3.0. which has been created using Open source MapServer 7.0.7 and python script.

1. It is provided to State Forest Departments on near-real time basis for forest fire points as detected by MODIS and SNPP-VIIRS for last 3 days.

   An instance of FSI WMS integration in Maharashtra Forest Geo-portal is shown in Fig.8.
2. The last 3 days data is represented with 3 different classes & colours for better visualization.
3. Feature information viz. acquired date and time, sensor and State name is also included in the WMS layer.
4. The service is completely automated.

Real Time WMS Service in Maharashtra Forest Geo-Portal

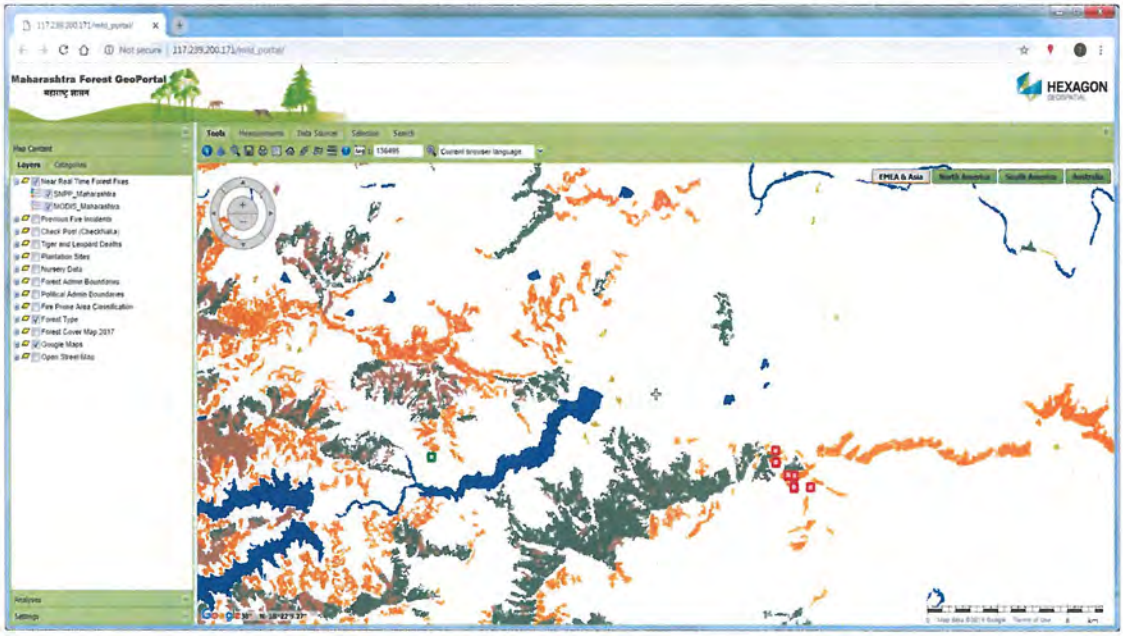

Fig. 8 Real-time WMS service as integrated in Maharashtra Forest geo-portal

d. Custom Mask Out including Industrial Area-

Custom Masking had been done through manual digitization process. These areas are used as filtering tools to eliminate those pixels which frequently appeared in Industrial areas. In order to ensure that the custom mask out of mining, Industrial and volcanic areas are used for the appropriate step in a process sequence, a few basic conventions should be adhered to:

i. Industrial or Mining areas were detected from Google Earth Image.
ii. Consecutive Fire point locations detected by SNPP-VIIRS are used to identify those areas.
iii. Fire Points Feedback report is considered to demarcate such areas.
iv. 500-meter buffer also generated over those mask out areas.

Fig. 9 Layer for Custom mask

Findings: Fire pixels usually appeared in Mining and Industrial area in a clump manner, apart from those areas sensor detects thermal anomalies in such areas where solar panel is installed and volcanic activities are occurring often.

e. Improved Feedback System

A link is provided in all the forest fire alerts at the end of the SMS to enable users to provide feedback on the aspects; such as whether fire has actually occurred or not, extent of area burnt (in Ha) and also any other observations they may want to make.

The state forest department officials can also provide feedback through their nodal officer page/ feedback login page. Also, for any detailed feedback, users can mail FSI at **forestfiremonitoring@gmail.com**.

It is expected from the user that they could provide as much details as possible regarding Forest Fire Alerts; like: 'Type of Land', 'Type of Fire', Cause of Fire', Fire Details' etc. (Fig. 10).

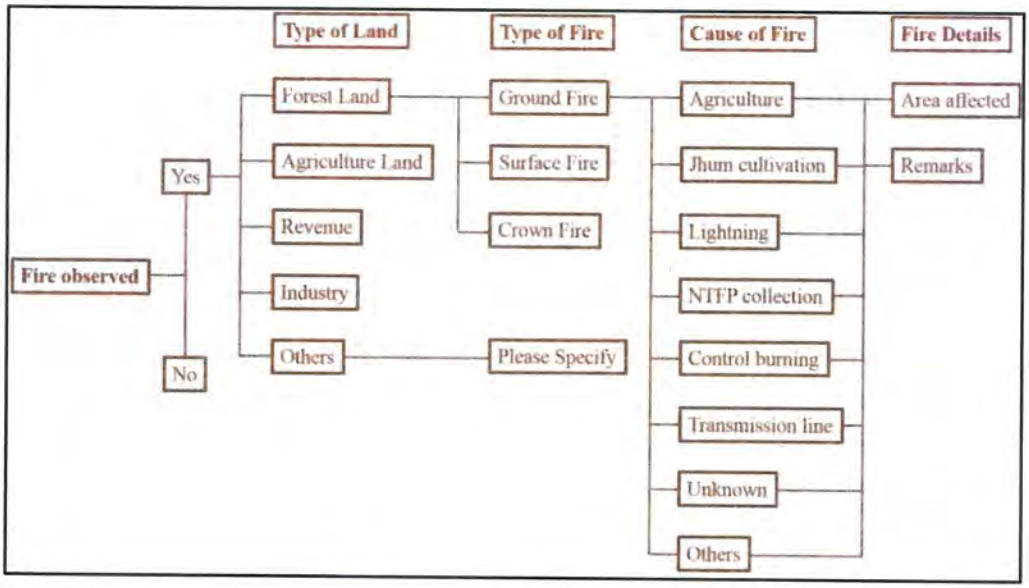

Fig. 10: Feedback Tree

f. Few Limitations in the Fire Alert System

Satellite fire detection has also got some minor limitations:

i. The algorithms cannot detect fires through thick cloud, smoke and haze. A large fire may therefore go undetected for several days and then suddenly it reappears later when the cloud cover gets removed. A small fire may burn and even die out without ever being detected.

ii. Same could be the case for ground or surface fires under very thick, dense canopy which could go undetected, as optical and thermal (like: MODIS and VIIRS) wavelength based sensors cannot penetrate through cloud or canopy cover. In those cases the satellite may miss the existence of fire.

iii. The forest fire alerts generated by FSI correspond to only 6 satellite overpasses in a day and all fires data active in between these satellite overpasses cannot be detected by the satellite based fire alert systems.

iv. The time lapse between fire detection by the satellite and dissemination of the alert to the user is between 1 to 1.5 hours, depending on the sensor and processing time. This delay limits the utility of satellite detection for tactical fire operations.
v. The actual size of the actively burning area cannot be determined from satellite imagery. A 1-km² hotspot pixel may represent a fire as small as 100 m². In addition, an intense fire covering an area less than 1 km² may actually show up as a cluster of several hotspot pixels.
vi. Within a pixel of size 375m X 375m, one cannot specify the actual fire location. In those cases an approximation is taken as, anywhere the fire is within 375 X 375 sqm; we need to consider its location at the centre of that pixel. When a pixel showing thermal anomaly falls in the junction of two or more adjacent range or beat boundaries; in those scenarios, the fire alert is disseminated to all the concerned persons of the said adjacent ranges and respective beats.
vii. Satellite detects any active fire irrespective of its source. Filtration of forest fire is done at FSI. **In some cases, fires in industries or agricultural land lying very close to forest area or falling under the RFA boundaries of states are sometimes considered as Forest Fires.** Although utmost care is taken to mask out such industrial fires to avoid any false alarm, still sometimes, such fires are disseminated as forest fires.

Therefore, it is highly recommended to use the FSI forest fire alerts for strategic purposes and not to rely on these for tactical firefighting purposes fully. Other sources of forest fire detection such as observations from watchtowers, ground based sensors, local information etc, wherever they are available, should be integrated and correlated for forest fire detection.

5.2 Early warning alerts for Forest Fire

Forest fires are difficult to predict in advance, as almost all fires are caused by people in our country, unlike the case in many Western countries for example Canada where only 60% of forest fires are manmade and the rest are caused by natural factors. Forest fires can thrive only when sufficient fuel is available and weather conditions are suitable for its initiation and spread. Accordingly, countries such as USA, Australia and Canada have Fire Danger Rating Systems (FDRS) in place to provide accurate advance warning of fires to foresters and communities based on current weather and fuel information. The experience of countries such as Indonesia, Croatia, indicate that straightaway adoption of FDR from another country without customization to local conditions can lead to failures.

Therefore, Forest Survey of India, with years of experience with the repository of fire related data, developed in 2016, an indigenous **"Early Warning Alert System for Forest Fire"**. The alerts to State Forest departments are based on parameters like Forest Cover, Forest Type, Climatic Variables (Temperature and Rainfall) and

recent fire incidences over the area. The GIS layers of these parameters are overlaid and intersect areas above threshold values are chosen and communicated as pre warning forest fire alerts in the form of KML files through email to the nodal officer of the State Forest Departments. These alerts which are generated based on short term weather variables, are valid for the ensuing week. This process was further refined in 2017 wherein, small areas which are vulnerable to fires were also alerted.

In the year 2017, the analysis was shifted to a grid based system (5km x 5km) allowing parameters to be quantified and represented within these grids. Certain additional parameters were also included to make the **"Early Warning Alert System for Forest Fire"** more robust.

The parameters currently used in the Pre Warning System are as follows:

1. Forest Cover Density Classes
2. Forest Type Groups
3. Daily Relative Humidity
4. Daily Maximum Temperature
5. Rainfall (Both of recent past and forecast)
6. Fire Alert database (2004 to 2016)

Forest cover density and Forest Type indirectly denote availability and type of fuel load respectively. Daily Maximum Temperature and corresponding Relative Humidity from Meteorological and Oceanographic Satellite Data Archival Centre (MOSDAC) was used to denote the moisture content of fuel and prevalent drought conditions over the area. Rainfall data of the previous 7 days obtained from Customized Rainfall Information System (CRIS) of India Meteorological Department (IMD) and Short term Rainfall forecast from Indian Institute of Tropical Meteorology (IITM), Pune was used to mask out areas receiving adequate rainfall so that such grids are not alerted.

A schematic diagram depicting the methodology adopted in generating Early warning Alerts is given below Fig. 11.

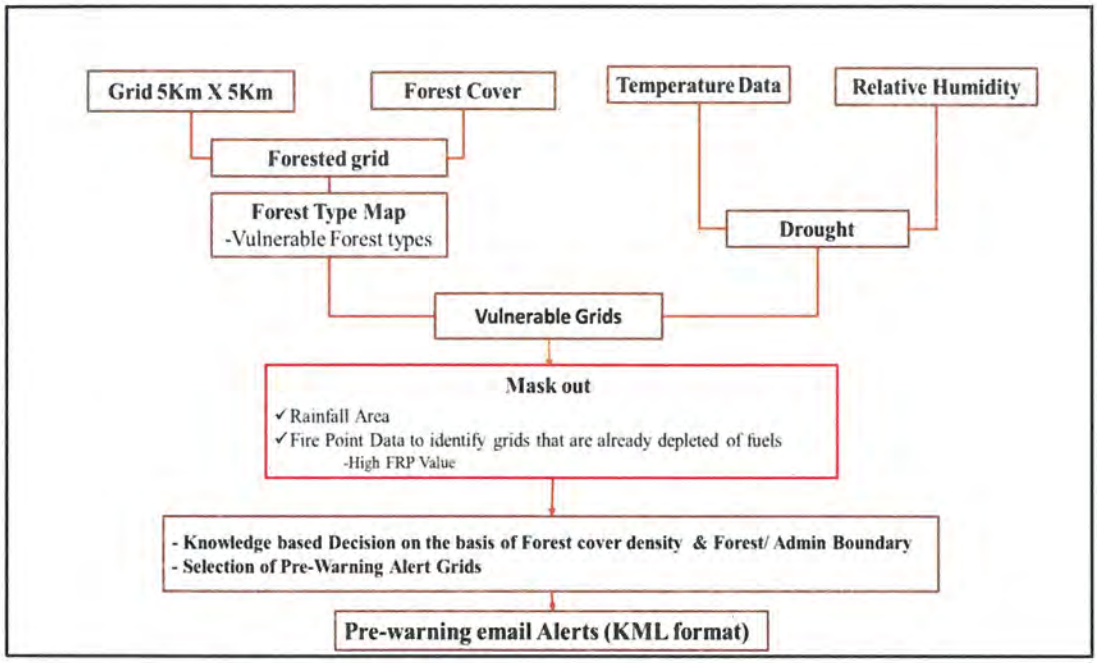

Fig. 11 Schematic diagram depicting Pre Forest Fire Early Warning Alert

Inclusion of more parameters such as slope, aspect soil type etc. and integrating with near real time weather databases of IMD and IITM are also envisaged to develop indices to accurately indicate the fuel characteristics, fire behavior, improve pre-warning and reduce processing time in the near future. As drought is an important factor to be considered while generating pre-warning alerts, it is envisaged to evaluate and integrate a suitable drought index. Keeping this in mind, FSI attempted to use **Keetch–Byram Drought Index (KDBI)** which has been tested in 25x25 sq. km grid in Dehradun, Uttarakhand.

The results of KBDI calculated for the pilot area of 625 square km near Dehradun showed that the KBDI index drops to its minimum value around week 10th to 12th (Mid-March) every year due to winter rainfall after which this starts to rise rapidly. The value of KBDI around week 10th to 12th (Mid-March) when it is minimum, varies from year to year. For example, this was below 100 in 2014 while it had already crossed 600 in 2016, which co-relates with the severe fire season observed in 2016. Forest fires are generally observed when the index crosses the value of 600. Therefore, KBDI can be used to forecast fire danger ten to twelve weeks in advance. This can enable the state forest department to plan for a severe fire season well in advance.

6. Closing Remarks

The Forest Fire Alert System software is indigenously developed by FSI. The Satellite Data Processing support is provided by NRSC, ISRO and the Satellite is provided by NASA.

Despite of coarser spatial resolution, the effectiveness in terms of Fire Detection and the Fire Alert Dissemination Algorithms are robust in nature.

7. Contact Information of FSI

For any queries, feedback or suggestions, the user may contact Centre for Forest Fire Studies, Forest Survey of India:

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or

write to us at forestfiremonitoring@gmail.com