DEVELOPMENT OF SATELLITE BASED NEAR REAL TIME CROP RESIDUE FIRE ALERT SYSTEM

R.S. Hooda[1], Nidhi Kundu[2] and Manoj Yadav[3]
[1]Haryana Space Applications Centre (HARSAC), CCS HAU Campus, Hisar-125004, Haryana, India
Email: hoodars@yahoo.com,
[2]Haryana Space Applications Centre (HARSAC), CCS HAU Campus, Hisar-125004, Haryana, India
Email: nidhi.ghanghas@gmail.com
[3]Haryana Space Applications Centre (HARSAC), CCS HAU Campus, Hisar-125004, Haryana, India
Email: manojyadav60@rediffmail.com

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ABSTRACT

Crop residue burning in both rabi (winter) and kharif (summer) seasons has emerged as a menace in the agricultural states of Haryana and Punjab causing severe environmental problems. Though Haryana Government has made it a punishable offence, yet the conviction is very poor, for want of timely information. The paper describes the development of satellite based Real Time Crop Residue Fire Alert System to provide real time crop fire information to the enforcement agencies. Data available from MODIS and Suomi satellites of USA through NRSC, ISRO, Hyderabad have been used to identify Active Fire Points on daily basis. Though it is a course resolution data, yet because of its daily repeat cycle it can indicate major fire points on daily basis. During the rice and wheat season of 2016-17 Active Crop Residue Fire Locations were observed in all the major crop growing districts of the state of Haryana during the harvesting period of each crop. During the rice and wheat harvesting season 2016-17, 12900 and 4300 major crop residue fire points, respectively were observed in the major crop growing districts of the state, clearly indicating that the menace is much more severe in rice crop (summer or kharif season) compared to wheat (winter or rabi season). This because of the fact that contrary to wheat straw, the rice straw is not palatable to the cattle and hence mostly set ablaze by farmers. The crop fire locations being received through the satellite on daily basis were sent directly to enforcement officials through SMS alert so as to initiate immediate action through an android based 'Crop Residue Fire Alert System'. The SMS alert directs to a link which opens the crop fire map indicating the fire locations for the day. By clicking at the location, it will indicate the name of the village and latitude and longitudes of the crop fire point to enable the enforcement agencies to locate the fire point on the ground.

1. INTRODUCTION

Crop residue burning is commonly practiced in the Indian part of the Indo-Gangetic Plains (IGP)–Indus (Punjab, Haryana) and Gangetic Plains (Uttar Pradesh, Bihar and West Bengal), primarily to clear the waste/residue after harvesting and for preparing the field for the next cropping cycle in a short time. The predominant cropping system in this region is rice–wheat rotation, accounting for about 10 million hectare (Ladha et. al., 2000 & 2003). Due to scarcity of labour, the farmers opt for mechanized combine harvesting technologies and easy way out of burning the crop residue in the field for preparing the field for the next cropping cycle in a short time. Crop residue burning in

both rabi and kharif seasons has emerged as a menace in the agricultural states causing server environmental problems. Punjab and Haryana are considered as the rice and wheat bowl of India and are also accountable for the highest crop residue burning in the country. Apart from the local air pollution effects, stubble burning in the two states is also believed to contribute to the photochemical smog in the IGP, especially in the Indian capital city New Delhi. In Haryana state the area under rice has increased from 2.0 lac ha. in 1966-67 to 13.54 lac ha. in 2016-17 and area under wheat from 10.0 lac ha to 25.76 lac ha. during the same period. Burning of crop residue leaves black coloration of the field which can be picked up and assessed by remote sensing. Such attempt has been made for Punjab using course resolution AWiFS satellite data for the year 2005 (Badrinath et.al., 2006). However, they have used a single date satellite data for both the seasons. Techniques of Remote sensing (RS) based crop discrimination and area estimation including single date approach based on maximum likelihood classification as well as hierarchical classification has been developed in India (Dadhwal et, al., 2002). As residue burning and ploughing the fields is a gradual process, all burning areas may not be picked up in the single date imagery**.** Singh et. al., (2009) investigated the use of multi-sensor characteristics for the accurate assessment of crop residue burnt areas at regular interval for two districts of Punjab. Temporal LISS-III, LISS-IV, MODIS and AVHRR data of pre-burning and post burning stages have been used in the quantitative estimation of burnt areas (Singh et. al., 2009). The multi-temporal image difference technique using three different indices (NDVI, NBR and GEMI3) were used to identify crop stubble burnt areas. Moderate resolution LISS-III data was found to be useful for accurate estimation of burnt surface. Crop residue discrimination over agricultural fields of Moga and Naraingarh areas of Punjab state of India was attempted by Singh et. al., (2013) using ground- based hyper spectral data. Area estimation of burnt paddy stubbles for major paddy growing districts of Haryana was attempted by Yadav et. al., (2014 & 2014) using multi-date AWiFS sensor data of Indian satellites. Yadav et. al. (2014) attempted estimation of wheat and rice residue burning area in major districts of Haryana. The information is useful to map and monitor the area under the residue burning but not useful for taking immediate action due to non availability of near real time information of the location where residue was set ablaze.

National Remote Sensing Centre (NRSC), Hyderabad is providing the information through Bhuvan Portal on active crop residue burning locations (Map and location coordinates) using NPP-VIIRS satellite data (spatial resolution of 375 and 750 m) which acquire the data 3-4 time is a day (24 hrs.).VIIRS is a successor to MODIS satellite in the earth observation era and has been providing data on active fire locations globally apart from other data for land, ocean and atmospheric applications since 2011.

The present study was attempted to develop satellite data based Near Real Time Crop Residue Fire Alert System to provide near real time crop fire information to the enforcement agencies. Data available through Bhuvan Portal of NRSC, ISRO, Hyderabad have been used to identify Active Fire Points on daily basis. The crop residue fire locations being received through the satellite on daily basis were sent directly to enforcement officials through SMS alert so as to initiate immediate action through an 'Crop Residue Fire Alert System'. The SMS alert directs to a link which opens the crop fire map indicating the fire locations for the day. By clicking at the location, it will indicate the name of the village and latitude and longitudes of the crop fire point to enable the enforcement agencies to locate the fire point on the ground.

2. MATERIALS AND METHODS

2.1 STUDY AREA

Haryana is a small north Indian state composed of mainly plain area lying between Ghaggar and Yamuna Rivers situated between 27º29' to 30º56' N latitudes and 74º27' to 77º36' E longitudes, covering an area of about 44212 sq. km **.** It occupies 1.35% of the total area of the country having seventeenth position in area as compared with other states and Union Territories. About 85% area of state the state is under agriculture. The average annual rainfall varies between 350 mm in south western districts to about 1000 mm in northern districts. Wheat is the dominating/major crop during rabi season and Rice is the dominating/major crop during Kharif season. During the Kharif season 10 major paddy growing districts of state including Ambala, Yamunanagar, Kaithal, Kurukshetra, Jind, Karnal, Panipat, Sonipat, Fatehabad and Sirsa as depicted in Figure1 have been included in the study while during the Rabi season 12 major Wheat growing districts viz. Kurukshetra, Kaithal, Jind, Karnal, Panipat, Sonipat, Jhajjar, Bhiwani, Hisar, Fatehabad and Sirsa districts as shown in Figure 2 have been included.

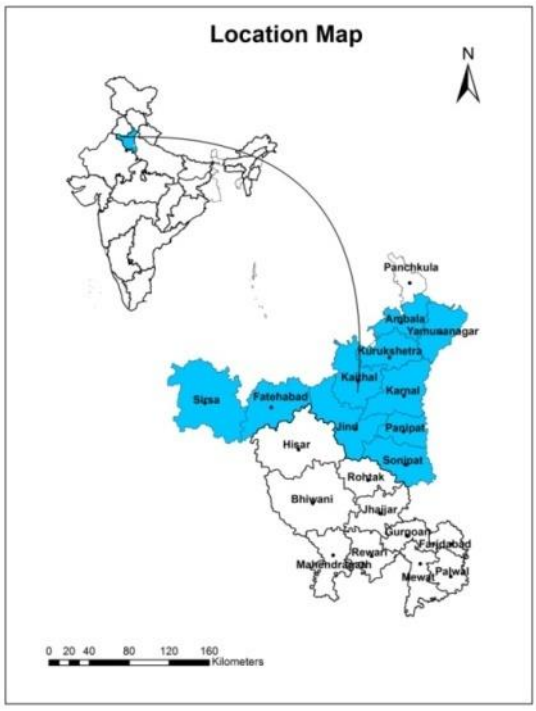

Figure 1: Study districts of Haryana during Kharif Season

Figure 2: Study districts of Haryana during Rabi Season

2.2 Data Used

For the present study, however, VIIRS 375 m active fire products available at the National Aeronautics and Space Administration (NASA) – 'Level 1 and Atmosphere Archive and Distribution System' (LAADS) Web were used. The data of India was made available through Bhuvan Portal of ISRO.

2.3 Services and Software Used

Google API, ArcMap, MS Access, My Map

2.4 Methodology

Information on active fire locations and relevant attributes from VIIRS sensors for the study area was transformed to point shape files and subsequently masked for agriculture sector alone using a spatial layer of total cropped area

from a standard land-use/land-cover reference map for further analysis. Data available from MODIS and Suomi satellites of USA through NRSC, ISRO, Hyderabad have been used to identify Active Fire Points on daily basis.

The excel sheets available at Bhuvan Haryana portal are downloaded. The excel sheet are having District Names, Latitude and Longitude location of the active fire. This data required some processing before publishing. Based on the requirements database was generated having village names and block names. Using Arc Map village name and Block names were added to data downloaded by Bhuvan, Haryana. An account was created on Google to use the My Map service with Google API. Using the drive the excel data was imported to Google. A link was created to share with everyone on net. Based on the web application SMS was sent to a group created in SMS gateway on a daily basis.

Crop fire Alert system was developed based upon the idea of utilizing the API's available freely for a Google account. For publishing the maps Google Drive was used. From Google API, sharing options were set in a manner that everyone on net will be able to view the link for maps depicting the active fire locations. Any changes that were made to sharing settings in drive are automatically reflected in My Maps due to the API provided by Google. Figure 3 describes the methodology of system developed.

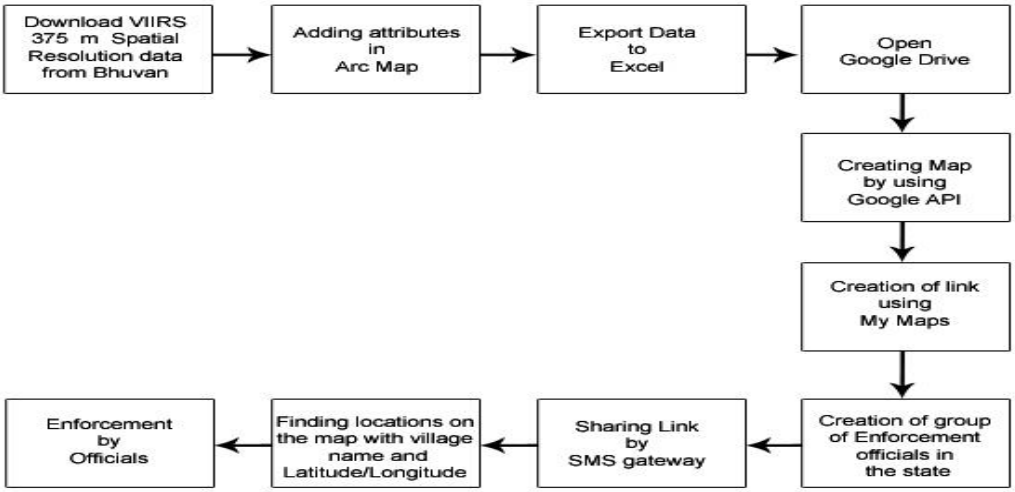

Figure 3: Methodology Flowchart

Sharing option in the Google drive had two options, sharing with email ids and sharing link with everyone. To provide information at field level in a mobile friendly manner a link was created and shared to everyone. Only requirement in this Fire Alert System is to purchase a SMS gateway service.

3. RESULTS AND DISCUSSIONS

The burnt area assessment assumes importance in terms of local, national and global relevance. During the rice and wheat harvesting season 2016-17 Active Crop Fire Locations were observed in during the harvesting period of rice (10 districts) and wheat (12 districts) as depicted in Figure 4 and 7. During the rice and wheat harvesting season 2016-17, 12900 and 4300 major crop residue fire points, respectively, were observed in the major crop growing districts of the state, clearly indicating that the menace is much more severe in rice crop (summer or kharif season) compared to wheat (winter or rabi season). This is because of the fact that contrary to wheat straw, the rice straw is not palatable to the cattle and hence mostly set ablaze by farmers.

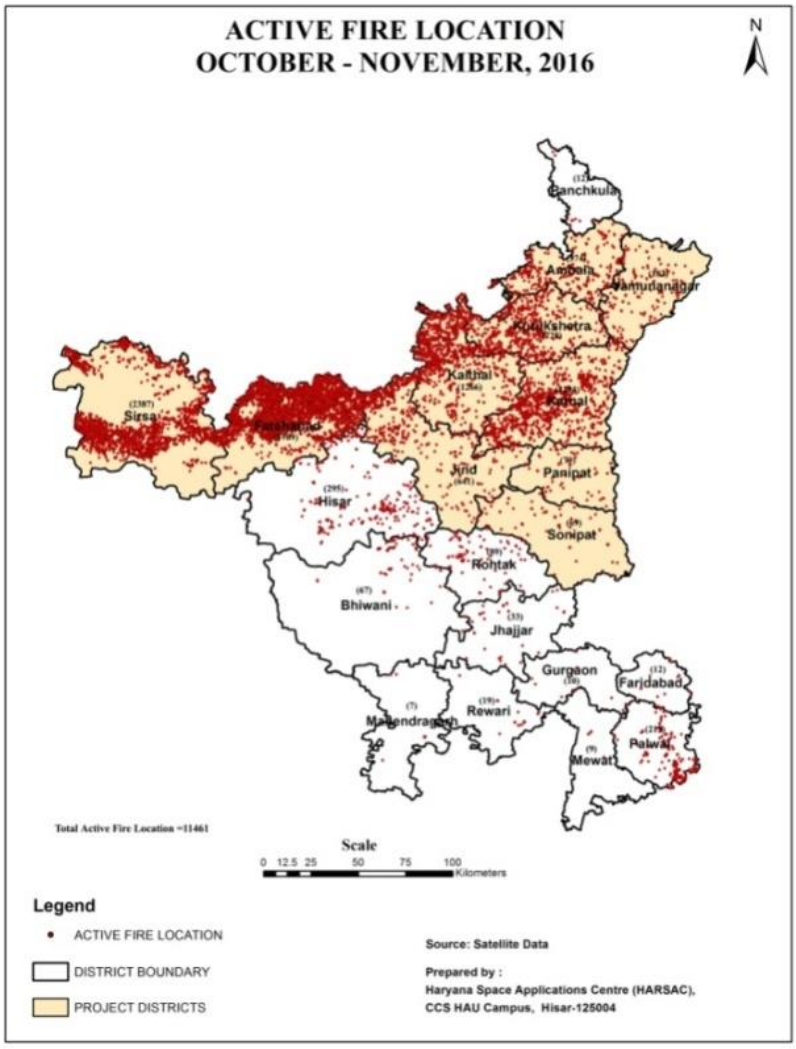

Figure 4: Rice Active Fire Location 2016

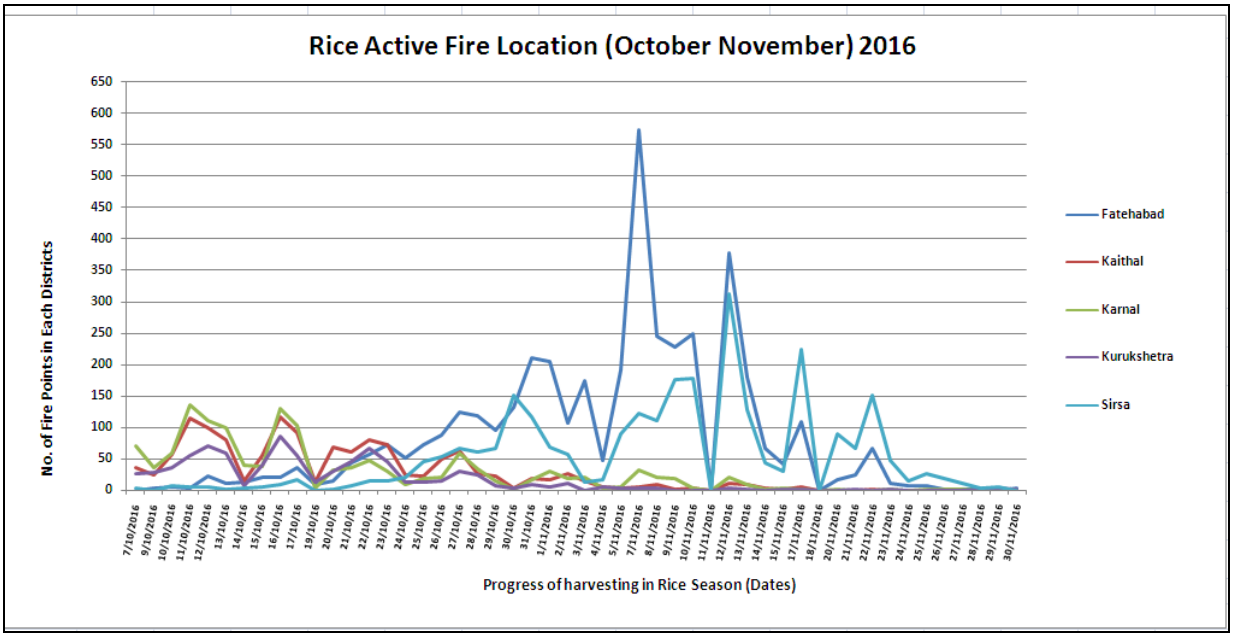

Figure 5: Trend for fire location in major districts during paddy harvesting season.

The crop fire locations being received through the satellite on daily basis were sent directly to enforcement officials through SMS alert through an android based 'Crop Residue Fire Alert System' so as to initiate immediate action. The SMS alert directs to a link which opens the crop fire map indicating the fire locations for the day. By clicking at the location, it will indicate the name of the village and latitude and longitudes of the crop fire point to enable the enforcement agencies to locate the fire point on the ground. Snap shots of the Active Fire Alert System are provided in Figure 6. Date wise active fire locations on Google maps are provided to enforcement officials for necessary action.

During the paddy season, major fires were observed in the northern districts of Karnal, Kurukshetra and Kaithal at the beginning of harvesting season i.e October month which slowly shifted to western districts of Fatehabad and Sirsa during late harvesting season (November month). Maximum number of 4178 crop fire active points were recorded in Fatehabad district, while least number of 82 fire points were observed in Panipat district for Rice crop. The number of fire points in the state started increasing from the second week of October, reached to a maximum during November and then started decreasing again. Maximum number of 587 crop fire active points was recorded in Karnal district, while least number of 125 fire points were observed in Bhiwani district for wheat crop. The number of fire points in the state started increasing from April, reached to a maximum during May and then started decreasing again. Trend of crop fire locations in major districts during paddy and wheat season is depicted in figures 5 and 8, respectively.

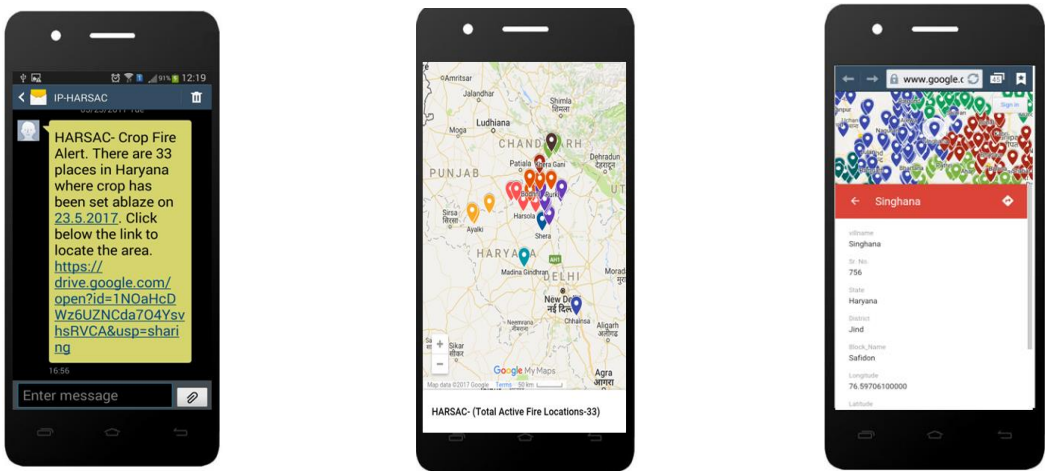

Figure 6: Active Fire Alert System

4. CONCLUSIONS

Satellite images of fire incidents will help authorities in Haryana to tackle stubble burning in the state, putting a check on the banned practice that causes air pollution and adversely affects human health. Near real-time fire alert system was developed for District administration for prompt action. The availability of information on active fire location will result in the development of better enforcement action. Google My Maps API is relatively an easy solution for those who require an immediate solution for providing alerts about geographic location of an event in real time without using lengthy programming. For GIS users' location plays very important role. The active fire Alert system is the easiest solution that could be used by GIS analyst .The Fire Alert system web application is developed using all the free resources available on Google. The application is capable of working without specific domain name. With help of application it is possible to provide location of an event occurring to any number of

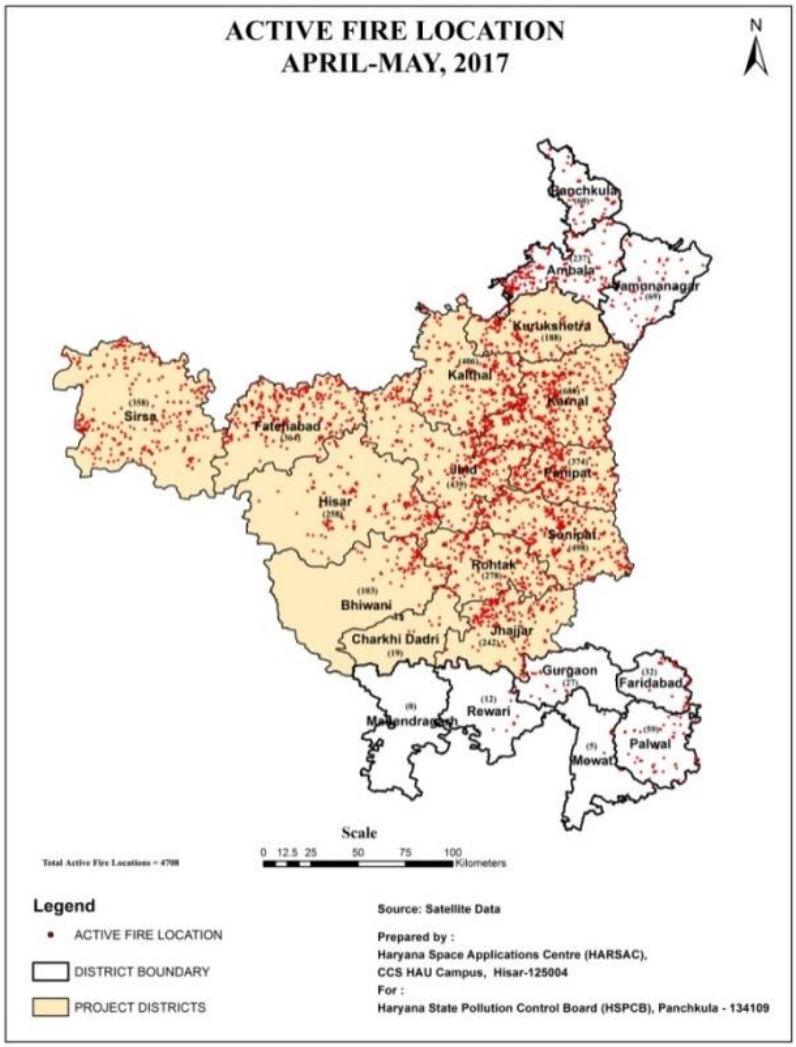

Figure 7: Wheat Active Fire Location 2017

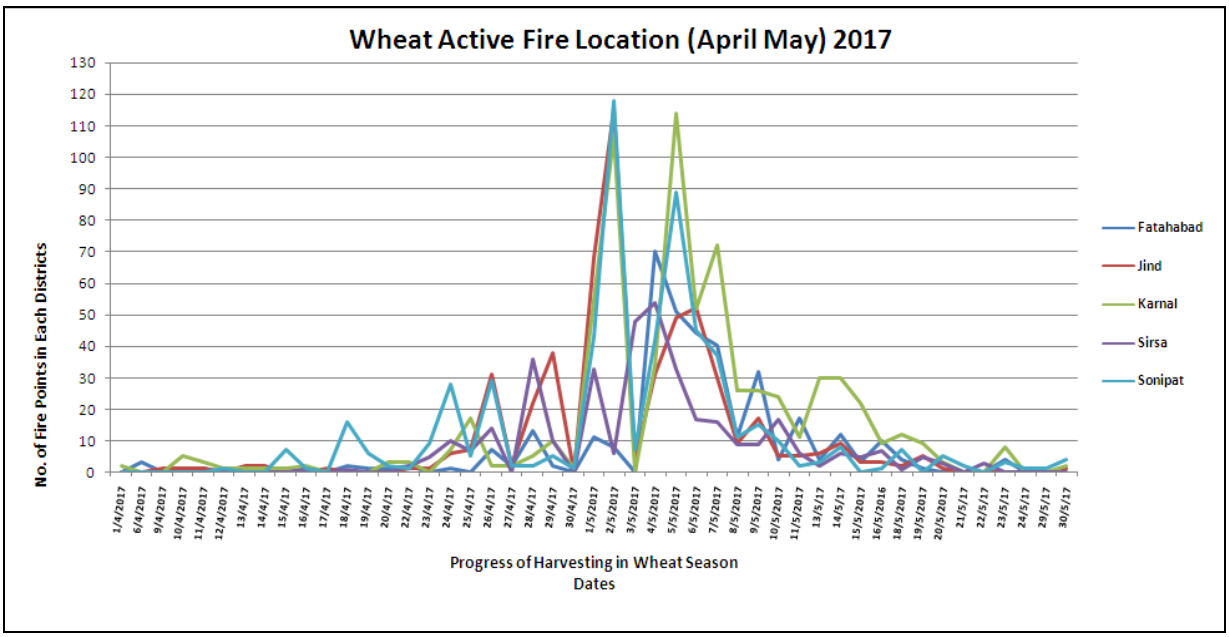

Figure 8: Trend for fire location in major districts during wheat harvesting season.

persons in almost seconds if you have geographical location. In case of disasters, it could be extremely helpful to provide a real time solution to various hazards based upon satellite data /digitized locations as exact information is the first requirement. Using Google API has some restrictions for accessing the web applications.

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