Assessment of forest fire false alarms In MODIS based data from Web Fire Mapper- A study in Indian Context

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Abstract

Forest fires have been a major natural disaster resulting in considerable loss of biodiversity and environmental degradation in India. From 2001, efforts were initiated in India for development of near-real time monitoring of forests fire and establishment of a forest fire information system at national level. With the availability of MODIS data on active fire locations through Web Fire Mapper, a unique methodology was developed in 2004 for near real time detection of forest fire in forest cover areas of the country. Information on active fire locations in India is being collected on almost daily basis and the coordinates of the fire points are geo-referenced and re-projected using GIS (Geographic Information System) software. These points are then overlayed on the forest cover map of the country prepared by the Forest Survey of India through interpretation of high resolution satellite data. The points falling within forest cover are selected thereby removing false alarms and then attribute information like map-sheet reference number, name of the state/district etc are linked to each point. False alarms are also removed based on the attribute data like brightness value and confidence level. The information is then disseminated to the concerned State Forest Department for verification and taking timely remedial measures. In a study conducted with data for fire season 2005 (February to June), it was found that Web Fire Mapper data in context of India has false forest fire alarms as high as about 50%. Highest numbers of false alarms were detected in March and April 2005. Highest percent of false alarms were noticed in the months of May and June when percent value of false alarms were found more than 80% particularly in May. Further study is being done on on data for fire season of 2006.

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Introduction

Forest fire is a major natural disaster having ecological and socio-economic consequences resulting in considerable losses including loss of timber, bio-diversity, wildlife habitat, wood and other forest products, damage to water and other natural resources, loss of natural regeneration etc. Bahuguna (2002) estimated that average annual loss due to forest fires in country is about Rs. 440 crore (US$ 100 millions).Therefore, forest fire control and management is an important aspect of management of forests. During fire season, appropriate steps like preparation of fire lines, construction of watch towers, engagement of fire watchers, involvement of local communities in forest fire combat etc are taken by the State Forest departments. However, not many efforts are made in activities like development of early warning system and fire risk zonation, early detection of fire, monitoring fire etc. Development of fire information system at national has started in recent years only while such at state level efforts are yet to begin. Effective forest fire control measures become difficult in India due to lack of timely information on forest fire occurrence.

Forest Survey of India (FSI), an organization under Ministry of Environment & Forests, Government of India, has taken a few initiativesin collecting as well as generating important information on forest fire situation in India. In 1995, FSI estimated that 53.1% of India's forest area is affected by fire. Of this 8.9% forest area is subjected to frequent fire while 44.2% area by occasional fire. From 2002, FSI took up works related to development of forest fire risk zonation models. It is known that assessment of forest fire risk depends on a number of biotic and non biotic factors. Forest fires are strongly linked to weather and climate. Topography is also one of the main factors influencing the fire behaviour (Faannigan and Harrington, 1988; and Brown and Davis, 1973 and Artsybashev, 1983). Slope, aspect and elevation have a direct affect on the severity and extent of fire. (Brown and Davis 1973 and Artsybashev 1983). FSI developed forest fire risk zonation models of important district and protected area.

It then initiated action on early detection of forest fire using satellites from 2001 using satellite data. With the availability of web based spatial information on active fires through the Web Fire Mapper (http://maps.geog.umd.edu) which displays active fire locations based on MODIS Rapid Response System-collaboration between NASA Goddard Space Flight Centre (GFSC) and University of Maryland, USA, FSI developed a methodology using a GIS based approach to use this information to remove false alarms and isolate

Methodology-

The methodology involves following steps: fire points falling within forest cover. The information is then disseminated through fax/e-mail to the concerned State Forest Department for confirmation as well as remedial measures.

1. Acquisition of Data from the website:

The Web Fire Mapper (www.maps.geog.umd.edu) is approached through internet and South Asia region is selected to get information on India.

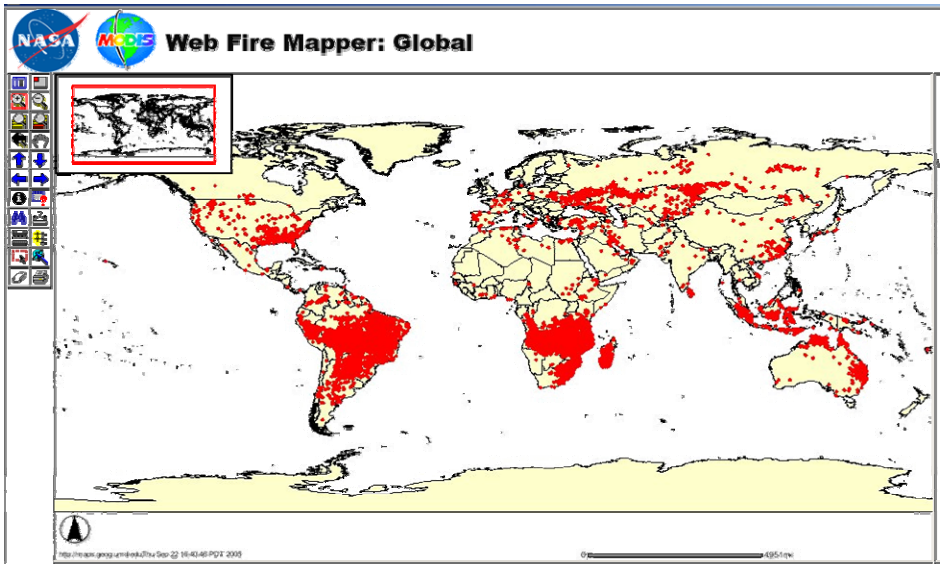

Fig. 1: Web Fire Mapper showing hot spots

The attribute information of active forest fire is collected from the website (Web Fire Mapper). Main attributes include geo-coordinates, temperature, confidence level etc.

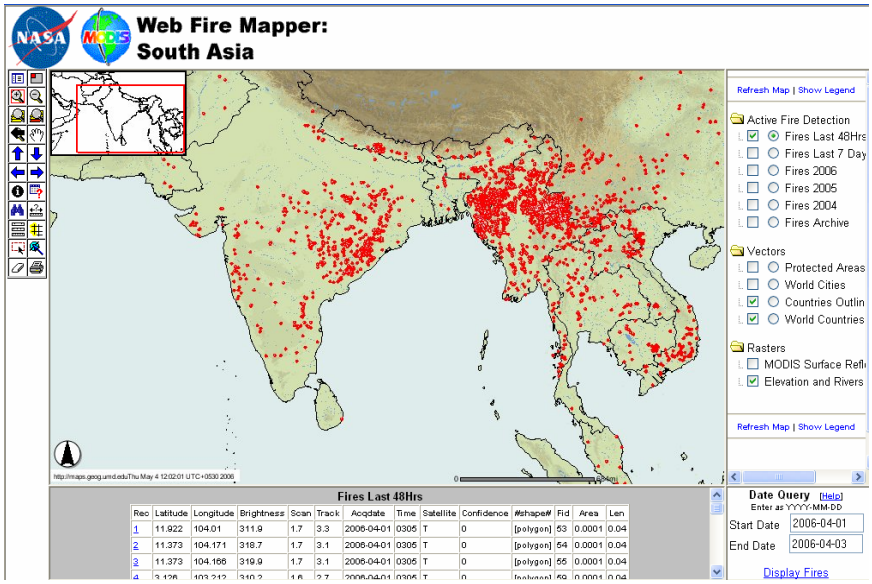

Fig. 2: ArcIMS viewer showing location and other information after point selection

2. Processing of the point Data

The points taken from the website are saved in the excel sheets. The points showing zero confidence limit and those having brightness value less than 45° C are removed from the database and the remaining are then converted into text (.txt) file. The txt file is converted into ASCII (American Standard Code for Information Interchange) format for further conversion into the arc coverage (point coverage) using Erdas Imagine 8.7 software.

3. Geometric correction

The point coverage so obtained is then geo-referenced into Geographic Lat\Long projection system (*Fig. 3*).

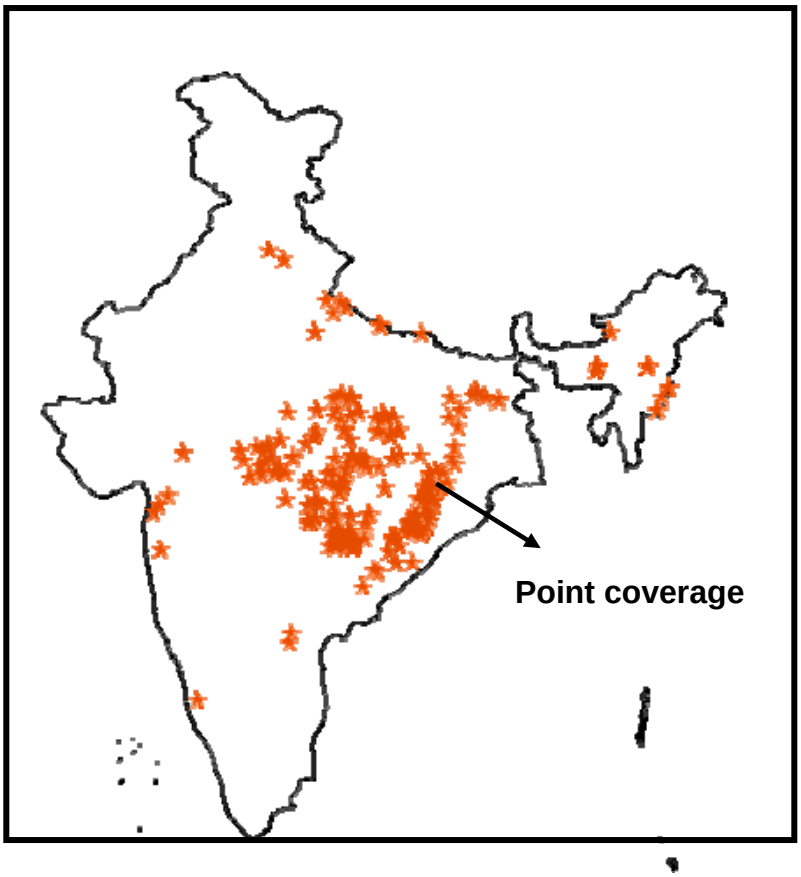

Fig. 3: Point coverage generated from .txt file

4. Joining of Attributes

The points are joined with other attributes such as state, district, and Survey of India (SOI) toposheet no. using Arc Info 8.2 Software. These points are overlaid on the forest cover map prepared by the FSI (*Fig. 4*). Points, which are not falling over the forested region, are removed and points that are falling on the forest are retained for further processing.

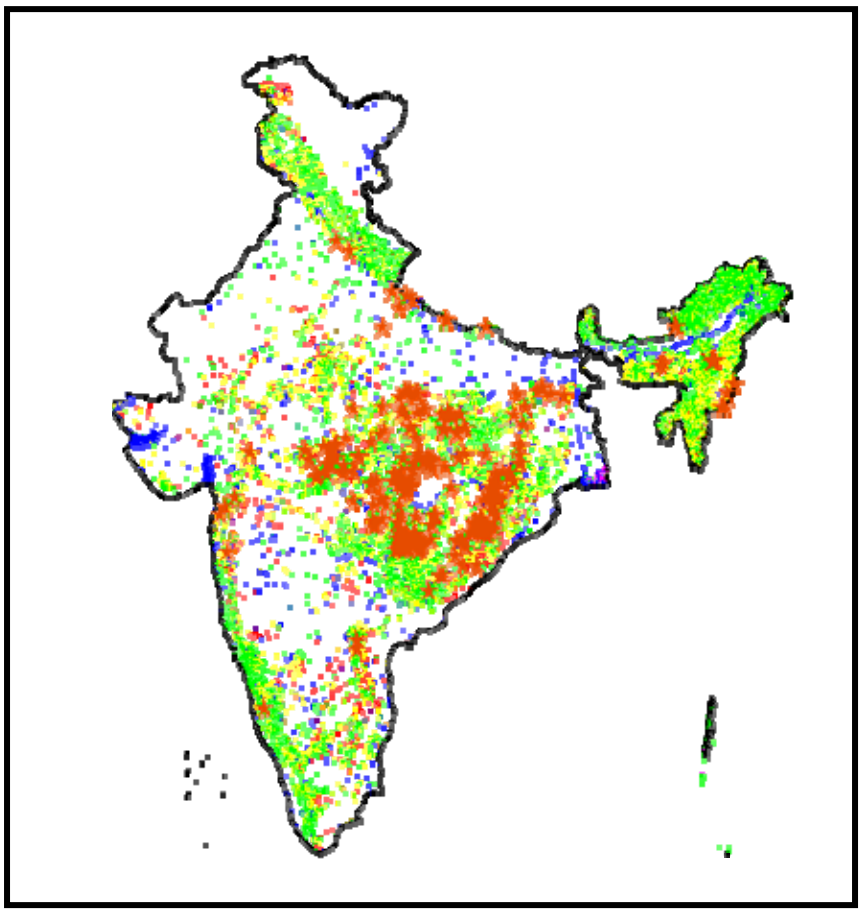

Fig. 4: Fire points over the forest cover map

5. Dissemination of information

Details of the points falling within the forest cover like date of occurrence, geo-coordinates, state, district, and SOI toposheet no. are transferred to the excel sheet. The information so generated is disseminated to the concerned State Forest Departments (SFDs) through FAX/e-mail for taking remedial measures. Flow chart of methodology is given in *Fig. 5*.

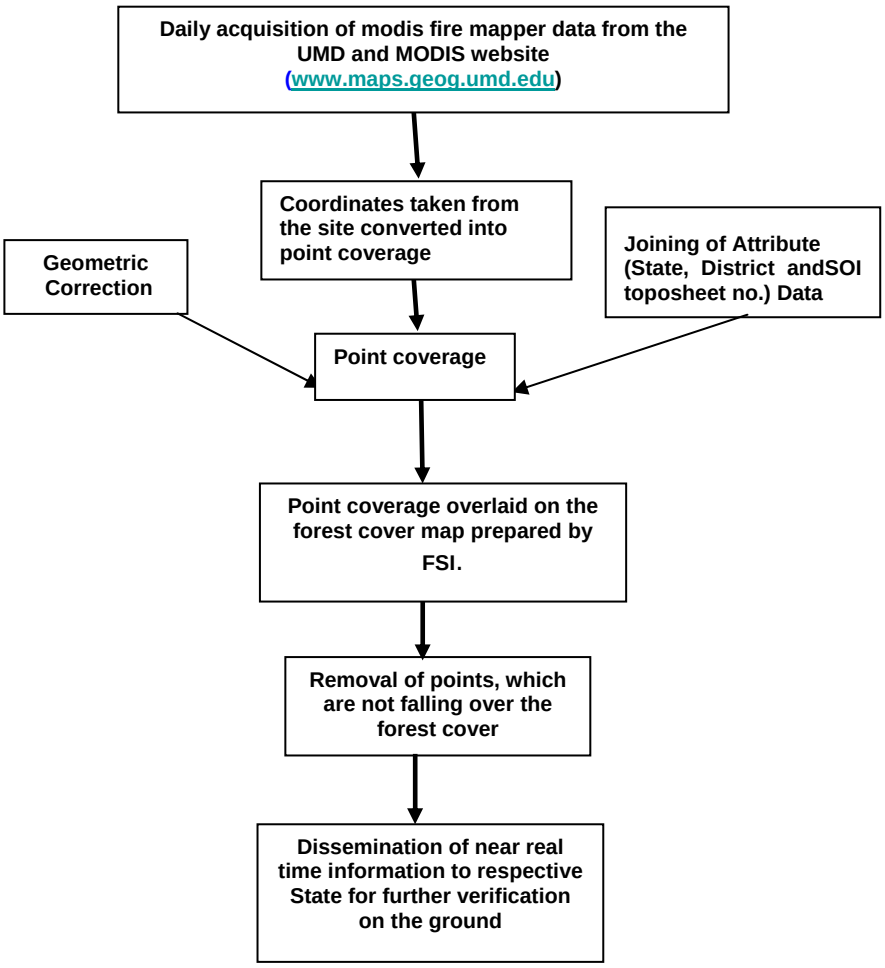

Fig.6: Flow Chart of Methodology

Results and Discussion:

Total forest fire alarms for the fire season of 2005 as recorded from the Web Fire Mappar (WFM) are given in *Table 1*. It shows State wise and also fortnightly data on active fire points. WFM reported as many as 13306 fire points during this period. Of this maximum points (about 70%) were reported in the period from 16th March to 15th April 2005. This is the season when slash burning is done in north eastern and some other parts of the country where shifting cultivation is practiced. States which are affected by shifting cultivation include north eastern states of Assam, Arunachal Pradesh, Manipur, Meghalaya Mizoram, Nagaland and Tripura, and parts of other states like Chhattisgarh, Madhya Pradesh and Orissa.

Table 1: *Fortnightly data* on active fire points in India as recorded from Web Fire Mapper in 2005*

States/Uts	16-28 Feb	16-31 March	1-15 April	16-31 April	16-31May	1-15 June	16-30 June	Total
A&N	0	0	0	0	0	0	7	7
Andhra Pradesh	513	175	148	0	58	0	32	926
Arunachal Pradesh	11	0	109	11	22	0	3	156
Assam	22	5	228	23	14	0	4	296
Bihar	19	2	76	25	2	0	3	127
Chhattisgarh	25	452	859	14	78	0	37	1465
Dadra & Nagar Haveli	1	0	1	0	0	0	0	2
Delhi	2	0	1	0	1	0	0	4
Goa	0	0	0	1	0	0	0	1
Gujarat	54	89	110	4	9	0	13	279
Harayana	4	1	61	0	264	23	0	353
Himachal Pradesh	3	0	4	0	34	0	0	41
Jammu & Kashmir	0	1	5	0	106	0	0	112
Jharkhand	23	41	120	16	32	0	19	251
Karnataka	221	103	49	0	15	0	7	395
Kerala	68	12	2	0	4	0	1	87
Madhya Pradesh	36	233	814	156	80	0	78	1397
Maharashtra	97	336	119	9	56	0	53	670
Manipur	11	4	215	10	1	0	0	241
Meghalaya	16	15	99	16	0	0	0	146
Mizoram	39	1437	284	1	5	0	0	1766
Nagaland	17	1	137	12	2	0	0	169
Orissa	115	522	801	34	63	0	40	1575
Punjab	0	2	49	0	1200	0	0	1251
Rajasthan	2	4	28	4	8	35	0	81
Tamilnadu	163	43	2	0	14	0	8	230
Tripura	14	228	88	0	0	0	0	330
Uttar Pradesh	51	74	335	79	74	1	52	666
Uttaranchal	9	4	49	0	61	92	6	221
West Bengal	27	21	7	4	1	0	1	61
Total	1563	3805	4800	419	2204	151	364	13306

* Due to technical reasons fire data of 1st fortnight of March and 2nd fortnight of May could not be recorded

Data of *Table 2* shows fire points which fall within the forest cover. These are obtained first by removing points having brightness value less than 45°C and confidence level less than 0% and then removing points falling outside forest cover layer of the respective area. In a ground verification done, it was found that the accuracy of these points were around 93%. Table 2 shows that the total number of active forest fires so worked out for the fire season 2005 was 6787. Of this maximum number were found in Mizoram, followed by Madhya Pradesh, Orissa and Chhattisgarh. It is also observed that maximum of fires are detected in the period from 16th March to 15th April 2005. It the period known for slash burning in shifting cultivation areas.

Table 2: *State-wise data on active fire points falling within forest cover during 2005*

State	16 - 28 Feb'05	16 – 31 Mar'05	1 – 15 Apr'05	16-30 Apr'/05	1 – 15 May'/05	1- 15 Jun'05	16- 30 Jun'/05	Total
Andhra Pradesh	482	89	59	4	13	3	0	650
Arunachal Pradesh	0	0	50	0	7	0	0	57
Assam	3	3	148	0	2	0	0	156
Bihar	9	1	43	6	1	0	0	60
Chhattisgarh	19	336	313	1	125	0	1	795
Dadra & Nagar Haveli	0	0	0	0	0	0	0	0
Delhi	0	0	0	0	0	0	0	0
Goa	0	0	0	0	1	0	0	1
Gujarat	20		51	1	4			76
Haryana	0	0	2		3		2	7
Himachal Pradesh	0	0	0	0	0	3	6	9
Jammu & Kashmir	0	0	0	0	0	16	13	39
Jharkhand	14	15	95	3	18	0	0	145
Karnataka		83	15	1	6			105
Kerala	42	0	0	0	0	0	0	42
Madhya Pradesh	16	183	551	46	72	1	4	873
Maharashtra	12	261	148	9	32	1		463
Manipur		4	113	62	0	0	0	179
Meghalaya	1	3	51	0	0	0	0	55
Mizoram	3	1098	341	58	0	0	0	1500
Nagaland	1	2	62	2	0	0	0	67
Orissa	238	0	513	2	65		1	819
Punjab	0	0	0	0	18	1	2	21
Rajasthan	1	3	7	2	0	0	0	13
Tamil Nadu	94	24	0	0	1	1	0	120
Tripura		201	123	0	0	0	0	324
Uttar Pradesh	1	5	21	9	4	1	2	43
Uttaranchal		1	17	3	13	35	70	139
West Bengal	26	0	2	0	1	0	0	29
Total	982	2312	2725	209	386	62	101	6787

Tables 3 and *4* show data on forest fire false alarms. These results show that approximately half of the total active forest fire points reported by WFM in 2005 were false. Seasonal and locational variations have also been noticed.

Table 3: *Fortnightly data on forest fire false alarms for the year 2005*

	16-28 Feb	16-31 March	1-15 April	16-31 April	16-31May	1-15 June	16-30 June	Total
Total Fire Points recorded	1563	3805	4799	419	2204	151	364	13305
False Alarms	581	1493	2074	210	1818	89	263	6518
False alarms (pct)	37.17	39.24	43.22	50.12	82.49	58.94	72.25	48.99

Maximum percent of false alarms were noticed in second fortnight of May and that too in states like Punjab, Harayana, Uttar Pradesh Rajasthan where maximum temperature frequently goes beyond 45° C. States showing 100% false alarms like Delhi, Goa, Dadra & Nagar Haveli etc very small sized states with a very insignificant forest cover. Interesting observation is found in case of Andaman & Nicobar Islands which is full of dense tropical rain forest and occurrence of forest fire was puzzling. In ground truthing it was found the fire points fall in Barren Island which is a volcano and it was active during that period. Part of this Island has good vegetation too.

Table 4: *State wise data on total fire points recorded, points within forest cover and percent false alarms*

States/Uts	Total No of Fire Points Recorded	Fire Points within Forest cover	False Alarms (pct)
A&N	7	0	100.00
Andhra Pradesh	926	650	29.81
Arunachal Pradesh	156	57	63.46
Assam	296	156	47.30
Bihar	127	60	52.76
Chhattisgarh	1465	795	45.73
Dadar & Nagar Haveli	2	0	100.00
Delhi	4	0	100.00
Goa	1	1	0.00
Gujarat	279	76	72.76
Harayana	353	7	98.02
Himachal Pradesh	41	9	78.05
Jammu & Kashmir	112	39	65.18
Jharkhand	251	145	42.23
Karnataka	395	105	73.42
Kerala	87	42	51.72
Madhya Pradesh	1397	873	37.51
Maharashtra	670	463	30.90
Manipur	241	179	25.73
Meghalaya	146	55	62.33
Mizoram	1766	1500	15.06
Nagaland	169	67	60.36
Orissa	1575	819	48.00
Punjab	1251	21	98.32
Rajasthan	81	13	83.95
Tamilnadu	230	120	47.83
Tripura	330	324	1.82
Uttar Pradesh	666	43	93.54
Uttaranchal	221	139	37.10
West Bengal	61	29	52.46
Total	13306	6787	48.99

It is intended to carry out the work further using date of fire season 2006 and the ground verification results for the same. The exercise may help developing appropriate algorithms for eliminating maximum false alarms and making the data more reliable for end users mostly the forest officers for taking remedial measures.

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