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ASSESSMENT OF INCREASING THREAT OF FOREST FIRES IN UTTARAKHAND, USING REMOTE SENSING AND GIS TECHNIQUES

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ABSTRACT
Forest fires in Uttrakhand have been regular and historic feature. Every year forest fires in Uttrakhand causes great loss to the forest ecosystem, diversity of flora and fauna and economic wealth. Forest fire is one of the major disasters in the forests of Uttarakhand. High temperatures with no atmospheric moisture were one of the important reason for forest fires in Uttrakhand. Remote sensing and GIS technology that has been used to detect forest fires and recent technology can send an early warning to prevent forest fires. Remote sensing has also been effectively used in the study monitoring, detection of forest fire and future planning. Thus the main aim of this study is the causes and where the forest fire takes place by preparing fire events density map on the bases of using Remote Sensing real time forest fire data from EOSDIS NASA and GIS techniques. The various parameters are taken in to account land use from BHUVN, forest type map, relief and slope. Later on to analyze the causes these aspects were compared with fire density map. Topography, slope and types of vegetation play important role in the spread of forest fire. Outcome of the study demonstrate that the proximity to inhabited places, dry climatic conditions and dry Chir pine forest cover are mainly responsible forest fire in the state. These types of studies are helpful to suggest preventive measures in different risk areas of Uttrakhand.

Keywords: Remote sensing and GIS technology, forest fires, detect forest fires techniques.

1. INTRODUCTION
Forest is one of the most important precious natural resource and play significant role in the human life and environment. Forests are socially and environmentally inter-linked with the people in the hilly areas and play important role in the economic welfare and development of the region.

Forest fire is one of the major disasters in the forests of Uttarakhand. These are many indigenous and endangered species which are adversely affected due to forest fires. Basically forest fires have been categorized into three types, ground fires, surface fire and crown fires. Ground fires are not easily predictable as it spread within rather than top of organic matter. It consumes organic matter like duff, musk or peat present beneath the surface litter of the forest floor. Second is surface fire characterized by the fast moving fire which consumes small vegetation and surface litter along with loss debris and third one is crown fire that burnt top trees or shrubs without any close link with surface fire. Current trend of increasing day by day rate of forest fire events in state, there is an urgent need to generate a geo-spatial fire events data base that help in planning, decision making measures. Remote sensing techniques and GIS techniques with satellite can contribute to a variety of natural resources applications. Technological development of satellite

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remotesensing is contribute to a batter cost-effective and real time solution for specifying the location of the fires, intensity of fire events and the extant of the burned area and thus useful for biodiversity conservation. Farther remote sensing data when combined with GIS and statistical models allow us to predict where and when forest fires will most likely occur. (Krishna, P. Hari and C. Sudhakar Reddy, 2012)

Remote sensing has opened up opportunities for qualitative as well as quantitative analysis of forests and other ecosystems at all geographical and spatial scale remote sensing has also been effectively used in the study monitoring and detection of forest fire. Forest fire very adversely effected animals not only by killing them but also by long term effects (Boer,1989) due to loss of fruit trees many animals and birds species are decline as they are dependent their food on these (Kinnarid and O' Brirn 1998).

In Himalaya region official methodology for fire loss assessment in resource based and mainly calculated on the bases of standardise economic norms fixed and timber destroyed by fires under different forest type. The environment loss is given least importance. The prescribed values of fire loss do not compensate the real wealth loss of the habitat, fire, fauna and various other microbiological and geo-hydrological cycles. The health ailments and other problems generated by fire fumes do receive due consideration is calculating fire loss.

Environmental factors are critically important in determining the severity of a fire season. In many forest ecosystems, reduced precipitation before and during the dry season can reduce fuel moisture and lower humidity near the surface, allowing fires to more easily escape from human control, and spread more rapidly over the landscape, He also explained that Low fuel moisture levels also make fires hotter, allow them to consume more fuel, and kill more of the trees inside the fire perimeter (James Randerson et.al).

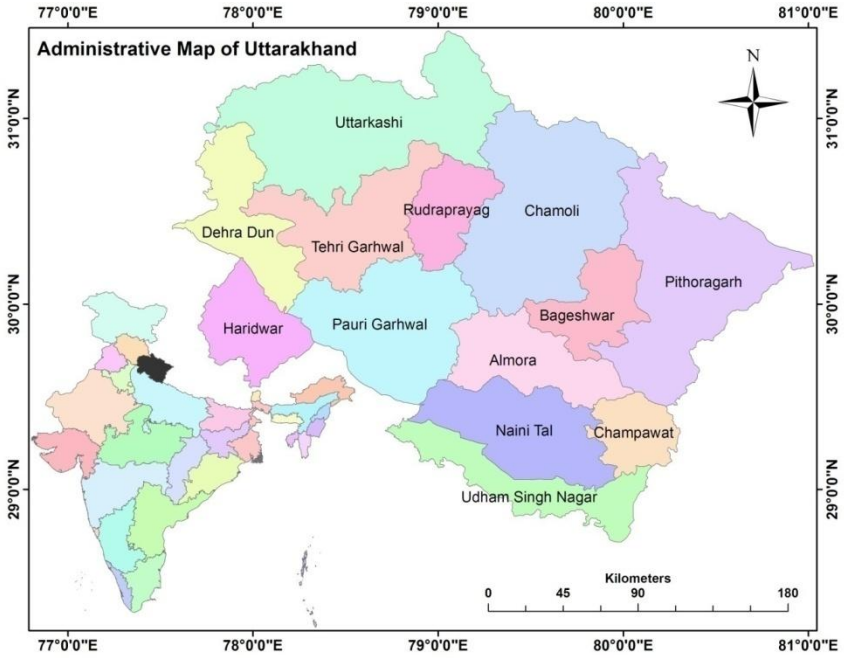

Fig. 1 Administrative Map of Uttarakhand

Study Area:

Uttarakhand is the 27th state of india occupy 53,483 km² geographical area, of which 86% is mountainous and 65% is covered by forest. Northern part of the state falls in Greater Himalayan range, covered by the high glaciated peaks, while the lower piedmont foothills are densely forested. The Himalayan ecosystem plays host to a large number of unique wild animals, plant species and rare herbs. Two of India's mightiest rivers, the Ganges and the Yamuna take emergence from the glaciers of Uttarakhand, and are fed by numerous permanent frozen glaciers and lakes in the region.

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Uttarakhand state has a variety of climate and vegetation with different elevation, from glaciers at the highest elevations to tropical forests at the lower elevations. The highest elevations are covered by ice, bare rocks and alpine meadows, dominated by various shrubs. Western part of Uttarakhand Himalaya covered by subalpine conifer forests lie just below the tree line at 3,000 to 2,600 metres elevation. In the transition belt of the region where broadleaf forests exists, which lie in a belt from 2,600 to 1,500 metres elevation and the Himalayan subtropical pine forests found blow to 1,500 metres elevation. The Terai, Savana, grasslands belt of Upper Gangetic Plains where moist deciduous forests are found along the Uttar Pradesh state border. This belt is locally known as Bhabar. These lowland forests have mostly been cleared for agriculture practices.

2. MATERIAL AND METHODOLOGY

For the basic material of this type of study, primarilyyear wise (1999 – 2015) and date wise (17 Feb to 13 May 2016)forest fire GPS points were collected from the Uttarakhand Forest Department website,(http://forest.uk.gov.in/contents/view/6/27/75-forest-fire-info)Getting Near Real Time Forest Fire Data (3 hrs.) from EOSDIS NASA site for South Asia (https://earthdata.nasa.gov/earth-observation-data/near-real-time/firms/active-fire-data). Land-use and Forest type Map were accessed form BHUVN (http://frienvis.nic.in/Content/Bhuvan-Thematic-Service_1812.aspx) and to interpret the causes of the forest fire. To analyse the forest fire sensitive areas in the state, forest fire density map were prepared in 10 sq. Km. pixel size grid of the state. Later on that density map were compared with Land-use &Land-cover and Forest type to find out the causes and how much area is affected from forest fire in the state. To prepare relief and slope Map ASTR DEM with 30m spatial resolution were used in this study.

3. RESULTS AND DISCUSSION

There is a strong occurrence of forest fires in the moderately dense forests and open forests as compared to very dense forest. The maximum occurrence of forest fire is in sub-tropical pine forests and tropical dry deciduous forests proximity to Tarai belt in Pauri, Nainital and Haridwar districts. Maximum incidents of forest fire happened in Pauri, Nainital and Chamoli that brunt the 950.75 ha., 483.96ha. and 454.45 ha. forest area of respective district. Proximity of the inhabited places to the forests in the area upholds that the forest fire is human induced disaster in the area. These results are based on the **NASA EOSDIS, ISRO** forest fire surveillance data and Uttarakhand Forest Department.

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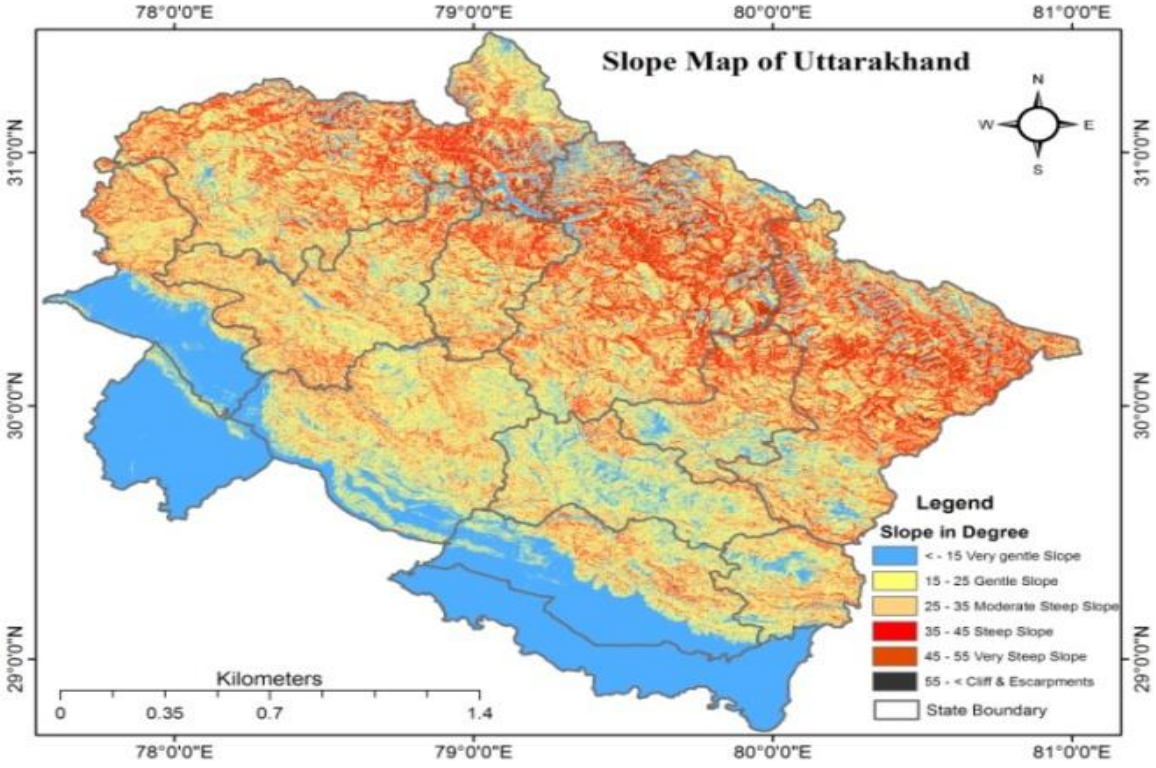

Fig. 2 Relief Map of Uttarakhand

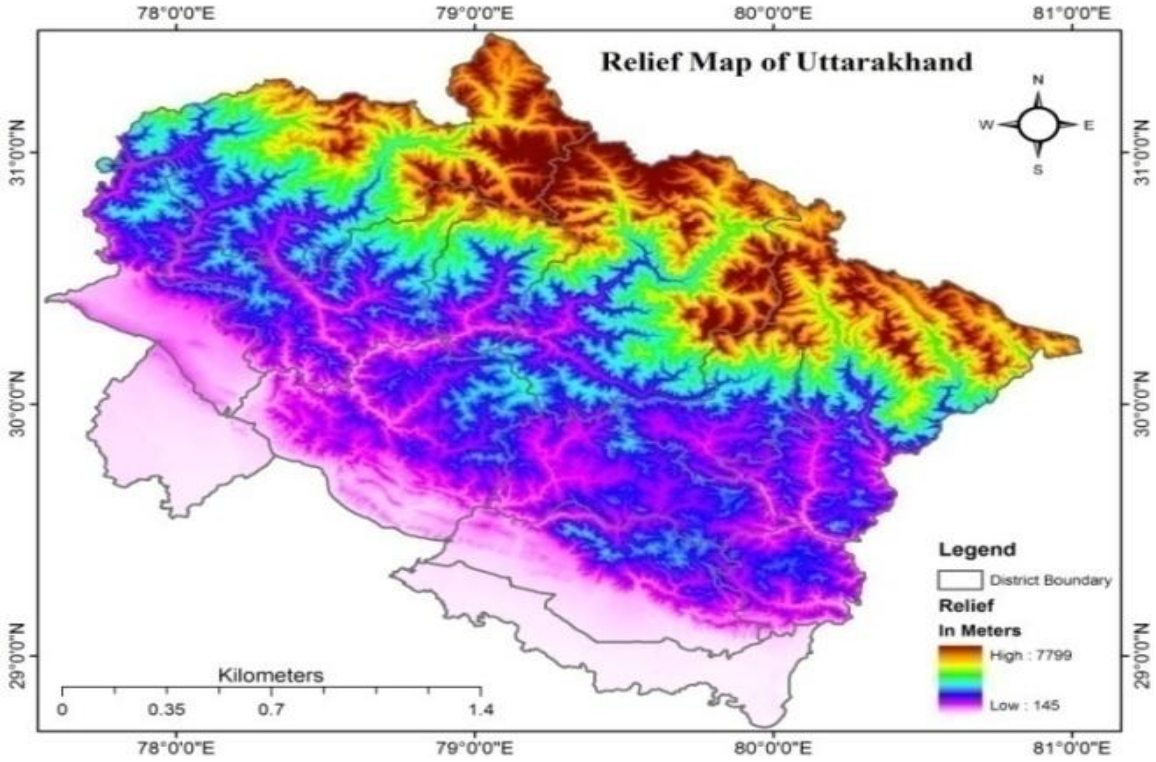

Fig. 3 Slop Map of Uttarakhand

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Various satellite images and sensors help us in identify the place where the forest fire take place in every three hours repetitive mode and through the NDVI assessed form many temporal multispectral images help in analysing the forest cover degradation due to fires. In Uttarakhand Himalaya forest situated between 300m and 200m. Above msl can be considered as fire prone. The region between 1000 and 1800 mt. above msl is mainly dominated by Chir Pine forest representing densely populated zone of the region. Chirpine is an exotic species of the Uttarakhand Himalaya. This species is so hostile that when it enters it replaces all other plants. Chir Pine is the dominating species in Uttarakhand.

The major forest fire season in the country varies from February to June. Reports have estimated that about 6.17% of Indian forests are subjected to severe fire damage annually. According to Ravi Chopra, an environmentalist and a former member of the National Ganga River Basin Authority (NGRBA), high temperatures with no atmospheric moisture were the major reason for this year's fires.

Forest officials and local people said most forest fire incidents were deliberate acts. The villagers tend to set grasslands on fire to get grass after the rains. If they set fire outside the fire lines, the fire from grasslands spreads to nearby forests. The sudden rise in temperature and the prolonged dry spell are also major the reasons for these forest fires. Most fire-related cases are found in the

Datewise Incidents of Fire in Uttarakhand, 2016

February		**March**		**April**		**May**	
Date	Incidents	Date	Incidents	Date	Incidents	Date	Incidents
17-Feb-16	8	2-Mar-16	10	7-Apr-16	2	7-May-16	6
18-Feb-16	14	8-Mar-16	49	9-Apr-16	45	8-May-16	3
19-Feb-16	5	9-Mar-16	15	11-Apr-16	56	9-May-16	15
22-Feb-16	7	10-Mar-16	19	12-Apr-16	38	10-May-16	3
24-Feb-16	8	11-Mar-16	8	13-Apr-16	65	11-May-16	4
28-Feb-16	28	15-Mar-16	23	14-Apr-16	296	12-May-16	6
		16-Mar-16	5	18-Apr-16	41	13-May-16	4
		18-Mar-16	21	20-Apr-16	28		
		28-Mar-16	43	22-Apr-16	44		
		29-Mar-16	47	23-Apr-16	27		
				24-Apr-16	210		
				25-Apr-16	174		
				26-Apr-16	140		
				27-Apr-16	338		

Shivalik range.

(Source: Uttarakhand Forest Department (NASA EOSDIS and ISRO)

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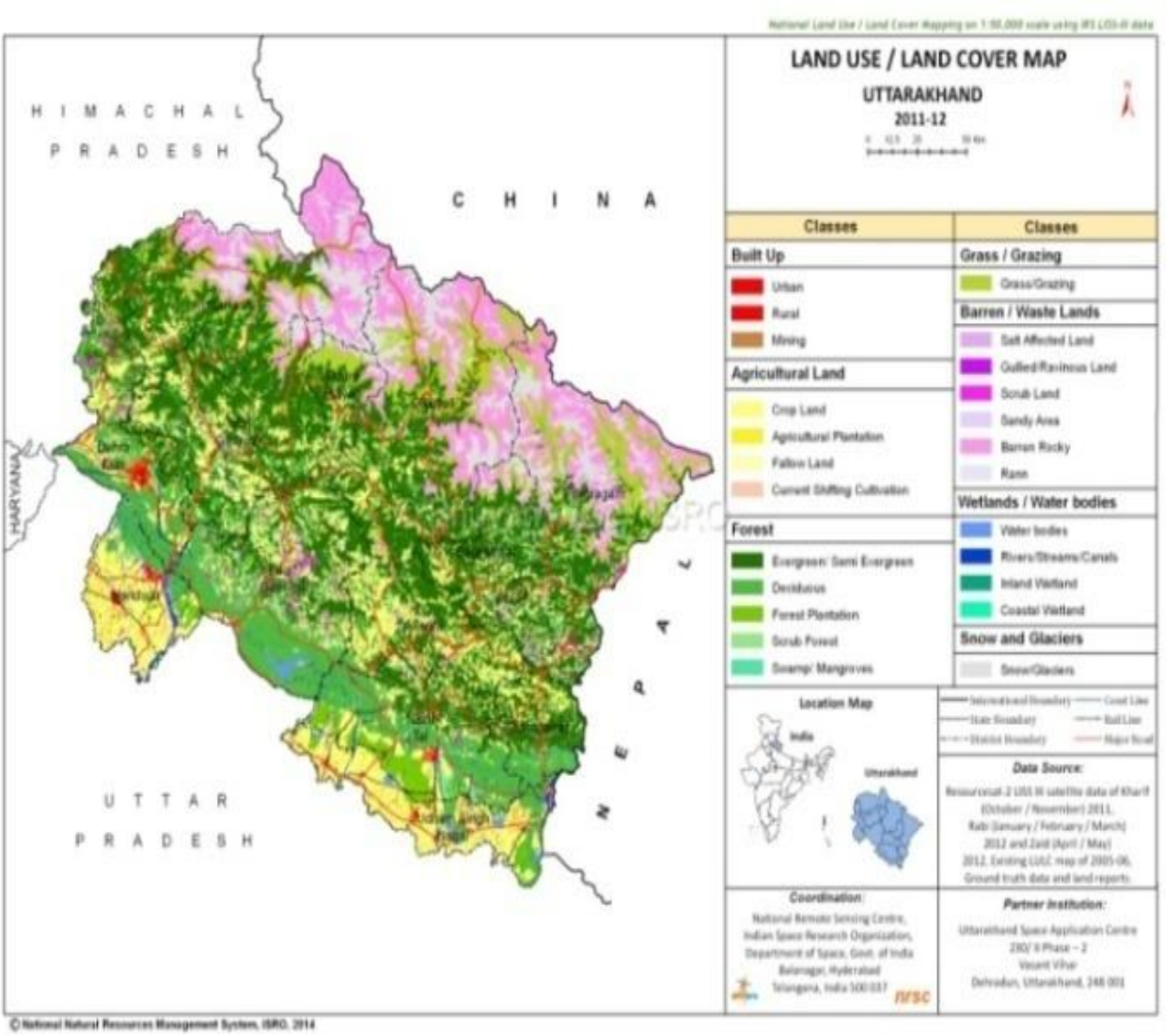
4. CAUSES OF FOREST FIRE IN UTTARAKHAND:

Dense and dry vegetation are more susceptible to forest fire drier the climate the more prone is site for fire. Aspect play one of the major roles in the spread for fire like southern slope which are more vulnerable region like topography influence the wind as a particular region like fire treeless more rapidly in up slope. The road play vital role in chance of fire and physical activities by man, animals or vehicle on the road can cause an unwanted fire. In settlement lots of human activities can causes fire in the proximity to settlement, which can spread forest fire and causes of lot of havoc in the area.



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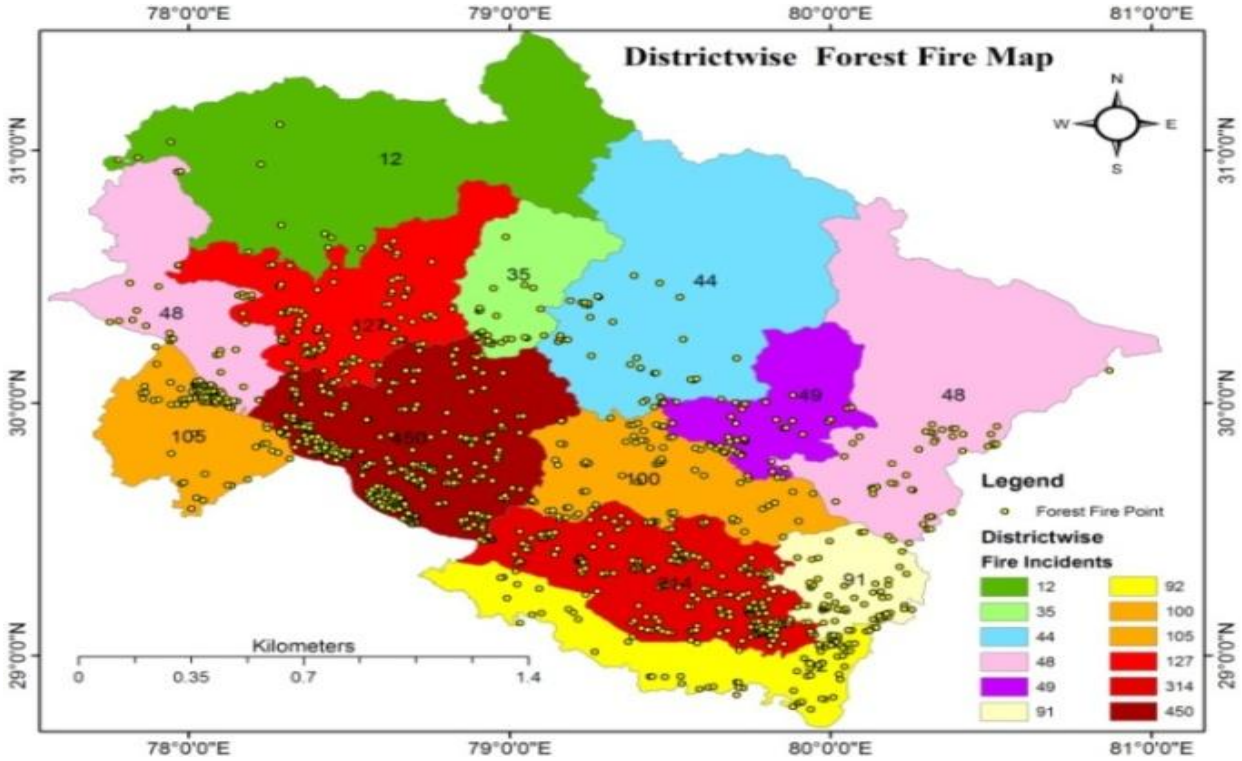

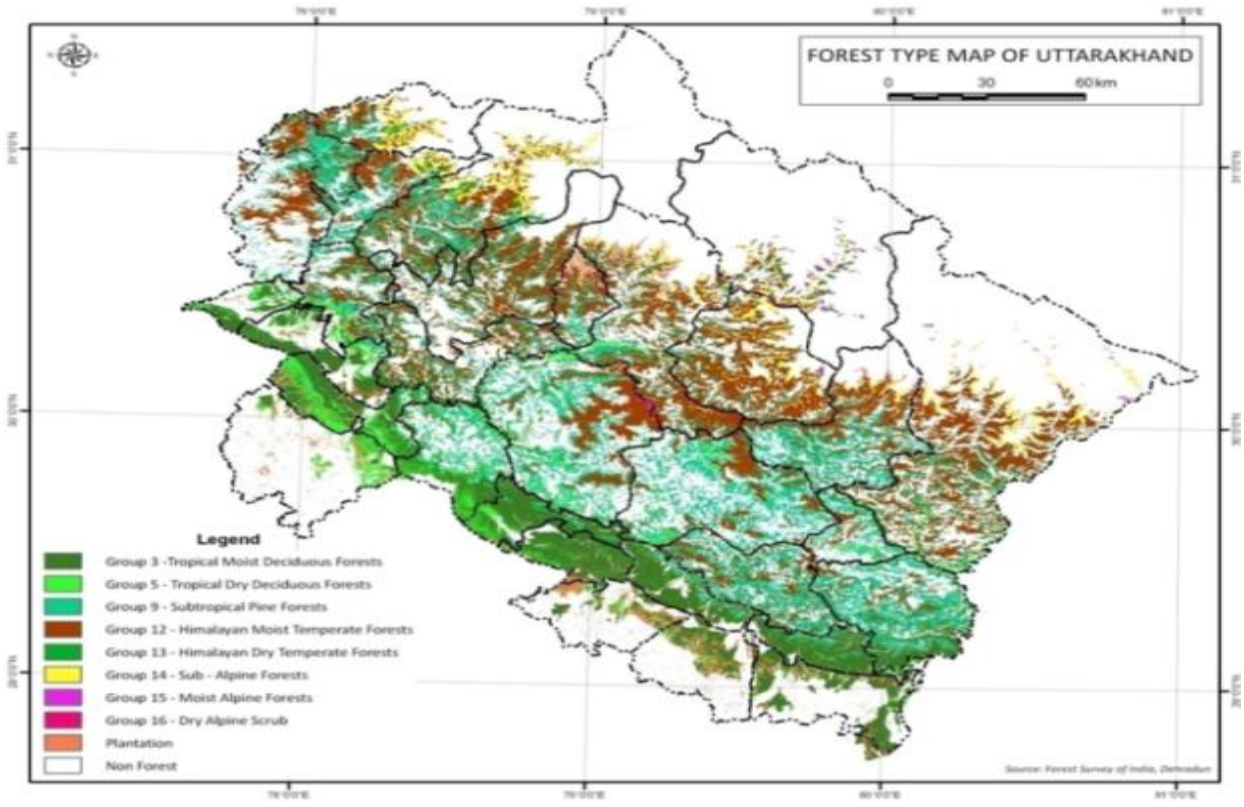

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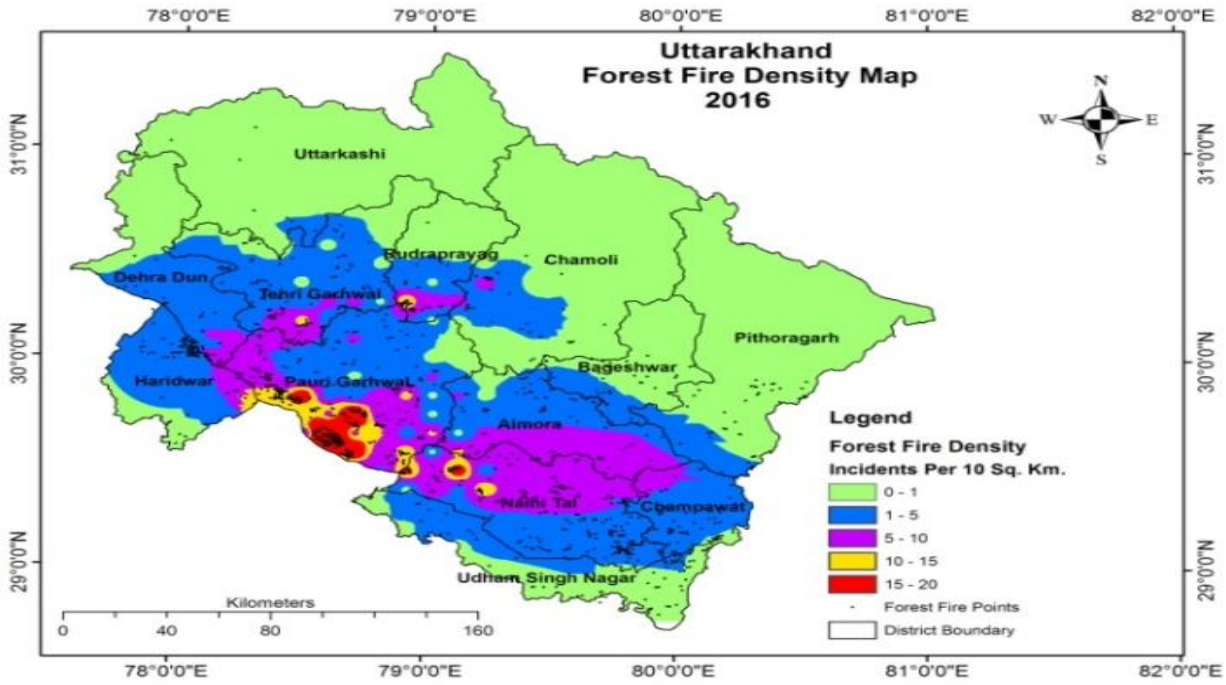

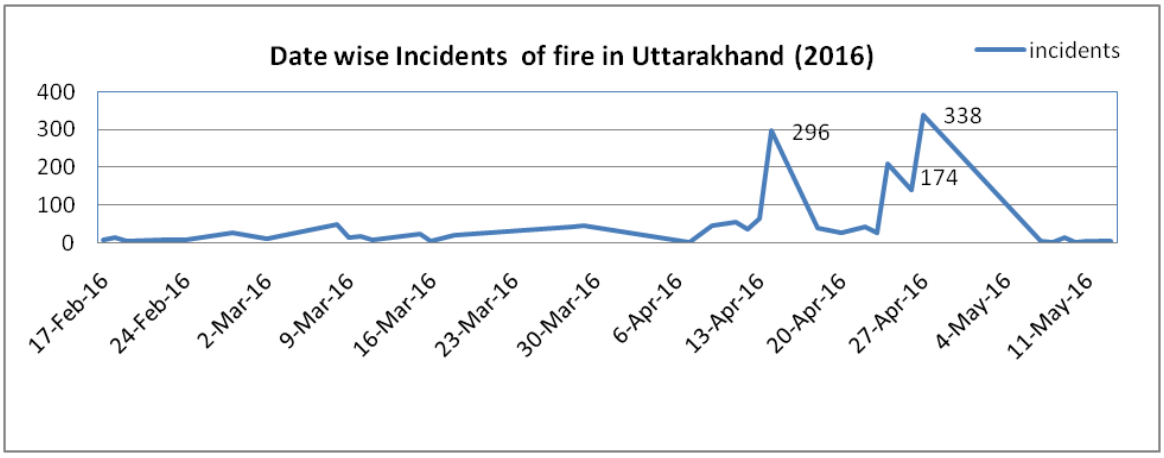

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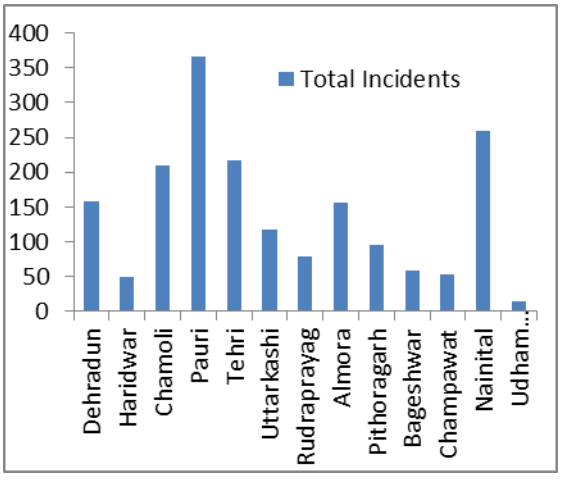
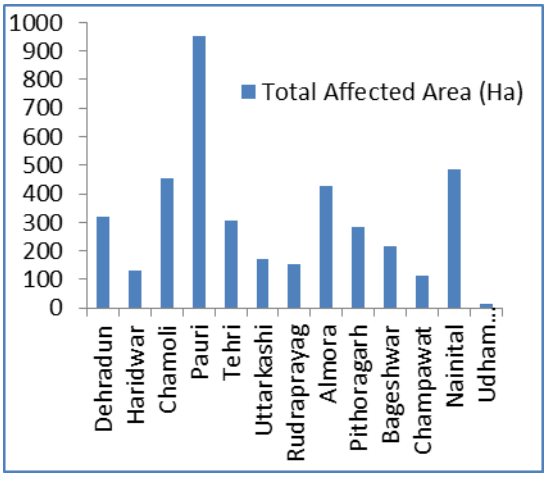
District	Incident No. In RF	Incident No. In Civil Soyam / Van Panchayat	Total Incidents	Affected RF Area (Ha)	Affected Civil Soyam / Van Panchayat Area (Ha)	Total Affected Area (Ha)	Plantation Affected Area (Ha)
Dehradun	134	24	158	261.2	57.15	318.35	0
Haridwar	50	0	50	130.08	0	130.08	12.5
Chamoli	106	103	209	245.85	208.6	454.45	0
Pauri	174	191	365	535.65	415.1	950.75	39.5
Tehri	146	70	216	217.95	88.5	306.45	3.5
Uttarkashi	82	35	117	112.9	59.3	172.2	28.25
Rudraprayag	38	41	79	68.2	87	155.2	2
Almora	92	65	157	268.85	156.75	425.6	12
Pithoragarh	42	54	96	121	163.6	284.6	0
Bageshwar	32	26	58	108.4	105.95	214.35	0
Champawat	31	22	53	65.01	49	114.01	0
Nainital	233	27	260	440.36	43.6	483.96	3.05
Udham Singh Nagar	14	0	14	13	0	13	1.4
Grand Total	**1174**	**658**	**1832**	**2588.45**	**1434.55**	**4023**	**102.2**





The weather also plays its part in this year. The official forest fire season in the state is between 15 Feb. to 15 June. When the air is dry and warm but this year first front fire incidents were registered in February. This year Uttarakhand received scanting rain in December and January making it an abnormally warm winter. Due to leave of rainfall in the winter months, there is no moisture in the air and soil so the fires started early.

In the recent last four month the forest fire has taken place in the sub-tropical pine forests and tropical dry deciduous forests vicinity to Tarai belt. Both Pauri and Nanital District where the maximum forest fire incidents are reported and lost very large area 950.75 ha. and 483.96 ha. area of the forest cover out of total 4023 ha. of forest land.

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Year	No. of Events Per Year
2005	106
2006	159
2007	220
2008	712
2009	3767
2010	1554
2011	77
2012	2646
2013	116
2014	657
2015	479

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2005	106
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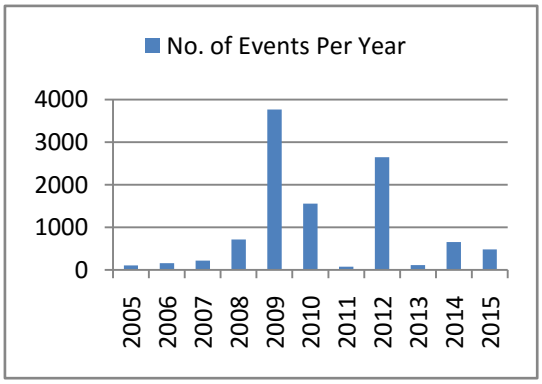
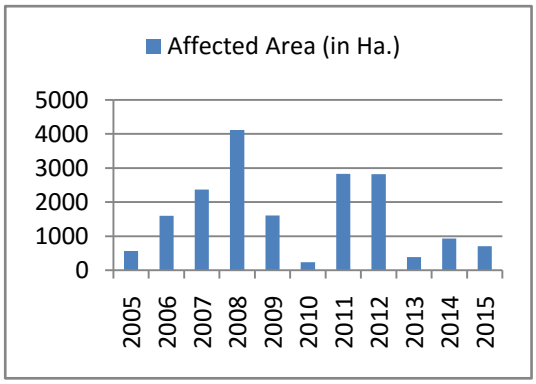
Source: Forest Survey of India and Haldwani Chief Forest Conservator Office





Source: Forest Survey of India and Haldwani Chief Forest Conservator Office

In this year, fire has been detected at more than 1200 places. Pauri, Nainital, Chamoli, Tehri Rudraprayag, Almora, Pithoragarh, and Uttarkashi have been declared the worst affected areas. In the last four months of forest fire, 1832 incidents have occurred with 4023 hectares of green cover getting blighted. The forest fires in Uttarakhand have severely affected the wildlife reserves across the state. In a source, it is said that 70 hectares in Rajaji Tiger Reserve and 60 hectares in Kedarnath Musk Deer Sanctuary had come under fire. The Corbett Tiger Reserve and Kalagarh Tiger Reserve.

5. POSSIBLE EFFECTS OF FOREST FIRE:

In short term effects of forest fire consumes vegetation woody debris and soil organic matter. It also heats soils and water streams. It kills animals, increases air pollution and effects the daily earners who are depend on various forest products for their livelihood.

In long term of forest fire, soil productivity is greatly affected which changes the forest structure and due to which future vegetation development will be affected and it may induce soil erosion. It will be adversely affected abundance, density and distribution of creature right from microbes to Fire vane become a threat of many forest wind their Biodiversity (Dennis Maijaard et al. 2001)

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A regional level biomass stock and hydrological cycle are adversely affected. Due to increased percentage of smoke in environment photosynthetic activity is reduced and thus health of human being and animals is also affected. (Turvey 1994)

In the long run, the many stresses by fire, cattle, and fuelwood cutting can lead to the complete destruction of Himalayan forests. The fire, as such, influences the structure and process of a natural forest ecosystem. The periodicity, spatial coverage, and severity of such fires vary temporally and these fires are generally associated with excessive accumulation of dry pine needles and leaf litter in pine and oak forests of Uttarakhand State.

6. CONCLUSION AND SUGGESTIONS

The worst hit districts are Pauri, Nainital, Rudraprayag, chammoli, Aalmora and Uttarakashi, where forests neighbouring 1500 villages and the forest ecosystem are under fire effect.

Fires are lit by people for a various reasons but fire become rampant when the fuel load is not removed and fire lines are not cleaned. Some measures to mitigate the impact of forest fire in the area. Some applied measures can be followed by the peoples where the forest fire took place with the help of forest department and government should come in the action also to make policy and planning implementation. Some Management measures can be suggested:-

- The focus should be on preventing fire from spreading.
- Local people should be involved.
- A long term measure can be as annual time management plan prepared with maps of vulnerable areas and an early warning system tandem with the forest survey of India. The plan should be ready up to December. Control room also should be established by December through June.
- More fire lines are needed in forest area in uttaraknhand.
- Modern technology should be used in preventing and controlling forest fire.
- There is an urgent need to initiate research in the field of fire detection behaviour and fire ecology for better management of forest fire.
- Joint forest management committees are to be organised at village level.
- The maximum number of forest fire is manmade, therefore it is recommended that the regular patrolling of forest should be done, motivate the local people and serve their livelihood requirements and attractions.
- In the areas where the fire took place every year, litter should be reported at the short distance and, may be controlled.

There are many ways in which the impact of forest fire can mitigate. The tree like Banj, Oke, Myrica, Alder and Rhododendron should be included in Chir Pine forest. Forest humus can be converted into bio bricks and vermin compost. Modern Fire fighting techniques should be adopted such as radio acoustic sound system for early fire detection and Doppler radar. There should be a strong collaboration between forest department and village people. Fire forecasting and warning system should be implementing. There is a urgent requirement of develop separate wing for fire fighting by the forest department.

Most of the local people utilize the forests resources, therefore if efforts are made to provide them subsidies and involve them in forest management practices. Their indigenous knowledge will definitely help us in controlling to some extent. The assessment of forest fire and degradation is most important factor to be considered for better management of forest resources of Uttarakhand. The satellite based remote sensing enabled to map and monitor vegetation resources in varying scale and time. The GIS and Reomte sensing techniques enables to organise datasets to analysis and decision making process. The satellite images have a considerable value for forest fire mapping and ecological degradation assessment. It helps in decision making process and proper establishment of a management plan for the green cover areas.We have to understand that we cannot stop forest fires but we can successfully control the fires so that it does not work havoc.

7. REFERENCES

[1] Krishna, P. Hari and C. Sudhakar Reddy. 2012. “Assessment of Increasing Threat of Forest Fires in Rajasthan , India Using Multi-Temporal Remote Sensing Data (2005 – 2010).” 102(9)
[2] Roy P.S, Indian Institute of Remote Sensing (NRSA) Dehradun, Forest Fire and Degradation Assessment Using Satellite Remote Sensing And Geographic Information System.

GLOBAL JOURNAL OF ADVANCED RESEARCH
(Scholarly Peer Review Publishing System)

[3] ENVIS (Environmental Information System) State of Environment & Related Issues Uttarakhand Environment Protection and Pollution Control Board , Dehradun. 248001

[4] Saklani P. Forest Fire Risk Zonation , A case study Pauri Garhwal , Uttarakhand , Forest Fire Risk Zonation , A case study Pauri Garhwal , Uttarakhand ,. 2008;

[5] Joshi, R. and Singh, R., 2010. "Impact of Forest Fires and Shrinking Water Sources on the Elephants of." 1(4):305–14.

[6] Kinnaird, M. F. and T. G. O'Brien (1998). Ecological effects of wildfire on lowland rainforest in Sumatra. Conservation Biology 12(5): 954-956.

[7] Turvey, N. D. (1994). Afforestation & rehablitation of Imperata grasslands in Southeast Asia, identification of priorites for research, education, training and extention. Canberra, Australia, Australian Center for International Agricultural Research (ACIAR) and Center for International Forestry Research (CIFOR).

[8] Dennis, R., Meijaard, E., Applegate, G.,Nasi, R. & Moore, P. 2001. Impact of human-caused fires on biodiversity and ecosystem functioning and their causes in tropical, temperate and boreal forest biomes. CBD Technical Series No. 5. Montreal, Canada, Convention on Biological Diversity.

[9] Sharma, S. and Rikhari, H.C., Forest fire in the central Himalaya: climate and recovery of trees, International Journal of Biometeorology, April 1997, Volume 40, Issue 2, pp 63-70

[10] Randerson, J. T. et al. The impact of boreal forest fire on climate warming. Science 314, 1130–1132 (2006).

[11] http://forest.uk.gov.in/contents/view/6/27/75-forest-fire-inf

[12] http://frienvis.nic.in/Content/Bhuvan-Thematic-Service_1812.aspx

[13] https://earthdata.nasa.gov/earth-observation-data/near-real-time/firms/active-fire-data

[14] http://www.vigilanceandlegalcell.co.in/fire/Office-DivisionwiseReport.php. 2016;8–9.

[15] http://indiatoday.intoday.in/story/forest?fires?uttarakhand?fire?special?report/1/666092.html