Indian Forester, 143 (8) : 800-802, 2017
http://www.indianforester.co.in

ISSN No. 0019-4816 (Print)
ISSN No. 2321-094X (Online)

RESEARCH NOTE

MODELLING FOREST FIRE DETECTION AND ITS CONTROL IN THE HIMALAYAS

Forest fires are a major cause of degradation of Himalayan forests. Forest fires are considered to be a very potential natural hazard with physical, biological, ecological and environmental consequences. It is one of the greatest enemies of standing vegetation and wild animals in a forest area. Understory/ regeneration are often affected very adversely. Even the big trees are not spared if the fire is severe due to its high flames and eventually it becomes a major cause to fire spreading. Ground fire destroys the organic matter available on the surface of forest area, which is required to maintain an optimum level of moisture and humus in the soil, though, annual fires decrease the growth of the grasses, herbs, shrubs and small tree which may be resulting in increased soil erosion (Kandya *et al.,* 1998). The forest fire is an natural calmatity which leads to the destruction of the forest and eventually leads to the change in climate. The climate change leads to the alteration of the normal cycle of heat and cold of the globe and the effect can be seen at the local level too. The Indian forests are vulnerable to forest fire and the reason for the vulnerability may be many but the most likely reason may be the frequent visits of the people residing in the periphery of the forest areas for firewood, fodder, and collection of minor forest produce (MFP). Forest type, fuel, biotic pressure, Climatic conditions such as rainfall and temperature also influence the vulnerability of the forest fire (Kumar *et al.,* 2013). High temperatures with low atmospheric humidity were one of the important reason for forest fires in Uttarakhand. According to Chandra (2005) the high resin content in sub-tropical pine region and dry conditions in the tropical region accelerate the fire.

The effect of fire on the nutrients of an ecosystem depends not only on fire types and its frequency but also on the available fuel load, time and season of the burn, vegetation type, topography and aspects. A fire of low intensity may stimulate seedling establishment and growth by increasing temperature and nutrient status of soil by removal of litter and vegetation cover.

History of Forest Fire in Himalayan region

In the Central Himalayan region, particularly Uttarakhand, fires due to anthropogenic activities are an integral part of the Chir-pine (*Pinus roxburghii*) – banj oak (*Quercus leucotrichophora*) forest zone (800-2000 meters), and enhance the domination and extension of chir-pine at the expense of broadleaf oak forests (Singh and Singh, 1992). These man-made forest fires are one of the major sources of formation of pollutants including black carbon which is regarded as a major cause of glacier melt in the Himalayan regions (Ramanathan and Carmichael, 2008), and has the capacity to influence the regional climate.

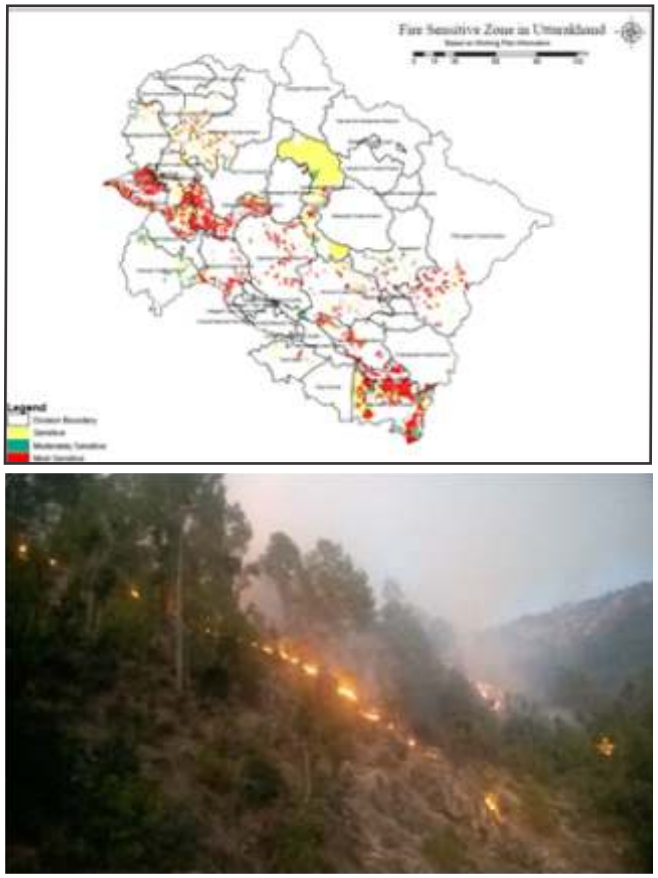

Fig. 1: A-Fire-sensitive zone of Uttarakhand division wise (Source: Uttarakhand Forest Department); B- Forest Fire in Uttarakhand Himalayas in 2016

The Forest Survey of India (FSI, 2015) has estimated that 1.45 million ha of total forest area is affected by fire annually also 6.17% of the forests area are prone to severe fire damages. Satellite observations have been the only source of observations on fires on a global scale (Jha *et al.,* 2016). Hotspots have been observed from a variety of sensors like AVHRR, ATSR, TRMM VIRS, MODIS, and the geostationary satellites Go and MSG. Active fire monitoring systems use satellite data from MODIS (Moderate Resolution Imaging Spectroradiometer) flying on the TERRA and AQUA spacecraft (Jha *et al.,* 2016).

Factors responsible for forest fires in Himalayan regions are as follows:

1. Vegetation type: Vegetation plays an important role in forest fire occurrence and its extension. Tree such as Chir-pine (*Pinus roxburghii*) exudates resin which contains turpentine oil and rosin and it is flammable.
2. Weather: The weather is relatively synchronised with the vegetation available. It determines the vegetation in a region and hence, plays a dominant role in occurrence/non-occurrence of a forest fire at the local level. If the weather is dry in an area, then the chances of forest fire in that area are relatively high.
3. Topography: Topography is an important physiographic factor, which is directly related to wind characteristics. Slope and aspects are two main topographical parameters which govern the forest fire incidences in Himalayan region.
4. Human settlement: The forest area near human settlements or transition zone between villages and forest are more prone to fire due to more no. of anthropogenic activities. The habitation/cultural practices of the inhabitants can lead to accidental fire.

Modelling approach in Forest Fire detection

The emission of energy in the form of light and heat during the forest fire can be easily detectable in electromagnetic (EMR) region. The changes in the reflectance spectrum on a temporal basis (before and after the forest fire) can be measured using sensors on remote platforms (Joseph *et al.,* 2009). Various satellite sensors have been used since the 1970s to detect different changes due to forest fires and to quantify the burnt areas. Researchers have tried to developed FRZ (Fire Risk Zone) map to tackle the disaster due to the forest fire in fire prone zone. Numerous researchers have studied the forest fire risk zone (FFRZ) with plenty of mapping methods with the help of remote sensing and GIS that contain topography, vegetation, land use, population and settlement information (Chuvieco and Salas, 1994). In modelling technique various parameters e.g. road, village, river, vegetation density, aspect, slope and Digital Elevation Model (DEM), etc. are taken into account. MODIS Rapid Response System Global Fire Maps, GLOBSCAR, European Forest Fire Information System, WEB FIRE MAPPER, GOFC/GOLD Fire Monitoring and Mapping Implementation Team, Canadian Wildland Fire Information System and Indian Forest Fire Response and Assessment System (INFFRAS) are some of the global, regional and national level initiatives for assessing the fire dynamics (Joesph *et al.,* 2009).

Present management plans for controlling of forest fire

The government of India has initiated many programmes at the local level, district level and state level to manage and minimise the forest fire hazards. It includes forest fire monitoring and developing early warning systems and many others. Management of forest fire through the governmental approach is not much sufficient until and unless we develop a sense of security toward batter environment and biodiversity conservation in the forest fringes villagers where the forest fire occurs. So government must aware/trained the villagers about consequences of forest fire and benefit of forest and biodiversity conservation in the regional/local level context. Activities such as organising seminars and workshop for local people and conservation related activities for students can help us to prevent forest fire due to anthropogenic activities.

Fire management in India is a concern with priority for the government; activities such as initiating R&D works as part of International Geosphere-Biosphere Programme (IGBP) and Long-Term Ecological Monitoring (LTER), by enhancing the efficiency of the fire detection and timely alert system by using ATSR series of satellites and BIRD in addition to MODIS and DMSP-OLS and by enhancing and Strengthen the present fire-fighting programs are example of some of the premier action/initiative taken by government (Joseph *et al.,* 2009). Similarly, fire watchers are employed to get a timely alert of the forest fire, fire trenches should be cleared, forest officers should exclusively attentive toward forest fire in their respective forest area.

Similarly, limiting the tourism in the buffer zone of a protected forest area, resettling the villagers from a fire prone zone to safe area and by make them less dependent on forest for livelihood can save Himalayan forest from fire during fire season as a precautionary measure. Preparation of integrative plan to tackle the forest fire involving the government organisation and institutes including Indian Council of Forestry Research and Education (Dehradun), Indian Institute of Forest Management (Bhopal), Forest Research Institute (Dehradun), Indian Institute of Remote Sensing (Dehradun), Wildlife Institute of India (Dehradun), National Remote Sensing Centre (Hyderabad), National Centre for Medium Range Weather Forecasting (Uttar Pradesh) and other major NGOs in the field throughout the country can help in timely management of the forest fire in Himalayan region. Also developing the legal framework for fire control prevention and control may be in the form of guidelines, circular or public notice (in respective local languages) with penalty specially during

fire season as per the fire prone zone of the area, should be constructed and circulated through all the departmental heads with strong and timely initiative. Locals may also be employed in the circulation of such notices or circulars and other activities such as in awareness program.

References

Chandra S. (2005). Application of Remote Sensing and GIS Technology in Forest Fire Risk Modeling and Management of Forest Fires: A Case Study in the Garhwal Himalayan Region. In Geo-information for Disaster management (pp. 1239-1254). Springer Berlin Heidelberg.

Chuvieco E. and Salas J. (1994). Mapping the spatial distribution of forest fire danger using GIS. *Geographical Information System*, 10(3): 333-45.

FSI (2015). India State of Forest Report, Forest Survey of India, Dehradun.

Jha C.S., Gopalakrishnan R., Thumaty K.C., Singhal J., Reddy C.S., Singh J., Pasha S.V., Middinti S., Praveen M., MurugaveL A.R., Reddy S.Y., Vedantam M.K., Yadav A., Rao G.S., Parsi G.D. and Dadhwal V.K. (2016). Monitoring of forest fires from space–ISRO's initiative for near real-time monitoring of the recent forest fires in Uttarakhand, India. *Current Science*, 110(11): 2057-2060.

Joseph S., Anitha K. and Murthy M.S.R. (2009). Forest fire in India: a review of the knowledge base. *J. Forest Research*, 14(3): 127-134.

Kandya A.K., Kimothi M.M., Jadhav R.N. and Agarwal J.P. (1998). Application of GIS in identification of fire prone areas—a feasibility study in parts of Junagarh (Gujrat, India). *Indian Forester*, 124(7): 531–535.

Kumar M., Sheikh M.A., Bhat J.A. and Bussmann R.W. (2013). Effect of fire on soil nutrients and under storey vegetation in Chir pine forest in Garhwal Himalaya, India. *Acta Ecologica Sinica*, 33(1): 59-63.

Ramanathan V. and Carmichael G. (2008). Global and regional climate changes due to black carbon. *Nature Geosci.*, 1: 221–227.

Singh J.S. and Singh S.P. (1992). Forests of Himalaya, Gyanodaya Prakashan, Nainital.

SHASHANK SHUKLA, SALMAN KHAN, V.K. DHAWAN AND VIJAY VARDHAN PANDEY
Forest Research Institute, Dehradun, Uttarakhand-248006
E-mail: shukla_agro@rediffmail.com