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Forest Fire in Uttarakhand: Causes, Consequences and Remedial Measures

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ABSTRACT

Fire is one of the major causes of forest degradation in India, and has wide ranging adverse ecological, economic and social impacts. In Uttarakhand, Chir Pine (*Pinus roxburghii*) forests spread over appx. 16% of total forest area (between 1000 and 1800 m asl) are particularly prone to forest fire (FF) due to resin-rich leaf litter accumulation on the forest floor during summer. Year 2016 (April- early June), witnessed a major Forest fire in the Chir Pine forests of Uttarakhand registering a total of 2069 Forest fire incidents affecting 4423 ha forests. This outrage of forest fire in Uttarakhand concerned everyone across the country, and to save the forests large scale efforts were made. Even National Disaster Response Force and helicopters had to be engaged in putting out forest fire. This article is a follow-up of a visit of Parliamentary Standing Committee on Science & Technology, Environment & Forests, Govt. of India to Uttarakhand (6-7 June, 2016) in the aftermath of Forest fire, and provides an overview of forest fire in Uttarakhand, its causes and consequences, and suggests some remedial measures.

Key Words: Chir Pine (*Pinus roxburghii*) Forests; Loss of Forest Wealth; People's Participation; Western Himalaya

INTRODUCTION

Historically, fire has played a significant role in environmental change and shaping the progression of human civilization (Agee 1993). It is a common saying that "Fire is a good servant but bad master". Fire might be used to enhance the supply of fuel (easy accessibility), managing wildlife habitats, clearing forest for agriculture, to promote growth of fodder for grazing, to easily collect non-wood forest products etc. (Schmerbeck and Seeland 2007). In any terrestrial forest landscape, fire can be of natural origin (lightning, volcanic eruption etc.), or man caused (intentional or unintentional) and may be categorized as surface fires, ground fires and crown fires (Pyne et al. 1996). Scientists have now accepted fire as an integral component of landscape, that facilitates continued existence of various plant species (Pyne et al. 1996, Semwal and Mehta 1996). Light fire helps unlock the nutrients accumulated in biomass pool and make them available to colonizing plants, and also breaks the dormancy of seeds and buds of many species (Pyne et al. 1996). However, at the same time, severe recurrent forest fires have several negative impacts on the environment and ecosystem, as these wipe out plants, timber wealth of forests and biodiversity, minor forest produce; accelerate soil erosion, change physical, chemical and biological characteristics of the soil, cause air pollution and increase air temperature due to emission of GHGs as well as black carbon (Saha and Howe 2003). Thus the impact of fire on vegetation may be benign or detrimental, depending on the severity of fire and management regime.

Fire is considered to be one of the major causes of forest degradation in India (Brandis 1897, Bahuguna and Upadhyay 2002). According to the Forest Survey of India, about 50% of the forest area in the country is fire prone and about 6% is prone to severe fire annually. Every year, close to 18,000 forest fire incidents are reported in India affecting an area of some 1.14 Mha (range= 1.45 to 3.73 Mha; Bahuguna and Singh 2002) with an estimated annual loss close to Rs. 4,400 million; that does not include intangible services of forests such as loss of biodiversity, carbon sequestration capability,

soil fertility, hydrological functions of the forests etc. (Parashar and Biswas 2003). In the Indian Himalayan region, on average 3908 Forest fire events occur annually (with 64% fire incidents occurring in the low elevation areas), with average burnt area of 1129 km^2, and black carbon emission of 431 t/yr (Vadreuv et al. 2012). In view of the magnitude of the problem of Forest fire the Government of India has issued national forest fire prevention and control guidelines, which involves over 36000 Joint Forest Management committees in forest protection and conservation, and efficient enforcement of legal provisions (Bahuguna and Upadhyay 2002).

MATERIALS AND METHODS

This article is based on extensive review of literature and in-depth discussions with a range of stakeholders (viz., local people, forest officials and field staff, researchers and academicians) and field visits to forest fire affected areas during 2016. Also, records from forest department were consulted. The information was pooled and synthesized and put in the context of a popular document providing forest fire management points in anticipation that it will invite attention of a wider section of society and sensitize them to take proactive role to save the forest wealth and biodiversity.

HISTORY OF FOREST FIRE IN UTTARAKHAND

In Uttarakhand major fores fire was recorded as early as 1911 (Rawat 1991). In 1912, for the first time fire protection was initiated in the Chir Pine (*Pinus roxburghii*) forests by the Forest Deptartment (Osmaston 1921), which included methods of control burning (once during December-January and next during May), slash burning in March and May, and ordinary burning (Rawat 1991). Controlled burning was always done downhill and it was the chief form of fire protection for established regeneration areas. Notably, during British era, many a times forests were burnt in Uttarakhand to protest against British Government's forestry policies and for independence and referred to as incendiary fires (Pant 1922).

In Uttarakhand, the periodicity, spatial coverage and severity of Forest fire vary temporally and these fires are generally associated with heavy accumulation of Chir Pine needles on the forest floor (Singh et al. 2106). Thus, Forest fire has become a recurrent phenomenon during summer (April-June), and sometimes in late winter (Sharma et al. 2014), particularly when the drought period after monsoon season is too long (Singh et al. 2016). In Uttarakhand State approx. 16.36% of forest area (between 1000 and 1800 m asl) is occupied by Chir Pine forests. This altitudinal zone is considered as the fire prone zone as well as its adjoining zone with Sal (*Shorea robusta*) forests towards lower altitudes (Singh et al. 2016), and Oak (*Quercus spp.*) forests towards higher altitudes. Under continuous anthropogenic pressure, grazing and recurrent burning, the early successional Chir Pine has also expanding into the socio-ecologically valued climax Oak forests (Singh et al. 1984). In 1999, there was a biggest Forest fire in the history of Uttarakhand with a total loss estimated at Rs. 50 lakhs, affecting about 5085.6 sq. km. (around 22.64%) forest area; out of it about 1225 sq. km. area got severely burnt (Forest Survey of India, 1999). Prior to it in 1995, another big episode of Forest fire affected 19.3% of the total forest cover of the State (NRSA Report). Looking at the statistics of Forest fire during 2005-2015 a total of 10473 incidents of Forest fire occurred in the last ten years in Uttarakhand (Figure 1). In 2009, the warmest year of our country since 2001 the maximum number of Forest fire incidents occurred in Uttarakhand (3767 incidents), followed by 2646 incidents in 2012 and 1554 incidents in 2010. And the minimum number of Forest fire incidents were recorded in 2011 (77 events). With regards to total number of Forest fire incidents in the last ten years Pauri-Garhwal registered the highest incidents (2364), followed by Nainital (1693), and the least in Pithoragrah Distt. (186). In Nainital district 122 fire incidents in June 1995 were the highest so far in Uttarakhand affecting 6099 ha area. In the last 15 years severe incidents of Forest fire took place in 2002-03, 2003-04 and 2008-09 affecting 4983, 4850 and 4116 ha forest area, respectively.

FOREST FIRE OF 2016 IN UTTARAKHAND

In Uttarakhand during summer 2016 (till 5 June 2016) a total of 1327 Forest fire incidents took place with total area affected was 4423 ha (Table 1). In terms of Forest fire incidents, among the 13 districts of Uttarakhand, maximum incidents were reported in Pauri (402), followed by Nainital (266) and Tehri (247). The least number of Forest fire incidents were reported in Udham Singh Nagar (16). The total Forest fire affected area was

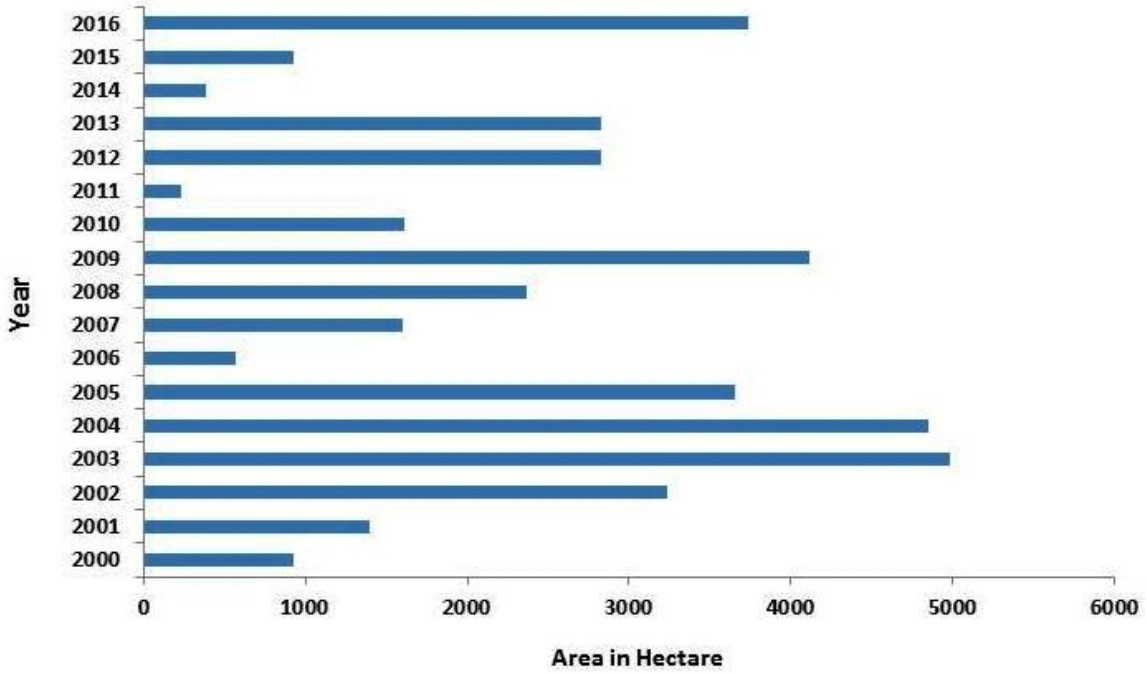

Figure 1. Area affected due to forest fire in Uttarakhand (Source: Chief Conservator of Forest, Vigilance & Law Cell, Haldwani).

Table 1: Summary of district wise fire incidents reported till 5 June 2016 in Uttarakhand (Source: Forest Department, Govt. of Uttarakhand)

District (Circle)	Number of fire incidents			Affected forest area (ha)			Plantation affected (ha)	Resin tapping blaze affected	Value of loss (Rs.)
	Reserve Forest	Civil Soyam / VanPanchayat	Total	Reserve Fforest	Civil Soyam / VanPanchayat	Total			
Dehradun	175	25	200	316.75	58.65	375.40	0.00	400	320200.00
Haridwar	52	0	52	132.58	0.00	132.58	12.50	0	66665.00
Chamoli	109	112	221	251.85	222.60	474.45	1.00	0	566000.00
Pauri	179	223	402	537.65	494.10	1031.75	39.50	0	898975.00
Tehri	165	82	247	248.70	101.75	350.45	3.50	0	222625.00
Uttarkashi	127	45	172	167.80	72.50	240.30	28.50	0	260125.00
Rudraprayag	39	43	82	68.70	91.00	159.70	2.00	0	221050.00
Almora	117	78	195	331.90	194.25	526.15	12.00	0	694825.00
Pithoragarh	43	54	97	125.00	163.60	288.60	0.00	0	372650.00
Bageshwar	33	27	60	108.90	106.45	215.35	0.00	0	321025.00
Champawat	33	26	59	67.01	52.00	119.01	0.00	0	130755.00
Nainital	239	27	266	451.26	43.60	494.86	3.05	0	545930.00
UdhamSingh Nagar	16	0	16	14.75	0.00	14.75	1.40	0	9000.00
Grand Total	1327	742	2069	2822.85	1600.50	4423.35	103.45	400	4629825.00

reported to be maximum in Pauri (1032 ha) and least in Udham Singh Nagar (15 ha). In addition, 104 ha forest plantations were also affected. The loss due to Forest fire was estimated at Rs. 4.62 million as per the scheduled rates (@ Rs. 1500 per ha for Pine forests) of Forest Department, Uttarakhand (Table 1). However, several other estimates published in newspapers during April-May 2016, put this estimate ranging from Rs. 4 million

to 50 billion. The protected areas such as Corbett National Park (261 ha), Rajaji National Park (70 ha) and Kedarnath Musk Deer Sanctuary (60 ha) were also affected due to Forest fire. During that period, 6 people died, 31 people injured and 7 animals died due to Forest fire, and district administration filed cases against 48 people found accused for igniting forest fire in Uttarakhand (http://forest.uk.gov.in/contents/view/6/27/75-forest-fire-info). Government deployed three National Disaster Response Force and raised the number of forest officials from 3,000 to 6,000, and two IAF helicopters to control the blaze in May 2016. Fortunately Forest fire was suppressed due to excessive rains from May Ist week onward in the region.

MAJOR CAUSES OF FOREST FIRE

Chir Pine trees due to their resin rich needle leaves and twigs are highly inflammable and prone to Forest fire. In Uttarakhand, about 4 lakh ton Pine needles are dropped annually in the Pine forests, which add to the inflammability of the forest floor due to rise in ambient temperature during summer. In Garhwal Himalaya, the frequency of fire in forests to be 2-5 yrs. and 11% pine forests of the region experience fire annually (Semwal and Mehta 1996). Fire incidents mostly take place between 12-4 PM and 4-8 PM, and inversely related with rainfall in March-June.

Forest fire can be divided into: (i) natural fire, (ii) man-made intentional, and (iii) accidental fire (Semwal and Mehta 1996). In Uttarakhand natural fire is of rare occurrence and mainly caused due to lightening that is intercepted by tall Pine trees, spark produced due to rolling down of quartzite stones and rubbing of bamboo shoots that catch the dried forest floor litter and grass and ignite fire. In 2016 continued drought after monsoon and El Nino effect has been mainly responsible for making the forests of Uttarakhand prone to Forest fire. For example, rainfall recorded at GBPIHED, Almora during November 2015 - April 2016 was only 56 mm, which is about 80% less than the previous year winter season (December 2014 - February 2015) rainfall of 278 mm. The man-caused intentional fire has been found to contribute more as compared to the man-caused accidental fire. In Garhwal Himalaya, it was reported that of the total incidents of Forest fire, 63% were man-caused intentional, and remaining 37% were accidental (Semwal and Mehta 1996). Man-caused intentional fire is ignited to remove unwanted grass and obtain better growth of succulent forage for livestock, drive away wild animals to avoid crop damage, extraction of honey from the bee hives and wild edibles, clear trekking paths, remove trees in the want of land encroachment, revengeful attitude of people, amusement by herders and children, etc. The man-caused accidental fire mainly owes to fire escaped in the adjoining forests during burning of weeds and crop remains to prepare cropfields for sowing crops, fire escaped to forests during control burning by Forest Department, motor road repairs, a live cigarette or bidi butt carelessly thrown by a passerby, camp fire by tourists, pilgrims and labour camps, sparking in the electricity transmission lines, etc.

Multiple Uses of Pine Trees Promote its Existence ?

Chir Pine is the most important species in India covering an area of 8900 km^2 , and has its roots in folklore and mythology (Tiwari 1994). It forms a straight cylindrical bole, and among the most important timber trees in forestry plantations. Though, the Chir Pine was in the Himalayas since time immemorial, its mass-scale regeneration was promoted for resin tapping in the British period (Rawat 1991). Its non-palatability, drought tolerance, fast growth and early-successional nature promotes its preponderance in inhospitable area where other broadleaf species such as Oak (*Quercus* spp.) does not grow (Singh and Singh 1992). Pine trees are also important as a source of valuable resin extracted from of its bole. India ranks 6^{th} position among the top ten resin producing countries of the world (Coppen and Hone 1995). In Uttarakhand about 7-8 Mg resin is collected every year costing @ Rs. 6000-7000 per 100 kg. Resin yields an essential oil on distillation, turpentine, and non-volatile rosin which is used in pharmaceutical preparations, perfume industry, disinfectants, insecticides, denaturants, and in adhesives, paper, rubber, soap, cosmetics, paint, varnish, rubber and polish industries. Resin is used by local people for medicare against boils, swellings and cramps, and mature bole is used as torchwood. The seed is edible and produces edible oil. The thick and soft bark is easily carvable to make useful decorative items. Pine cones are also used as decorative items, and leaves are extensively used to make brooms, thatching roofs and making cattle-bed and FYM. In spite of all these utilities, Pine forests are accused for voracious use of soil water leading to drying up of streams and springs and suppress floral diversity of forest floor (Joshi and Negi 2011).

ENVIRONMENTAL IMPACTS OF FOREST FIRE

In spite the colossal loss to forest wealth every year due to Forest fire its impacts on forests and environment are least investigated. Some of the impacts of Forest fire reported in this region are summarized as: (i) Increased atmospheric CO_2, SO_x, NO_x and particulate matter (black carbon and soot) leading to loss of visibility and trouble to asthma patients and eye irritation. A study at Srinagar-Garhwal during summer 1999 when due to 2514 fire events 40,195 ha forest area was burnt in Garhwal region the mean ambient CO_2 level rose from 338 to 382 ppm reducing the solar radiation to a minimum of 0.532 - 0.137 kW/m^2 thus modifying local /regional climate (Joshi 2003); (ii) The smog and ashes flying through the air due to Forest fire is inducing glacier melt; (iii) The south and south-west slopes are prone to Forest fire as compared to north slopes, and the herb biomass and productivity (both above and belowground) increases following Forest fire (Bhandari et al. 2012). They found soil N in the burnt forests low (0.08 - 0.17%) as compared to unburnt forests (0.16 - 0.21%). However, both P (0.55 - 0.98%) and OC (2.5-3.0%) in burnt forests was greater than the unburnt forests (P= 0.54 - 0.72%; OC= 0.8-1.9%). (iv) In the forests of Binsar Wildlife Sanctuary, Almora it was found that Forest fire leads to differential regeneration of woody species that may lead to change in composition of forest in future (Ilyas and Khan 2005); and the loss of soil seed bank and young growth of plants makes the forest devoid of under storey and poor in biodiversity (Rikhari and Palni 1999). In the same forest following Forest fire it was reported that young trees of *Q. leucotrichophora* (<40 cm circumference at breast height) were susceptible to fire but promote regeneration of *Lyonia ovalifolia* (Sharma and Rikhari 1997); (v) In the repeatedly burnt areas some weeds e.g., *Lantana camara* (shrub), *Anaphalis* spp., *Echinops cornigerous, Eupatorium odoratum*, *Imperata cylindrica*, *Parthenium hysterophorus* (herbs) etc. profusely proliferate after Forest fire that does not allow other native species to grow. Needless to say that numerous soil micro (bacteria, fungi etc.) and macrofauna (nematodes, mites, insects, ants, earthworms, millipedes, etc.) important for soil fertility maintenance, and birds, reptiles, amphibians, insects and moths, butterflies, mammals (monkeys, leopard, wild boars, etc.) are either killed or affected due to Forest fire (Bist et al. 2016). In addition, nests and nesting grounds, siblings and habitats of wild animals are wiped away following Forest fire; (vi) Following Forest fire forest floor become prone to soil erosion and small-landslides during monsoon rains leading to flash floods and siltation of water bodies downstream. The forests of Uttarakhand present micro-habitats of many high value medicinal and aromatic plants, NTFPs, and a variety of mushrooms, lichens and orchids, wild edibles on which people depend are lost due to Forest fire. This loss of natural wealth is not accounted for in usual calculus of monetary loss in our GDP that has several manifestations to our socio-cultural fabric.

REMEDIAL MEASURES/SUGGESTIONS TO CONTROL FOREST FIRE

Historically, methods such as creating fire lines and control burning / counter fire (fight fire with fire) was the approach adopted by the Forest Department since the British period (Rawat 1991). In the past, a total of 9000 km long fire lines (30, 50 and 100 ft. wide) created in the forests of Uttarakhand. These need to be cleared every year so that fuel loading and inflammability of the forest floor is reduced. Some of the remedial measures to control and avoid Forest fire are: (i) Both traditional methods (fire lines, control burning, counter fire, etc.) and technology to fight against forest fire need to be employed. Timely mobilization of tools, equipments and resources is needed to the fire sensitive areas to invite people's participation. (ii) Gradual elimination of Pine trees, lopping of lower branches and its regeneration (particularly along the roads, trekking paths and fire sensitive places) through plantation of more fire adapted and resistant species such as *Lyonia ovalifolia, Myrica esculenta, Pyrus pashia* (trees), *Carissa spinarum, Pyracantha crenulata, Rhus parviflora* (shrub), *Arundinaria nepalensis*, *Chrysopogon aciculatus, Heteropogon contortus* (grasses), *Crotalaria albida, Desmodium microphyllum* (legume) and *Ajuja parviflora, Micromeria biflora* (non-legume) forbs need to be propagated / planted. Also, controlled burning along the foot paths, motor roads and public places prior to fire season is required. (iii) The huge Pine needle biomass (organic resource) need to be utilized for industrial use such as in gasifires for electricity generation, oil extraction, bio-briquetting, handicraft, fancy items and paper making, manufacture of hardboard and packing material etc. That will generate employment and income for the local people and increase their participation in Forest fire control and protection of forests provided proper training, infrastructure and technical support is available. AVANI Bio-Energy organization at Berinag (District Pithoragarh) has been successfully using the

Pine needles in gasifier and produces 10,800 kWh electricity per year, which is fed directly into the existing grid, providing reliable and clean energy to the area (Source: biomasspower.gov.in). The use of Pine needles for making check dams in the forests by the Forest Department in Uttarakhand (Chandran et al. 2011) would utilize this raw material to conserve soil and water and keep the forest floor moist to avoid spread of Forest fire. (v) Resin extraction should be done 3-4 ft. above the ground and in the trees having 4 ft. girth as per the Forest Department guidelines. It is often seen that the resin tapping on younger trees by making furrows close to the ground (1-2 ft.) that makes the trees prone to catch surface fire that subsequently converts into crown fire. Borehole method of resin tapping (i.e., use of 2.5 cm diameter and 10 cm deep borehole on 4 ft girth trees) as practiced in Himachal Pradesh need to be implemented for maximum resin yield (Sharma and Lekha 2013). (vi) There is a need to make the Forest fire forecast service taking into account the post-monsoon drought, air temperature, humidity, fuel loading and other topographic factors for adequate preparedness in the fire sensitive zones. (vii) Awareness programmes, workshops, availability of fire fighting equipments, provisioning of incentives to communities, provisioning of rescue and medicare (even insurance) to those injured during Forest fire, taking help from village institutions i.e. Gram Panchayats, community based organizations, NSS, NCC, Eco-Clubs, students will also help to control the Forest fire. (viii) There is also a need to harness the wisdom of local people to manage Forest fire. In many areas of Uttarakhand there are very strong Van Panchayats who protect the forests from Forest fire to sustain their need should be incentivized and brought into the forefront of forest policy/programme formulation (Singh 2007). Also, reward and punishment system to ensure the accountability of Forest Department in Forest fire management need to be revisited.

In the aftermath of the devastating Forest fire of Uttarakhand in 2016, a strong plea has been made to lift the ban on green felling above 1000 m altitude to allow the people to grow and harvest their trees on private land so that they earn livelihood and resort to conserve their trees/forests (Padmshree Dr. Anil Joshi; Hindustan (Hindi Daily), 18 May 2016). It has been felt that ignoring traditional rights of rural people on forests has affected their livelihood due to imposition of Forest Conservation Act (1980) and creation of Protected Area network (appx. 15% of the geographical area of Uttarakhand) has gradually reduced the dependence and emotional attachment of people with the forests. Detailed scrutiny of causative factors of Forest fire before selectively lifting the ban on cutting the Chir Pine trees (at least near the human habitation) need to be considered to favour people and their participation in forest protection and management (Negi and Dhyani 2012).

CONCLUSION

Forest fire of 2016 has left us with certain key questions/learning's: (i) Less understanding of the proximate causes of devastating Forest fire; (ii) Insufficient preparedness of the Forest Department to deal with the situation in spite the El Nino effect and long post-monsoon drought; (iii) Inadequate budgetary, infrastructure and man-power support to mobilize for mitigation measures; (iv) Arbitrary approach and use of technology in hurry to extinguish Forest fire; (v) Ambiguous methods to assess the impacts of Forest fire that grossly underestimated the loss to forest wealth; (vi) Reasons for non-participation of local people in Forest fire control are less understood; and (vii) Policy change required to protect forests, control Forest fire and encourage people's participation.

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