

**Forest fire in western Himalayas of India: A Review**<sup>1</sup>Manmohan JR Dobriyal and <sup>2\*</sup>Arvind Bijalwan<sup>1</sup>Dept. of Silviculture & Agroforestry, College of Forestry, Navsari Agricultural University, Navsari, Gujarat, India<sup>2</sup>Indian Institute of Forest Management (IIFM) Bhopal, M.P., India\*Author for correspondence, email: [arvindbijalwan276@gmail.com](mailto:arvindbijalwan276@gmail.com)

**Abstract:** Western Himalayas comprised different forest types from alpine forests to semi-evergreen, deciduous, sub-tropical broad-leaved hill forests, sub-tropical pine forests and sub-tropical montane temperate forests. Geographically it extends to J & K, HP, UK and hill part of Punjab & Haryana dominated by coniferous forest of chir pine. In UK and HP major fires have been noted in 1911, 1921, 1930, 1931, 1939, 1945, 1953, 1954, 1957, 1958, 1959, 1961, 1964, 1966, 1968, 1970, 1972, 1995, 1999, 2010, 2012 and 2016. Forest fires cause wide ranging adverse ecological, economic and social impacts. The major reasons of forest fire in the hilly region are high fire fuel material of dry Chirpine needles and dry leaf litter of other broad leaved trees on the forest floor as Chirpine covers a significant (about 16%) area under forest and every year encroaching the mixed species area due its hardy dominating nature as well as ban on green felling above 1000 mts elevation. There is scope to make the local community, NGOs, Community Based Organizations (CBOs) completely involved in the system to minimize the fire hazards. Van Panchayat is a unique model in the state of UK effectively managing forest since a long time but forest communities needs capacity building and to be acquainted with modern methods to combat forest fires. To convert the fire hazard Chirpine needle as a resource (raw material) for different uses through creation of Forest Self-Help Groups (FSHG) or Forest Special purpose Vehicle (FSPV) with industrial linkage for its removal with the help of villagers to make the bio-briquette, compost or vermicompost, composite boards, panels and tiles etc. To check the spread of fire a proper fire Forecasting & warning system, modern fire fighting techniques for Early Forest Fire Detection Using Radio-Acoustic Sounding System, Doppler RADAR etc seem to be reasonable option. The awareness among local people and participatory approach or JFM committees can be a better solution. Further, Forest insurance policy (fire) can be an option for at least valuable forests by GOI and other measures suggested in the paper for forest fire control and management in western Himalaya.

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**1. Introduction**

*"Fire is one of the early tool man used in his struggle to master the Nature"*. Forests are an important livelihood resource for about 100 million forest dwellers and about 400 million forest-dependent people in India. Many forest-dependent communities use fires to sustain their livelihoods as it facilitate people's collection of fodder, fuel wood, and a number of non-timber products from forests. The fire season usually coincides with the hot summer which extends from January to May in India (Bahuguna & Singh, 2002). Fire damage depends upon the frequency & intensity of fire; the type of the forest, availability & inflammability of fuel load on forest floor and the micro climatic factors. India has variety of dense forests in tropical south, Himalayan mountains and the wet north-east regions. Western Himalayas has alpine forests to semi-evergreen, deciduous, sub-tropical broad-leaved hill forests, sub-tropical pine forests and sub-tropical montane temperate forests. As per the state of forests report 2015 of the Forest Survey of India (FSI) the actual forest cover (21.34%) and tree

cover (2.82%) of India is 24.16% (forest & tree cover) of the geographic area, corresponding to 79.2 million ha. The western Himalaya in Jammu & Kashmir (J & K), Himachal Pradesh (HP), Uttarakhand (UK) and hill part of Punjab & Haryana comprised major coniferous forest of Chir pine.

**2. History and Major Causes of Forest fires in India**

Human induced forest fires in the Himalayan state of Uttarakhand have been a regular and historic feature. Major fires have been noted in 1911, 1921, 1930, 1931, 1939, 1945, 1953, 1954, 1957, 1958, 1959, 1961, 1964, 1966, 1968, 1970, 1972, 1995, 1999, 2012 and 2016. Some fires during 1921, 1930 and 1942 have been associated with popular movements against the then British government's forestry policies and for independence (Bhandari et al, 2012). During the period 1990-2016, the worst incidents of wildfires occurred in Uttarakhand. In 1995, around 3.75 lakh hectares and in 1999 around 80,000 hectares of forest was destroyed in Ganga-

Yamuna junction region in Uttarakhand and in 2008, forest fires in Melghat in Maharashtra affected some 10,000 hectares of forests. Another estimate in HP and UK state that from 1995 to 1999 had fire hazards in an area of 677 700 hectares occurred. Also in 2010, about 19,000 hectare forests were affected by Fire in Himachal Pradesh. Sikkim, Uttarakhand and Himachal Pradesh are among the most forest fire affected states of India.

In India, forest fires are the significant and prominent contributory factor in the degradation process, although the extent of total damage is factually to be verified. According to a study made during 1989, during the sixth Five Year Plan (1980-85) 17,852 fires were reported affecting an area of 5.7 million ha or an annual average of some 1.14 million ha (Saigal, 1989). Data collected by the FSI indicate that the forest area that is affected by annual fires may be as high as 37 million ha (MoEF, 1987). Rodgers (1986) suggested that the non-burning of sal forest in Dudhwa U.P. since national park status in 1974 has allowed a dense undergrowth of unpalatable shrubs to develop. This prevents swamp deer making movements to drier grasslands in the monsoon, reduces chital forage availability and has prevented much sal seedling regeneration. India has about 1.7 million hectares of productive coniferous forests with such valuable timber with estimated growing stock of these forests is over 200 million cubic metres. Conserving marshes, swampy area and water catchments are essential for forest fire prevention. Many effects are related and interacting, fire ecology is thus both complex to understand and difficult to evaluate.

Major factors lead to forest fire in India is due to negligence, such as fires spread by throwing the matchstick after lighting the bidi and cigarette or their stubs / butts. Another reason in India forest fires is also caused by the burning of agricultural residue (straw/husk etc) for cleaning the agriculture field. Many times the visitors/ tourists do camp firing etc for their entertainment. Sometimes short circuit of electric lines inside forest as well as use of torchwood during night by villagers in remote areas leads forest fires. Fires also caused by bursting of crackers particularly what you call the rockets firing in any religious and other celebration ceremonies while crossing the forest areas. Nomadic herders' camps in forest and intentional fires by timber mafia and wildlife poachers also reasons of forest fires in many areas of the country. Local people also do forest floor burning for various traditional reasons like grasses rejuvenation; mahua flower and sal seed collection on the clean forest floor, to promote a better flush of tendu leaves and shifting cultivation etc. Some fires also occur naturally by lightning, rubbing of bamboo, rolling

stones etc (evidences as such not proved). Besides these reasons fire climate (high temperature, low humidity & high wind velocity) and fire material (leaves litter & grasses) are accelerating factors for fast spread of fires. The ground fires are common and less harmful compare to crown fires which engulf more area. In India forest fire varies from one forest type to other e.g. Tropical dry deciduous forests are more prone for forest fire compared to tropical rain forest having high humidity (Dobriyal and Bijalwan, 2016a).

### 3. Forest fire Management in India

In India there are no comprehensive data to indicate the loss to forests in terms of area burned, values, and volume and regeneration damaged by fire. FSI in a country-wide study in 1995 estimated that about 1.45 million hectares of forest are affected by fire annually. According to an assessment of the Forest Protection Division of the Ministry of Environment, Forests and Climate change, Government of India, 3.73 million hectares of forests are affected by fires, annually in India. Around 50% of the forest areas as fire prone with very heavy, heavy and frequent forest fire damages are noticed only over 0.8%, 0.14% and 5.16% of the forest areas respectively. Thus, only 6.17% of the forests are prone to severe fire damage annually (Mehta, 1996). A large fraction of India's deciduous and semi-deciduous forests is characterized by open and frequently burned stands. According to the Constitution of India forests are in the concurrent list where, the central and state governments in the country are enabled to legislate on forestry issues. The implementation part of the forest policy/programmes lies with the state government. Thus, fire prevention, detection, and suppression activities are the responsibility of the forest department of state government while the policy, planning, and financing are the primary responsibility of the Union Government. Forest fire prevention is an important function of the Forest Protection Division in the MoEF & CC, GOI which is headed by a Deputy Inspector General of Forests. The plan scheme on "Modern Forest Fire Control Methods" was implemented in states and also proposed to set up a National Institute of Forest Fire Management in the country for proper research, extension of technology and training of personnel. This project launched in fourteen states and covers more than 70 percent of the forest area of the country. This assistance was being used by the state governments for procuring hand tools, fire resistant clothes, fire fighting tools, radios, fire watch towers, fire finders, creation of fire lines, research, training, and publicity on fire control programme. There is generally no separate wing for carrying out forest fire management in the states, during forest fire seasons in

some of the divisions, to help regular staff fire watchers are recruited by the state governments as a special provision. During the 10<sup>th</sup> Plan a Centrally Sponsored Scheme called “Integrated Forest protection Scheme (IFPS)” continued during 11<sup>th</sup> and 12<sup>th</sup> Plan period with the new name “Intensification of Forest Management Scheme (IFMS)” with objectives to address the most pressing needs of forest protection. The components of the scheme includes forest fire control and management, survey, demarcation and preparation of working plans, strengthening of infrastructure such as roads, camp offices, watch towers, improved mobility, fire arms and use of modern information and communication technology etc. In North East (NE) states and North West (NW) Himalayan state it 90% funded by central government. (<http://envfor.nic.in/division/introduction-11>).

#### 4. Forest fires in Western Himalayas

In forest fire of 2016, over 4,500 hectares area was affected in Himachal Pradesh, some 40% more than the 3,185 hectares in Uttarakhand. The fire had damaged around 3500 hectares of land and loss of fauna and flora. Forest fires cause wide ranging adverse ecological, economic and social impacts. (Kavita, 2016). Majority of fires occur in the in Uttarakhand along Chir pine (*Pinus roxburghii*) forests because leaves of this conifer tree catch fire easily though its bark makes it resistant to the fire. Uttarakhand forest fires are mostly intentional for the purpose of collection of forest resources such as resin, sal seeds, honey, timber etc. People also burn the forests to improve grass growth, scare away the wild fauna, encroachment, accidental or other reasons. Recurrent surface fire, over grazing and trampling impacts characterizes the mountain forests in the Himalayan foothills and mountains of Northern India. The mature pine trees (*Pinus roxburghii*) are fire tolerant but is lacking regeneration and a higher mixed proportion of fire-susceptible broadleaved trees, e.g. oaks (*Quercus* spp.). Indian states experiences most of forest fires during summer months from April to June, though the extent and type varies from state to state, type of forest as well climatic conditions like prolonged spell of dry conditions or delay in arrival of monsoon etc.(Chandran et al, 2011). Himalayan states of Uttarakhand and Himachal Pradesh are tourist attractions in summer but fire created panic among them due to recurrent fires. On 3 May, 2016 the forest department estimated the monetary losses at approximately ₹ 29 lakh. The estimate is based on the standard rule book followed by the department with empirical formulae for such calculations and does not take into account ecological and wildlife losses. With 10,000 personnel and two IAF choppers fighting the blaze in Himachal Pradesh in fire affected six districts:

Shimla, Solan, Una, Bilaspur, Kangra, Hamirpur and Sirmaur. Most of the Himachal fires are ground fires barring the Taradevi forests and a dozen places in Bilaspur and Una. ( Mohit Sharma, 2016). As per reports Uttarakhand Forest Department has also employed 9,000 men with three teams of the NDRF and one of the SDRF. Two IAF Mi-17s have been flying sorties to dump water picked from the Bhimtal lake and the Srinagar, Garhwal, reservoir over the affected areas of Kumaon and Garhwal (Trivedi, 2016).

Wildfires are an annual occurrence in Uttarakhand but in 2016 it was devastating for local people and cause irreparable damage to valuable natural resources of the state. This year the forest fire started right in the month of February and spread chaos in most of the forest areas of the state. The major reasons of forest fire in the hilly state are high fire fuel material of dry Chirpine needles and dry leaf litter of other board leaved trees on the forest floor associated to chirpine. Chirpine covers a significant (about16%) area under forest in the state and every year encroaching the mixed species area due its hardy dominating nature as well as ban on green felling above 1000 mts elevation. The chirpine itself is highly resistant to fire due to thick bark but the fallen dry needles are highly inflammable and its open resin ducts on the trunk are considered to be main catalyst for forest fire in pine forests. The needles of chirpine used for the bedding material to the livestock, briquettes, compost, biomass energy, boards and variety of other uses but could not utilize in mass scale. Unfortunately in recent years’ mass migration of villagers from the hilly state also check local utilization the pine needles leading to high fire fuel for forest fire. It is also important to know that forests in Himalayan areas are spread over difficult and inaccessible hilly terrain where forest officials itself not has access without the help of locals but now became no’man’s land it is even difficult to forest department to cope with the situation. The low rains with dry spell in winter also lead to early forest fire in the state. (Dobriyal & Bijalwan, 2016b).

#### 5. Difference Western Himalayan forest fires and other forests in the country

In Uttarakhand forest fire is common phenomenon in summer season. The major reasons of forest fire are high fire material of chir pine needles and other board leaves trees leaf litter under chir tree (chirpine) and mix species forest associated to it. Chirpine needles are highly inflammable and considered to be one of the main causes of forest fire. The species itself is highly resistant to fire due to thick bark but its exposed resin ducts make it prone to fire. Another reason could be mass migration of the people

from the hilly state to the plain and township leaving very few families in village. There was a time when villagers used to collect the litter (particularly chirpine needle & oak) for the bedding purpose of their domestic animals, which use to reduce fire hazardous material in forest areas. Further the villagers also being in large number use to douse the fire by community approach in initial stage itself but now when no habitation in remote villages who will spot, report and stop the fire. Most of forest areas in Himalayan areas are difficult hilly terrain and inaccessible where forest department itself not has reached without the help of locals but now becomes no man's land which is spreading across.

The fires in other parts of country are different from the Himalayan chir pine forests the inflammability of pine needles and resin ducts of tress make it more susceptible. The steep sloppy and undulated terrain and high wind velocity makes much faster spread of fire within few hours. In other parts of country mainly flat or mild undulated lands are there with mix deciduous forests with teak where leaf fire material is not that much inflammable and spread of fire also slow due to less wind velocity. Secondly the fire detection and control measures can be resumed in short notice in other parts but in Uttrakhand and other hilly areas first the detection of forest fire is difficult due to topography (even by satellite imageries) and to reach the place takes lot of effort and control fires is equally difficult specially along the steep slopes. The spread of Himalayan forests is much more than other with limitation of movement so more depend on local people for control the fire at local level. In recent years migration of people for employment and government pro conservation strategies for wilderness by vacating the people from forest areas without equally investing in watch and ward of forests lead to total isolation of these forest areas. In last two decades there is abnormal rise in temperature, you can say climate change is also one of the reason. The low rains in winter or dry spell of winter also lead to early forest fire with high intensity and drying of natural sources of water.

#### **6. Consequences of Fires**

Black smoke created from forest fire may cause glacier melting and leading to pollution in Perennial River. March to May is nesting period to most of the birds which they lay eggs on grounds had to lost them and threat to their survival. Butterflies and Moths are equally susceptible to smoke and fires directly. Most of the other wildlife young ones may gutted in fires. The small rains in winter or dry spell of winter lead to early forest fire with high intensity. It also change in microclimate and species composition as most the valuable herbaceous species lost in fire.

#### **7. Legislative, policy and planning to control forest fires in context of forest management**

India's National Forest Policy (1988) presents a visionary strategy for forest conservation and management and emphasizes protection of forests against encroachment, fire, and grazing. It states that the incidence of forest fires in the country is high to extent that standing trees and fodder are destroyed on a large scale and natural regeneration annihilated by such fires. There is need to follow special precautions during the fire season with improved and modern management practices adoption to deal with forest fire. The NFP, 1988 directives are a positive step towards protection of forests from fire. The legal and policy framework exists in support of fire protection in the country. Indian Forest act 1927 illustrates that every citizen/ forest dwellers has to help in forest protection activity including fires (Bahuguna, 1999).

In our knowledge there are forest fires preventing and remedial measure programmes are implemented by state and central government. Moreover, community is made aware to protect forest fire. Forest community such as in the form of Joint Forest Management (JFM) programme have also done introduction of modern methods to combat forest fires (Chetankumar, 2002). FSI, Dehradun with ISRO satellite system has been given responsibility of forest fire warning system on the basis of meteorological data of temperature and wind velocity in fire prone areas. FSI send information to PCCF of states and from where it disseminate to range and block level but how are it is taken seriously it is a matter of scrutiny. The detection and monitoring forest fire also carried out and similar sent to all state forest departments. Though there is no separate policy on forest fire but certainly there are forest protection guide line especially from fire at central and state level and also regular fund also allotted for prevention of forest fires to forest department.

The conventional approach of centurion old model of making fire lines criss crossing the whole forests (also used for inspection path) and burning and clearing them before the summer also not practiced properly due to lack manpower in forest department. Generally a Forest guard/ Beat guard has to look after 15-20 sq. km (1500- 2000ha) forest area which seems to be difficult to cover even in week in plain areas than what about hilly areas like Uttrakhand. Most of beats in states are without beat guard or manpower shared with 2-3 beats. The scale of the damage and the waste of natural resources due to uncontrolled fires has brought the issue of forest fires to the forefront of forest policy but not culminated yet.

An important start was made in 1984 when the FAO/UNDP-assisted project in modem forest fire



control was launched by the Government of India on pilot project of Haldwani (Uttarakhand) and Chandrapur of Maharashtra forest divisions but the same has not been adopted in larger context (Sangal, 1989). The modern fire fighting techniques as Early Forest Fire Detection Using Radio-Acoustic Sounding System, Doppler RADAR etc seem to be reasonable option. Further, use of modern system of forest fire detection and monitoring with the help of FSI & ISRO and also awareness among local people with their participation can be a better solution. Since 2004, FSI has been monitoring forest fires across the country using MODIS (Moderate-Resolution Imaging Spectrometer) and GIS based technology. FSI, Dehradun with ISRO satellite system has been given responsibility of forest fire warning system on the basis of meteorological data of temperature and wind velocity in fire prone areas. FSI send information to PCCF of states and from where it disseminate to range and block level but how are it is taken seriously it is a matter of concern (<http://www.fao.org/docrep/t9500e/t9500e06.htm>). In India, there is an urgent need to initiate research in the fields of fire detection, suppression, and fire ecology for better management of forest fires.

#### **8. Possible solution to minimize the forest fire hazard in Western Himalaya**

Forest fires preventing and remedial measure programmes implemented by state and central government in vulnerable areas with insufficient fund allocation. There is also every scope to make the local community, NGOs, Community Based Organizations (CBOs) completely involved in the system to minimize the fire hazards. Van Panchayat is a unique model in the state of Uttarakhand effectively managing forest since a long time but with time forest communities needs capacity building and to be acquainted of modern methods to combat forest fires. The pine needles which are considered main fire hazard need to be converted as resource for community by extending capital, technological and industrial support for its effective utilization and as a livelihood opportunity. Forest scientists have already developed different uses of chirpine needles for briquettes, compost, board, tiles, etc. Some of the suggestive measures can be tried to convert the fire hazard chirpine needle as a resource (raw material) for different uses through creation of Forest Self-Help Groups (FSHG) or any local Forest Special purpose Vehicle (FSPV) with industrial linkage for removal of dry needles of chirpine with the help of villagers to make the bio-briquette, compost or vermicompost, composite boards, panels and tiles etc. Further, this activity can be link with employment generation schemes (MNREGA, Skill India, women

empowerment, Make in India) of GOI. This will provide the double benefit, in one way removal of pine needle from the forest and the other is to give them employment and generate their income, this is a sort of bio-fuel and there is always welcome for bio-energy resources.

Migration of people is another indirect issue need to address to control fires. The willingness of local community in the villagers to stay in the hilly state can improve given the assurance of employment and other basic facilities of health, education and communication thus checking the migration to the township and plain areas. Moreover, those who are living in villages are not willing to continue with poor agriculture or animal husbandry due to economic concerns but can be motivated nature associated activities with market tag like for organic culture of crops, millets, vegetables, milk, mushroom, fruits, colorants and fibres etc. These all activities involve the people in vigil, alertness and protection of their surroundings.

The conventional approach of centurion old model of making fire lines criss crossing the whole forests (also used for inspection path) and burning and clearing them before the summer also not practiced properly due to lack manpower in forest department. Generally a Forest guard/ Beat guard have to look after a large forest area which seems to be difficult to cover even in many days in the tough hilly terrains therefore, forest fire fighting staff should be exclusively recruited in the forest department with their acquaintance with modern forest fire fighting technologies. There can be other approaches to reduce the fire hazard from monoculture/pure chirpine forest by inclusion/plantation of indigenous broad leaved and moisture conserving species in chirpine forest particularly *Banj oak*, *Myrica*, *Alder*, *Rhododendron* etc in higher elevation and *Sal*, *kahir*, *Harad*, *Baheda*, *Arjun*, *Sissoo* etc in the lower elevation. The selection of species for the plantation in chirpine forest must be done after realizing the local ecology and needs of people. Also there is a need to strictly follow scientific and advance bore hole method for resin extraction with possibility of spreading minimum fire hazards.

On scientific forestry front a gradual arrest of spread of chirpine forest, specially above 1000 mts elevation which leading to change in forest composition of moist Oak -deodar forests by applying the principle of stand dynamics and proper silvicultural measures. The selective green felling of chir pine as a silvicultural thinning and improvement thinning for improvement of Deodar -oak forests is need to be done by representing the case in supreme court but it does not mean to harvest the chir pine trees in mass scale. Even in lower elevation felling is allowed but forest department is not having regular

schedule of felling of chir pine forests which need to be addressed in all working plan / forest management/ wildlife management plan/ forest ecosystem management plan of forest divisions. It has been observed dry spell periods are keeps on increasing over the years and moisture regime is gradually depleting, which needs to be addressed by proper soil and water conservation measures in much more scientific way to maintain the soil moisture and recharge the natural water springs.

Participatory approach is key for the success all the initiatives which reflects in JFM areas by strengthening JFM committees. Similar approaches needs in strengthening van panchayat and other local bodies in hill state. Forest department even with the help of FSI and early warning system will not able to detect the fire unless ground support of aware locals. Sensitization of both forest department and locals is equally rewarding to combat forest fire cases at early stage. Last but not least the main weapon against all odds communication (media) through any print or electronic media including social media, community radio programmers or Jan vani, Doordrahan etc. can also act as boosters to aware the people ill effects of fire as well as how to control the fire in shorter period of detection. This communication measures should be activated in start of summer itself and some reward, recognition also to attach in name of legends from Garhwal and Kumaon regions for motivation purpose of locals. We can say in fire control strategy more emphasis to be given to prevention than cure as its of no use to cure after loss of all biodiversity, forest wealth and lives in general. In short we can adopt the following to control the forest fire in respect to western Himalaya- Change in species composition that is inclusion of suitable composition of trees with chirpine forest like Banj oak, Myrica, Alder, Rhododendron etc. To check the migration of people form hilly areas of Uttarakhand. Good and sound collaboration of forest department with forest villagers is required. Proper fire Forecasting & warning system to prevent the forest fire. Creation of separate wing for fire fighting in forest department. Conversion of forest litter and humus to bio bricks and vermi compost. The modern fire fighting techniques as Early Forest Fire Detection Using Radio-Acoustic Sounding System, Doppler RADAR etc seem to be reasonable option. Further, use of modern system of forest fire detection and monitoring with the help of FSI & ISRO and also awareness among local people with their participation can be a better solution. Implementation of standard fire fighting methodology through fire danger rating system for different types of forests (Forest fuels). Forest insurance policy (fire) can be an option for at least valuable forests by GOI (Bijalwan & Dobriyal, 2016a).

## 9. Way Ahead for Fire management in India

The successful method of fire protection in traditional forest management was an elaborate network of fire lines, block lines and guidelines, and their early clearing and burning need to be logically strengthened. Inculcate the sense of belonging for the forests to work effectively for the conservation of natural forests. The awareness campaign is a long way to bring down the forest fire incidences through the pioneer leaders who march for the cause of protection of natural resources. Emergence and functioning of forest fire Protection Committees (FFPC), Opinion leaders, Demonstrations and videos shows on how to control forest fire can create a lasting impression on the minds of local people. (Shrivastava, 1999). The institutionalization of the conceptual shift in Forest management from purely state sponsored to Joint Management with people's involvement through participatory approach in fire prevention and control. Mutual confidence and public support has to be created by participatory approaches e.g. incentives, income generation activities, involvement in production enterprises etc. for involvement of communities in fire prevention and control (Goldammer, 2000).

People's view on the occurrence of forest fires is of vital importance in assessing the impact of community efforts at fire control. Socio-economic and cultural surveys reveals that communities do not realise the economic and ecological losses due to forest fires. Therefore, a motivation strategy for prevention requires an initial understanding of the cultural, socio-economic and psychological background of community perception of fire losses. Equity in benefit sharing has been another factor, which was found to affect the community efforts to control forest fires. Proper planning is imperative for fire prevention. This calls for the three general approaches to work in tandem i.e. Education, Engineering and Enforcement (Nair 1992). Hazard reduction or limiting the exposure of forests to fire risks constitutes mainly the engineering aspect needed (Brown and Davis 1973). The clearing along paths, early and control burning of vulnerable areas, fire lines etc. with assurance that the public abides by the rules and regulation set out for prevention of fires calls for effective enforcement of regulations. Finally, while community participation is important, it needs to be further augmented with appropriate pre-fire planning and fire prevention strategy like developing fire plans, fire maps, and capacity building through training, pilot demonstration, followed by fire suppression mechanism, and necessary post-fire rehabilitation and management.

Despite the widespread occurrence of fires in Indian forests, we still lack precise information regarding fire occurrence, fire frequency, fire intensity, and the exact causes of fire. Even though most fires today are likely to be human-caused, the reasons could be manifold. By and large, forest fires are linked to the benefits that people obtain from forests. To a lesser extent, forest fires are linked to people's religious beliefs or cultural practices. In addition, forest managers use fire as a habitat management tool e.g. to maintain grasslands for herbivores. To design framework for integrated forest fire management, this seeks to accommodate the differing forest management goals of a diverse range of stakeholders (Singh, 1997).

It is possible that the transformation of fire occurrence from a poorly managed practice into a tool for sustainable forest and landscape management, applied judiciously, and in cooperation with forest authorities, could result in acceptable tradeoffs between local livelihoods and the conservation of forests and biodiversity. This type of fire management would require knowledge as well as a shared consensus about the role of forest fires in meeting people's livelihood needs, and its influence on ecosystem processes, biodiversity, carbon sequestration, and the supply of other ecosystem services. a long way towards reducing conflict between resource managers and forest dependent communities, making them allies in conservation, and resulting in benefits to biodiversity as well as people's livelihoods.(Vibha Sharma, 2016).

## 10. Conclusion

The conservative estimate of loss from fire in India is around Rs 35-40 crores annually. The regular occurrence of fires, despite over a century of strict fire suppression by different means suggests that fires potentially play an important role in people's management of their landscapes. Our knowledge about the causes of fires, their extent, effect on forest ecosystems, and their link to the goods and services that people derive from forests is limited. This lack of understanding of human induced fires regularly becomes out of control which sometimes directed to small gain from forest by local communities. The ecological, socioeconomic, or cultural effects of fire strive for fire management that meets the livelihoods needs and effective forest resource utilization by forest-dependent communities while also conserving forests and biodiversity.

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