Literature Survey

Team ID	:PNT2022TMID18327
College Name	:Sona College of Technology
Department	:Computer Science Engineering
Team Leader	:Hari Hara Kumar
Team Member	:Ashwin
Team Member	:Thirugnanasampanthar
Team Member	:Avuddayappan kasi Visvanathan

THE IMPACT OF FOREST FIRE ON FOREST BIODIVERSITY IN THE INDIAN HIMALAYAS

Abstract :

Frequent fires in the Himalayan region of Uttaranchal in the Indian Himalayas have been blamed for forest deterioration. It is true that frequent fires on large scales cause air pollution, mar quality of stream water, threaten biodiversity and spoil the aesthetics of an area, but fire plays an important role in forest ecosystem dynamics. Moreover, it is not fire, but other anthropogenic activities plus fire that are degrading the forest of the Indian Himalayas. In the present study the role of fire in shaping forest structure and composition is analysed. If fire is managed wisely it can be used as the cheapest means of forest management. For this purpose different fire characteristics are assessed together with their interrelationship with forest flora.

Introduction

Fire has long been integral part of the forest environment and has played an important role in shaping the flora and fauna. A fire may be either beneficial or detrimental to individuals of a particular species but the effect of a single fire is not as environmentally significant as a change to the fire regime (Smith, 1995).

The social, economic and ecological cost of fires has demonstrated that the resources many governments have to respond to forest fires are often overwhelmed. A UN mission report on the 1997 Indonesian forest fires concluded that the blazes had "an important international dimension in relation to severe, transboundary air pollution, and the large scale destruction of the unique aspects of the existing biodiversity which represents a world heritage" (UNDAC 1997).

In Indian context according to a study by Srivastava (1989), during the Sixth Five-Year Plan (1980-85) 17852 fires were reported, affecting an area of 5.7 million ha, or an annual average of some 1.14 million ha. Inventories conducted by the Forest Survey of India show that on average 55% of forest area in India is affected by fire and 78 percent by grazing. Subsequently, little regeneration occurs in 72 percent of forested areas (Ministry of Environment and Forest, 1997). The annual losses from forest fires in India for the entire country have been moderately estimated at Rs 440 crores (US$ 107 million). This estimate does not include the loss suffered in the form of biodiversity, nutrient and soil moisture and other intangible benefits. India witnessed the most severe forest fires in during the summer of 1995 in the hills of Uttaranchal and Himachal Pradesh in north west Himalaya. An area of 677,700 ha was affected by fires. The quantifiable timber loss was around Rs. 17.50 crores (US$ 43 million).

In the present study fire is studied as agent of transformation which affects biotic and abiotic component of ecosystem and thus altering productive, protective function of a forest. This is highlighted in the ecosystem fragmentation, alteration in ecosystem structure and function, biodiversity status of an area. An attempt is made to study the short and long term effect of fire on biodiversity status.

The study area is characterized by hilly and mountainous terrain supporting varied forest types and composition controlled by altitude, landuse/land cover types along with perpetual snow cover on the mountain peaks. Variation in altitude is quite appreciable ranging from about 549m to 3750m. There are no perpetually snow-covered areas in this range. The area under forest cover represents 56.14% out of its total geographical area. Pine is the dominant forest type followed by oak, oak mixed and deciduous. Pine is most susceptible to fire almost every year particularly near habitation/agricultural patches.

Fire a necessary evil!

Any fire on a forestland which is not being used as a tool in forest protection and management in accordance with an authorized plan may be referred to as a wildfire (Show and Clarke 1978, Artsybashev 1986). Fire alone has rarely destroyed a landscape, evolutionary adaptations have seen to that. But fire and hoof, fire and axe, fire and plough, fire and sword; all magnify the effects by altering the timing of the fire, its intensity, the fuels on which it feeds, or the biological potential for exploiting the aftermath of a burn (Chaturvedi 1999).Spatial and temporal variation in severity within a fire can have long-lasting impacts on the structure and species composition of post-fire communities and the potential for future disturbances (Ryan 2002). Plant species surviving fires known as pyrophytes coppice and have responses resulting into offspring from seed. An individual plant may be exposed to several fires, each with different fire characteristics and fire effects. To determine the significance of adaptive traits consideration must also be given to the life cycle of the species and fire regimes to which the species is subjected.

Effect of Forest Fire on Forest Biodiversity

Grazing and fire are linked to plant invasions. Gaps created by high-intensity fires are particularly susceptible to invasion by exotic species e.g. *Imperata cylindrica* quickly recovers after fire and may respond with an increase in cover. Invasive species depletes the biodiversity of an area through allelopathic path ways.

Terminalia chebula, *T. bellirica, T. tomentosa* which is having highly commercial and medicinal value respectively is facing severe problem due to forest fire leaving behind poor stocking. Species like *Lantana camara*, *L. indica,*, *Eupatorium glandulosum, Parthenium hysterophorus,, Cassia tora*, *C occidentalis*, etc. have invaded several of the significant sites of forest biodiversity conservation.

Many believe that fires are bad but they are actually necessary to promote diversity (Douglas 1971, Kovacic 1998). Forest species change in composition after fire, this may be good or bad depending on the utility of the stands that preceded and succeeded the fires (Lutz 1956).

1. Protective Value: increased erosion/sedimentation, introduction of weeds etc.

2. Present and Potential Value: loss of recreational use, loss of visual amenity, changed water yield and quality, extinction of species.

3. With What degree of difficulty can forest be re-established after fire e.g. allow the tree species to persist at a site but not the hollow dependent mammals, death of ´charismatic' animals

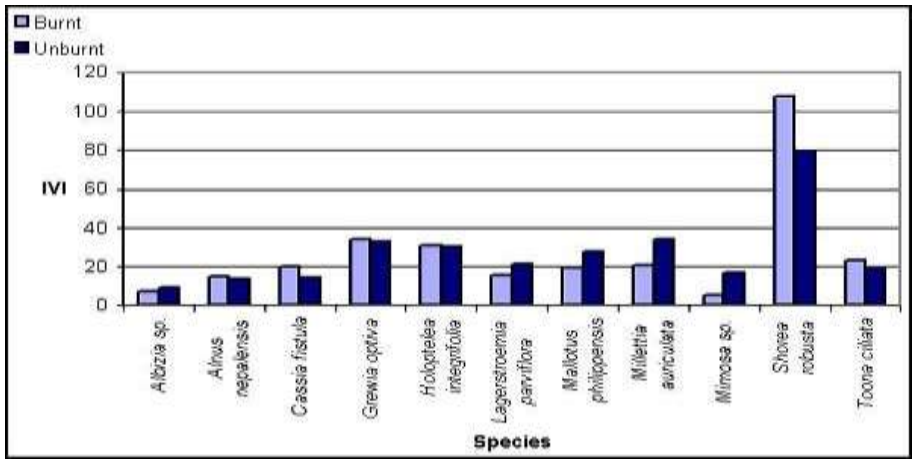
4.Is future protection increase in difficulty after forest fire? Role of Fire in Forest Management

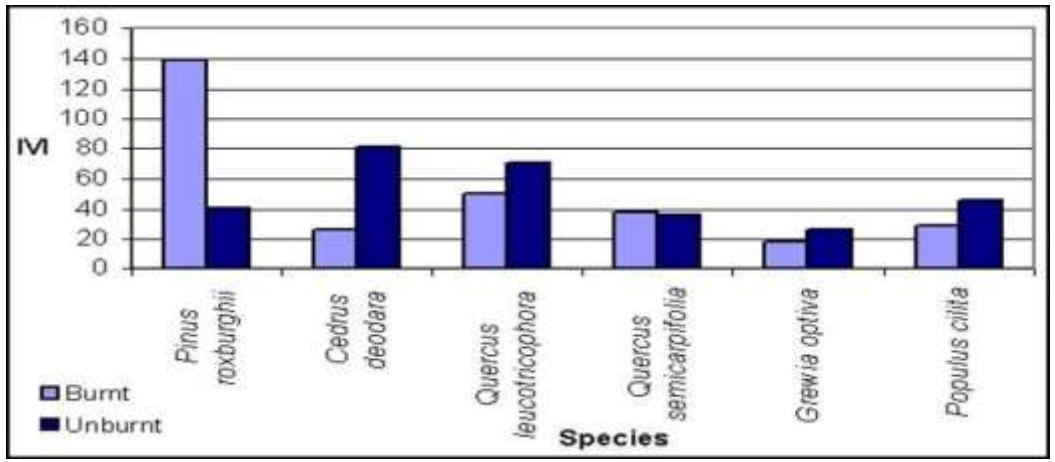
Overly simplified fire prevention propaganda which gave recognition only to the destructive effects of fire (Vélez 1990) led also to a school of thought that all fire on wild-lands was bad and that even accepted uses of fire must be tolerated only as a matter of choosing the lesser of two evils. How can fire help forests? The answer depends on the nature of the ecosystem, the weather, and the amount of fuel available(Kayll 1974, Viro 1974, Terry *et al*. 1996), but in general, controlled fires can:

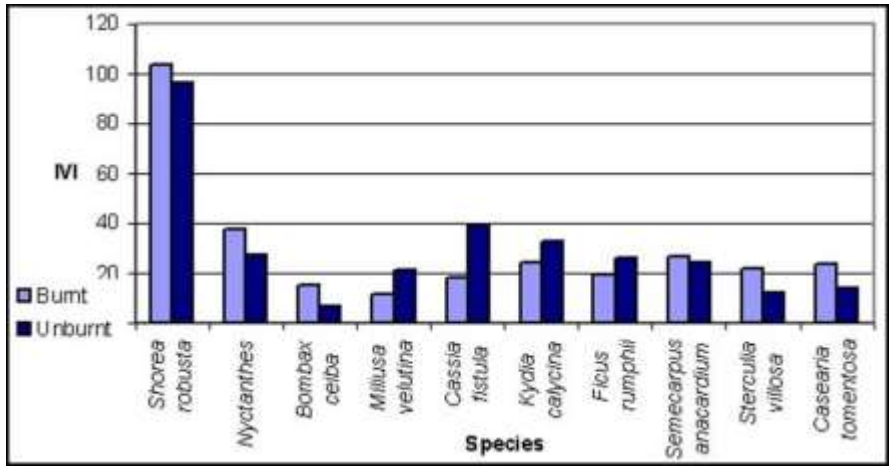
1. Reduce the build-up of fuel, and thus the intensity of future burns.
2. Recycle nutrients bound up in litter.
3.Reduce competition, allowing existing trees to grow larger. To control the encroachment or development of undesirable plants and encourage desirable food plants such as legumes for both forage and soil improvements, or shrubs.
4. Leave snags that provide nesting spots for woodpeckers and other birds.
5. To remove unpalatable growth remaining from previous seasons.
6. To stimulate growth during seasons when there is little green grazing.
7. To control or destroy insect and disease.
8. To aid in the better distribution of animals on a range or management unit, including bird habitat.
9. To stimulate seed production or opening of cones and prepare seedbeds for seeding, either naturally or artificially.
10. To establish fire breaks in a system of protection from wildfire.
11. To provide training for fire fighters and fire researchers.

Methodology

To estimate biodiversity quadrates were laid in sites, which had history of forest fire of different intensities, and in sites with similar condition i.e. natural forests where sites escaped fire. The data was analysed and based on that a list of species was prepared depicting response of fire. For each species Importance Value Index (IVI) was calculated. Importance Value Index: IVI- which is the total sum of relative density, relative frequency and relative dominance was applied. For herbs data were analysed for frequency and Shannon-Wiener diversity index. This index measures diversity by the following formula:







Graph 1: Comparative Analysis of IVIs (Trees) of burnt and unburnt area of Narendranagar

Graph 2: Comparative Analysis of IVIs (Trees) of burnt and unburnt area of Dhanaulti

Graph 3: Comparative Analysis of IVIs (Trees) of burnt and unburnt area of Dat Ka Mandir

Result and Conclusion

Fire exclusion programs often result in exceptionally destructive fires by permitting abnormal fuel buildups and vegetational deterioration. In the case of Tehri-Garhwal Himalayas, field data analysis suggest that low intensity surface or ground fire were less detrimental to forests of Sal (*Shorea robusta*), Teak(*Tectona grandis*), Chir Pine (*Pinus roxburghii*) trees but herbs and shrubs were most suffered. Bare soil was devoid of surface cover which makes it susceptible to soil erosion. Some trees suffered fire scars which were vulnerable spots for infestation by insects and pests. It was also observed that it is not fire alone responsible for degradation of area but it's the combination of fire and grazing; because grazing is quite ubiquitous in Upper Himalaya especially goat, sheep rearing which are browsing animal causing more damage to regeneration by devouring even smallest twig of plant. Secondly goat and sheep can approach difficult terrain and making area devoid of vegetation, thus increasing more damage to forest by virtue of landslides. Similarly grazing by cattle in lower reaches of Himalaya has major impact on soil compaction, destroying of new regeneration by their hooves and grazing. On the basis of quadrate study for assessment of status of biodiversity of flora species, it is clearly evident that fire control floristic dynamics of the area; like in area of Asarori range, on second visit after 2 months of fire a prolific regeneration of obnoxious climbers, *Lantana camara* and other weeds was evident. *Shorea robusta* suffered the least but its seedlings were heavily damaged and only few resprouted from coppice. This can be another problem related with regeneration of Sal. Also Sal suffer dieback problem in the region and fire aggravates it. Immediate effect of fire on fauna was that they migrated to nearby human settlement areas for want of food, water and shelter. Chittal were sighted drinking water near roads.

In Narendra nagar site in Uttaranchal himalaya *Shorea robusta* was the successful survival after fire but *Cassia fistula* suffered to certain extent on comparison with unburnt site. Among the shrubs *zizipus species* has taken advantage of fire as it can survive xerophytic conditions after fire and can grow well from hidden buds shoots near base which escape fire. Some of the species, which were totally exterminated, were *vitex negundo, hypericum species*. Thus, fire has decreased floral diversity of burnt area to a considerable extent.

In temperate forest of Dhanulti himalaya *Pinus roxburghii* was the successful survivor of fire, this is because of its adaptive traits such as chambered bark, self pruning habit, serotinous cones etc. *Cedrus deodara* is more susceptible to damage by fire that is why it is confined to moist localities of the area.

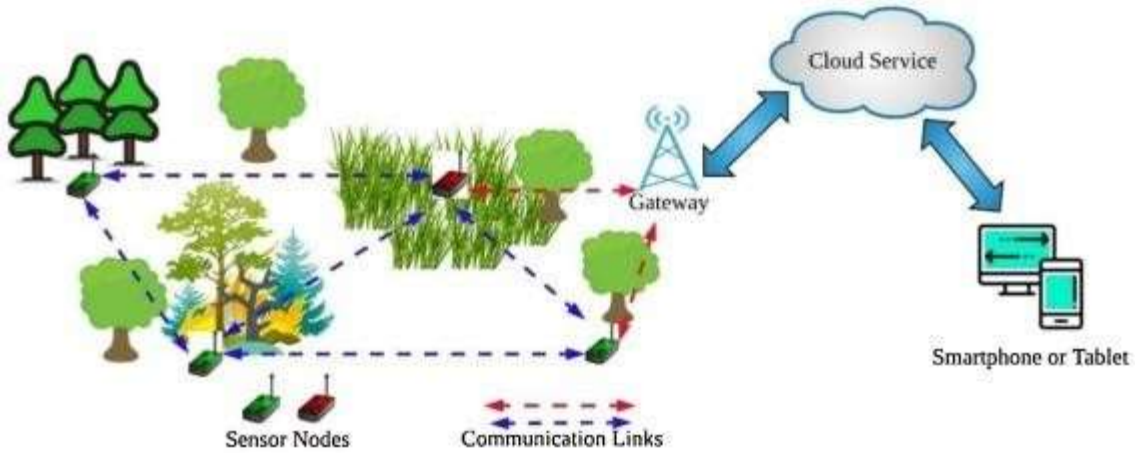
Among the undergrowth of pine and deodar forests the fire damage most of the species like *Berberis species* as it has low moisture content in tissues but it reinvaded area by means of available seed bank. In the study area it was observed that upper soil flora and fauna and microbial rich humus was either completely or partially damaged depending upon locality factor, fire characteristics. It was also observed that ground cover was having higher percentage of invasives with gregarious growth, for e.g., *Sarcoccocoa species, Princepia species, Dapenae species* etc. Ground was covered with layer of chir pine needle with hindered further growth of other species and most important of all creating favourable condition for frequent revisit of fire.

Overall biodiversity status in all three sites of burnt areas was significantly less than unburnt sites. This is evident from the comparison of Shannon-Wiener diversity index for burnt and unburnt areas of Dhanaulti, Narendra nagar, Asarori range forest. For this some of the possible explanation can be on most of the sites frequent fire was intentionally set up for new flush of grasses. This suggests that uncontrolled grazing is rife in those areas, so it is cumulative effect of frequent fires and uncontrolled grazing which has depleted the biodiversity of the area. Moreover, fire increased accessibility to these areas so people used to collect Non-Timber Forest Products from these areas which has considerable impact on floristic composition.

Recommendation for need and priorities

For successful use of fire as a management tool in sustainable forestry practices it is must to carry out fire-prevention measures in frequent fire prone areas as integrated element of forestry in accordance with scientific norms; improve airborne forest fire monitoring and ground-based fire detection and patrolling. It is obvious due to difficult terrain, inaccessibility, lack of technical staff regular patrolling of the fire prone area is not possible; this can be overcome by suitable silvicultural measures employing rehabilitation of burnt sites with broad leaved evergreen trees. For successful rehabilitation of burnt sites utilize to the full extent the regeneration potential from unburned forest fragments. Further need of the work is elucidated as follows:

1. Establish plantations only in accessible sites by using fast-growing species in order to speed up carbon sequestration.
2.Concentrate and prioritize planning and implementation of forest cultures in protection forests in water catchment regions and unburned forest fragments with a high protective value for habitat rehabilitation of rare and the most valuable wildlife animal species.
3. Livestock grazing breaks up potential fuel and establishes trails through the forest that can be used as fire breaks, but there is need of controlled grazing below carrying capacity of ecosystem.



THANK YOU