FIRE AND FOREST MANAGEMENT: AN OVERVIEW

DIPANJAN GHOSH*

Ecology or the study of relationships between fire, environment and living organisms is a well discussed topic in today's context. Natural and man-made attempts of fire can be good for an ecosystem. On the other hand, majority would argue that forest fires are bad, as fires cause pollution and related environmental problems. The purpose of this article is to review the pros and cons of forest fires in the light of forest management.

Introduction

The word ‘fire’ brings different images to our mind. Fire is one of the most destructive natural forces in this green planet. Side by side, it is one of the greatest tools that enabled us to be civilized. So what is fire? Is it our fiend or friend? As fire destroys everything including vegetation, animals, human lives and properties that cannot escape its path, most people think of fire as ruinous and harmful. But some people, mostly ecologists, have studied the effects of fires in different environments and have found that fires can actually be instrumental for the survival of many plants and animals in a forest ecosystem.

Fire is associated with many events from very early in Earth's history. Evidence of the occurrence of fire found in charcoal deposits called ‘fusain’ in some petrified tree trunks of the Paleozoic Era suggest that fire may have influenced the shaping of landscapes much before our forefathers learned to use fire. During prehistoric period, humans used fire as a cultural tool to clear fields for cultivation, to drive game, and as a means of communication. Of the many ways in which pre-historic humans modified the forest, fire was enough effective to significantly influence the forest types. Moreover, fire is the single most important tool today, in converting tropical forests to agricultural land.

Inferno in the Forest

Started by humans or weather, whipped by wind and fueled by dry leaves and twigs, the forest fire generally occurs worldwide in most forests and grasslands. Fires in the forest are classified into three categories. Ground fire or muck fire occurs beneath the top soil. This fire spreads very slowly and in most of the cases it becomes very hard to detect and control such type of fires. They may continue to burn for months and destroy vegetative cover of the soil. In case of creeping or surface fire, the fire generally spreads slowly over the forest floor, burning with a low flame and sometime remains restricted to the humus layers occurring over the top soil. Surface fire may spread rapidly by wind over the vegetation of the lower canopy composed of grasses, herbs and shrubs (Figure 1). Crown fire is the most unpredictable fire that consumes the entire upper canopy of a forest. Among the aforesaid fire incidents, the fire spreading most rapidly is the firestorm, which is an intense fire regulated largely by air over a large area.

In fact, fires are a natural part of the circle of forest life in most types of forests and grasslands. Natural sources like lightning, volcanic eruption, etc., can cause forest fires. Lightning induced fires are quite common in boreal forests where the forest floors are rich in raw humus deposits and with minimal microbial activities. However, such fires often do not last long and get extinguished by rain, without causing much damage. Incidents of forest fires due to volcanic eruptions or the mutual friction between tree trunks, bamboo culms, rolling stones, etc., are of very rare
occurrence. Certain insects and small animals are also responsible for the forest fires indirectly. Insect activity leaves many woody plants dry and dead. These dead trees are inflammable and provide fuel for fire. In the tropical rain forests, squirrels make trees prone to lightning by mutilating their tops. Conifers and other resinous plants are more vulnerable to fire.

In India, forest fire is a seasonal phenomenon that occurs mainly in grasslands and various types of forest compositions such as pine and broad-leaved hill forests, montane wet temperate forests, sub-tropical dry evergreen forests, tropical dry evergreen and semi-evergreen forests, tropical thorn forests and tropical moist as well as dry deciduous forests. For instance, Himalayan montane forest vegetation and shola grassland ecosystem of the Western Ghats encounter fire incidence in regular intervals, mostly during the dry season. However, fires can occur in rainforests too, but under very extreme weather conditions. Similarly, some grasslands that occur in alpine regions of the Himalayas that are maintained by frost throughout the year, and not fire.

Dry forests and grasslands have ample amount of fuel in the dry season each year. But lightning fires are not as common in dry forests because of the rare incidence of lightning during the dry season. In addition, leaf litter is not consistent throughout the year and accumulated dry biomass is consumed by termites and some microorganisms within a few days. So, there are very limited chances of fire occurring naturally in India and most of the incidents are caused due to anthropogenic activities.

There are some other anecdotal evidences supporting the spread of fire in forests as well as in grasslands. Sometimes fires are set on to the forest to improve the quality of pasture land and to create fresh grass growth for cattle; to facilitate the collection of various forest produce such as tender leaves, honey, lichens, dry grasses and seeds. Moreover, smugglers and poachers burn forest area to have more visibility and to avoid encounter with wild animals. Sometimes people set fire to scare away wild animals from villages and agricultural fields.

A Fiery Tradition

Slash and burn method or swidden or shifting cultivation is an age-old method of traditional farming in which the area of cultivation is shifted, although the farmers and their families remain in the same place, generation after generation. Perhaps slash and burn methods were first used significantly in the Neolithic revolution, i.e., about 9000-11000 years ago at the end of the last ice age when humans turned to farming, after leading a life as gatherer and hunter.
At present it is practiced mainly in the tropical rain forests and grasslands throughout the world. The slash and burn cultivation is very common in few areas as an indigenous agricultural system in India and it has many names. In Assam and the rest of the North-East, it is known as ‘jhum’, in Odisha as ‘podu’, ‘dah’ or ‘kamana’; ‘penda’ in Madhya Pradesh and in the Western Ghats, it is known as ‘kumri’, ‘hakkal’ or ‘punam’.

In its early days slash and burn method of cultivation was practised in different forest areas irrespective of their types and status, by local inhabitants and jungle dwellers. After independence of India, this type of farming is now restricted only to a few forest areas that are managed by local communities, mostly tribal or aboriginal people. Shifting cultivation is not allowed in protected areas of national parks and sanctuaries, though it may be practised in some reserve forests associated with human inhabitation and are located in hilly inclines to open plain land areas.

After winter, a portion of the hill-slope or forest is first marked off for cultivation. It is cleared by lopping off the undergrowth and branches of trees, which are allowed to dry in the sun for some time. Shortly before onset of rains, the dry leaves and bushes are set on fire. Farmers take care that the fire does not spread into the forest. When the fire dies down, the ashes are lightly spread over the ground and crops are sown thereafter. The fire kills the weeds and insects, and the ashes fertilize the ground.

In some parts of our country, the land may thus be used for only one season or two. In few other areas, it may be used for three seasons and then left for a number of years to recuperate. The period of recovery may vary from ten to twenty years. However, with increase in human population and increasing pressure on land, swidden cultivation cycle has reduced progressively from five to six years.

**Controlled Fire**

In United States, Canada and Australia as well as in some African and South American countries, lots of works have been done in the field of ecopyrology which deals with fire on grasslands and forests as well as on the use of fire in land management. Controlled fire or swailing is a technique used as a genuine wild land management measure and are performed by trained personnel under the supervision of forest department. Since 1995, the United States Forest Service has incorporated burning practices into its forest management policies. However, in India and other Asian countries such burning practices are in early stages of
forest management and are yet to be opted on a large scale basis. An exception is Kaziranga National Park, Assam, where the grasslands are burnt every year. Also there are some dry forests in South India where patches are burnt by forest department along roadsides to increase their efficiency as fire breaks in case of wildfire.

Controlled burning or prescribed burning reduces the possibilities of wild fires. Clearing leaf litters, dropped branches, inflammable grasses, and ground vegetation from the forest floor with low intensity controlled fires can help in preventing furious wildfire incidents that spread out of control and completely damage forests. As a result, it can be a tool for foresters in forest management and grassland restoration. There are different types of controlled burning methods involving modern pyrotechnologies\(^5\). Broadcast burning is the burning of scattered slash over a wide forest area. Pile burning is gathering up the litters into piles before burning. However, both these techniques are not practised in India. Field burning, practised prior to shifting cultivation, is also a kind of controlled burning.

Back burning, which differs considerably from controlled burning, is a way of reducing the amount of flammable materials during a wildfire. It is done by starting small fires along a man-made or natural firebreak in front of a main fire front. The basic reason for back burning is that there is little material that can burn when the main fire reaches the burnt area. Back burning is applied in forests of South India to control wildfires.

In United States and Canada, controlled fires are sometimes ignited using a tool known as driptorch, which allows a steady stream of flaming fuel to be directed to the ground as needed. Driptorch may be mounted on a helicopter or on the side of a road vehicle for setting on fires within a short time as well as in large areas.

**Benefits and Losses of Burning**

Fire has several positive as well as negative ecological impacts. Low intensity fire that does not grow out of control has collective advantages to the ecosystems and its various species. Forest fire removes low-growing undergrowth and small tree species as well as cleans the forest floor of debris. Reducing this competition for nutrients and space allows established trees to grow stronger and healthier. When fire removes a thick stand of shrubs, the water supply is increased and thus other plants are benefitted. On the other hand, both surface fire and crown fire are responsible for the overall damage to forest trees. If trees die, the forest ecosystem gradually becomes a grassland ecosystem. Fire can be a major threat to the rarer tree species resulting in an irreversible loss to flora. Repeated fire incidents considerably reduce regeneration of trees and wiping out the traces of tender plant species. Certain ectotrophic mycorrhizal associations are also harmed by fire or more correctly smoke, acting like fumigating agent.

Fire opens up forests so that sunshine can get through which encourage plants to grow. Besides, forest burning completely destroys the aerial parts of affected plants though their roots, rhizomes or other underground parts sometimes remain unaffected. Under favourable conditions they may grow and produce new plants. Forest fire perpetuates certain fire dependent plant species and also helps in regeneration (Figure 2) of some other plants of tropical and sub-tropical plains. Some tropical grasses and legumes such as turkey foot (*Andropogon gerardii*), piligrass (*Heteropogon contortus*), needle grass (*Stipa comata* and *S. speciosa*), kangaroo grass (*Themeda triandra*), lanceleaf rattlesnake (*Crotalaria lanceolata*), wild indigo (*Tephrosia juncea*), Sicilian sumac (*Rhus coriaria*), sugar bush (*R. ovata*), etc., require fire treatment for seed germination.

Similarly, growth of some other tropical forest plants like buttercup tree (*Cochlospermum religiosum*), dhamin (*Grewia sapida*), dwarf bush willow (*Combretum nanum*), fireweed (*Epilobium angustifolium*), quaking aspen (*Populus tremuloides*), etc., and some pyrophilous fungi, for instance, *Pyronema confluens* are stimulated by fire. Certain European and North American conifers like black spruce (*Picea mariana*), sandhill pine (*Pinus clausa*), lodgepole pine (*P. contorta*), chihuahua pine (*P. leiophylla*), etc., are serotinous, i.e., they open cones to disperse seeds after getting heat from fire.

Conversion of forest to cultivated fields using fire lowers the mineral value of the soil leading to site degradation and reduction in genetic potential and diversity. With reduction in shifting cycle from 20-30 years to 2-3 years, the land under shifting cultivation loses its nutrients, moisture and the top soil. It directly affects the crop yield. With reduction in crop yield, the families start moving to other virgin areas. Frequent shifting from one land to the other has affected the ecology of the region. The area under natural forest has declined; the fragmentation of habitat, disappearance of native species and invasion by exotic weeds and other plants are some of the other ecological consequences of swidden agriculture. Also repeated short-cycle slash and burn practices have created forest canopy gaps which are evident from the barren hills (Figure 3) in few North Eastern states such as Assam, Mizoram, Manipur and Arunachal Pradesh, where shifting cultivation is practised.
Fire, though indomitable, determines the spread of the vegetation in certain areas. For instance, the composition of the vegetation at all altitudes in the Himalayas has been much figured by fires. Mature trees of chir pine (Pinus roxburghii) can withstand forest fire. However, seedlings of this pine are not fire resistant and frequent burning makes regeneration impossible. The blue pine (P. wallichiana) is not fire resistant though its growth is favoured by fire. The blue pine regenerates quickly on drier areas of the Himalayas which have been gutted out by fire. On the other hand, the Himalayan cypress (Cupressus torulosa) is exceptionally susceptible to burning. As a result this plant shows restricted distribution on steep limestone rocks which are devoid of inflammable undergrowth.

Many forest trees struggle against certain pathogenic or non-pathogenic diseases and insect infestations. Forest fire kills harmful pests, parasites, fungi as well as invasive weeds and keeps the forest healthy.

Forest fire causes a huge outcome of smoke (Figure 4), mainly due to large scale biomass burning. Various gases of biogenic origin such as carbon dioxide, carbon monoxide, methane, non-methane hydrocarbons, nitrous oxide, and nitric oxide are produced by such burning incidents. In fact, forests generally maintain the balance of gases like oxygen and carbon dioxide in the atmosphere. However, the gases generated due to forest fire not only pollute the atmosphere but also contribute to green house effects and global warming. In addition, biomass burning may be a significant global source of methyl bromide, a furious chemical responsible for ozone depletion. Particulates produced during forest fires have substantial impact on human health. The spread over smoke may impose low visibility problem to aeroplanes, ships and vessels which often terminate in to an accident as happened in Indonesia few years ago.

Fire cannot usually finish all at once. Animal reaction to fire depends on their mobility; ability to find safe shelter and sensitivity to smoke and heat. Most of the animals remain unharmed as they can take temporary shelter in unburnt or already burnt areas. Fires burn the eggs of birds, destroy the young animals and damage their habitats. As habitat is burnt some animals are unable to move to other areas, due to unfamiliarity. Birds take advantage of their flight to escape fire. Snakes, lizards and some small mammals avoid the fire by taking refuge in deep underground burrows and crevices. Surprisingly, some non-burrowing animals are killed by suffocation, when trapped inside smoke laden burrows or pits. Some cold blooded animals including snakes are seen to bask in burnt areas where the ground is warm. Burning of thick grasses affects both prey and predator, as cover for both is lost. Some animals’ death can also result from heat stroke. However, only large and intense fires (very rarely happens) can damage and kill all types of wildlife including mammals. Fire also causes scarcity of forage as well as specific food species for animals in the ecosystem. However, fire is actually good for animals in the long run. It triggers the growth of different grasses and thus improves the quality of forage. Animals grazing on burnt grasslands are found to gain in weight more rapidly than those grazing on unburnt grasslands.

**Conclusion**

It may be concluded that fire in the forest always does not have to bear a negative stereotype. Natural fire is actually vital to the survival of several species including human. Furthermore, fire does not mean the end of the ecosystem, rather fire helps in rejuvenation. But one cannot forget that fire causes pollution and related environmental problems. Moreover, all kinds of forests and grasslands cannot be managed through controlled burning. As forest burning is practised once in a year by the forest departments, then what should the plans of forest managers be for all the year round. Forest management by fire is very costly also. In a country like India, it would be wiser to say that the costs and benefits of burning should be assessed before setting an area on fire.

**References**