

Review Article

<https://doi.org/10.20546/ijcmas.2023.1202.009>

Forest Fires: An Assessment of Terrestrial Ecosystems

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ABSTRACT

Keywords

Forest fire, biodiversity, climate change, soil, species, communities

Article Info

Received:

03 January 2023

Accepted:

29 January 2023

Available Online:

10 February 2023

Forests are basis of life. They are called lungs of planet. They sustain biodiversity and provide endless products and important resources such as storage of carbon, flood & landslide control, clean supply of water and air, medicines, crops and other ecological services. India occupies just only 2.5% of the global geographical area, 1.8% of the overall forest area and it supports 16% of the total human population of world. In this backdrop forest fires have provided huge damage over the years ravaging ecosystems, communities, and economies. The impacts of forest fires on biodiversity, climate, forest species, and soil characteristics in India are described and various strategies adopted by the government of India in order to detect and control the forest fires are presented.

Introduction

The most serious hazard in forests is forests fire. Forest fire refers to uncontrolled fire occurring in vegetation more than 1.8 metres (6 feet) in height. According to the State of Forest Report 2021, approximately 22% area of forest cover in India falls under the highly and extremely fire-prone category. Fuel, oxygen and heat sources help the spreading of wildfires.

Fuel is any flammable material surrounding a fire, including trees, grasses, brush, They pose a threat not only to the forest wealth but also to the entire regime to fauna and flora seriously disturbing the bio-diversity and ecology of the region.(Kittur *et al.*,

2014) Various studies mention that forest fires have become extreme and have increased in frequency worldwide (Cochrane, 2009). India with 21.67% (7,12,249 km²) area under forests is no exception to forest fires. 55% of forests in India are vulnerable to intermittent fires (Forest Survey of India, 2011a) Out of the 647 districts in India, nearly 380-445 districts encountered fires every year from 2003 to 2016 (World Bank, 2018).

During summer season the forests become littered with dry senescent leaves and twinges, which can catch fire ignited by the little spark. Very recently Himachal Pradesh and Uttarakhand have had major wildfire breakouts. In 2021, there were prolonged fires in Uttarakhand, Himachal Pradesh (Kullu

Valley) The Himalayan forests, particularly, Garhwal Himalayas have been burning regularly during the last few summers seasons, with huge loss of vegetation cover of this region. (Certini *et al.*, 2005; Murthy *et al.*, 2019). Recently Jaunpur region of Garhwal Uttrakhand witnessed huge forest fire.

In India, forest fires are most commonly reported during March and April, when the ground has large quantities of dry wood, logs, dead leaves, stumps, dry grass and weeds that can make forests easily go up in flames if there is a trigger. (Bahuguna and Upadhyay *et al.*, 2002). In nature, especially in higher latitude forests, fires help maintain a healthy forest ecosystem by releasing important nutrients into the soil and aiding seed dispersal. (Cochrane *et al.*, 2009). High atmospheric temperatures and dryness (low humidity) offer favorable circumstances for a fire to start. Factors responsible for Forest fires are natural as well as anthropogenic

Natural causes include Many forest fires start from natural causes such as lightning which set trees on fire. However, rain extinguishes such fires without causing much damage. High atmospheric temperatures and dryness (low humidity) offer favorable circumstance for a fire to start. Anthropogenic causes include Fire is caused when a source of fire like naked flame, cigarette or bidi, electric spark or any source of ignition comes into contact with inflammable material. (Kittur *et al.*, 2014)

Results and Discussion

Natural or controlled forest fire. Forest fires caused by heat generated in the litter and other biomes in summer through carelessness of people (human neglect). Forest fires purposely caused by local inhabitants. Types of Forest Fire: There are two types of forest fire i) Surface Fire and ii) Crown Fire

Surface Fire -A forest fire may burn primarily as a surface fire, spreading along the ground as the surface litter (senescent leaves and twigs and dry grasses etc) on the forest floor and is engulfed by the

spreading flames. They occur in deep accumulations of humus, peat, and similar dead vegetation that become dry enough to burn. Underground fires spread slowly and are hard to detect, hence they may burn for months destroying the vegetative cover of soil

Crown Fire- The other type of forest fire is a crown fire in which the crown of trees and shrubs burn, often sustained by a surface fire. A crown fire is particularly very dangerous in a coniferous forest because resinous material given off burning logs burn furiously. This type burn trees up their entire length to the top. On hill slopes, if the fire starts downhill, it spreads up fast as heated air adjacent to a slope tends to flow up the slope spreading flames along with it. If the fire starts uphill, there is less likelihood of it spreading downwards.

The youngest mountain ranges of Himalayas are the most vulnerable stretches of the world susceptible to forest fires. The forests of Western are more frequently vulnerable to forest fires as compared to those in Eastern Himalayas. This is because forests of Eastern Himalayas grow in high rain density. With large scale expansion of chirr (Pine) forests in many areas of the Himalayas the frequency and intensity of forest fires has increased. Preparedness and Mitigation Measures Forest fires are usually seasonal. They usually start in the dry season and can be prevented by adequate precautions. Earlier fire was prevented in the summer through removal of forest litter all along the forest boundary. This was called "Forest Fire Line" This line used to prevent fire breaking into the forest from one compartment to another. Chandra *et al.*, (2015).

Fire spreads only if there is continuous supply of fuel (Dry vegetation) along its path. The best way to control a forest fire is therefore, to prevent it from spreading, which can be done by creating firebreaks in the shape of small clearings of ditches in the forests. (Hussain *et al.*, 2018). The followings are the important precautions against fire: Keep the source of fire or source of ignition separated from combustible and inflammable material. Keep the

source of fire under watch and control. Ramakrishnan *et al.*, (2007). Not allow combustible or inflammable material to pile up unnecessarily and to stock the same as per procedure recommended for safe storage of such combustible or inflammable material. Adopt safe practices in areas near forests viz. factories, coalmines, oil stores, chemical plants and even in household kitchens. Incorporate fire reducing and fire fighting techniques and equipment while planning a building or coal mining operation. Arrange fire fighting drills frequently.

Forest fires also pose serious health hazards by producing smoke and noxious gases, (Finlay *et al.*, 2012). These events in Indonesia after the forest fires on the islands of Sumatra and Borneo in 1977 have shown that burning of vegetation gives off not only carbon dioxide but also a host of other, noxious gases (Green house gases) such as carbon monoxide, methane, hydrocarbons, nitric oxide and nitrous oxide, that lead to global warming and ozone layer depletion (Khaki *et al.*, 2015).

Wildfires emit billions of tonnes of carbon dioxide into the atmosphere which causes harm to climate and living organisms (FAO, 2020). Consequently, thousands of people suffered from serious respiratory problems due to these toxic gases. (Ubeda *et al.*, 2016) Burning forests and grasslands also add to menace of global warming. (Kittur *et al.*, 2014) Recent measurement suggest that biomass burning may be a significant global source of methyl bromide, which is an ozone depleting substance. González-Cabán *et al.*, (2013). Wildfires can impact the economy as many families and communities depend on the forest for food, fodder, and fuel. It burns down the small shrubs and grasses, leading to landslides and soil erosion. It can change the microclimate of the area with unhealthy living conditions. Impact on biodiversity India is rich in floral and faunal resources, accounting for 60-70% of the world 's biodiversity (Giriraj *et al.*, 2008; Hemp *et al.*, 2009). Wildfires have devastating effects on biodiversity by destroying trees, food supplies and by increasing the resulting susceptibility to predation of surviving animals. In

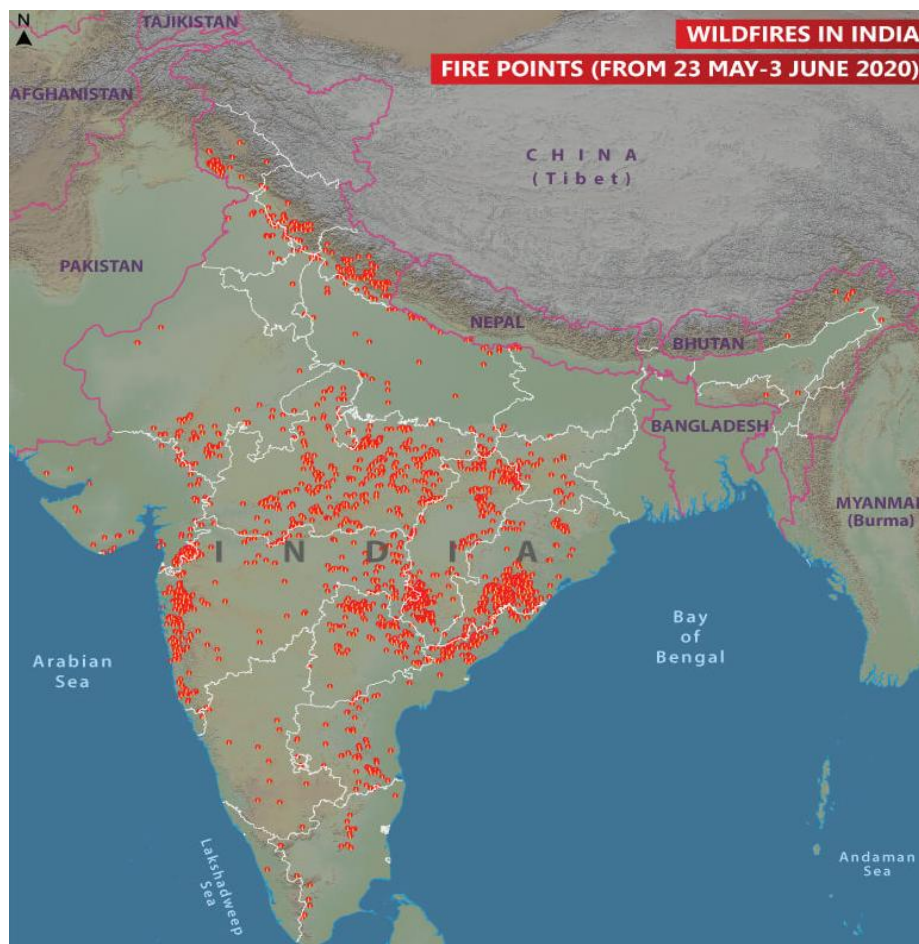
Uttarakhand's pine, oak, and mixed deciduous forests have changed by Human pressures such as burning, lopping, grazing, and collection of leaf litters. This has led to the transformation of Uttarakhand's oak forests into pine forests (Parashar *et al.*, 2003). Regarding soil, It can affect many physical and chemical soil properties including "loss of organic soil and structure, reduced porosity, and increased pH" (Certini, 2005; Jhariya *et al.*, 2014). Further increased water repellence resulting in reduced penetration and increased runoff, which leads to huge soil erosion.

Anthropogenic climate change has attempted to put huge pressure on numerous forest species and has weakened their ability to cope fires. Within certain regions of the world, more extreme and recurrent wildfires are expected to occur in the future due to climate change (Pitman *et al.*, 2007; Wilson *et al.*, 2010; Khaki *et al.*, 2015; Murthy *et al.*, 2019). In India, forest fire detection systems are based on on the MODIS (Moderate Resolution Imaging Spectroradiometer) instrument and the Visible Infrared Imaging Radiometer Suite (VIIRS) for satellite-based hotspot observation (World Bank, 2018).

Though forest fire is often seen as harmful, a number of forests are specifically fire-adapted: the species of plants and animals native to those ecosystems are enhanced thereby (Ramakrishnan *et al.*, 2007) Some plant species even require fire for their seeds to germinate. (Zhang *et al.*, 2018). The Ministry of Environment, Forests, and Climate Change has prepared a National Master Plan for Forest Fire Control. The Forest Survey of India (FSI) monitors the incidence of wildfires. This plan proposes to introduce a well-coordinated and integrated fire-management program that includes the following components:

Prevention of human-caused fires through education and environmental modification. It will include silvicultural activities, engineering works, people participation, and education and enforcement.

Fig.1 Map of India showing wildfire incidents from 23 May -3 June 2020. Source: SNPP & MODIS (Provided by Forest Survey of India)



More emphasis be given to people participation through Joint Forest Fire Management for fire prevention. Prompt detection of fires through a well coordinated network of observation points, efficient ground patrolling, and communication networks World Bank, 2018.

Remote sensing technology is to be given due importance in fire detection Wotton *et al.*, (2010). For successful fire management and administration, a National Fire Danger Rating System (NFDRS) and Fire Forecasting System Fast initial attack measures and vigorous follow-up action. Introducing a forest fuel modification system at strategic points. Several Forest Fire Prevention and Management (FFPM) Practices are used to prevent forest fire. The clearance of fire lines and conducting controlled

burning to limit fuel loads. Other methods may include silvicultural practices such as selective thinning and planting fire-adapted tree species in fire-prone areas. Telangana is the only state to have digitized locations of fire lines. Early warning and fire danger rating systems are also part of the prevention process (Wilson *et al.*, 2010).

Forestry is the second-largest land use after agriculture and accounts for about 1.5 % of the nation's GDP" (World Bank, 2005). With 65 million people identified as tribal groups, they rely on the forests. The existing estimates of the potential cost of forest fires in India are likely underestimated at approximately INR 1,101 crore (US\$ 164 million, 2016 prices) per year (World Bank, 2018). The loss of biodiversity, timber, increased carbon

sequestration, soil moisture, and nutrient loss, etc., are not taken into account in this estimate. Thus present analysis puts forward an urgent need to control forest fires in order to conserve the biodiversity, soil, species composition in forest areas and other ecosystem services.

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<https://doi.org/10.1016/j.proeng.2017.12.034>

How to cite this article:

Gupta, A. and Singh, S. 2023. Forest Fires: An Assessment of Terrestrial Ecosystems. *Int.J.Curr.Microbiol.App.Sci*. 12(02): 98-103. doi: <https://doi.org/10.20546/ijcmas.2023.1202.009>