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Commentary

Forest Fire Regime in Himalaya Likely to Change for Worse

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ABSTRACT
Traditionally, forest fires in the Himalaya were of small scale and patchy (mainly driven by human action), occurring between March and May in dry and hot conditions. The resin rich Chir pine (*Pinus roxburghii*) forests characterised by inflammable litter provided abundant fuel for burning, but traditional practices of forest use such as firewood collection, litter removal, and grazing reduced the risk of large fires. Recently, the abandonment of agriculture and reduced forest dependence have changed fire regimes, increasing the potential for significant, destructive fires with rapidly warming temperatures. In this context, Bhutan's strategy to restrain traditional forest use practices by communities post-1970 demonstrates how reduced community involvement increased large fire outbreaks. The densification of pine forests due to a ban on tree cutting may also modify the fire behavior. In the past, fire suppression policies in the US led to catastrophic fires. Hence, research-based and community-inclusive approaches and strategies are required to avoid the risk of large forest fires due to the changed situation in Uttarakhand.

Key words: Agriculture abandonment, Forest densification, Forest fires in Himalaya, *Pinus roxburghii*

TRADITIONAL FOREST FIRES

Traditional forest fires in much of the Himalayas are characterized as small, patchy surface fires of low intensity, which do not cause structural changes in a forest stand. Mostly man-made, these forest fires generally occur during the pre-monsoon period (typically March to May, Singh et al. 2016), when temperatures are high, moisture is low, and the forest floor mass is thick due to yearly litter fall, which is easy to ignite. This combination of dry and warm weather, the forest litter deposition on the ground, and the tradition of fire ignition results in frequent small fires, particularly in and around Chir pine (*Pinus roxburghii*) forests. The long resinous pine needles (20-35 cm) make a loose oxygen rich litter layer, which is highly flammable in dry pre-monsoon. Since Chir pine litter decomposes slowly, the forest floor fuel mass keeps on building year after year. However, in the past, the litter collection by local communities for composting kept the fuel mass low (Fig. 1). The composted litter was a major source of nutrients for growing crops. The livestock grazing kept herbaceous litter thin, and the collection of firewood by local communities from the forest floor kept flames of forest fires low (Fig. 1). According to an earlier estimate, for each unit of energy of agronomic production, 8-10 energy units were extracted from forests (Singh and Singh 1992). Thus, uncontrolled forest biomass collection degraded forests, but the surface fires remained small, patchy, and largely manageable.

The thick barked (up to 6 cm thick) Chir pine promoted fire incidents by providing more inflammable fuel, and this took competitive advantage over broadleaved species which are relatively thin-barked. However, trees of Chir pine are also killed by frequent fires. Once heavily damaged by fire, the pine trees fail to survive, as they scarcely resprout and coppice. While oak trees get quickly burned (bark generally <2 cm thick), they may recover because of their respiration ability. Very little research is available to show the relative position of these two species in the post fire period. However, elsewhere, there are instances of rapid oak recovery in the post-fire phase. For example, the

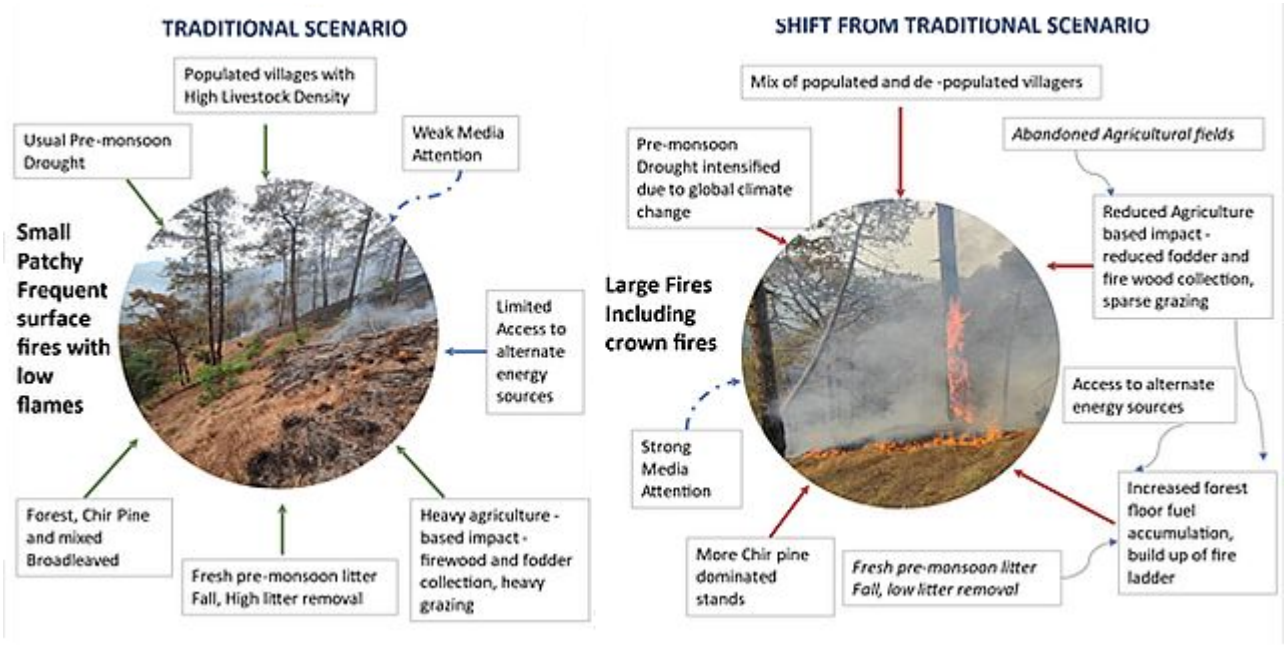

Figure 1. A representation shift in driving forces of human ignited fires in Chir Pine-Oak zone of Himalaya; increase in forest floor fuel, partial depopulation and abandonment of agriculture in combination with climate change may modify the nature of forest fires. Because of the reduced dependence on forests, local communities are losing interest in forests, which could have dire consequences for forest conservation. Pre-monsoon is typically April-May

Columbian oak, *Quercus humboldtii* showed resprouting in 80% of trees two years after burning (Aguilar-Garavito et al. 2023). Cork oak (*Q. suber*) is known for resprouting after burning and growing in importance within the burned forests (Dib et al. 2023).

SMALL FIRES NEEDED TO PRE-EMPT BIG DISASTROUS FIRES

These small fires were useful in that by consuming forest floor litter to an extent; they did not allow considerable forest floor litter accumulation, thus preventing big, disastrous fires, so common in developed countries like Australia and USA, when small fires were suppressed. Air pollution, black carbon deposition on glaciers, and consequent melting are matters of relatively new concern. Therefore, even small fires cannot be allowed to be so frequent.

SHIFT IN SCENARIO

The Himalayan scenario concerning forest fires is changing now. Abandonment of agricultural land, migration of people, and depopulation has been spreading in several parts of the Himalayas, particularly in Uttarakhand and Nepal. Other associated changes include decreased domestic livestock and grazing and weakening forest dependence. The collection of forest biomass for fodder, firewood, and litter composting has declined for quite some time. The livestock trails so familiar on mountain slopes have almost disappeared. Firewood has been partly replaced by cooking gas in many areas of the Indian Himalaya. Agricultural abandonment could be seen even when people have not outmigrated. Subsidized food grain might facilitate agriculture abandonment, particularly in rainfed agricultural areas. In this respect, the example of Bhutan is worth mentioning (Tenzin et al. 2024). Prior to 1970, forests in Bhutan were affected by grazing, burning, collection of non-timber forest products, firewood, etc. The forest floor was thin, so the fires were small and mild. However, after the Bhutan's Forest Act (Anonymous 1969), local community activities were restricted as the system became highly centralized. After 1970, there was a marked shift in fire, with fires of 1985, 1989, 1996, 2010, and 2013 burning >90% of sample plots.

Figure 2. A densified Chir pine forest stand (a) in which several thin stemmed trees have bark much thinner than that is found in a typical open type (b)

Earlier fires affected one or two sites in an area. The large build up forest floor mass in the absence of continuous collection of forest biomass by people was the principal cause large fires after 1970.

Because of the ban on tree cutting, Chir pine forest stands are getting densified and close canopied with limited light availability (Fig. 2). The new trees in such dense stands are thin barked, hence quickly burned. They act as a ladder for surface fires, which turn into crown fires occasionally. Hundreds of dead, thin, barked Chir pine trees can be seen in a densified forest after a fire incident. Resin tapping combines with fire to cause an increase in tree mortality. To deal with this changed situation, the Uttarakhand government must develop a research-based controlled burning to avoid widespread destructive fires.

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