Article

Impact of Pine (Chir) Expansion on Forest Ecology in Uttarakhand

Indresh Kumar Pandey, Assistant professor, Dr. Shivanand Nautiyal Govt. PG College, Karnprayag, Chamoli, Bharat

Introduction

Conservation of biodiversity is the most burning issue of today. Global warming and climate change, along with human activities, have been affecting biodiversity since time immemorial. Despite adequate environmental awareness in Uttarakhand, pine is becoming a major problem for biodiversity. *Pinus roxburghii* (pine), the three-needled Indian pine and the most flammable species (Sati, 2023), is a native of the Himalayas and widely spread over India, Nepal, Pakistan and Afghanistan at an altitude of 500 m to 2,200 m. It is a tree with a long evergreen crown and may attain a height of 50 m. It has been reported that 16.36% of the forest area in Uttarakhand at an elevation of 1000 m to 1800 m above sea level is covered by pine forests (Bargali et al., 2020). Despite the ban on pine plantations, pine trees are spreading naturally. The expansion of pine in the forests of Uttarakhand is posing serious ecological challenges, threatening the ecosystem and biodiversity. This study investigates the multidimensional aspects and impacts of history of pine expansion in Uttarakhand, focusing on its effects on floral diversity, fire frequency, hydrological impacts, man-animal conflict and ecosystem services. Historically a natural component of the Himalayan ecosystem, pine has become an increasingly dominant species, invading the areas traditionally dominated by broadleaf forests, especially mid-elevation oak forests, due to its invasive nature, anthropogenic disturbances and frequent forest fires (Chowdhary et al., 2025).

Study Area

Uttarakhand, the 27th state of India, has a geographical area of 53,483.36 km^2 of which 93% is mountainous mainland and 65% is forest covered (Negi & Kumar, 2016). The state extends with Geographical Coordinates, from Latitude 28° 43' N to 31° 28' N to Longitude 77° 34' E to 81° 03' E. Average Population Density of Uttarakhand is 189 per km^2 (India state of forest report, 2023).

Methodology

Methodology includes extensive review of literature and research articles. Our study also used field observations and historical data to compare areas with high pine densities to areas with native broadleaf trees. The present article has been divided into four sections including history, responsible factors, impacts and control measures for expanding pine forest.

Results

In Uttarakhand, five species of pine has been reported to grow in wild conditions (Table 1). Preliminary findings suggest that dense pine trees lead to heavy accumulations of highly flammable resin-rich leaf litter (pirul), increasing the risk and intensity of forest fires.

Table 1. List of Pine species found in Uttarakhand

Pine species	**Common name**
Pinus roxburghii	Pine (Chir as local name)
Pinus wallichiana	Blue pine
Pinus gerardiana	Chilgoza pine
Pinus kesia	Khasi pine
Pinus bhutanica	Bhutan white pine

This positive feedback cycle, induced by fire, further increases the dominance of fire-adapted pines over less tolerant species, leading to a reduction in native floral diversity and changes in species richness. Forest fires result into increased frequency of human-animal conflict. In addition, the specific pine litter chemistry alters soil nutrient cycling, which can cause soils to become acidic and impede regeneration of native species. Expanding pine trees in place of diverse broadleaf forests also affects important ecosystem services, such as water retention, carbon absorption and availability of non-timber forest products for local communities. This study aims to quantify these ecological changes and provide a comprehensive understanding of the mechanisms driving pine expansion. The results will contribute to the development of sustainable forest management strategies that will reduce the negative ecological impacts of pine and help to conserve the rich forest biodiversity of Uttarakhand.

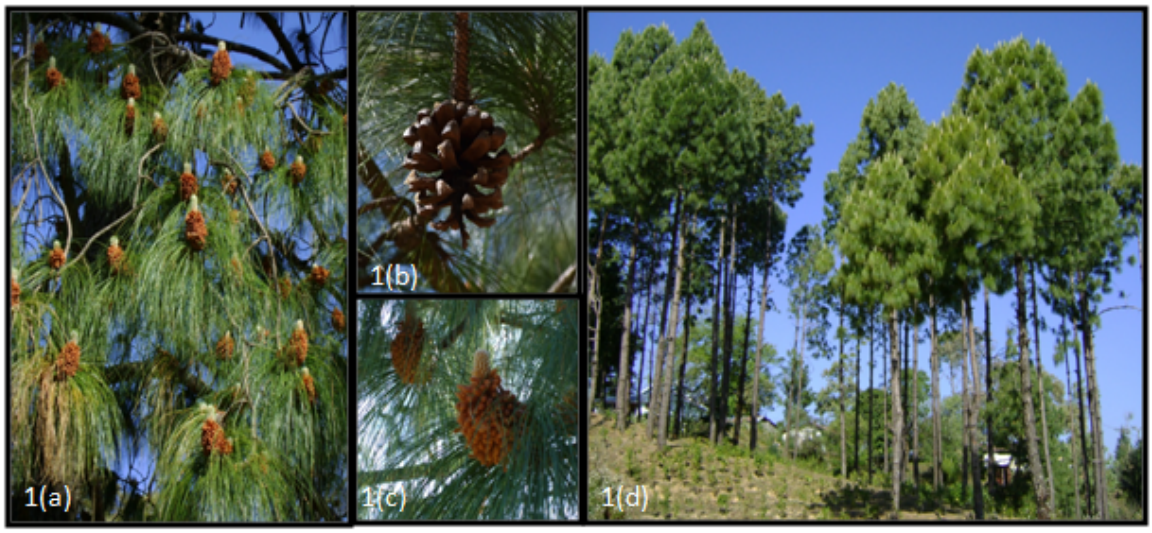

Fig.1. Pinus roxburghii, (a) Tree with several male cones, (b) Female cone, (c) Male cones, (d) Pine monoculture

Discussion

Although pine trees are native to Uttarakhand, the British colonial administration promoted the spread of pine trees to replace broadleaf trees such as oak for economic gain, particularly for resin extraction and timber. This led to the dominance of pine trees in the region, which increased the incidence of forest fires due to their flammable needles and cones. The British commercial interest in the resin called linseed led to the establishment of the first industry in the Himalayas, but the fast-growing nature of pines and large-scale felling of oak forests allowed pine trees to spread rapidly in the central mountain regions. After the Treaty of Sugauli (1815-16) the British sought to reap economic benefits from the forests of the region. Pine resin was valuable for industries such as soap, paint and turpentine, and its wood was used for construction and other purposes. The British distributed pine seeds among village headmen and encouraged them to plant them in upland areas. The fast-growing nature of pine helped it

spread easily and spontaneously. The colonial practice of clearing oak forests to make coal and charcoal created a favourable environment for the faster-growing and more resilient pine trees.

Impact of Pine expansion includes Increased Forest Fire Risk, Altered Forest Structure, Impact on Water Resources, Socio-Economic Consequences and Vulnerability to Climate Change. Pine forests are highly vulnerable to forest fires due to the accumulation of highly flammable, resinous pine needles on the forest floor, a process that is further aggravated by anthropogenic activities. The dominance of pines, which cover a significant portion of Uttarakhand's forest area, leads to changes in the overall forest structure and composition, thereby affecting biodiversity. Although not explicitly detailed in all studies, pine forest fires have been linked to water scarcity and drought conditions, suggesting an indirect impact on local water availability (Naudiyal & Schmerbeck, 2017). Frequent fires in pine forests cause significant damage to the environment and economy of the region. Climate change exerts further pressure on these pine forests, negatively impacting their natural structure and function (Chauhan et al., 2018).

Conclusions

The inference drawn from the study of all these points is that preventing the spread of pine forests and planting broadleaved native flora in their place will be beneficial for the ecology of the region. Forest fires result into loss of biodiversity and adversely affect tourism due to environmental pollution. Conservation of fauna can also be accelerated by developing mixed forests replacing the pine forests. Hence, by controlling the expansion of Pine forest a holistic ecosystem management may be accomplished.

References

Bargali, H., Singh, P., & Bhatt, D. (2020). Role of chir pine (pinus roxburghii sarg.) in the forest fire of Uttarakhand Himalaya. *ENVIS Bull. Himalayan Ecol*, *28*, 82-85.

Chauhan, J. S., Gautam, A. S., & Negi, R. S. (2018). Natural and anthropogenic impacts on forest structure: a case study of Uttarakhand state. *The Open Environmental Research Journal*, *11*(1).

Chowdhary, M. A., Sharma, V., Gadri, H. S., Roy, S., & Bhardwaj, P. (2025). Spatio-temporal mapping and climate change impact on current and future expansion of P. roxburghii in the Himalayan Biodiversity Hotspot. *Environmental Monitoring and Assessment*, *197*(3), 1-20.

India state of forest report -Vol. II (2023).Forest Survey of India, Dehradun.

Naudiyal, N., & Schmerbeck, J. (2017). The changing Himalayan landscape: pine-oak forest dynamics and the supply of ecosystem services. *Journal of Forestry Research*, *28*(3), 431-443.

Negi, M. S., & Kumar, A. (2016). Assessment of increasing threat of forest fires in Uttarakhand, using remote sensing and GIS techniques. *Global Journal of Advanced Research*, *3*(6), 457-468.

Sati, V. P. 2023. *Sustainable Forest Management in the Himalaya*, Springer Nature, Cham, Switzerland, ISBN: 978-3-031-21935-1.

Article