Silvicultural Approach for Fire Adapted Landscape

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ABSTRACT

One of the significant ecological and socioeconomic issues of concern in forested habitats globally is the rising incidence and ferocity of forest fires that are fuelled by land pressures and climatic change. The potential of silviculture as an active response to the creation of climatically resilient forests is discussed in this paper. The ecological functions of fire as a nutrient cycler and habitat modifier and the practice of using adaptive silviculture technologies such as thinning, controlled burning, species selection, and construction of firebreaks are discussed. Restoration and adaptive silviculture as an active response to forest recovery and resilience under conditions of shifting climatic conditions receive high precedence. Methods used to link flame with hazards such as artificial intelligence-based clustering techniques and GIS-based risk zoning are discussed in this paper.

INTRODUCTION

Increasing numbers of wildfires are dominating both ecological and socioeconomic spheres in most forest regions worldwide. Fires have changed regimes due to climate growth, resulting in more frequent, intense, and large-scale burns than in the past. The idea of fire-adapted landscapes has caught increased interest in this

new landscape. Forest management by a silvicultural framework offers a critical method of building landscapes that are fire-adapted. By deliberate manipulation of plant patterns by species selection, prescribed burning, and thinning, silviculture can enhance forest heterogeneity, reduce fuel loads, and enhance resistance to catastrophic fire events.

Classification of forest fire

Based on the location of their activity, forest fires are classified as follows:

Creep fire: This fire spreads under the ground cover for a few days which is undetectable and then suddenly emerges as a wildfire. This type of fire is difficult to identify.

Ground fire: Ground fire only burns the vegetation present in ground cover. The carpet of herbaceous plants and low shrubs that covers the soil is burned away by ground fire.

Surface fire: A type of forest fire which burns mostly as a surface fire, spreading along the ground as it consumes surface litter and burns away the forest undergrowth.

Crown fire: This form of forest fire involves the crowns of shrubs and trees burning, usually fuelled by a surface fire. Crown fires are especially dangerous in coniferous forests due to the highly flammable resinous material released from burning logs. (Varun Attri *et al*., n.d.)

Role of fire in Forest Ecosystem

Among other man-made and natural disturbances, fires are essential for controlling the location, biomass, and composition of forests. To reduce the emissions of greenhouse gasses by implementing proper landscape designs which have an influence on global carbon cycle requires an understanding of how fire contributes to the loss of forests worldwide (Van Wees *et al*., 2021). Fire plays an important role in management of forests by reducing biomass in the forest, which helps to decrease the impact of wildfire in the future. It helps in nutrient cycling and controls plant competition and encourages the growth of beneficial plants like legumes etc and, fire clears out unwanted plants, reduce incidence of pest and diseases and supports regrowth during dry periods. It also enhances wildlife habitats by creating nesting spots and aiding animal movement. Fire helps build firebreaks, releases seed, prepares seedbeds for new growth, and is valuable for ecological studies and training firefighters. (Amit Parashar & Sas Biswas, n.d.)

Silvicultural Strategies in Fire-Prone Areas

Silviculture is turning attention towards enhancing forest resistance, fire risk minimization and ecological sustainability in fire prone regions of India. Selective thinning for fire risk minimization and tree spacing improvement is one of them which reduces crown fire spread. Controlled burning method or prescribed burning method is applied for the elimination of undergrowth vegetation and debris, especially in dry deciduous pine forests where significant numbers of leaf litter and debris get accumulated. Introduction of fire-resistant and local species such as *Tectona grandis* (teak), Terminalia spp., and Acacia spp. plays an important part in natural replenishment and species richness. Agroforestry is also practiced along with buffer zones to take pressure off core area forests and establish fire resistant landscapes. Assisted natural regeneration and artificial mixing of species assists reconstruction of degraded habitats and enhancing structural diversity and fire risk reduction. Firebreak line establishment particularly along fire vulnerable regions like Western Ghats and Central Indian forests is a prevention measure to inhibit fire spread. Joint Forest Management

(JFM) is important involving local people in monitoring, early detection and post fire rehabilitation. These are multi layered silvicultural practices to maintain forest vitality at fire affected landscapes of India.

Restoration and Adaptive Silviculture

Climate-driven wildfires, influence land-use history, are a impending threat to forest ecosystems. Restoration and adaptive silviculture have become complementary methods for enhancing forest regeneration and resilience. Restoration includes stabilizing terrain, reconstruction of native ground cover, and rehabilitating processes. Methods can include erosion control, using fire-adapted vegetation, invasive species management, and soil recovery.

Adaptive silviculture uses forest management strategies that look ahead to future disturbances. It focuses on stand structural heterogeneity, encourages fire-resistant species, incorporates prescribed burning, and employs long-term monitoring to inform flexible management decisions.

Forest fire zone mapping based on GIS or remote sensing data varies across studies, with each employing different methods that consider human-caused and natural factors, including temperature, that influence forest fire risks. Additionally, artificial intelligence techniques like the k-means clustering algorithm can be applied to prepare forest fire risk zone maps. Sevinç (2022)

Challenges in Implementing Fire-Resilient Silviculture

Several factors make it hard for the implementation of fire-resistant silviculture. Proper species selection and treatment design need to be carried out which are influenced by ecological variety and uncertain future climate regimes. Major constraint is due to resource unavailability which include staffing shortages, difficult terrain, and insufficient financing. Planning and implementation of projects is affected by laws and permits that postpone or hinder essential treatments like prescribed fire. Acceptability of these landscaping designs may be hindered by public opposition, especially from smoke and aesthetic concerns (North *et al*., 2015)

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