Review Article

Plant Diversity, Regeneration and Conservation of Sal Forests: A Review

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ABSTRACT

The current scenario of the Indian sal forest is in alarming situation. The disturbance caused by humans and excess exploitation of its resources seriously impacts the regional sal forest. Associates of Sal is commonly harvested for household purposes, fire-wood, timbers, gums, tannins, paper plates and medicinal purposes. The greatest threat to the sal forest ecosystem is the rapid expansion of urbanization. The Sal-dominated forest is losing biodiversity at an alarming rate due to illegal cutting, encroachments and illegal trading of wildlife. The paper reviews the sal forest's species diversity, regeneration status and conservation strategy. This study has been conducted after an immense literature survey and interpretation of published data concerning current disturbances to the sal forests of India. This study aims to adopt a sustainable forest management strategy based on a scientific understanding of professional silviculture practices. Proper forest conservation calls for a policy that would involve the mass participation of not only government officials but also the locals of the area.

Keywords: Sal forest, Regeneration, Conservation, Sustainable development.

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INTRODUCTION

The growth of the world's natural vegetation has been decreasing alarmingly, and a huge part of this area is being converted into monoculture to meet the increasing demand of society. The Terai region forests of Northeastern Uttar Pradesh were previously grouped under northern tropical moist deciduous forests. As per the classification of Champion and Seth,[1] these forests consist of moist deciduous and semi-evergreen forests. The UNESCO, IBP site characterization, Gorakhpur Forest Division has been designated as broad-leaved deciduous plantations.[2] The forests of Gorakhpur division are mainly of Sal (*Shorea robusta* Gaertn.) which has been developed through a form of *taungya* cultivation. The composition of the old *taungya* forest of the region resembles the natural growth forest because of the dominance of sal trees, which is the common overstory of natural forests too.[3] Disturbance has been considered as an important component of community structure, but its quantification is the major problem for the community study with relation to environmental change.[4] Due to recurrent disturbance and the complex need of society, nearly all natural habitats have come under pressure of overexploitation resulting in the loss of habitat characteristics and rapid extension of several co-occurring species. Unless conservation measures are taken for the sustainable use of plant resources, the forest having valuable plant diversity, mainly of medicinal and recreational importance cannot be saved. The forest ecosystem has now been modified by a number of flora and fauna.[5] If the natural habitats of plants are not given adequate protection, the altering landscape can act as a *death trap* for many medicinal and economically important plant species. This is now common knowledge that the loss of any species invariable affects ecosystem stability. As per National Forest Policy,[6] forests should occupy at least 33% of the geographical area in India. The FSI[7] assessment

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reported that forest cover in India is presently 24%, and to achieve the target of 33%, it would require planting more tree saplings. *Shorea robusta* Gaertn f. (sal), family Dipterocarpaceae is native to the Indian subcontinent. Geographically, the sal forest forms the continuum starting from sub- Himalayan through Punjab and up to North- East state of Assam.[8] The understory plant diversity of sal forest is strongly influenced by its large canopy. The common congeneric species of the sal forest is like *Mallotus philippensis*, *Moghania chappar, Desmodium gangeticum, Clerodendron infortunatum, Leea alata, Bredelia retusa, Terminalia tomentosa, Bauhinia vahlii* etc. The disturbance of a few species is less common, but others are invading the relatively disturbed community by way of their non-seed regeneration strategies. Therefore, the plant diversity, population dynamics, and self-conservation strategy of a few congeneric species are properly investigated, and their economic benefits must be analyzed.

India has a rich source of species diversity of medicinal and socio-economic plants distributed in different geographical and ecological conditions in the country.[9] A recent study estimates that approximately 80% of the World population residing in developing countries directly depends on herbs for their medication. The component of species diversity i.e. species richness and species evenness, are the prime factors that determine the functional traits of the region that affects several ecosystem processes.[10] Even the gum from Sal tree also has good medicinal properties. Sal forests are one of the most disturbing forests not only because of the extraction of valuable timber but also for providing various non-timber forest products.[11,12] The present review paper comprises scattered information on the species diversity, regeneration and conservation value of the sal forests in India. The present information will emphasize the significance of sal forest for human welfare and will also highlight the new impetus for academicians in the future.

PLANT DIVERSITY AND CAUSES OF ITS THREAT

Walter G. Rosen coined the term *biodiversity,* but the term was popularized by the scientist Wilson later. It is the collection of all existing life, including plants, animals, and microorganisms. It provides essential livelihood as well as the security of world food. Diversity can be defined in terms of species richness and species evenness with their relative frequencies. The species diversity is organized mainly at three levels ranging from genic level, species level to ecosystem level. Thus, diversity encompasses differences in genes, species, and ecosystems with their relative richness and relative abundance.[13] In the broad sense, plant diversity satisfies human needs directly as well as indirectly. Plant diversity is the reservoir of fertilizer, pesticides, herbal medicines, food, diverse pollinators, and future gene bank. Plant diversity enhances the plant genetic material, mixed plantation, silviculture practices, crop rotation, and diverse agroforestry system and supports agro-economic socio-economic services. Forests not only support a large number of ecosystem services but also provides goods and welfare to mankind and the environment. Simultaneously, forests can sequester a large amount of carbon and act as residences for diversity, serve tourism, regulate floods, and provide niches for billions of floras and fauna (Figure 1).

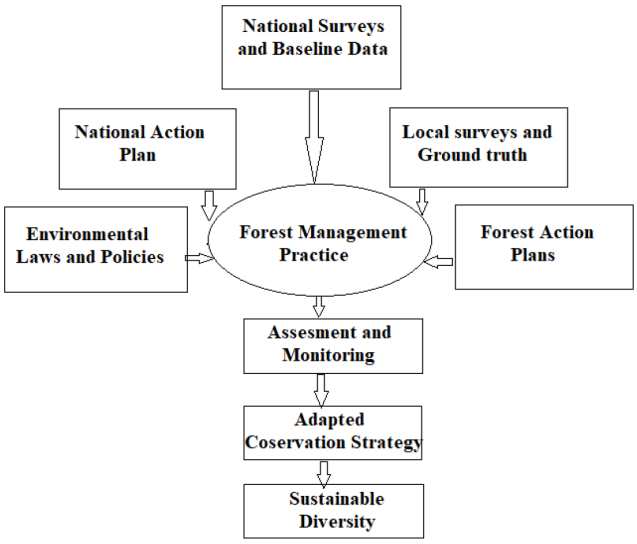

Figure 1: Action plan for sustainability and biodiversity conservation.

Forest plays a very important role in the carbon sequestration and biogeochemical cycle. The livelihood of one-third of the human population across the world directly or indirectly depends on forest products. Global biodiversity was mainly affected by large-scale alteration of habitat, over-exploitation of natural resources, the arrival of noxious weeds, climate perturbations, and disturbance of ecosystem structure.[14,15] Some remarkable factors that affect plant diversity are as follows.

Ecological degradation

Ecological degradation is the destruction of natural communities that is viewed to have a negative impact.[16] Degradation comprises the negative impact on air,

soil, water quality, desertification, habitat destruction, species extinction, and deforestation too. This degradation leads to enhanced propagation of plant disease, stress, depletion of plant diversity, and also reduced agricultural yield. A total of 75% of global terrestrial biodiversity is occupied by the forest, and this is the basis of providing various ecosystem services.[17] Forests not only regulate the biogeochemical cycle but are also an important asset in mitigating carbon emissions.[18]

Invasive and Endangered species

The invasion of exotic species can alter the plant diversity and community structure of the forest ecosystem (Table 1). It is one of the major threats to the sustainability of the forest ecosystem. Invasion of alien species not only leads to plant diversity loss but also alters the socio-economic services as well as ecosystem services.[14,19]

Habitat destruction

The current anthropogenic perturbations have raised the chances of habitat destruction and act as one of the major causes of the loss of species diversity.[8] It is quite apparent that the conservation of plant diversity for its present and future use is essential.[20] The group of complicated masses of vegetation, predominantly a composite of woody climbers (thicket) is generally present in undisturbed moist tropical forests. This was frequently compared in moderately disturbed sal stands facing regular trampling and grazing by herds.[8] These thickets, however, were largely covered by some liana species, which possess deadly thorns and prickles. Several species uncommon to general forest vegetation were commonly found within these thickets.

Table 1: Alien plant and their effects on human health.

Invasive plant species	Spread mode	Impact on health
Eichhornia crassipes	Direct and through vector	Deteriorate water quality, mosquito outbreaks and causing schistosomiasis
Lantana camera	Vector	Host for *Glossina* spp., spreading sleeping sleekness
Parthenium hysterophorus	Direct	threat to biodiversity also causes allergic reactions
Ailanthus altissima	Direct	This leads to myocarditis due to long-term exposure; dermatitis
Pistia Stratiotes, Hydrocotyle and Ranunculoides	Vector	The outbreak of Malaria by hosting *Mansonia* spp.
Xanthium, A cacia Eucalyptus, Casuarina Helianthus and *Acer*	Direct	Environment imposes a threat to allergy to eye, ear and nose.

Agricultural practice

Variation in cultivation practices causes a dynamic change in vegetation. During *taungya* cultivation, trees are cut down and burned, and the enriched field is used for some years as agricultural land. Later left field naturally developed into a forest. Such type of shifting cultivation practice is a serious cause of deforestation and native species loss in the tropics.[21] Due to the increase in population pressure in the tropics, the rate of shifting cultivation is increasing at a fast pace. This practice leads to biodiversity loss on a larger scale.

DEFORESTATION AND SPECIES EXTINCTION

Deforestation is a major threat to biotic perturbations in the tropical forest. Its impact on tropical hot spots has been investigated by Mayers *et al*.[22] Currently, the Himalayan region acts as the gene pool for rare and endemic plant species. This is due to favourable climatic and edaphic conditions.[23] These factors also help to colonize the animal and plant species of the adjacent areas. Due to large-scale change in land use pattern to increasing human population pressure, the Himalayan region also faces large-scale change in its composition. Deforestation leads to species extinction in the forest community at a large scale.

SPECIES DIVERSITY VS REGENERATION

The species richness of sal forest is not very high, but its species diversity is very important for the regeneration and conservation of associated plant species.[24] Several workers have already studied the Indian sal forest for its species richness and diversity pattern.[5,8,20,24,25] The composition of forests largely depends on the regeneration pattern and diversity of associated plants in space and time. Various types of disturbances alter the composition and density of seedlings and saplings in the forest understory.[26] The successional age series study of natural forests, managed plantations and uneven-aged stand are essential to know the regeneration status, community composition and stability of the forest ecosystem.[27] In an unfavourable environmental condition, regeneration through seed is quite rare. In this case, the non-seed regeneration strategy is very

important for the early recovery of the disturbed plant communities. A group of woody plants may help maintain a modest layer of understorey vegetation. [28,29] Such a non-seed regeneration with prolific ramet producers provides sufficient species diversity and vegetal cover to the understory flora and fauna.

CONCLUSION

The practice of planting and managing forested areas for the human welfare and sustainability of future generations is known as forest conservation. Forests are basic sources of plant diversity, and their benefits in the future society are potentially threatened by environmental activities such as deforestation, climate change, change in land use patterns and non-management practices. Plant diversity is a basic natural resource for human welfare over the world. In forest conservation, local people's participation is an important factor associated with community forestry, which refers to forest management by local inhibiting adjacent to the forest. The sustainable use of forest products and well-planned management practices play a vital role in the conservation of natural resources, its conservation, and ecological stability.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

REFERENCES

1. Champion HG, Seth SK. A revised survey of the forest types of India. Government of India Publications; 1968:404.
2. De Angelis DL, Gardner RH, O'Neill RV. Productivity in temperate woodlands, CRC handbook on nutrition and food. Press, Cleveland: Chemical Publishing Rubber Co; 1978.
3. Pandey SK, Shukla RP. Plant diversity and community patterns along the disturbance gradient in plantation forests of sal (*Shorea robusta* Gaertn.). Curr Sci. 1999;77:814-8.
4. Upadhaya K, Pandey HN, Law PS, Tripathi RS. Diversity and population characteristics of woody species in subtropical humid forests exposed to cultural disturbances in Meghalaya, Northeast, India. Trop Ecol. 2004;45(2):303-14.
5. Pandey SK, Shukla RP. Regeneration strategy and plant diversity status in degraded sal forests. Curr Sci. 2001;81:95-102.
6. NFP. National forest policy, Government of India. New Delhi: Ministry of Environment and Forests; 1988.
7. FSI. Forest Survey of India, state of forest report. Ministry of the Environment and Forests Government of India; 2017.
8. Pandey SK, Shukla RP. Plant diversity in managed sal (*Shorea robusta* Gaertn.) forests of Gorakhpur, India: Species composition, regeneration and conservation. Biol Conserv. 2003;12:2295-319.
9. Singh JS, Chaturvedi RK. Diversity of ecosystem types in India: A review. Proc Indian Natl Sci Acad. 2017;92(3):569-94. doi: 10.16943/ptinsa/2017/49027.
10. Singh JS, Singh SP, Gupta SR. Ecology, environmental science and conservation. S Chand and Company Pvt. Ltd., 2015.
11. Gautam KH, Devoe NN. Ecological and anthropogenic niches of sal (*Shorea robusta* Gaertn. f.) forest and prospects for multiple-product forest management- a review. Forestry. 2006;79(1):81-101. doi: 10.1093/forestry/cpi063.
12. Chitale VS, Tripathi P, Behera MD, Behera SK, Tuli R. On the relationships among diversity, productivity and climate from an Indian tropical ecosystem: A preliminary investigation. Biodivers Conserv. 2012;21(5):1177-97. doi: 10.1007/s10531-012-0247-9.
13. Magurran AE, Gill BJ. Biological diversity: Frontiers in measurement and assessment. Oxford, UK: Oxford University Press; 2011.
14. Raghubanshi AS, Rai LC, Gaur JP, Singh JS. Invasive alien species and biodiversity in India. Curr Sci. 2005;88:539-40.
15. Lockie S, Ransan-Cooper H. Biodiversity and sustainable development. In: Redclift M, Springett D, editors. Available from: https://www.routledge.com/Routledge-International-Handbook-of-Sustainable-Development/Redclift-Springett/p/book/9780415838429. International Handbook of Sustainable Development. Routledge. London: Routledge; 2015.
16. Shukla RP, Pandey SK. Vegetation and plant diversity. New Delhi: SSPH; 2020:232.
17. IUCN. IUCN red list categories and criteria. Version 3.1. 2nd ed. Gland, Switzerland and Cambridge, UK: International Union for Conservation of Nature and Natural Resources; 2012.
18. Pandey SK, Chand N, Nandy S, Muminov A, Sharma A, Ghosh S, *et al*. High-resolution mapping of forest carbon stock using Object-Based Image Analysis (OBIA) technique. J Indian Soc Remote Sens. 2020;48(6):865-75. doi: 10.1007/s12524-020-01121-8.
19. Kumar Rai PK, Singh JS. Invasive alien plant species: Their impact on environment, ecosystem services and human health. Ecol Indic. 2020;111:106020. doi: 10.1016/j.ecolind.2019.106020, PMID 32372880.
20. Kumar R, Saikia P. Floristic analysis and dominance pattern of sal (*Shorea robusta*) forests in Ranchi, Jharkhand, eastern India. J For Res. 2020;31(2):415-27. doi: 10.1007/s11676-018-0829-9.
21. Ramakrishnan PS. Shifting agriculture and fallow management options. In: Cairns M, editor. Shifting agriculture and environmental change: Indigenous people, agriculture and forest conservation; 2015:186-98.
22. Myers N, Mittermeier RA, Mittermeier CG, Da Fonseca GAB, Kent J. Biodiversity hotspots for conservation priorities. Nature. 2000;403(6772):853-8. doi: 10.1038/35002501, PMID 10706275.
23. Wambulwa MC, Milne R, Wu Z-Y, Spicer RA, Provan J, Luo Y-H, *et al*. Spatiotemporal maintenance of flora in the Himalaya biodiversity hotspot: Current knowledge and future perspectives. Ecol Evol. 2021;1-19. doi: 10.1002/ece3.7906.

24. Singh A, Reddy VS, Singh JS. Analysis of woody vegetation of Corbett National Park, India. Vegetatio. 1995;120(1):69-79. doi: 10.1007/BF00033459.
25. Tripathi AK, Shankar U. Patterns of species dominance, diversity and dispersion in' Khasi hill sal' forest ecosystem in northeast India. For Ecosyst. 2014;1(1):23. doi: 10.1186/s40663-014-0023-2.
26. Pandey SK, Shukla RP. Plant population structure and species diversity status at two disturbance regimes within mixed forests and sal forests of Gorakhpur, India. Int J Ecol Environ Sci. 2018;44:43-58.
27. Pandey SK. Structure and diversity of associated plant communities along the age series in sal plantations of Northeastern UP. Ind J Ecol. 2018;45:93-9.
28. Pandey SK, Shukla RP. Effect of disturbance on population structure, regeneration and conservation of *Moghania chappar* in sal forests of Gorakhpur, India. Trop Ecol. 2019;60(3):337-49. doi: 10.1007/s42965-019-00035-y.
29. Shankar U. A case of high tree diversity in a sal (*Shorea robusta*)-dominated lowland forest of Eastern Himalaya: Floristic composition, regeneration and conservation. Curr Sci. 2001;81:776-86.

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