National Journal of Advanced Research
www.multidisciplinaryarticle.in
ISSN: 2455-216X
Received: 01-04-2024, Accepted: 22-04-2024, Published: 16-05-2024
Volume 10, Issue 1, 2024, Page No. 65-68

A review on impact of anthropogenic stress on biodiversity in Himalayan region of India: A floristic analysis

Gousiya Majeed*, Syed Aasif Hussain Andrabi, Sajjad Ahmad Khan
Department of Agricultural Science, Glocal University, Saharanpur, Uttar Pradesh, India

Abstract

After conducting a comprehensive analysis of numerous studies, it is evident that significant changes have occurred in the floral patterns, soil quality, soil erosion rate, and ecology of the anthropogenic activity zones in the Himalayas. While the anthropogenic activities disturbed areas showed higher plant diversity, they were predominantly dominated by shrubs and herbs, including invasive alien species or non-native plants associated with food grains. Consequently, the regeneration of plants in these disturbed zones was categorized as 'poor' or 'fair'. The analysis of Relative Dominance Index (RDI) also revealed that the dominant plant families in the anthropogenic activities disturbed zones were unique, indicating a strong influence of human activities on plant succession. However, the composition of trees remained the same in both disturbed and undisturbed anthropogenic activity zones. The maturity index and continuum index were relatively low in disturbed zones, indicating a slower rate of succession, while the similarity index highlighted the notable differences between the disturbed areas and undisturbed forests. The combined indices have revealed that the presence of invasive alien species has resulted in heightened competition among species and changes in species composition. This ultimately poses a threat to the long-term survival of numerous native species. These findings clearly demonstrate the impact of human activities, which occur on a monthly basis throughout the year. However, in the tourism area of the Himalayas, such significant disruptions have not been observed, mainly due to the distinct nature of the activities taking place. To mitigate and control the impact of human activities on the Himalayas, it is crucial to enforce strict regulations based on scientific research and an action plan.

Keywords: Anthropogenic, floristic pattern, biodiversity

Introduction

Tropical forests cover an area of 13.76 million square kilometers worldwide, making up 60% of the Earth's forests (FAO, 2005). Despite occupying less than seven percent of the land surface, these forests are incredibly rich in biodiversity, housing over half of all plants and animals (Groombridge and Jerkins, 2000) [14]. They also play crucial roles in regional hydrology, carbon storage, and global climate regulation (Fearnside, 1997; Laurance, 1999) [11, 20]. It is no wonder that 18 out of the world's 34 biodiversity hotspots are found in tropical forests (Mittermeier *et al*., 2004) [23].

The significance of these forests lies in their ecosystem services. They support high species richness and diversity (Jepson *et al*., 2001), contain substantial amounts of standing biomass, and play a major role in the global carbon cycle, both in terms of carbon flux and stored carbon volume (Bonan, 2008; Baishya *et al*., 2009) [5, 1]. Moreover, they contribute to 33% of the global net primary productivity (Sabine *et al*., 2004). Consequently, tropical forests have become the focus of extensive experimental and theoretical research in recent years (Malhi *et al*., 1999; Malhi and Grace, 2000) [22].

The rapid destruction of tropical forests is continuing worldwide at a concerning pace, surpassing an annual loss of 1-4% of their current area (Laurance, 1999) [20]. Each year, approximately 13 million hectares of forest are being cut down or destroyed (FAO, 2005). While the rate of destruction has not significantly changed in recent decades, the global biodiversity landscape is undergoing an unprecedented transformation (Pimm *et al*., 1995) [30]. The primary factors driving this change include forest destruction, climate change, pollution, unsustainable exploitation of natural resources, and the introduction of non-native species (Sala *et al*., 2000).

Biological diversity plays a vital role in maintaining the resilience, equilibrium, and productivity of ecosystems. It is also crucial for the livelihoods of human communities, especially those living in and around forests (Thompson *et al*., 2009) [37]. In India, tropical forests cover approximately 86% of the total forested land (moef, 2012) [24]. The country boasts 16 different types of forests, with the largest area occupied by tropical moist deciduous forests (37%), followed by tropical dry deciduous forests (29%), tropical wet evergreen forests (8%), subtropical pine forests (6.5%), tropical semi-evergreen forests (4.1%), mountain wet temperate forests (3.6%), tropical thorn forests (2.6%), sub-tropical dry evergreen forests (2.5%), moist alpine scrub (2.1%), littoral and swamp forests (0.6%), subtropical broad-leaved forests (2.5%), Himalayan dry temperate forests (0.3%), tropical dry evergreen forests (0.2%), and small patches of subalpine and dry alpine scrub (Raju, 1997).

India reportedly possesses a range of 16,500-19,400 types of flowering plants, accounting for roughly 7% of the total known species worldwide. A significant number of insects, approximately 60,000, have been identified so far, with around 107 species being aquatic. The country has also documented 48 gymnosperms, 1,135 pteridophytes, 2,850 bryophytes, 2,021 lichens, 6,500 algae, and 14,500 fungi. Notably, 30% of plant species recorded globally are exclusive to India (BSI, 2012). A recent study delves into the present condition of India's forests, encompassing forested areas, carbon stocks, and afforestation patterns within the country. It is projected that approximately 77% of India's forested regions will undergo changes in their forest types due to various human-induced pressures and climate change (Chaturvedi *et al*., 2010) [7].

Statement of Research problem

Numerous research papers have addressed the escalating ecological concerns surrounding biodiversity. The ongoing issue of water pollution has led to significant challenges in this area. Furthermore, extensive studies have examined the ecological effects of deforestation. Similarly, there is a wealth of documented research on the ecological and socio-economic impacts of human activities (Figure 1).

Results

Since the early 20th century, researchers have been investigating the impact of different tree species on soil chemistry (Finzi *et al*., 2002; 2003) [12-13]. Several studies have compiled evidence regarding the effects of various tree species on soil properties (Binkley, 1995). Plants in their natural habitats often encounter variations in soil nutrient levels (James *et al*., 2003). In response, many plant species concentrate their roots in areas with higher nutrient availability (de Kroon *et al*., 2009) [8]. A common outcome of nutrient heterogeneity is an increase in plant performance, as indicated by the accumulation of dry mass. Moreover, the distribution of soil nutrients can also affect the interactions between plant species (Mommer *et al*., 2011; van der Waal *et al*., 2011) [26, 39]. For instance, altering the degree of nutrient heterogeneity can lead to changes in the relative abundance of species grown together in mixtures (Waal *et al*., 2011) [39].

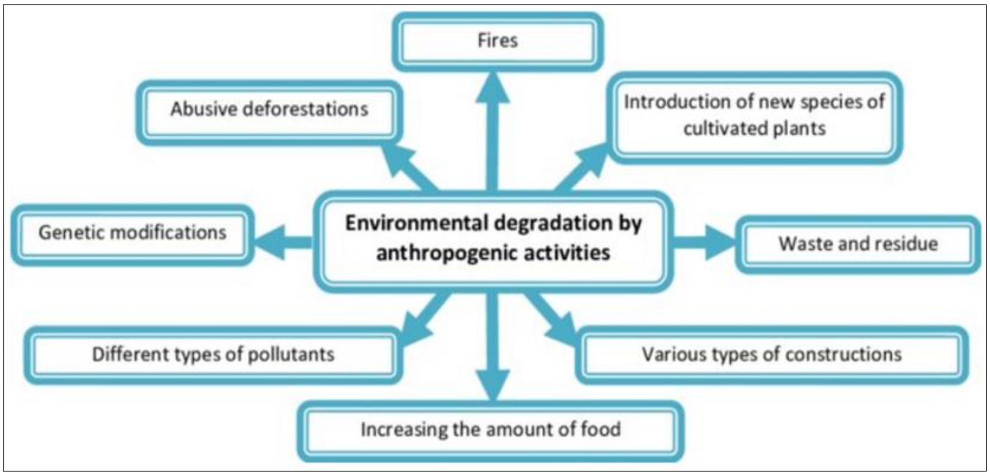

Fig 1: Sources of environmental degradation by anthropogenic actions

Plants possess the ability to concentrate their roots in areas with high nutrient levels. This ability creates heterogeneity in soil, leading to increased competition among neighboring plants. The concentration of roots in a smaller soil area intensifies the competition. Soil nutrient heterogeneity plays a role in enhancing interspecific competition (Rajaniemi, 2007) [32]. The competitive advantage of species is influenced by their capability to place their roots where nutrient levels are abundant. Heterogeneity only affects competition when there are differences among species in this ability (Bliss *et al*., 2002) [4]. Additionally, there are studies that explore the potential mechanisms by which different tree species impact soils (Binkley and Giardina, 1998). Differences in the chemistry and quantity can also have an impact on the availability of nutrients in the soil (Moffet *et al*., 2004; Rhoades, 2007) [25, 33]. Various species may differ in their ability to extend fine roots into deeper soil, allowing them to access larger reserves of cations (Dijkstra and Smits, 2002) [9], or potentially increasing cation supplies through weathering (Binkley and Giardina, 2008) [2]. One of the most common effects of tree species on soils is the strong negative correlation between the ratio of lignin to nitrogen in leaf litter and N mineralization (Binkley and Giardina, 2008; Ferrari, 2009; Thomas and Prescott, 2010) [2, 36].

Geomorphology plays a crucial role in the current study. Studies have confirmed that soil erosion and sediment deposition are primarily influenced by geomorphology (Pelacani *et al*., 2008) [29]. In this analysis, two main geomorphic units have been identified: Denudational slope and denudational hill. Denudational hills are large hills with resistant rock formations that are shaped by differential erosional and weathering processes (denudation), while denudational slopes are areas that have undergone denudation (Yokoyama *et al*., 2002). Denudational slopes make up 538.54 km2 (58.22%) of the geographical area, while denudational hills cover an area of 127.12 km2 (13.74%). It has been reported that regions where these two geomorphic units are found also experience high rates of soil erosion (Tomar and Singh, 2012) [38]. Another important geomorphic unit is valley fill, which refers to the unconsolidated sedimentary deposit that fills or partially fills a valley (Poesen *et al*., 2003) [31]. In this analysis, valley fill occupies an area of 186.34 km2 (20.15%). Valley fill found within small basins is a direct result of changes in runoff and erosion on nearby slopes, providing localized and long-term records of soil erosion (Knox, 2001) [19].

General Discussion

The researchers conducted a comprehensive analysis of the effects of human-induced stress on biodiversity in the Himalayan region of India. They utilized phytosociological, pedological, and geospatial analyses to examine the impact of anthropogenic activities on the flora, soil, and geospatial elements in the Sabarimala area of the Pamba range, as well as the impact of anthropogenic activity in Thekkady range. The findings revealed that the Himalayan region of India is confronted with numerous conservation challenges resulting from human activities.

Through a comprehensive analysis of various conducted studies, it is evident that significant alterations have occurred in the floral pattern, soil quality, soil erosion rate, and ecology of the anthropogenic activity zones in the Himalayan region of India. While a higher level of plant diversity was observed in the disturbed zone, it was primarily dominated by shrubs and herbs, including invasive alien species or non-native plants associated with food grains. However, the composition of trees remained consistent in both the disturbed and undisturbed zones. Herbs and shrubs were annually removed during every season, resulting in a high loss of lower branches for the trees. The studies also highlighted that the changing plant composition, particularly due to invasive alien species, will have an impact on the overall biodiversity in the area (Chapin *et al*., 2010) [6].

The analysis of time series data on the changes in vegetation vigor categories based on NDVI values revealed that the categories of very low and low increased between 1970 and 2014, while moderately high and high categories showed a decreasing trend. These changes were primarily observed in disturbed areas of the Himalayan region in India. The reduction in ground vegetation cover and conversion of grasslands were identified as factors influencing the NDVI values. Landscape analysis indicated a significant increase in fragmentation, porosity, and patchiness over the years, leading to the disruption of forest integrity and continuity. The rise in non-forest land use categories, such as built-up areas, roads, open forests, and agricultural settlements, contributed to these changes in the landscape. Anthropogenic activities have increased since the 1960s, with large-scale constructions occurring in the region during the 1980s and 1990s.

The rising need to convert forests into different land categories in alignment with human activities beyond what Sabarimala area can sustain has led to the fragmentation, permeability, and disruption of forest land, particularly in the Himalayan region. Currently, construction activities are ongoing as part of the Sabarimala master plan, aimed at enhancing the overall development of the Himalayan area by improving infrastructure and accommodation facilities. These activities will have an impact on the landscape elements in the years to come.

Conclusion

The map indicating the potential for soil erosion in the study area shows that there are areas with high susceptibility to erosion, specifically in a small geographical location near Sabarimala affected by human activities. The removal of vegetation cover, the creation of trek paths, and the use of tractor routes to Sabarimala may lead to severe soil erosion in this area. Further analysis indicates that changes in land cover patterns will greatly impact the likelihood of soil erosion. The high erosion susceptibility could result in the loss of soil nutrients and potentially explain significant seasonal variations observed in soil nutrient levels during soil studies.

Recommendation

The existence of invasive non-native species within undisturbed regions signifies inadequate forest management, thus necessitating the development of effective scientific strategies for weed control in the area. By treating the entire landscape as an interconnected system and supporting the entire biotic community, we can ensure the long-term preservation of the Indian Himalayan region.

References

1. Baishya R, Barik SK, Upadhaya K. Distribution pattern of aboveground biomass in natural and plantation forests of humid tropics in northeast India. Tropical Ecology,2009:50(2):295-304.
2. Binkley D, Giardina C. Why do tree species affect soils? The warp and woof of tree–soil interactions. Biogeochemistry,2008:42:89–106.
3. Binkley D, Giardina C. Why do tree species affect soils? The warp and woof of tree–soil interactions. Biogeochemistry,2008:42:89–106.
4. Bliss KM, Jones RH, Mitchell RJ, Mou PP. Are competitive interactions influenced by spatial nutrient heterogeneity and root foraging behavior? New Phytologist,2002:154:409–417.
5. Bonan GB. Forests and climate change: Forcing, Feedbacks and the climate benefits of forests. Science,2008:320(5882):1444-49.
6. Chapin FS, Zavaleta ES, Eviner VT, Naylor RL, Vitousek PM, Reynolds HL, *et al*. Nature,2010:405:234-242.
7. Chaturvedi RK, Gopalakrishnan R, Jayaram M, Bala G, Joshi NV, Sukumar R, *et al*. Impact of climate on Indian forests: a dynamic vegetation modeling approach. Mitigat. Adapt. Strat. Global Change,2010:16:119–142.
8. de Kroon H, Visser EJW, Huber H, Mommer L, Hutchings MJ. A modular concept of plant foraging behavior: the interplay between local responses and systemic control. Plant, Cell and Environment,2009:32:704–712.
9. Dijkstra FA, Smits MM. Tree species effects on calcium cycling: the role of calcium uptake in deep soils. Ecosystems,2002:5:385–398.
10. FAO (Food and Agriculture Organization of the United Nations). 2010. Forest Resources Assessment: Tropical countries. Annual report 2010 of Food and Agriculture Organization of the United Nation.
11. Fearnside PM. Environmental services as a strategy for sustainable development in rural Amazonia. Ecol. Econ,1997:20:53–70.
12. Finzi AC, Canham CD, van Breeman N. Canopy tree–soil interactions within temperate forests: species effects on soil pH and cations. Ecol. Appl,2002:8:447–454.
13. Finzi AC, van Breeman N, Canham CD. Canopy tree–soil interactions within temperate forests: species effects on soil carbon and nitrogen. Ecol. Appl,2003:8:440–446.
14. Groombridge B, Jenkins MD. Global Biodiversity: Earth’s Living Resources in the 21st Century. The World Conservation Press, Cambridge, 2000.
15. Gurukkal R, Raju S. Enclave Management Study. School of Social Sciences. Mahatma Gandhi University, Kottayam. Report, 2002.
16. Khan SA, Gulfishan M, Mir RA, Andrabi SAH. Forest cover change detection through modern applications and its environmental impacts, a review. Int J Ecol Environ Sci,2022:4:75-82.
17. Khan SA, Mir RA, Andrabi SAH, Gulfishan M. Forest land encroachment in Kehmil Forest Division of

Kupwara District: Dimensions, causes and consequences. Curr World Environ,2022:17:410-416. Doi: http://dx.doi.org/10.12944/ CWE.17.2.12

18. Khan SA, Gulfishan M, Mir RA, Andrabi SAH. Analysis of Forest Cover Change and its Environmental Impact in Kupwara Region of Jammu and Kashmir Through Remote Sensing. Environment and Ecology,2022:41(1):86—95. January-March 2023 ISSN 0970-0420.
19. Knox JC. Agricultural influence on landscape sensitivity in the Upper Mississippi River Valley. Catena,2001:42:193–224.
20. Laurance WF. Reflections on the tropical deforestation crisis.Biol. Conserv,1999:91:109–17.
21. Laurance WF. Reflections on the tropical deforestation crisis.Biol. Conserv,1999:91:109–17.
22. Malhi Y, Grace J. Tropical forests andatmospheric carbon dioxide. Trends in Ecology and Evolution,2000:15:332-37.
23. Mittermeier RA, Gil PR, Hoffmann M, Pilgrim J, Brooks T, Mittermeier CG, *et al*. Hotspots revisited. Cemex: Mexico City, Mexico, 2004.
24. MoEF (Ministry of Environment and Forests). National Policy and Macrolevel Action Strategy on Biodiversity. Ministry of Environment & Forests, Government of India, New Delhi. India, 2012.
25. Moffet CA, Richardson JL, Lura CL, Arnt JL. Soil development differences under larch, cottonwood, and prairie in north-central North Dakota. Soil Surv. Horiz, 2004, 48–55.
26. Mommer L, Visser EJW, van Ruijven J, de Caluwe H, Pierik R, de Kroon H. Contrasting root behaviour in two grass species: a test of functionality in dynamic heterogeneous conditions. Plant and Soil,2011:344:347–360.
27. Mooney HA, Oesterheld M, Poff NL, Sykes MT, Walker BH, Walker M, *et al*. Global biodiversity scenarios for the year 2100. Science,2000:287:1770-74.
28. Ono R, Rios AF. The oceanic sink for anthropogenic CO2. Science,2004:305:367-71.
29. Pelacani S, Marker M, Rodolfi G. Simulation of soil erosion and deposition in a changing land use: A modelling approach to implement the support practice factor. Geomorphology,2008:99(4):329-340.
30. Pimm SI, Russell GJ, Gittelman JL, Brooks TM. The future of biodiversity. Science,1995:269:347–50.
31. Poesen J, Nachtergaele J, Verstraeten G, Valentin C. Gully erosion and environmental change: Importance and research needs. Catena,2003:50:91-113.
32. Rajaniemi TK. Root foraging traits and competitive ability in heterogeneous soils. Oecologia,2007:153:145–152.
33. Rhoades CC. Single-tree influences on soil properties in agroforestry: lessons from natural forest and savanna ecosystems. Agrofor. Syst,2007:35:71–94.
34. Sabine CL, Feely RA, Gruber N, Key RM, Lee K, Bullister JL, *et al*.
35. Sala OE, Chapin III FS, Armesto JJ, Berlow R, Bloomfield J, Dirzo R, *et al*.
36. Thomas S, Rajeshkumar S. Effect of Arbuscular Mycorrhizal Fungus and Plant Growth Promoting Rhizomicro- Organisms on Productivity of Strobilanthes Ciliatus Nees., An Endemic to Western Ghats, South India. International Journal of Pharmaceutical Science Invention,2014:3(7):26-29.
37. Thompson I, Mackey B, McNulty S, Mosseler A. Forest Resilience, Biodiversity, and Climate Change. A synthesis of the biodiversity/resilience/stability relationship in forest ecosystems, 2009.
38. Tomar AS, Singh UC. Geomorphological Mapping Using Remote Sensing and GIS A Tool for Land Use Planning Around Shivpuri City, M.P., India. IOSR Journal of Computer Engineering (IOSRJCE),2012:5(1):28–30.
39. van der Waal C, de Kroon H, Heitko¨nig IMA. Scale of nutrient patchiness mediates resource partitioning between trees and grasses in a semi-arid savanna. Journal of Ecology,2011:99:1124–1133.
40. van der Waal C, de Kroon H, Heitko¨nig IMA. Scale of nutrient patchiness mediates resource partitioning between trees and grasses in a semi-arid savanna. Journal of Ecology,2011:99:1124–1133.