Assessment of Factors Responsible for Forest Loss in Tropics

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Abstract— *The tropical forest harbors the most enriched and highly diverse ecosystem in the world. Presently, many natural, as well as human-induced activities, are causing a deliberating impact on the biodiversity of this forest. The loss of primary vegetation in these forests has imbalanced the natural cycle of the surrounding environment. Among natural drivers, floods, drought, hurricane, and biotic stresses like pathogen and pest attack, whereas several anthropogenic activities such as forest fire, grazing, land modification through agricultural activities, exploitation of trees for fuel-wood and timber purpose, illegal cutting of vegetation are altogether responsible for massive destruction and degradation of tropical forestry. Various awareness drives has halted the rate of deforestation in last three decades; however, during the same time period, the global area of tropical forest cover has reduced at an alarming rate. In order to restore the loss, there is an urgent need to focus on conservation strategies like habitat rehabilitation, preservation of rare and endangered tree species, application of the new scientific methodology, and most importantly the rehabilitation of barren and waste forest land to ensure the functioning of a forest ecosystem. This research highlights the present status of plant diversity and the main drivers of biodiversity loss in tropical forests.*

Keywords— Tropical forest, biodiversity loss, conservation, habitat rehabilitation.

I. INTRODUCTION

Biodiversity plays a significant role in forest ecosystem functioning and ecosystem services. There exist an important relationship between forest biodiversity and multi-functionality, among ecosystem services. However, the quantitative and causal relationships among forest biodiversity and ecosystem services are not clearly understood (Brockerhoff et al., 2017). Many anthropogenic activities like biodiversity loss, land degradation, and climate change, led to forest modification yet the degree of forest loss is not properly quantified and mapped. According to a study, only 40.5% or 17.4 million km2 of forest exhibit a high level of landscape-level integrity and only 27% of this land area is under protected areas. In these protected areas, only 56% of forests represent a high level of landscape-level integrity. Therefore there is an urgent need to check deforestation and restore natural forests globally (Grantham et al., 2021). The natural processes and forest management should be combined together to control extinctions and restore species richness in degraded lands (Lugo et al., 1993).

Changing climate, rise in temperature, and GHG emission has a great impact on tropical forest biodiversity (Pandey et al., 2016). The tropics have witnessed heavy habitat destruction which may cause a mass extinction in the years ahead. According to a dataset estimation of species richness of 875 ecological samples, about 41% of the tree and animal species are absent from disturbed habitats, however, most of the samples still represent forests of some kind. The homogenization of local communities provides strength to disturbance as losses are partially balanced by gains in these forests (Alroy, 2017).

In tropical forests, the rare plant species coexistence is facilitated by non-random spatial distributions or niche differences, understory plants, and impact of host-specific pests on reproductive adults (Janzen-Connell effects), whereas the established and abundant species are influenced by negative density (Wright,2002). In tropics, the plant diversification is mainly influenced by broad ecological settings as woody plants show contrasting differences in community ecological patterns, population genetic, biogeographic, and phylogenetic. These woody vegetation shows high β-diversity among separate areas of forests, as these areas contain monophyletic clades of endemic plant species with geographically structured intraspecific

genetic variations that are geologically old (Pennington et al., 2009). Major terrestrial biomes like tropical rainforests are biologically enriched and most of their diversity is still unidentified. The traditional and molecular methods help in providing basic information for studying both the origin and management of plant diversity in tropical forests. Modern tools like DNA diagnostic tools, multilocus genomic markers, and plastid "DNA barcodes" can be successfully applied in the taxonomic discovery of tropical forest plots (Dick & Kress., 2009). In the coming years the functional diversity, distribution, and dynamics of tropical trees can be properly addressed using functional genomics (Swenson et al., 2012).

A sampling of rare tropical trees is more challenging due to extensive cryptic diversity. The integration of geography, morphology, and genomics, is a better option for estimation of the species which helps in understanding the origins of diversity and making ease the conservation efforts (Federman et al., 2018). Some of the dimensions of plant diversity like structural, functional, and, taxonomic, show a significant relationship with timber and non-timber forest product (NTFP) services. The richness of tree species in tropics is positively correlated with carbon stocks and as the geographical extent increases there exist a negative correlation with the bonding of this relationship. There should be a strong strategic policy designing on conservation of biodiversity and carbon stocks maintenance at local to regional spatial scales (Steur et al., 2012). The use of a similar technique with some geometric modifications and image mosaicking helps in identifying land cover data and can provide information on forests, plantations, agriculture, non-vegetated, and other land use categories. It also helps in estimating the magnitude of changes in forest cover and assessing of causes of these changes over time (Wijayaa et al., 2015).

Human-induced land modification in the tropics has significantly shown a wide impact on biodiversity and people. Poverty, corruption, environmental apathy, poor natural resource governance, and lack of conservation funding are some of the major challenges in front of conservation biologists. Thus the biologist, civil society, lawyers, social scientists, funding agencies, governments and non-governmental organizations, national and multinational corporations should come forward not only to understand but also to save biodiversity (Sodhi, 2008). In tropical deciduous forests, the rapid inventory information about baseline data of tree species diversity and structure helps in the management of protected areas. This along with in situ methods has the potential in facilitating the conservation of natural forests (Naidu et al., 2018). The forest conservation model requires extensive testing in all forest biomes and geographical regions before implementation (Pandey et al., 2015). The study of the relationship between tree species composition, richness, and carbon stock of tropical dry forest need special attention as it helps in monitoring, predicting, and finding solutions for the management of these ecosystems, often vulnerable to anthropogenic activities. Fine-scale inventory data of tree species has the potentiality in designing predictive models for the effective management of these forests (Sainge et al., 2020).

II. PLANT DIVERSITY OF TROPICAL FORESTS

In tropical deciduous forests the rapid inventory information about baseline data of tree species diversity and structure helps in the management of protected areas. These along with in situ method have potentiality in facilitating the conservation of natural forests (Naidu et al., 2018). In tropical forests the rare plant species coexistence are facilitated by non-random spatial distributions or niche differences, understory plants, and impact of host-specific pests on reproductive adults (Janzen-Connell effects), whereas the established and abundant species are influenced by negative density (Wright, 2002). Forest litterfall enriched in carbon, nitrogen, phosphorus, potassium, calcium improves soil fertility and moisture helping forest recovery and preservation (Pandey et al., 2016). In tropics the plant diversification is mainly influenced by broad ecological settings as woody plants shows a contrasting differences in community ecological patterns, population genetic, biogeographic, and phylogenetic. These woody vegetation shows high β-diversity among separate areas of forests, as these areas contain monophyletic clades of endemic plant species with geographically structured intraspecific genetic variation that are geologically old (Pennington et al., 2009). The soil rich in nutrients favors dense forestation, tree regeneration along with increasing moisture helping germination and seedlings' survival (Singh & Pandey, 2017). Major terrestrial biomes like tropical rainforests are biologically enriched and most of their diversity is still unidentified. The traditional and molecular method helps in providing basic information for studying both the origin and management plant diversity in tropical forest. Modern tools like DNA diagnostic tools, multilocus genomic markers, and plastid "DNA barcodes" can be successfully applied in taxonomic discovery of tropical forest plots (Dick & Kress, 2009). In the coming years the functional diversity, distribution, and dynamics of tropical trees can be properly addressed using functional genomics (Swenson et al., 2012).

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effective management of these forests (Sainge et al., 2020). Forest mapping, modeling, remote sensing, and computer software have the potentiality in studying rare and threatened plant species and their conservation (Pandey et al., 2016). Sampling of rare tropical trees are more challenging due to extensive cryptic diversity. The integration of geography, morphology, and genomics, is a better option for estimation of the species which helps in understanding the origins of diversity and making ease the conservation efforts (Federman et al., 2018). Some of the dimensions of plant diversity like structural, functional, and, taxonomic, show significant relationship with timber and non-timber forest product (NTFP) services. The richness of tree species in tropics is positively correlated with carbon stocks and as the geographical extent increases there exist a negative correlation with the bonding of this relationship. There should be a strong strategic policy designing on conservation of biodiversity and carbon stocks maintenance at local to regional spatial scales (Steur et al., 2012). The use of similar technique with some geometric modifications and image mosaicking helps in identifying land cover data, and can provide information of forests, plantations, agriculture, non-vegetated and other land use categories. It also helps in estimating the magnitude of changes in forest cover and assessment of causes of these changes over time (Wijayaa et al., 2015).

III. FACTORS RESPONSIBLE FOR FOREST BIODIVERSITY LOSS

The continuous loss of biodiversity of global forests in general and tropical forests, in particular, has always remained a matter of serious concern for forest managers. The rapid rate of deforestation is although less than the net loss of forest area, showing a net decline of 4.7 million hectares from 7.8 million hectares per year from 1990 to 2020, or a decrease of 178 million hectares (FAO, 2020). Among various factors, agricultural expansion is the main driver causing deforestation and degradation in tropical forests. In the last 2-3 decades commercial agriculture accounted for 40 % tropical forest loss (FAO, 2020). In the tropics, this activity is of great threat as secondary forests are expanding whereas primary forests are reducing. The maturity and management of planted forests need better understanding. Earlier studies reported continental differences in the diversity due to land-use intensity or differences among species in response to disturbances. The dataset study of tropical countries suggests that species richness in the secondary forest is comparable to primary forest; however, community composition is different in these forests. Compare to other continents, the Asia continent shows a significant difference regarding responses of an individual taxonomic group especially the oil palm plantations, in secondary or planted forests (Phillips et al., 2017). Besides, extraction of wood, fire, drought, grazing and browsing effect and poor management of state government are also the important drivers of deforestation. In warmer regions of the world like North Ethiopia, the dense and open forest account for 83% of forest cover in 1973, which reduced to 39% in 2015 (Hishe et al., 2021). Another important cause of forest loss is illegal harvesting, infrastructure development, and encroachment. The success of Reducing Emissions from Deforestation and Forest Degradation 'REDD+' is based on the identification of these drivers, along with government policies to restructure and reshape the over-dependency on forest resources (Pandey et al., 2013).

The forest loss is a very complex cultural, socio-economic, and political event. The miners, loggers, and rural communities are some of the primary actors responsible for forest exploitation directly causing forest declination. Thus there is a need to understand the main causes such as population growth, distribution of economic and political power, drawbacks in the market system, corruption, and undefined government policies. Accordingly, the introduction of remedial measures should be very specific to fulfill the desired target in due course of time to resolve this complex event (Contreras-Hermosilla, 2000). The loss of tropical forest biodiversity is also attributed to over-exploitation, fragmentation, invasive species, and global climate change causing alteration in species richness and diversity. However, these parameters are not properly addressed on account of their organization and functioning especially in the case of secondary forests and need better understanding and research in the concerned area (Morris, 2010). In some cases the deforestation has also caused an adverse impact on water and an energy resource, however, this impact is not properly estimated. The intensive agricultural practices, illegal lumbering, and growth of human settlements caused the extinction of valuable forest species. The use of geospatial technology based on satellite images helps in better understanding and analyzing the rate of deforestation and impact on forest diversity in these areas (Adeoye and Ayeni, 2011). In some parts of the world as in the Brazilian Atlantic forest the fuel-wood harvesting although an important driver of deforestation has become a necessity for nearly 76% of households residing in 7 rural settlements. In these circumstances, the government has to pay more attention to poverty amelioration along with biodiversity conservation (Specht et al., 2015).

The use of satellite data in the Indonesian forests, the third-largest biome in the globe revealed major information on forest cover and modification during 1990-2012. According to this study, the rate of deforestation declined in 2000-2012 compared to 1990-2000. The major drivers of forest changes in the region reported were subsistence agriculture, plantation forest, and conversion from shrubs/open land, oil palm expansion, and mining. (Wijayaa et al., 2015). The major cause of a decline in

forest structure in Bhutan is selective felling and resource extraction arising due to anthropogenic activities that have created gaps resulting in colonization by non-timber species (Tenzin and Hasenauer, 2016). The biodiversity loss has also affected global carbon concentration in the atmosphere. The deforestation and degradation along with draining and destruction of peat swamp during 1990-2010 in South-East Asia resulted in 60-90% carbon emission; however difficult to be estimated, but during the same period the rate of deforestation declined which is not enough to balance the co2 concentration. The reduction of carbon emission from land, mainly from fossil fuel is a better option in stabilizing carbon concentration in the atmosphere (Houghton, 2012). The loss of trees disturbs the ecological functioning of any forest. The rare tree species loss is of great concern as they possess distinct traits of ecosystem services. This loss cannot be compensated by local species thus there should be both conservations as well as restoration of multifunctional keystone species for ensuring diversity and long-term ecosystem functioning (Tekalign et al., 2017).

IV. CONCLUSION

In conclusion, the loss of tropical wilderness will cause an adverse impact on the natural cycling of environmental components and directly affect the ecosystem functioning of major biomes of the globe. The monitoring of forest area loss using satellite data is urgently required followed by implementing control measures. The weakness in government policies to prevent illegal cutting and trafficking of timber and forest produce should be properly addressed. In situ conservation, conserving keystone species, human population settlement, and other such types of strategies will prevent the loss of valuable species of the tropical forests.

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