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Restoration of Forests: Human Concern

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ABSTRACT

Human depends upon the forest for their day-to-day need. The increasing population has caused the over-exploitation of natural forest resources. Initially, the rate of forest exploitation was balanced by the rate of natural restoration but in the last few centuries due to the population explosion and increased greed of humans, the rate of deforestation is far more than the rate of restoration, which results in the degradation of forests globally. Forest degradation is followed by many consequences including unavailability of forest goods and services, reduction in pollutant absorption by forests which in turn accelerate global warming, climate change, etc. There is an urgent need to conserve what we have left with and restore what we have lost otherwise the outcomes of human greed will be drastic.

Forest restoration is the process of improving the health, productivity, and array of life of a forest and re-establishes the integrity of the ecosystem. There are usually 4 strategies of restoration used according to the type of ecosystem and level of degradation, these are rehabilitation, reconstruction, reclamation, and replacement. Principles involved in restoration are ecological (benefit the environment), economical (economically support the community), and community-based (enhance the community values like integrity, etc.). Restoration varies from site to site, according to the environment and species present in the degraded ecosystem, it is a normal belief that species with larger seed sizes can withstand stress conditions, and tree legumes form the excellent primary introduction subjects in such areas due to their nitrogen-fixing ability. The process of restoration involves multiple steps and for a successful restoration project implementation of each step should be careful. As with any other project, restoration has its challenges like fund availability, exotic species, lack of support and awareness, etc.

Keywords- Restoration, degradation, reference species, monitoring.

I. INTRODUCTION

Human needs are served by forests for an indefinite time in form of food, timber, fibers, etc. and now the awareness of society's dependence on the forest is much stronger than before. Despite all this awareness, the unsustainable use of forest resources led us to the vast degradation of forests. It is estimated that more than 2 billion hectares of forest area are degraded worldwide and require restoration (Lindenmayer, et al., 2012). There are many social factors responsible for degradation including, economic, demographic, technical, and governance (Kanninen, et al., 2007). Although 12% of the total global forest is reserved and expected to be repositories of biodiversity there is no forest in the world left without human disturbance, even our so-called reserve forest is often degraded and threatened by encroachment. Degradation can occur in degrees; for example, land may be classed as marginal, fragile, or degraded (Hudson & Ayala, 2006); or ecosystems as degraded, damaged, or destroyed (Society of Ecological Restoration, 2004). The loss of forests leads us to the loss of ecological services like biodiversity, carbon sequestration, and protective and productive functions. Loss of forest cover also accelerates the process of climate change, global warming, and the greenhouse effect because forests or trees are known to absorb responsible pollutants. So, conservation of what have we left with and restoration of what we have lost should be our utmost priority in the current situation.

II. WHAT IS RESTORATION?

No forest in the world remains completely unaffected by humans, the effects imposed by humans are either direct like overexploitation, invasions, etc. or indirect like impacts of climate change, change in weather patterns, etc. In both scenarios, nature is the one that suffers. WWF defines forest restoration as "the process of improving the health, productivity, and array of life of a forest and is a complex undertaking that can never fully bring back the original forest" (WWF, n.d.). It can also be defined as "actions to re-instate ecological processes, which accelerate recovery of forest structure, ecological functioning and biodiversity levels towards those typical of climax forest" (Elliott, et al., 2014). Forest restoration can also be defined as accelerating the regeneration process by removing and overcoming the hurdles to natural forest regeneration (Lamb, 2011; Holl, 2012).

Generally, the term restoration is being confused with replantation but in reality, restoration is an umbrella covering replantation, conservation of remnant vegetation, biodiversity conservation, and economy; hence IUCN introduced a new concept of FLR i.e., Forest landscape restoration. IUCN defines FLR as an

ongoing process of regaining ecological functionality and enhancing human well-being across deforested or degraded forest landscapes. FLR is restoring a whole landscape to meet present and future needs and to offer multiple benefits and land uses over time (IUCN, 2003). Restoration practices in degraded land may involve seed addition (Turner, et al., 2006; Kirmer, et al., 2012), native species transplant (Stradic, et al., 2014), turves and rhizomes transfer (Cooper & MacDonald, 2001) and use of exotic species for revegetation to reach specific goals as prevention of soil erosion rapidly (usually a threat to native species).

III. PRINCIPLES OF RESTORATION:

The soul of all the principles of the restoration lies in healing the degraded land and then helping it to be actively restored. There are mainly 3 core principles of restoration viz.

1. Ecological principle of forest restoration: Re-establishment of a fully functional ecosystem is the prime object of any restoration program. A fully functional ecosystem possesses the "ability of an ecosystem to support and maintain a balanced, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitats within a region" (Karr, 2000). It includes processes like planning and documentation, assessment, monitoring, evaluation, protection of areas with high integrity, restoration approaches like active restoration (introduction of native species), and passive restoration (natural recolonization of species).

2. Ecological economic principle: It believes in improving the integrity of an ecosystem in an ecological and institutional make-up that accounts for the economic benefits and costs associated with restoring natural capital (DellaSala, et al., 2003)

3. Communities and workforce principles: A sustainable restoration promotes the relation of humans to the land by ecological integrity, preserving and restoring culture; and supporting workers and communities economically. In turn, a strong, healthy, and diverse community and a skilled committed workforce is the base of an effective restoration (DellaSala, et al., 2003). The foundation of effective restoration lies in the meaningful involvement of communities, groups, agencies, and stakeholders (Higgs, 1997).

IV. RESTORATION STRATEGIES

There are usually 4 restoration strategies, being used according to overall objectives, initial site conditions, and landscape context (Stanturf, et al., 2014). These strategies involve:

(i) Rehabilitation applies to restore native species in a degraded but existing ecosystem. Rehabilitation can use 2 alternate approaches one is, a conversion which involves the complete replacement of one species with another (Zerbe, 2002) and the second is the transformation which involves only partial replacement (Pommerening, 2006).

(ii) Reconstruction is used to restore an ecosystem that is not completely degraded but recently in other resources used as forest area converting into pasture etc., these lands usually contain competing species and degraded soil by the previous land uses. In this, the treatment approaches include improving the soil quality via increasing organic content, reducing weed seed banks, planting the desired seedlings, etc. (Benjamin, et al., 2005).

(iii) Reclamation involves the restoration of completely degraded land, usually devoid of any vegetation. Restoration of such area is most difficult, sometimes non-native species are grown at first to make land favourable for native species. Other approaches include amelioration of soil, early weed control, natural recolonization of native species and irrigation, etc. (Lamb, et al., 2012).

(iv) Replacement involves replacing the flora or their locally adapted genotype with either other plant species or a different genotype of the same species, which is not native to the area with changing climate (Williams, et al., 2013).

The restoration project is a complex process and must include a clear logic as to why restoration is needed, a site in need of restoration with its ecological description, an index of goals and objectives to achieve, design and description of the reference (modal for planning a restoration project and later for its evaluation), description of how the restored ecosystem integrates with the landscape, plans, schedule, and budget for restoration process; careful monitoring and evaluation of the process, strategies for long term protection and maintenance of restored ecosystem (Society of Ecological Restoration, 2004). An ecosystem is considered restored when it contains a characteristic community as a reference, has indigenous species, contains all functional groups required for the continued stability of the restored ecosystem, is capable of sustaining reproducing population, integrates with the surrounding landscape, possible threats from surrounding landscape are eliminated, it should to resilient to normal stress condition and should be self-sustainable, provides natural goods and services to the society in a sustainable manner, strengthen the community relations by individual participation in the restoration project (Society of Ecological Restoration, 2004).

Designing a restoration pattern is a must for the success of restoration planning. A good design must include landscape engineering, selection of appropriate plant species, water management, etc. Reintroduction of the plant at a suitable distance is also a part of good restoration design to reduce competition between plants (Stradic, et al., 2014).

Some characteristics of plants like seed size, and germination phenology influence plant recruitment patterns and affect the success of the restoration. Plants with larger seeds tend to germinate in stressful conditions imposed by drought, herbivores, competition, etc. (Moles & Westoby, 2004). Larger seeds give rise to longer roots, enabling them to absorb from greater depth, reduce competition, and have high nutrients (Leishman & Westoby, 1994). However, a study on Fabaceae plant seeds shows that seeds with larger and smaller sizes are more potent to germinate than intermediate seeds (Pereira, et al, 2013).

Degraded lands are poor in nutrient as well as water content and provide a stressful environment for seed germination, but restoration of such lands is necessary to restore the ecological integrity of the area. Such lands are N and P poor and the biological nitrogen fixation ability of legumes can be considered of key importance to overcoming nutrient deficiency, increasing greatly biomass production and N use efficiency (Morris, et al., 2011). Legumes can increase soil fertility, reduce the external input and regulate the biochemical cycle (Good, 2018). When the N content of the plant increase it leads to an increase in photosynthesis and leaf area which in turn increase the biomass (Junyu, et al., 2016; Li, et al., 2012). Nitrogen-fixing species increase eight times the biomass growth as compared to non-nitrogen fixing species mostly in stem and leaves (Jaquetti, 2018). Legumes with high or very high level of VAM (Vesicular Arbuscular Mycorrhizae) colonization are considered ideal for restoration practices (Rajpurohit & Jaiswal, 2020).

Grasses are usually pioneers on degraded or disturbed land. Thus, their role in restoration is very important. There are 2 opposite views regarding the role of grasses in restoration one says that grasses alter the soil consistency and make a favourable microclimate for seed germination (Vieira & Scariot, 2006) while the others say that grasses inhibit seed germination and plant growth by competition (Craven, et al., 2009; Orth & Ramos , 2011).

V. CHALLENGES IN FOREST RESTORATION

The global human population is increasing at a rate faster than ever and is expecting a 50% increase in the next 4 decades. With increasing, population dependency on land use also increases proportionally, for home, agriculture, food, work, fuel, fiber, etc., in that case, forest restoration seems nothing more than just another factor seeking land. Moreover, in a situation like this where land is inelastic restoration or conservation of any area leads to leakage i.e., deforestation and overexploitation of another area. However, the best way to balance food production and environmental needs is to improve the use of already cleared land (Herrero, et al., 2010; Phalan, et al., 2011). Another challenge faced during the restoration projects is the effective removal of invasive species, which affect germination as well as the survival of native species negatively (Campoe, et al., 2010). Conflict of interest is yet another problem associated with restoration because there are many stakeholders involved in the project, each having particular interests. Funds, careful implementation, monitoring, lack of local participation, lack of awareness, and no support from the government are other issues associated with restoration.

Restoration projects are hindered by abiotic factors like altered physical and chemical properties (low soil moisture and low nutrients), and increased soil nutrients (in the case of degradation by agriculture) (Wong, 2003; Yuan, et al., 2006). Biotic factors like low soil microbes especially mycorrhizal fungi in disturbed land (Rajpurohit and Jaiswal, 2021), exotic species, dispersal of propagules, and seed germination also determine the rate of restoration (Shu, et al., 2005). The introduction of a whole plant community in a degraded area is costly and hard to implement thus usually a single species is reintroduced (Sampaio, et al., 2007). Restoration success usually depends upon various criteria (Society of Ecological Restoration, 2004; Ruiz-Jaen & Aide, 2005), 2 most considered criteria are (i) the ability of introduced species to reach and reproduce in the degraded area and (ii) the tendency of introduced species to alter its immediate environment i.e. to make it favourable for other species which are less tolerant to the harsh conditions of degraded land.

VI. CONCLUSION

Forest restoration is a relatively new but interesting concept helps us to restore what was degraded and natural restoration is time taking process. To accelerate the process of restoration selection of appropriate planning and designing, selection of native plant species and proper monitoring is necessary. There are a few challenges in the process but there is nothing we can't overcome, policies should be made for restoration, awareness campaigns should be organized at local levels, different stakeholders should be involved in the process and funds should be raised by the government, non-government organization, and different stakeholders.

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