OPINION

Needs for policy on landscape restoration in India

Ramalingam Ravi and Dharma Rajan Priyadarsanan

In India, population growth and rapid industrialization concurrent with an ever-increasing quest for better quality of life have resulted in a growing demand for energy and infrastructure, leading to significant impact on the country's environment and ecology. Resources such as natural forests are particularly exploited through agricultural expansion, timber extraction, monoculture plantations, rail and road networks, hydroelectric projects, mineral exploration and mining. Apart from these, the Indian forests form the livelihood base for nearly 173,000 villages[1]. The consequences of overexploitation of forest resources include depletion of natural resources, soil erosion and land degradation, lower productivity, groundwater depletion, reduction in species diversity and an overall increase in the extent of wasteland. At present, it is estimated that approximately 68.35 million hectares (m ha) of the total geographic area of our country is considered as wasteland, of which nearly 50% of the land is degraded non-forest land[2].

The anthropogenic pressure on natural landscapes is not limited to India alone. Globally, the world's natural habitats continue to be converted to other land uses at a very high rate. Worldwide, it was estimated that around 16.1 m ha of natural forests were lost annually during the 1990s (ref. 3). However, there are efforts to repair some of the damages which humans have inflicted on the ecosystems and biodiversity, through ecological restoration. Ecological restoration mitigates widespread loss and ravaging of ecological integrity in natural and semi-natural areas[4]. Restoring degraded areas is an important activity among today's conservation efforts to counter the effects of anthropogenic pressures, such as fragmentation and degradation, on the world's natural ecosystems[5]. Therefore, ecological restoration is considered as the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed[6]. These restoration projects are often driven by either biocentric or anthropocentric goals[7,8]. Biocentric goals encourage restoring native biota similar to those which existed during pre-disturbance conditions (for example, restoring populations of critically endangered or threatened species in the wild, or restoring a natural habitat). In contrast, anthropocentric goals seek to return degraded areas to some sort of functioning ecosystems (for example, restoring suitable plant cover to control soil loss).

The biocentric restoration projects have largely contributed to the scientific knowledge pertaining to habitat restoration. For instance, 'repairing the rain forests' project by the Nature Conservation Foundation[9], is a good example for habitat restoration. Restoration efforts such as these are the measures to restore the dwindling forest ecosystems, which can provide habitat for many native and endemic flora and fauna. However, 'strict' and 'site-specific' biocentric restoration projects may not be adequate to compensate for large-scale loss of biodiversity and ecosystem services in human-dominated landscapes, where multiple stakeholders are involved[10].

Contrary to biocentric restoration, large-scale multi-purpose restoration projects seek to restore ecosystem functions and services in human-dominated landscapes, where the loss of biodiversity and the rising poverty levels of the rural masses are prominent[10]. Governments and global conservation organizations have recognized the need for forest landscape restoration to address environmental and economic problems of the rural masses living in the tropical countries. For instance, these projects are particularly deemed important in the tropical countries, where more than half the world's rural population survives depending on several forest resources for its subsistence[11,12]. Therefore, restoration projects should be as diverse as their goals that ascertain achieving prescribed ecological targets. Measures pertaining to enhance rural livelihood (e.g. availability of non timber forest products, grazing lands), biodiversity (e.g. species richness and composition) and ecosystem processes (e.g. pollination and loss or retention of soil nutrients) are some of the popular targets pursued by restoration projects.

During this century, ecological restoration is rapidly diversifying to adapt and mitigate global environmental change. This has led to a growing awareness of the need to develop different restoration strategies based on the priorities such as what to be restored and for whom. Recognizing the diversity of restoration goals, strategies and techniques, robust public policies are required for assuring their effectiveness in achieving the targets of the compensatory mitigative processes. Here, public policy is 'a course of actions adopted and pursued by a government to solve a problem'[13].

A few countries such as USA, Canada, and the Scandinavian countries, etc. have brought attention to ecological restoration as a public policy. In USA, the legal and scientific framework for the restoration of severely disturbed ecosystems is perhaps best illustrated by Surface Mining Control and Reclamation Act of 1977 (SMCRA)[14]. According to the mandates of SMCRA, the land disturbed by mining must be restored to the same landform and land use, with the same kind and amount of vegetation which existed before mining. This simple mandate on revegetation of mined lands has resulted in a set of rules and standards for assessing its success. Accordingly, each land-use category must meet its own set of standards; failing which the reclamation is deemed incomplete. For example, if mining is undertaken in forested landscapes, then the ecological targets pursued by post-mining restoration projects should include the productivity, ground cover, diversity and seasonality of the native habitat. In addition, the measures of such ecological targets should equal or exceed those of similar habitats in the surrounding areas. Such mandates prompted the corporates and land managers to collaborate with the scientific community for designing and implementing appropriate restoration projects. Thus, large mined areas often provide a readymade experimental set-up to restoration studies as mining industries are legally obligated to restore such areas to their pre-disturbance conditions. Additionally, academicians and researchers took this as an opportunity for long-term partnership with the corporates (involved in mining) and land managers to document the process of biodiversity recovery over decades. Hence SMCRA has helped in the rapid development of

restoration ecology as a scientific discipline.

In India, the legal framework that binds the environmental management of industrial development projects appears to have only recently become a standard practice. Here, regulation is achieved through various Acts, such as the Environmental Protection Act of 1986, the Forest Conservation Act of 1980, the Mines and Minerals (Regulation and Development) Act of 1957 (amended in 1988 and 1994), as well as other provisions made by the government from time to time. The Ministry of Environment and Forests (MoEF) has undertaken several initiatives on afforestation programmes according to the environmental protection and forest conservation acts.

Mining operations usually involve deforestation, habitat destruction, biodiversity erosion and widespread environmental pollution. Unfortunately, the subsurface resources such as minerals and ores are superimposed by biological resources such as forests. This has made mining essentially a destructive developmental activity to promote the growth of nation's economy. Therefore, the Compensatory Afforestation Fund Management and Planning Authority (CAMPA) was formed by the MoEF under the guidelines by the Supreme Cou rt of India, to promote afforestation and regeneration activities as a way of compensating for forest land diverted to non-forest uses (mainly mining)[15]. Under this programme, all the State Forest Departments are encouraged to work along with the local communities through the joint forest management. However, the state CAMPA guidelines do not set particular standards to be met in habitat restoration or land reclamation projects. Instead, they focus on a general afforestation programme with little or no regard to ecological targets to be met.

Furthermore, most of these policies do not prescribe the desirable ecological targets to be met. For instance, the Mines and Minerals (Regulation and Development) Act prescribes that 'No mining lease would be granted to any party, private or public, without a proper mining plan including the environmental management plan approved and enforced by statutory authorities. The environmental management plan should adequately provide for controlling the environmental damage, restoration of mined areas and for planting of trees according to the prescribed norms. As far as possible, reclamation and afforestation will proceed concurrently with mineral extraction'[16]. As a result, most mining companies include land reclamation programmes in their developmental plans. However, the policy does not clarify if ecological targets such as species richness or the community structure of pre-existing vegetation or those similar to the surrounding areas should be attained during post-mining restoration. Consequently, most post-mining restoration is largely limited to monoculture plantations or revegetation with a few species, which may not be adequate in compensating for the loss of forests. Despite this progress, there is a continual challenge in relating the scientific knowledge to policy because of the struggle with how policy-relevant findings of such studies could be deployed.

Successful land reclamation or restoration of degraded lands largely depends upon the social and political will along with awareness and motivation of the people, coupled with strict institutional and legal framework. Recently, restoration ecology has been identified as an inter-disciplinary science that draws immense knowledge from the fields of natural and social sciences. This growing knowledge on ecosystem restoration helps in drafting procedural guidelines for ameliorating the ecosystem damage by prioritizing and pursuing ecological and social targets. In addition, ecological restoration should help achieve the complementary goals such as biodiversity conservation and enhancing rural livelihood. This will strengthen the linkages between biodiversity and its ecological functions and services, and reduce the human use of natural forests. Further, ecological restoration of degraded landscapes is often seen as an important response to global climate change as it influences the global carbon budget[17]. Therefore, a model legislation effectively bringing together scientific research in the restoration for multiple land uses will bring in clarity of purpose, comprehensiveness, and on-the-ground achievements for the landscape restoration programmes in the country. Such a policy should include clearly stated guidelines and established standards (particularly ecological and social targets) which should help maximize the restoration potential of compensatory mitigative processes.

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Ramalingam Ravi and Dharma Rajan Priyadarsanan are in the Ashoka Trust for Research in Ecology and the Environment, Royal Enclave, Srirampura, Jakkur Post, Bengaluru 560 064, India.*
**e-mail: priyan@atree.org*