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Conservation In Heterogeneous Landscape - Sacred Groves Matter.

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Abstract: *Landscape ecologists are of the view that heterogeneity of the landscape is the major factor that has to be considered when conservation strategies are planned. Heterogeneous landscape consists of elements like, agricultural fields, pasture lands, plantations, homestead farms, water bodies and remnant woodlands/patches depending on the magnitude of human interventions on the system. The importance of woodlands/remnant patches for maintaining diversity in landscape has already been worked out to some extent although socio-culturally protected patches (aka sacred groves) are less represented. Contrary to the common understanding of the sacred groves' role in biodiversity conservation, there are hardly any studies on their landscape level importance. As well understood in the landscape conservation studies, the interaction of these groves with the surrounding landscape and the impact caused by changes in the surrounding system on these groves need to be considered while planning an effective conservation strategy. This article aims to highlight few potential aspects of sacred groves in heterogeneous landscape and their possible role in ecosystem research.*
Keywords: *Landscape heterogeneity, remnant forest, sacred groves*

I. Introduction

Spatial heterogeneity refers to the uneven distribution of species in various patches of a landscape across environmental and biotic gradients. The neo conservationists have begun to consider the spatial heterogeneity of a landscape as an important component in deciding the composition and diversity of the system. Spatial heterogeneity at various scales of an ecological system affects the important functions starting from community composition to ecosystem processes [1]. The continuum and the interaction of diverse landscape elements in determining the ecosystem functions make the process dynamic.

In general, a habitat of an organism itself is a combination of different patches of a landscape which help the individual/population to carry out its different life processes. Landscape heterogeneity combines variations in patch quality, size and distance between patches. It is well accepted that a heterogeneous landscape supports more number and types of organisms due to the very nature of the diverse components compared to the homogeneous landscape [2]. The interaction among different life-cycle processes forms a delicate network across the landscape where landscape heterogeneity matters most [3].

The process of land clearing and environmental degradation is continuing rapidly in many regions such as South East Asia and South America particularly in rainforests [4]. Habitat fragmentation has three major components, namely loss of the original habitat, reduction in habitat patch size, and increasing isolation of habitat patches all of which contribute to a decline in bio diversity within original habitat [5-6].

In view of declining biodiversity all over the world, decision makers are now paying attention towards heterogeneous landscape due to inadequate coverage of protected area network and diverse requirements of the organisms concerned. It is practically impossible to maintain vast undisturbed protected areas against ever increasing demand of land for livelihood maintenance. Eventually, most protected areas in tropical regions are embedded within a matrix of heterogeneous land uses and are often directly or indirectly affected by forest fragmentation, road construction, agrochemicals, hunting, cattle grazing, agricultural incursions, fire, invasive species, over-harvest of non-timber forest products, logging, and mining in the surroundings [7-10].

Mosaic landscapes serve as alternative habitats for organisms which otherwise would have perished when a particular habitat is destroyed. An estimated 350 million ha in tropics are classified as degraded due to inappropriate use of fire, land clearing, poor grazing management, and destructive harvesting of ecosystem resources [11]. Pollination systems are under threat due to habitat fragmentation, agricultural intensifications and invasions [12-14]. Moreover the minimum size of the habitat required also influence the extinction of a species apart from the ability of the organism to move [15]. The forests near a field will boost up production due to its positive impact on the number and activity of pollinators, aquifer management, increased soil fertility and it will also supply seed dispersal agents which will help in maintaining bio diversity.

II. Sacred Groves- As Part Of Heterogeneous Landscapes

The sacred groves (SGs) are segments 'of landscape, containing vegetation and other forms of life and geographical features that are delimited and protected by human societies under the belief that to keep them in a relatively undisturbed state is expressive of an important relationship of humans with the divine or with nature [16]. These groves are present across the globe in different names, preserved by locals. In due course due to changes in belief system, values, and increased demand for food, these patches which were a connection between natural forests and human settlements diminished in size and became isolated entities amidst human modified landscapes. Despite having social protection to some extent, their landscape value is still underrated (TABLE.1).

Sacred groves are characteristically forest fragments, connected or disconnected with the contiguous forest tracts. However, the uniqueness lies in its association with human beings which often comes from their socio-religious believes. This voluntary association with forest ultimately manifested into peoples' involvement in biodiversity conservation without having any extramural support. Their role in regional/local biodiversity maintenance cannot be ignored. Many trees and other plants in these groves function as key stone species and directly supply natural predators of crop pests, agents of seed dispersal and mainly pollinators. Ramakrishnan in his study [17] recommends the use of culturally valued tree species which improves soil fertility, such as the Nepalese alder (*Alnus nepalensis*), bamboo species that conserve N, P and or K, or traditional lesser-known food-crop legume species, such as *Flemingia vestita*, for speedy recovery of the fallow phase' of crop lands in mountain regions.

Ren et al[18] points out that these culturally protected forests can be used for restoration of forests. Gao .et al. in their study[19] in the culturally protected forests of China identified that 85.4 % of the local trees species were found in culturally protected forests. These forests may act as seed (species) pools to neighbouring forests and areas. Ray et al.[20]found that groves preserve regional endemic species pool in altered landscape. In Africa, groves act as shelter for regional plant and animal species pools amidst modified landscape [21-23].

Considering the functional aspects of the landscape, groves/remnant patches have potential to provide a spectra of functional traits which is related to the ecosystem services. Although studies are there for forest patches, grove specific findings are yet to be done [24-26]. Even, continuous monitoring of grove biota (especially plants) would reveal phenological diversity in the system which have important role in maintenance of local invertebrate and small vertebrate communities.

When a forest patch is fragmented, the organisms present, suffer due to increased exposure to and interference from the outside world. There might be new invasions, competitions and disturbances. These sacred groves which often act as corridors between natural forests and rural landscape with agricultural fields, plantations, homestead farming areas etc, save the organisms under threat due to fragmentation by providing refuge. In Kodagu region of Karnataka, sacred groves in combination with the tree cover in coffee plantations played an important role in maintaining forest bird diversity [27].

Veach et al.[28] showed that forests adjacent to the villages were dramatically different compared to more isolated ones nearby. Intense exploitation for firewood and timber dramatically reduced the biomass in these areas, and also reduced diversity. Sacred groves are also forest patches but the exploitation will be drastically less here due to the myths attached. This increase in bio mass will not only have a positive impact on the micro flora and thus soil quality, but will also contribute significantly to the ground water, amelioration of soil, plant health and crop production in the adjacent fields. Thus in effect the value of the ecosystem services of the landscape is increased by the presence of sacred groves.

A sacred grove surrounded by crop fields can be compared to an effective agro forestry system which has intrinsic potential to provide food, fuel, fodder, green manure, and timber resources under the notion of sustainable harvesting. Furthermore, there is an accumulation of scientific evidence about the environmental functions of agro forestry, such as their role in the regulation of physical and chemical fluxes in ecosystems, and mitigation of environmental pollution [29]. In addition to the aboveground diversity, greater organic matter flux and/or favourable soil moisture relations [30] stimulate drilosphere systems (associations between earthworms and soil bacteria), implying higher belowground diversity.

Most of the big trees in sacred groves have deep root systems. They play a very important role in nutrient recycling by making the subsoil resources available to shallow rooted plants in the associated landscape by 'nutrient pumping' and 'hydraulic lift'[31].This heterogeneous matrix with mixed species of trees will have greater nutrient use efficiency compared to mono specific cultivations [32]. The sacred forests are also of great forestry interest as indicators of the natural productivity of the region. Ecologically valuable species like *Albizia lebbeck* and *Ficus glomerata*, which conserve high amount of nitrogen, phosphorous, magnesium and calcium in their leaves, are found in several sacred groves of Manipur [33].

Expanding the size of the global terrestrial sink is one strategy for mitigation of CO2 build-up in the atmosphere [34]. Nair et al [35] put forth the argument that woody perennials transport half of the carbon assimilated to the soil by rhizodeposition, fine root and litter dynamics and augments the soil organic carbon.

This is very much applicable for sacred groves. Trees in managed species mixtures have a great potential to bring about micro-site enrichment through litter fall [30], [36-37].

Landscape level consideration of sacred grove has been felt in watershed management also. Studies have pointed out that, old growth forests or natural forests have greater potential for water conservation than plantation or secondary forests. In spite of having numerous documentation on sacred groves' connection with water bodies, experimental evidences are very few for consideration [38-39].

III. Challenges ahead

3.1 . Changes in land use pattern

Conversion of natural forests to plantations and crop fields leads to loss of pristine vegetation and loss of key stone species. It is due to rapid declination of the grove area and increasing isolation in the landscape, forest based species (especially medium to large animals) found it difficult to survive in the grove. In most of the semi-natural/altered landscapes, groves often represent as cluster of trees or mere patch of vegetation with minimal care. The declination of area and loss of quality often lead to change in species composition, introduction of generalist and invasive species in the grove. More importantly, land use decisions in the local/regional levels do not pay much importance on sacred groves' existence value which subsequently affects its' survival.

The rapid increment of homogenous pattern leads to declination of dependent faunal guild in the landscape especially for those members who require specified niche for their survival. The intensive chemical based agriculture system affecting the landscape diversity in many ways (eg. soil microflora and fauna). Being a part of the heterogeneous system, groves become affected too through fertilizer mixed water flow, lacking of natural food resources for grove biota etc.

3.2. Changes in belief systems

Belief and taboos are the constructive tools for conserving sacred groves, and erosion of belief and taboos has led to deterioration of groves. Studies conducted in the Himalayan region of India pointed out that due to the economic pressure many traditional communities are forced to over exploit the community protected forests [40]. Khumbongmayum[41] states that the privileges the groves used to enjoy as part of cultural taboos do not exist anymore. The changes in culture in the society have increased the disturbances to the groves.

3.3. Exploitation of Resources in the sacred groves and surroundings

The restriction on resource use is a key factor for sacred grove's survival. However, this age hold practice has been changed considerably in recent time period. It is because of the negligence in maintenance, valuable timber resources have been utilised for domestic or social purposes, leaf litter collection (for manure preparation) and water body diversion are few of the regular activities in the grove area. Apart from tree members, the ground flora is under severe pressure for requirement of cattle food, local diet even for medicinal use. Sacred groves in Peepasar and Khejarli villages of the state of Rajasthan have been degrading due to uncontrolled grazing [42]. Conversion of sacred groves into coffee plantations and human habitation is the major threat to the conservation of groves in Kodagu districts of Karnataka [43].

3.4. Developmental activities- detrimental to the bio diversity

The construction of massive temple and allied structures in the groves are common across the world. This will not only reduce the soil cover and affect the microflora but also increases other anthropogenic disturbances. Most of the groves have water bodies which cater to many aquatic species of plants and animals. But in the semi urban tracts of Palakkad, Kerala these water bodies are well protected by concrete walls and have extensive domestic use. These groves which provided perennial water sources and which replenished the aquifers have got reduced to scrub jungles and of water bodies with alarming algal growth (Eutrophication).

3.5. Local awareness on sacred grove

Even though the importance of forests is well known and the forests are protected legally by the Government, sacred groves require more attention. Considering sacred grove as an integral component of the rural landscape is still not taken seriously although grove specific awareness has been increased manifold. Therefore, conservation and management planning is emphasizing on sacred grove as single entity rather than including its' surroundings. Moreover, landscape level planning and awareness requires involvement of multiple stakeholders with diverse interests. The exercise is tedious and time consuming as it requires a broader group of communities to be engaged. Similarly, landscape level planning requires through understanding of the spatial dynamics of the species community which is still an area of active research with comparatively lesser implementation details.

IV. Conclusion

Though research works are available about the diversity and the need to conserve the bio diversity, the need of the hour is to consider the sacred groves as part of a large heterogeneous landscape which includes the surrounding areas of the grove which are in constant interaction with the grove system .This paper is an attempt to attract the attention of researchers, designing conservation strategies for sacred groves, towards the concept where the sacred grove is considered as an important part of the heterogeneous landscape.

There is a rapid increase in interest for biodiversity outside protected area. The dynamic co-existence between anthropogenic environment and natural world provide us some valuable insights into species adaptive capacity in anthropocene. Heterogeneous landscape provides us an opportunity to implement the very idea of sustainable development with biodiversity conservation, where sacred groves have important role to ensure peoples' participation in conservation movement. A few steps can be taken in this direction.

Study on local /regional landscape features

Some important aspects are, detection and identification of semi-natural/heterogeneous landscapes, spatial pattern of species distribution, identification of stepping stones/shelters/corridors, status of disturbance and its anticipated forms in near future etc. which would play a vital role to generate necessary base level information for planning and strategy formulation.

Assessment of sacred groves

Spatial distribution pattern of sacred groves in the landscape, their species strength, ecological health (vegetation composition, soil character, water availability, micro flora and fauna, disturbance etc.), potential for corridor/ecological network formation are few key features has to be worked with.

Peoples' involvement

Sacred grove acts as a model system to understand how peoples' conscious decision can maintain ecological integrity of a specific system. In heterogeneous landscape, both exploitative and sustainable decisions are running parallel. However, it is required to put emphasis on the importance of having remnant patches/tree clusters in the landscape and the same should be incorporated in the local/regional planning. Peoples' participation in conservation can be strengthened by careful implementation of sacred grove concept in overall management plan. However, in view of changing religious beliefs and practices, it may require to incorporate provision for monetary/other benefits to the communities associated with the conservation work.

TABLE .1. **Key characteristics of sacred groves in heterogeneous landscape**

Landscape aspect of sacred grove	Services for benefit of local community
Isolated vegetation patch or cluster of trees heterogeneous species composition assemblage of diverse functionality local level nutrient cycling, micro environment maintenance local support for small to medium size faunal guilds	Multispecies assemblages ensure availability of multiple products Effective pollination and predator control network which boosts up agricultural production Efficient nutrient cycling, soil moisture maintenance and carbon sequestration at local level Germplasm and local species pool conservation
Problems/challenges faced by the system	**Recommendations/potentials**
Intensive agriculture reduces heterogeneity Grove area is encroached/converted for financial purpose Lack of understanding on the system dynamics Local/regional negligence to incorporate the tradition in land use planning	Study/research on landscape heterogeneity Assessment of conservation potential of the landscape Awareness generation on heterogeneous landscape Incorporation of traditional knowledge in local/regional land use planning.

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