Chapter 8

Conclusion

8.1. Major findings

The present study titled ‘Spatial ecology of plant communities in a mixed dry deciduous forest of Western Ghats’ has addressed the forest degradation at landscape and species levels. The area selected for the landscape study was Attapady, while the species level study was confined into the eastern part of the Attapady landscape specifically called Anaikatty hills.
Vegetation type map derived from IRS P6 LISS III data of 2005 showed that forest constituted 65% of the total area. Among the forest types, thorny scrub forest was the dominant cover followed by dry deciduous forest, moist deciduous forest, semievergreen forest and evergreen forest. Change assessment showed that the vegetation of the Attapady landscape was modified over a period of three decades. The major classes such as deciduous, evergreen and semi evergreen forests in 1973 were transformed into thorny scrub land, agriculture/plantation and barren lands by 2005. All the five forest types of the study area have undergone degradation during 1973-2005. Agriculture and plantation areas were increased at the expenses of semievergreen forest, dry deciduous forest and thorny scrub land. The study period also witnessed an increase in barren and settlement areas mainly from agriculture and scrub lands.

Fragmentation analysis proved that the forests of the Attapady landscape have fragmented considerably during the period of 1973-2005. During this period the number of patches and patch density were increased which points out that individual patch of Attapady landscape were fragmented into sub-patches. The detailed analysis of fragmentation at class level revealed that evergreen forests have undergone changes both at the extent (deforestation) as well as homogeneity (fragmentation). All other forest types such as semi-evergreen, moist deciduous, dry deciduous and thorny scrub showed a more or less similar pattern i.e., increase in number of patches, patch density, total edge, edge density, distance between homogeneous patches and split index, and decrease in mean patch size. The results indicated that none of the forest types are away from the influx of human population and associated pressure. The result was in agreement with the studies in the temperate and the Neotropics that the
prevalent human activities and its associated impacts could exerts pressure on the contiguity of the forest.

A total of 106 species of trees, 122 species of shrubs, 145 species of herbs were enumerated from the floristic assessment. It composed of 2,255 individuals of trees, 8,599 individuals of shrubs and 16,659 individuals of herbs. Among these plants, four species of ‘plietesial flowering’ and seventeen species of endemics were reported. Shannon-Weiner diversity index was higher for trees followed by shrubs and herbs. In comparison with other mixed deciduous forests, the diversity was higher in Anaikatty hills which could be attributed to the gradients of biotic pressure and associated hypotheses on intermediate disturbance. The girth wise distribution and basal area estimates indicated that the area has undergone selective logging in the past. It also revealed that the local people depend on the forest for their day-to-day life.

Regeneration assessment found 106 species trees, 76 species saplings and 79 species seedlings. Calculation of the diversity indices revealed that trees are having highest diversity followed by seedling and sapling. DCA ordination and post-hoc analyses on environmental correlations uncovered the significant environmental determinants of plant community structure in the study region. Tree population assemblages were determined by both altitude and disturbance gradients, while species assemblages of the regenerating populations were primarily influenced by disturbance. Regeneration assessment revealed that among 117 tree species, 12 species showed a good regeneration pattern, 46 species were in the category of fair regeneration and 21 species were exhibited poor regeneration. A failure of regeneration mode is observed for 27 species which neither had seedlings and nor saplings. Many primary forest
species have serious regeneration problems and fall in the category of either poor regeneration or no regeneration classes. Population dynamics selected primary forest species and generalist species also point out that the future community would be disturbance adapted generalist community. It is also envisaged that many old-growth ‘specialists’ may decline over time and expected to face local extinction.

Disturbance analysis highlights that two habitats differed in floristic composition due to various disturbance factors. A total of 1891 trees belonging to 98 species of trees were recorded in the low disturbed site whereas the high disturbed forest haboured 1485 trees belonging to 45 species of trees. Community structure of low disturbed stand characterized by the floristic structure of *Nothopegia racemosa*–*Albizia amara*–*Maba neilgherrensis* whereas high disturbed stand showed *Albizia amara*–*Pleiospermum alatum*–*Bauhinia racemosa* as their vegetation community. Diversity indices also showed a reduction in highly disturbed habitat. Correlation analysis between tree diversity and disturbance factors pointed that both the habitats were under threat from different sources of disturbances at varying intensities. The major disturbance parameters in low disturbed habitats were past logging followed by cutting and illicit felling, grazing, and NTFP collections. While major threats to high disturbed habitats were from extensive human presence, past logging, lopping of fuel wood, and cutting and illicit felling.

### 8.2. Conservation Implications

The present study points out that Attapady landscape has degraded considerably in both quality as well as quantity during the last three decades. Although the results are
confined to Attapady landscape, it could be possible to extrapolate the scenario to the whole Nilgiri Biosphere Reserve where dry forests are heavily degraded from the surrounding human population. It is high time to design an eco-restoration programme for the dry forests of Nilgiri Biosphere Reserve. Otherwise it may lead to ‘inferior community’ or ‘pioneer desert’, and such ecosystem may have limited efficiency to provide its services and functions as it provides in its original state. In this context, the eco-restoration programme titled ‘Attapady Wasteland Comprehensive Environmental Conservation Project’ (AWCECOP) initiated by the Government of Kerala under an autonomous institution ‘Attapady Hills Area Development Society (AHADS)’ is worth noting. The major objective of the programme was halting the processes of ecological and social degradation, and improving the livelihood base of the tribal communities using participatory resource management.

As part of the eco-restoration activities, AHADS planted seven million seedlings in state forestlands and private wastelands and found that the survival rate of plants in the forest areas is about 70% and in the private wastelands is 62%. AHADS states that afforestation programes along with soil and water conservation activities has exhibited sudden ecological response. Significant outcomes include the increase in greenery in degraded areas and thereby increase in biomass, rejuvenation of the dried streams, increase in water level in surrounding wells and streams. They also claim that the stringent measures to protect the forest from cattles and fire had profound effect to maintain the green cover.

Results show that Barren/ Settlement areas occupy 153.15 km$^2$ of the Attapady landscape which approximately constitute 13% of the study area. As first step of eco-
restoration programme, planting seedling into the barren area on a priority basis could improve the quality of the landscape. For this purpose candidate species should be of ‘habitat generalist’ as they can tolerate the tough condition and grow faster. Some of the candidate species include *Acacia canescens, Albizia amara, Atlanticia racemosa, Maba buxifolia, Mundulea sericea, Pleiospermum alatum* and *Zizyphus oenoplia*.

The most challenging aspect of any eco-restoration programme is to reconstruct the biotic linkage i.e., plant – animal interactions of the ecosystem through pollination and seed dispersal. This can be done as an advanced step of the eco-restoration programme as it requires vegetation cover. This can be also done for the areas with existing vegetation. The study shows that many old growth forest species showed a trend of dwindling population. As a second phase of the eco-restoration activities AHADS can concentrate on the re-engineering the functional attributes of eco-system. Planting seedlings of ‘old growth’ forest species can sharply accelerate the process of revegetation of complex communities. Active enrichment with a variety of animal-dispersed species appears to be the best method for recruiting diverse mature forest tree species and this involves the selection of right candidate for rehabilitation. Species should be animal-dispersed to harness most effectively the natural processes of dissemination into and out of different patches, and should represent a variety of fruit sizes and attractiveness to the birds, primates, bats and other arboreal and terrestrial mammals that will mediate the process. Planting seedling of such old growth species especially in the dry deciduous system will help to arrest the habitat degradation. Moreover many studies suggest that dry deciduous system have very good resilience and show quick response to eco-restoration programme.
Species that lack either seedling or sapling calls immediate conservation action (species recovery programme) against from patchy distribution or local extinction. Candidate species should be selected on the basis of their ecological value (RET species and endemic species) and economic value (species with NTFP value). Some of the species for species recovery programme include *Cassine paniculata, Glyptopatalum lawsonii, Litsea laevigata, Litsea ligustrina, Memecylon edule, Neolitsea scrobiculata, Phyllanthus emblica, Santalum album, Sappindus emarginatus* and *Syzygium densiflorum*. As these species are habitat specialist they require additional care for their growth.

Recruitment of *Cycas circinalis* in the study area (during our rigorous field exploration we came across one tree and a number of saplings) and occurrence of other ten new species in the recruiting class shows the resilience of the system. The recruiting class occurred in areas where human activities are minimal. It proves if the disturbances factors are minimum or less, the system can enhance the regeneration processes. So the anthropogenic activities like cutting, lopping, over exploitation of NTFP’s and other disturbance factors should be prohibited in the area. Control of cattle grazing can significantly promote the recruitment as the grazing results the browsing and trampling of seedlings and also loosen the topsoil which enhances the soil erosion of the area. So an effective protection mechanism, scrutinized rehabilitation and managed ecological restoration can bring back the ecological stability to Attapady landscape with its ecological functions and services.