Chapter 7
Conclusion and Recommendations

Arid and semiarid regions come under dry lands which cover approximately 40–42 % of land area of planet Earth and support about two billion people of the world and 90 % live in developing countries. A variety of factors influence the process of desertification and land degradation in semiarid region; therefore, the area under this land category is expanding year by year. India occupies only 2.4 % of the world's geographical area, yet supports about 16.7 % of the world's human population; it has only 0.5 % of the world's grazing land, but supports 18 % of the world's cattle population. About 50.8 m ha land area (15.8 % of the country's geographical area) is arid, 123.4 m ha (37.6 %) is semiarid, and 54.1 m ha (16.5 %) area falls in the dry sub-humid region. All put together, about 228 m ha area, i.e., 69 % of the geographic area of the country is dry land (Ajai et al. 2009). In arid and semiarid regions, the livelihood activities of the residing population depend on two sectors—agriculture land use in which the cultivation is restricted to high productive but limited land area, and animal husbandry as availability of rangelands provides fodder to large animal population which depends on typical vegetation of arid and semiarid regions. The arid and semiarid regions are highly complex, thus make a sensitive ecosystem in which disturbances at smaller scale would create threats to the sustainability, which seems to be irreversible keeping current environmental and ecological problems in view. The semiarid region in India is home to very significant population which depends on the available land resources, natural as well as cultivable lands. Therefore, the challenge for the stakeholders is to achieve the goals of economic security and environment sustainability. Landscape of semiarid zone comprises variety of ecosystems, which are highly fragile with large risks that is caused due to factors such as increasing population, resource exploitation, unfavorable climate and weather conditions, climate change, increasing pressure on rangelands during excessive grazing by domesticated animals, high intensification of available arable lands, and land degradation and desertification. During last four decades, the area under semiarid region in India has increased by 3.45 million ha. Therefore, the sustainable management of land and resources is prime concern for the various stakeholders. The study on biodiversity is crucial to understand the potential and prospects for any ecosystems. In the study undertaken in the entire area about 2800 km of semiarid region of Karnataka, India examined both the plant and animal diversity. This rigorous work on the biodiversity covering phytoplankton to higher plants and zooplankton to

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invertebrates and vertebrates provides strong baseline study of biodiversity in the area located in semiarid region. With the help of Phytosociological 376 species of angiosperms (Trees, Shrubs, Herbs, and Climbers), 1 bryophyte, 4 pteridophytes, and 21 phytoplankton were recorded. The number of bryophytes and pteridophytes species recorded is low as a geo-climatic condition of the area is not suitable for those species. However, gymnosperm was reported only in cultivated land. The recorded faunal diversity of the area is composed of 164 species of insects, 82 species of spiders, 17 mollusks, 11 fishes, 5 amphibians, 13 reptiles, 71 aves, 11 mammals, and 24 zooplankton. Varieties of butterflies were spotted in and around the study zone. The biodiversity of the region is somewhat typical characteristics of any semiarid climatic zone of the country. The diversity among the floral and faunal species was found to be good in the study region. Moreover, 3 plant species, viz., *Santalum album, Acacia ferruginea, Sphaeranthus amarathoides* were found under red list of IUCN and put the categories of endangered, vulnerable, and least concerned status, respectively. However, there would be degradation of forest and consequent adverse impacts on the existing biota of the area due to various anthropogenic activities. Those impacts in the form of loss or disturbance of natural values such as biodiversity, conservation, and landscape need to be managed. The following measures can be suggested to manage the adverse impacts on biodiversity.

1. Ex-situ conservation of biodiversity is recommended, if directly affected by any human activity. Proper area of suitable environmental parameters should be identified, and methods for management should be developed as a part of Environmental Management Plan.
2. Afforestation Plan and Command Area Development Plan should be formulated following due procedure to ensure the sustainable landscape development.
3. The possible loss of seed bank from the topsoil should be compensated in nearby suitable area for regeneration of vulnerable species, preferably in the buffer zone of the study region.
4. Special care should be taken to conserve the economically important and medicinal plants which are of significant importance for the local people.
5. Proper reclamation of soil should be done and ecosystem rehabilitation should be practiced using only local plant species.
6. Assessment of biodiversity should be done periodically to evaluate the biodiversity of the study area.

7.1 Conservation and Multiplication of Multipurpose Tree Species

Forest conservation is one of the primary steps required for the development of the region. This region is under semiarid zones in southern India where the plant growth is limited as well as sparsely distributed. There are two forests developed in last three decades although need proper maintenance and efforts toward

development of forest ecosystems in the region. Selection of multipurpose tree species would support conservation options in the region. There is a need to cultivate bamboo, and species such as *Acacia* spp. and *Casuarina equisetifolia*, *Melia dubia* for plantation at larger scale, which are fast growing tree species and having potential to fulfill the requirement of people for their fuel, fodder, and timber demand. Apart from this, bioaccumulator species have to be planted for phytoremediation. In the study area, a few bioaccumulator species were found, viz., *Calotropis procera*; *Hibiscus esculentus*; *Chenopodium album; Typha angustifolia; Amaranthus viridis; Cyperus rotundus; Ricinus communis; Solanum nigram; Phyla nodiflora* in terrestrial ecosystems and species such as *Hydrilla; Chara* in aquatic ecosystems.

7.2 Development and Demonstration of Agroforestry Models in the Region

Agroforestry concept needs to be diffused among the people of the region as this provides an opportunity to harvest the annuals with perennials from the same unit of land. Agroforestry is an old concept in that in different parts of the country, agroforestry (different sub-terms) systems have been developed by the people/traditional societies through their own indigenous ecological knowledge base (which is passed on through generations) for maximizing the output from a unit of land. Sustainable use of land use and land cover is one of the most important issues that suffer as a result of deforestation. Therefore, in the current context, all agroforestry systems have positive effects and influences upon land, water, and resource management. Agroforestry technologies have the potential applicability to improve land use and biophysical properties of lands on the one hand and to provide an opportunity for fulfilling the daily needs of rural populace on the other. Plantation of compatible and desirable species of wood perennials on farmlands results in an improvement in soil fertility. In our study region, *Azadirachta indica and Melia dubia* have potential for agroforestry species. Development of proper agroforestry models includes the following benefits.

1. Plantation of compatible and desirable species of wood perennials on farmlands results in an improvement in soil fertility.
2. This will reduce the dependency of the people on forests for their demand for fuel, fodder, fiber, and leaf litter.
3. Agro-forestry increases the organic contents of the soils through the addition of leaf litter and other plant parts.
4. More efficient nutrient cycling within the system leads to more efficient utilization of nutrients that are either inherently present in the soils or externally applied.
5. Inclusion of perennials with the annuals, in due course of time, would certainly help improve the biophysical components of the landscape, increase the carrying

capacity of lands, and maintain different temperature regimes. However, this needs a long-term scientific planning.
6. Nitrogen-fixing tree species enhance the productivity of crops and reduce farmyard manure input. This again reduces the pressure on the forests.
7. Further, in the state of Karnataka whose maximum land comes under the dryzone, agro-forestry will certainly contribute to the improvement of water drainage for recharging ground water in the region.
8. Agroforestry system provide fodder for animals and thus to some extent, the fodder demand can be reduced by the agroforestry system.

7.3 Development of Bird Sanctuary

Many migratory birds come to the study region from far off lands during certain seasons for breeding and as well as for feeding. These areas can be developed as sanctuary so that it can increase their population. Measures can be taken by the forest department to foster the necessary habitats specific to the birds such as maintaining healthy water bodies without human interference. For example, painted stork and purple heron require watery habitats with plenty of feeding and breeding sites; those water bodies can be maintained as a sanctuary. Tree species such as manila tamarind, tamarind tree and neem tree will improve the population of Koels as this is the favorite fruit. Apart from this, the species, viz, *Acacia nilotica* (kari jali) *Aegle Marmelos* (belapatri); *Albizza lebbeck* (baage mara); *Albizzia amara* (chujjulu); *Azadirachta indica* (bevu); *Delonix alata* (kempukenjiga); *Ficus benghalensis* (alada mara); *Ficus religiosa* (arali mara); *Mangifera indica* (maavina mara); *Melia azedarach* (are bevu); *Samanea saman* (bhagya mara); *Tamarindus indica* (hunsina mara); and *Thespesia populnea* (arasi mara) have to be preferred for plantation as these plants provide nesting habitat and food for the birds.

7.4 Conservation of Wild Animals

This can mainly be developed by involving the local people and educating them. The forest departments and the NGOs can have a joint cooperative effort in this regard rather than doing it all alone. Projects for conserving wild animals can be developed along with educating the people about the significance to conserve them. Many species are being killed for their believed medicinal values, which is a myth in most of the cases and thus damaging the biodiversity of the study region. Some animals due to loss of habitat are forced to search for new habitats that create human–animal conflict in agricultural land and human habitats. Many poisonous snakes are being killed out of fear due to lack of awareness that professional snake catchers could be called to catch the animal without killing and transported to its suitable habitat.

7.5 Carrying Capacity of Grazing Areas/Rangelands for Sustainable Landscape Development

There is a need for estimating the carrying capacity of various rangelands/grazing areas located in semiarid region. This work needs coordination with the department of animal husbandry of the state. The use of resources available in various sub-systems of production provides the sustainability to animal husbandry system. The semiarid regions are highly suitable for animal husbandry, and apart from the main land use, the people of the region depend on animal husbandry system for their subsistence. If the livestock population exceeds, the over-exploitation of resources starts thus creates conflicts between villagers and the various other stakeholders for example the forest department. This further aggravates in the area where apart from high livestock density the conservation policies are implemented for example—protected areas, reserve forests, etc. Therefore, it is necessary to analyze the impact of resource availability on animal husbandry sub-system and its ecological and economic consequences on the region under changing environmental, political, and socioeconomic factors. The options for resource management in semiarid regions are not so simple. The suggestions would be maintaining equilibrium between livestock numbers and the carrying capacity of the area on one hand and exploring alternate livelihood options on the other.

If animal husbandry sector of semiarid region which is the subsidiary occupation for sustaining the livelihood of the people is not beneficial, then to replenish the loss from animal husbandry, the pressure on other sectors of the village ecosystem would increase in the circumstances of (i) intensification of agriculture land use in the region and (ii) over-exploitation of the natural resources for economic gains. But, alternate options would not ensure sustainable development thus cannot be recommended. Therefore, a sound region-specific approach needs to be developed. In this direction, the development of land-use and land-cover models, with an emphasis on land-cover change, and bioresources of the semiarid region would help provide feasible solutions. A data analysis at various spatial scales has to be carried out while applying modern tools such as satellite Imagery (remote sensing) and Geographic Information Systems (GIS). This work will be helpful to understand the consequences of the changing scenario on various habitats of the semiarid regions.

7.6 Drinking Water Supply Through Pipeline

The domestic requirement of water for the villages of the study regions is being provided in the form of wells and borewells. Water supply through pipelines is not available to the people and thus the continuous use of borewell water can cause adverse effects on the vegetation and landscape and also deterioration of ground water table. The probable degradation can be checked by banning use of groundwater while providing drinking water through piped water supply from River Krishna and River Bheema.

7.7 Awareness Programs About the Importance of Semiarid Region Under Changing Climate

Climatic variables such as temperature, rainfall, and humidity have the effect on agriculture and rural development. During the study, it was observed that there has been a shift in rainfall seasons that has impact on agriculture thus has resulted in changing the cropping pattern. This is because of irregularities in climate pattern in the last three decades. Educating the local people by conducting workshops on these issues pertaining to climate change will help them to be prepared for the changes in the climatic pattern.

During empirical field studies, it was noticed that the people are unaware about the outcome of various developmental activities. Therefore, there is a need to provide basic information on scientific and technical aspects of the various developmental programmes currently in implementation form in the study region. Thus, a need is to organize various programmes at regular intervals with the involvement of the local people and various other stakeholders. The programme can include workshop, discussion, and debate at gram panchayat (village council) level, showing posters, video clips, etc., to the people about the contribution of various policies and programmes in the overall development perspective of the semiarid region. This can further be linked with current climate debate in view of that the semiarid regions are highly exposed to the climate vulnerability. Therefore, the mitigation and adaptation approaches can be taken into account with help and supports from various agencies with participation at local level. Teaching school-going children by teachers about the importance and sensitivity of semiarid landscape will not only help the children but also help in educating their parents who have not had formal education. Special local dedicated volunteers can be trained by the government to raise the awareness about biodiversity conservation and management and explain the benefits in the vernacular language.

Reference

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