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Biodiversity: Western Ghats **24**

Status of Forests in Shimoga, Central Western Ghats

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Western Ghats mountain ranges constitute the beautiful array of mountains along the western coast of India. It separates the Deccan Plateau from a narrow coastal strip along the Arabian Sea. This particular mountain range starts from the southern part of the Tapti River near the border area of the states of Gujarat and Maharashtra. Western Ghats mountain ranges cover a length of around 1600 km running through the states of Maharashtra, Goa, Karnataka, Tamil Nadu and Kerala finally terminating at Kanyakumari district, in the southern-most tip of the Indian peninsula. The Western Ghats is rich with different kind of vegetation and topographical features. This bioregion is highly rich with flora and fauna and is considered as one of the 34 biodiversity hot spots of the world. The stretch of Central Western Ghats ranges from 12° to 14°covering areas of Coorg district, Hassan, Chikmagalur, Shimoga upto south of Uttara Kannada. The status of forests in Shimoga was studied by reviewing the working plans, administrative reports, settlement reports and other available research papers. There are five types of forests in Shimoga district: - Southern tropical wet evergreen forests, Southern tropical semi evergreen forests, Southern tropical moist deciduous forests, Southern tropical dry deciduous forests and Southern tropical Scrub forests. The district comprises of three forest divisions- Shimoga, Bhadravathi and Sagar. The forests of the district, which yield rich and valuable products, covered an area of 4, 34,516 hectares nearly 40.27 % of the land in the district. The areas of different types of Forests are as follows: Evergreen forests- 69459 hectares (16%), Semi-evergreen- 88135 hectares (20.28%), Moist deciduous- 130612 hectares (30.06%), Dry deciduous -109539 hectares (25.21%) and Scrub Forests-24111 hectares (5.55%). The Kan forests which are most often climax evergreen forests preserved through generations by village communities of Malnadu regions as sacred forests or sacred groves and were characteristic in Shimoga

district. During the field investigations, it was observed these ecological sensitive habitats are being destroyed and encroached at Halmahishi and Kullundi villages. Kans jurisdiction is under revenue department instead of forest department is the prime reason for partial or complete conversion for alternative land use. Large amount of forest were allotted to the Mysore Paper Mills for raising of pulpwood plantations. The chief sources of forest revenue in the district were the hard and soft woods and sandalwood exploited for commercial purposes. Some forest areas were cleared and assigned to the landless and other needy persons to meet the continuous demand and more land for agricultural purposes. The study in the Kurnimakki-Halmahishi *kan* of about 1000 ha reveals the vegetation of the kan, though heavily fragmented, due to ever increasing human impacts, nevertheless, is a mosaic of various kinds of forests. The most significant is the discovery of swampy areas within this kan which have few individuals of large sized threatened tree species *Syzygium travancoricum,* classified in the IUCN Red List as "Critically Endangered". The tree is on the verge of extinction, and for the Shimoga district, the only occurrence of this tree is the Kurnimakki-Halmahishi *kan*. The Kullundikan of about 453 ha has a narrow belt of original tropical rainforest dominated by the tree *Dipterocarpus indicus,* considered 'Endangered' by the IUCN. The revenue department in control of this *kan*, being totally ignorant of its vegetation richness has made several grants within the *kan* for cultivation of coffee and arecanut. The grantees have also done encroachments within this climax forest area of high watershed value.

Keywords: Forests, Western Ghats, Sacred Groves, biodiversity

INTRODUCTION

Western Ghats mountain ranges constitute the beautiful array of mountains along the west coast of India. It separates the Deccan Plateau from a narrow coastal strip along the Arabian Sea. The mountain range starts from the southern part of the Tapti River near the border area of the states of Gujarat and Maharashtra. Western Ghats mountain ranges cover a length of around 1600 km running through the states of Maharashtra, Goa, Karnataka, Tamil Nadu and Kerala finally terminating at Kanyakumari district, in the southern-most tip of the Indian peninsula (Daniel, 1997). The Western Ghats is rich with different kind of vegetation and topographical features. This bioregion is highly rich with flora and fauna and is considered as one of the 34 biodiversity hot spots of the world. The forests of Western Ghats, in view of their floristic diversity and numerous multipurpose species, are considered a varietal storehouse of economically important plants. The tropical climate complimented by heavy precipitation from southwest monsoon and favorable edaphic factors create an ideal condition for the luxuriant growth of plant life, which can be seen only in few parts of the world (Gadgil, 1996). The stretch of Central Western Ghats ranges from 12° to 14° covering areas of Coorg district, Hassan, Chikmagalur, Shimoga upto south of Uttara Kannada.

Protection of forest patches as sacred has been reported from many parts of India in the recent decades. Trees were normally not cut in such forests as they were dedicated to gods (Gadgil and Vartak, 1976). These sacred forests are known by various names in peninsular India: such as devarakadu, devarbana or kan in Karnataka, kavu in Kerala, kovilkadu in Tamil Nadu and devrai in Maharashtra. The forested districts of Uttara Kannada and Shimoga in the central Western Ghats of Karnataka are dotted with several groves with lofty lush-green forest cover known as 'kaans'; literally meaning "thick evergreen forests" (Joshi & Gadgil 1991). These forest patches are also called 'devar kaans' (sacred forests), as the natives of these regions preserve kaan forests traditionally as the abodes of sylvan

deities maintaining a lasting relationship with nature (Gokhale 2004). These Sacred forests served many functions like conservation of biodiversity and watershed, moderation of climate, and enhancement of landscape heterogeneity which promoted varied wildlife. Studies highlight that, groves support a good number of rare and endemic species, which are extra-sensitive compared to common species, and persist only in favourable niches, and the sacred groves are ideal places for them (Jamir and Pandey 2003; Sukumaran and Raj 2007). The village sacred forests ranged in size from few hectares to few hundred hectares. The Kans of Sorab taluk in Shimoga covered 13,000 ha or 10% of Sorab's area. (Chandran MDS, 1997).

However, social believes around these sacred kan forests have been decreased due to the influence of modern lifestyle and agriculture. Increasing human population and declining fertility of agricultural land have increased dependence on the forests as a source of income and hence resulted in non-sustainable harvesting of the resources. Encroachment, and illegal felling of the valuable timber trees, have increased and thereby eroded plant wealth. Apart from these effects, kaans are also exposed to different kinds of exploitation such as conversion of these landscapes into monoculture plantations, allotting them for rehabilitation purposes, etc. (Gokhale 2004). Thus there is a fear of losing rich treasures of traditional conservation culture as well as protected biodiversity in these landscapes. Since kaan forests are located in areas of high to moderate rainfall, it is likely that species composition is influenced by both rainfall and by the level of disturbance; forest disturbance would affect local diversity and in turn the dependent fauna (Parthasarthy 2001).

Along with the number of kans, the extent and the size range are also important to understand the potential of these forest patches in present- day context. As discussed earlier kans were exposed to different kind of exploitation like selective felling, conversion to plantation, allotting the land for non-forest purposes like rehabilitation of people, etc. This study was done to analyze the situation of forest in Shimoga district, Karnataka. Kurnimakki-Halmahishi Kan and Kullundekan in the Taluk of Thirthahalli in Shimoga district was studied, mainly from the vegetational angle and for cognizance of threats facing it.

MATERIALS AND METHODS

Shimoga district of Karnataka state is situated in the heart of the Western Ghats region, which is one of the 'hot-spots of biodiversity' in India. Shimoga district is situated between 13°27' and 14°39' N latitude and between 74°37' and 75°52' E longitude in about the mid-southwestern part of the Karnataka State (Fig. 1). The district receives an average annual rainfall of 2869 mm (Annual rainfall report, Govt. of Karnataka). The important rivers that flow through the Shimoga district are the Tunga, Bhadra, Tungabhadra, Sharavati, Kumudvati and Varada. The forest change dynamics was analyzed using temporal remote sensing data of the period 1973 to 2012. Remote sensing data analysis involved following steps: (Ramachandra et.al, 2012)

i. **Pre-processing:** The remote sensing data obtained were geo-referenced, rectified and cropped pertaining to the study area. Geo-registration of remote sensing data (Landsat data) has been done using ground control points collected from the field using pre calibrated GPS (Global Positioning System) and also from known points (such as road intersections, etc.) collected from geo-referenced topographic maps published by the Survey of India. The Landsat satellite 1973 images have a spatial resolution of 57.5 m x 57.5 m (nominal resolution) were resampled to 28.5m comparable to the 1989 - 2010 data which are 28.5 m x 28.5 m (nominal resolution). Landsat ETM+ bands of 2010 were corrected for the SLC-off by using image enhancement

techniques, followed by nearest-neighbour interpolation.

ii. **Vegetation Cover Analysis**: Normalised Difference Vegetation index (NDVI) was computed to understand the changes in the vegetation cover during the study period. NDVI is the most common measurement used for measuring vegetation cover. It ranges from values -1 to +1. Very low values of NDVI (-0.1 and below) correspond to soil or barren areas of rock, sand, or urban builtup. Zero indicates the water cover. Moderate values represent low density vegetation (0.1 to 0.3), while high values indicate thick canopy vegetation (0.6 to 0.8).

iii. **Land Use Analysis:** The method involves i) generation of False Colour Composite (FCC) of remote sensing data (bands – green, red and NIR). ii) Selection of training polygons iii) loading these training polygons co-ordinates into pre-calibrated GPS iv) collection of the corresponding attribute data (land use types) for these polygons from the field and supplementing this information with Google Earth v) 60% of the training data has been used for classification, while the balance is used for validation or accuracy assessment.

Land use analysis was carried out using supervised pattern classifier - Gaussian maximum likelihood algorithm. Mean and covariance matrix are computed using estimate of maximum likelihood estimator. Accuracy assessment to evaluate the performance of classifiers, was done with the help of field data by testing the statistical significance of a difference, computation of kappa coefficients and proportion of correctly allocated cases. Recent remote sensing data (2012) was classified using the collected training samples. Statistical assessment of classifier performance based on the performance of spectral classification considering reference pixels is done which include computation of kappa (κ) statistics and overall (producer's and user's) accuracies. For earlier time data, training polygon along with attribute details were compiled from the historical published topographic maps, vegetation maps, revenue maps, etc.

Vegetation studies in Kan: Vegetation was studied in 26 sampling localities within the Kurnimakki-Halmahishikan Kan and 16 localities in Kullunde Kan using Point-centred quarter method. The Shannon diversity index for trees of Kans was calculated.

RESULTS AND DISCUSSION

The administration of the Forest Department in the district is under the charge of the Conservator of Forests, Shimoga Circle, Shimoga. The district has been divided into three Forest Divisions, namely, Shimoga, Bhadravati and Sagar Divisions. The forests of the district, which yield rich and valuable products, covered an area of 4, 34,516 hectares nearly 40.27 % of the land in the district. The areas of different types of Forests are as follows: Evergreen forests- 69,459 hectares (16%), Semi-evergreen- 88,135 hectares (20.28%), Moist deciduous- 1, 30,612 hectares (30.06%), Dry deciduous -1, 09,539 hectares (25.21%) and Scrub Forests-24,111 hectares (5.55%). Vegetation cover of the study area was analyzed through NDVI. Figure 2 and table 1 illustrates that area under vegetation has declined from 96.57% (in 1973) to 91.72% (in 2012). Land use analysis for the period 1973 to 2012 has been done using Gaussian maximum likelihood classifier and the temporal land use details are given in table 2. Figure 3 provides the land use in the region during the study period. There has been 1.47 % growth in built up area during last four decades with the decline of vegetation by 2.6 %.

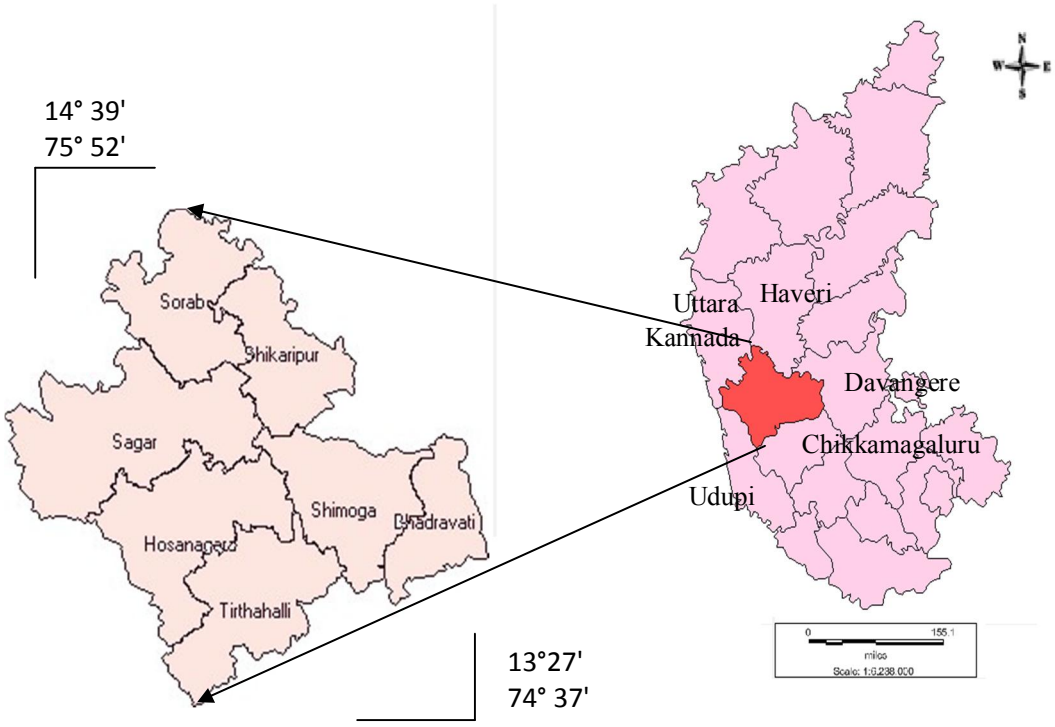
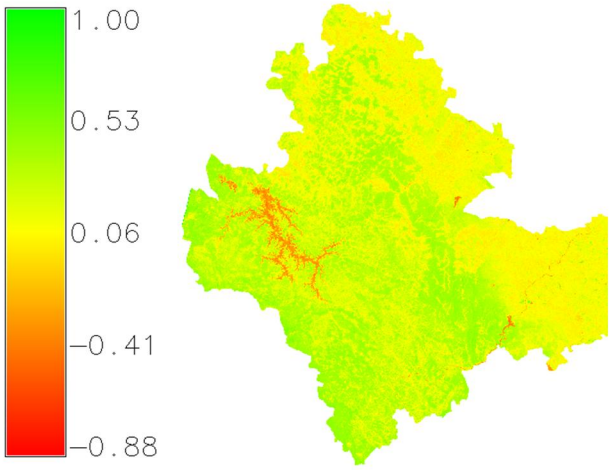


Figure 1: Study Area: Shimoga

Figure 2: Land Cover changes from 1973 to 2012

1973- Land Cover



2012- Land Cover

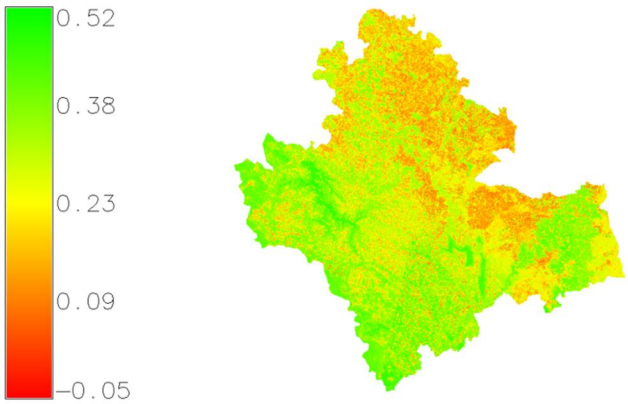
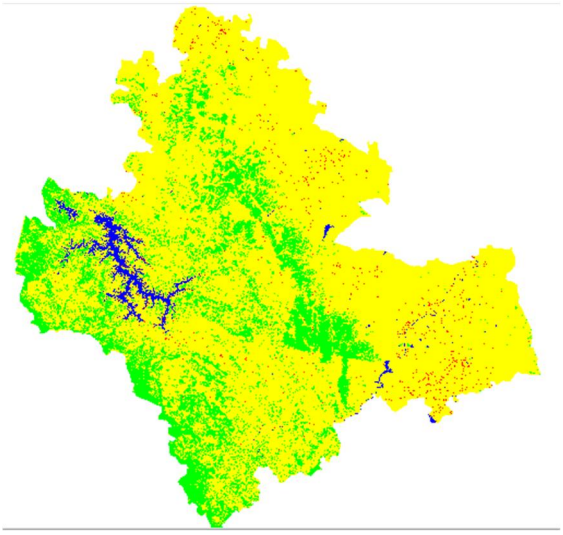


Figure 3: Land Use changes in Shimoga District

1973- Land Use



2012- Land Use

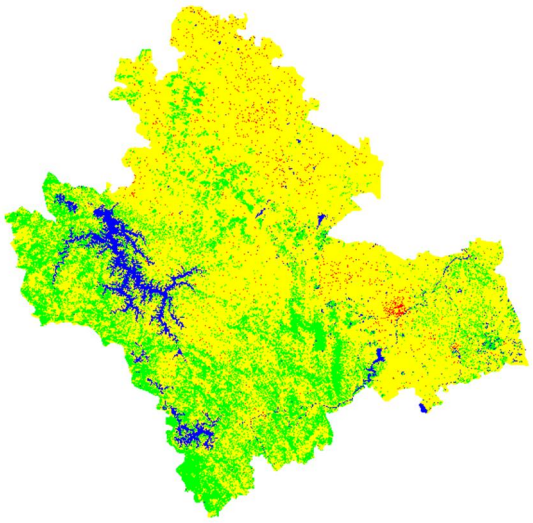


Table 1: Land Cover statistics

Land Cover (%)		
	Vegetation	Non-Vegetation
1973	96.57	3.43
2012	91.72	8.28

Table 2: Temporal land use dynamics

Land Use (%)				
	Urban	Vegetation	Water	Others
1973	0.66	23.88	1.91	73.61
2012	2.13	21.28	3.09	73.63

Case studies on two Kan forests of Thirthahalli Taluk

Kurnimakki-Halmahishi Kan and Kullundekan in the Taluk of Thirthahalli, Shimoga district was studied in the month of April 2012, mainly from the vegetation angle and for knowledge of threats facing it. The Kurnimakki-Halmahishi Kan is said to be about 1000 hectares and Kullunde Kan covers an area of 453.86 hectares. These are not a single piece but distributed in several survey nos. There is considerable confusion on the demarcation of the boundaries of the Kan due to encroachments, conflicting Claims of ownership and other practical problems. Shimoga and Chikmaglur districts were part of erstwhile Mysore state. Kan lands were recognized by state Forest department till almost 1970. But after that those survey numbers were merged in reserved

Forests and other kind of forests including minor forests, State forests and District forests. Evergreen to semi-evergreen forests and secondary moist deciduous forests were the main forest types present in these Kans.

Fragmentation of vegetation: The Kan forests were praised in the past for their unique evergreen vegetation of lofty trees, rich moldy soils, fire security, as source of perennial streams and production of various products in demand for human subsistence, especially as centers of pepper production. Today a close look at the Kurnimakki-Halmahishi Kan on the ground or using aerial imageries, reveal a high degree of forest fragmentation. The composition of the landscape elements of the Kan does not conform to the past descriptions of such sacred forests from Central Western Ghats. It appears that many a stream originating in the Kan get dried up in the summer months resulting in abandonment of minor tanks constructed along their courses, thus obviously, with adverse consequences on farming downstream and water-flow into the Thunga River diminished. Such severe human induced changes in the evergreen forests of Western Ghats are bound to have cascading consequences on human welfare in the Deccan plains mainly because of reduced water flow in the east-flowing rivers.

Tree species in evergreen-semi evergreen forest type: Evergreen trees of 25-30 m height were numerous in the forest and belonged to species such as *Aphanantha cuspidate*, *Canarium strictum*, *Mangifera indica*, *Syzygium hemisphericum*, *Syzygium travancoricum* etc. Evergreen trees of the second level of general heights from 15-25 m include *Actinodaphne hookeri*, *Aglaia roxburghiana*, *Anthocephalus kadamba*, *Beilsmeida fagifolia*, *Dimocarpus longan*, *Ficus callosa*, *Holigarna ferruginea*, *Hopea ponga, Olea dioica*, *Syzygium cumini* etc. Deciduous species like *Careya arboa*, *Lagerstroemia microcarpa*, *Stereospermum personatum*, *Terminalia paniculata*, *Terminalia bellirica*, *Vitex altissima*, *Xylia xylocarpa, Zanthoxylum rhetsa* etc. The secondary deciduous forests within the Kan and their peripheral areas are obviously due to forest fragmentation through cutting and burning. Altogether 46 species in evergreen and 25 tree species were found in deciduous forest of Kurnimakki-Halmahishi Kan. In Kullunde Kan, a part of it was cleared and was with coffee plantation had 21 tree species. Another coffee planted area had 19 species, whereas the deciduous forest had least number (7). The Shannon diversity index for trees was found to be higher (3.45) for the evergreen dominated patches than for the deciduous (2.79) in Kurnimakki-Halmahishi Kan (figure 4).

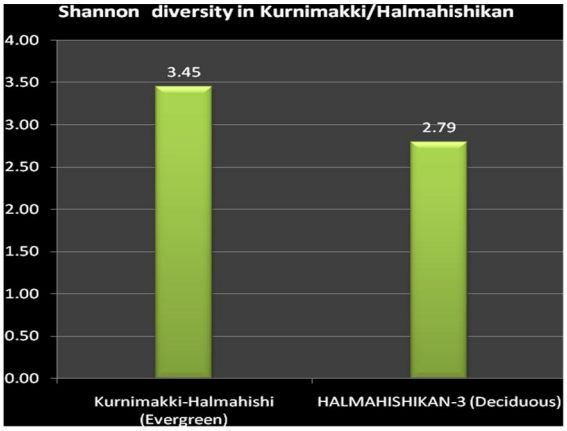


Figure 4: Shannon diversity index for evergreen dominated and deciduous dominated areas in Kurnimakki-Halmahishi Kan

In case of Kullunde Kan, Diversity index (Shannon diversity) for tree species for the evergreen forest was highest at 3.11, for the forest patch allotted to private person and protected as such (figure 5). When a climax evergreen forest of *Dipterocarpus indicus* and *Calophyllum tomentosum* domination was partially cleared and planted with coffee, despite the isolated towering trees remaining, the

diversity index was lower at 2.75. Yet another portion with coffee had reasonably good number of species, although they were of secondary nature and smaller in stature with diversity index at 2.87. The lowest diversity of 1.85 was for the secondary moist deciduous forest.

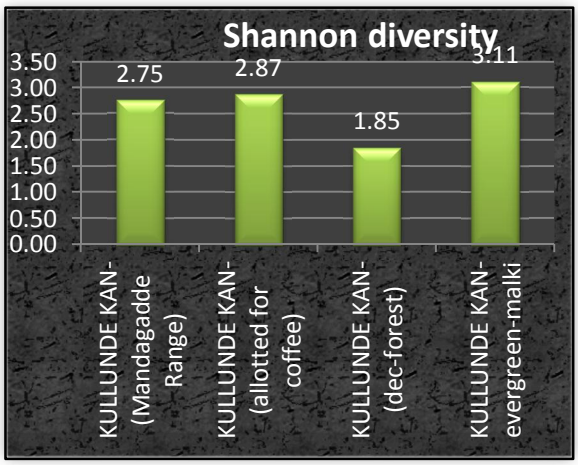


Figure 5: Shannon diversity index for tree species in four categories of forests, with the intact preserved forest in malki land showing marginally higher diversity in Kullunde Kan

Swamps with *Syzigium travancoricum*: In some of the swampy water bodies associated with the Kan we could see small populations of *Syzigium travancoricum*, an evergreen endemic tree of the Western Ghats, which has been red listed as critically endangered by the IUCN. Discovery of this majestic tree in the Kurnimakki-Halmahishikan, new report of such a species from Shimoga district itself, underscores the importance of preservation of Kans as Heritage sites from cultural, biological angles. Its rare occurrence associated with swampy places in some of the evergreen Kan forests of Ankola and Siddapur, 700km north of Travancore came as surprise, while this finding highlights the role of Kans as centres of biodiversity conservation in otherwise human impacted landscapes (Chandran et al., 2008).

Sacred Kan on the wane: The Kan forests of Central Western Ghats were important natural sacred sites and cultural centres of the pre-British village communities. At one time, they rose majestically in the horizons, covering large areas in the high places of the malnadu village landscapes, surrounded by cultivations, timber rich secondary forests, and savannized grazing areas. Perennial streams gushing out of these sacred forests were often embanked to make irrigation tanks. Unfortunately, the Kans did not merit consideration as sacred places of village communities under the British rule and so after independence. In Shimoga district, particularly, many kans were brought under the jurisdiction of the revenue department, which allotted Kan lands for meeting various non-forestry purposes such as for growing coffee, expansion of cultivation, for grazing purposes and numerous others, neglecting the rare species they conserved and also of their crucial hydrological importance. The Government also conceded large portions of Kans on long leases to the Mysore Paper Mills for growing industrial woods like *Eucalyptus* and *Acacia* sp. after clearing the natural vegetation.

CONCLUSION

Land over analysis show vegetation has declined from 96.57% (in 1973) to 91.72% (in 2012). Land use analysis for the period 1973 to 2012 has been done using Gaussian maximum likelihood classifier and the temporal land use show 1.47 % growth in built up area during last four decades with the decline of forest vegetation by 2.6 %. Major human induced ecological changes in the Western Ghats started with the arrival of agriculture and animal husbandry. Collection of forest produce such as pepper, cardamom, ivory, honey, wax has gone on for a long time in the Western Ghats. Several industries were started in the early decades before independence, primarily to utilize the forest resources of the Western Ghats. These have included saw mills, brick and tile, paper, polyfibre, matchwood, plywood, and

tanning. A few other industries have sprung up based on the mineral resources of the hills such as the steel works at Bhadravati. These created pressure on extraction of forest products. Pepper and cardamom, which are native to the evergreen forests of the Western Ghats, were also taken up as plantation crops on a more extensive scale in modern times. Many of the newer plantations were taken up by clear felling natural evergreen forests tracts which till then had predominantly tribal populations. Kans (Sacred groves) being the centres of spiritualism, culture and community get together are important places for re-emphasizing their roles in conservation of nature. Proper survey and mapping of boundaries of all kans must be done in order to protect them from encroachment and other threats. Strict actions should be taken against encroachers. Taking special care of threatened species and threatened micro-habitats within the kan forests will also help in protection. Providing good protection and adopting better management practices in moderately disturbed kans could return the vegetation to high species richness and stocking density. It would also give a better chance of establishment to sensitive evergreen species, to endemic species, and to those in RET categories, as well as to economically important species, through natural succession.

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Syzygium travancoricum

Monoculture plantations

Firing and Logging in Kans

Encroachment