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Conservation and Sustainable Management of Ecologically Sensitive Regions in Western Ghats

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Abstract— **The Western Ghats is one among the 35 global hotspots of biodiversity and it lies in the western part of peninsular India in a series of hills stretching over a distance of 1,600 km from north to south and covering an area of about 1,60,000 sq.km. It harbours very rich flora and fauna and there are records of over 4,000 species of flowering plants with 38% endemics, 330 butterflies with 11% endemics, 156 reptiles with 62% endemics, 508 birds with 4% endemics, 120 mammals with 12% endemics, 289 fishes with 41% endemics (http://wgbis.ces.iisc.ernet.in/energy/water/ paper/researchpaper2.html#f) and 135 amphibians with 75% endemics. The rich biodiversity coupled with higher endemism is due to the humid tropical climate, topographical and geological characteristics, and geographical isolation (Arabian Sea to the west and the semiarid Deccan Plateau to the east). The Western Ghats forms an important watershed for the entire peninsular India, being the source of 37 west flowing rivers and three major east flowing rivers and their numerous tributaries. The stretch of Central Western Ghats of Karnataka, from 12°N to 15°N, from Coorg district to the south of Uttara Kannada district, and covering the Western portions of Hassan, Chikmagalur and Shimoga districts, is exceptionally rich in flora and fauna. Sustainable management of these ecologically fragile systems requires a synoptic ecosystem approach that relates to the dynamics of natural variability and the effects of human interventions on key indicators of biodiversity and productivity. As a result of the development programme based on ad-hoc decisions, considerable changes in the structure and composition of the landscape in the region have been very obvious during the last four decades. These changes have adversely affected the ecology, biodiversity and hydrological regime of river basins resulting in diminished river / stream flows. In this context, understanding landscape dynamics has become an important component of ecosystem management as it quantifies the relationship of structural and functional components at various scales. Temporal geospatial data along with collateral data and metrics aid in assessing the status of the landscape. Geo-visualization of landscape dynamics enables the regional planner in evolving appropriate conservation strategies for sustainable management. The talk would demonstrate the potential of multi-resolution (temporal, spatial and spectral) remote sensing data in conjunction with geospatial technologies in demarcating ecologically sensitive regions at gram-panchayat levels in Central western Ghats for successful implementation of Biodiversity Act, 2002 at local levels.**

Keywords*— *Multi resolution remote sensing data, geospatial analysis, landscape dynamics, habitat fragmentation, ecology, biodiversity, Eco sensitive regions

I. INTRODUCTION

The conservation and sustainable management of ecosystems are the vital components in the pursuit of development goals that are ecologically, economically and socially sustainable [1,2]. A great diversity of species, including the humans, has been associated with each other for long periods of time and co-evolution is at the Centre of all ecosystems. The individual cannot live independently of the living environment and actions of individuals have an impact on the environment. Ecologically sound planning requires an understanding of the complex functioning of ecosystems, and recognition of the full range and diversity of resources, values and ecological services that they represent [1,3]. In this regard, the current research envisions the beginning of an on-going process to integrate ecological and environmental considerations into administration in the biodiversity rich district of Karnataka. This is a major step towards an ecological audit that eventually should result in the conservation and sustainable use of biodiversity. This process in due course will create an integrated database on biodiversity for the district and also furnish analyzed data, advice and management prescriptions to beneficiaries at every level from the village communities to the Government. Integrated Ecological carrying capacity study provides the regional planner in evolving appropriate conservation strategies for sustainable management particularly on a defined geographical area. Decision making on developmental activities, entail planning that depends upon the availability of reliable and accurate data. Data required for natural resource planning include spatial data such as, information of physiography of the area, land use,

assets, etc. Geographic information system (GIS) with a capability of handling spatial data helps in the analysis and visualization of results effectively, and aids decision making process. Objective of the current research is to understand the landscape dynamics through temporal remote sensing data and develop conservation strategies through geo-visualization of ecological, land cover dynamics, flora and fauna status, hydrology and social aspects.

II. STUDY AREA

Uttara Kannada district is one of the richest biodiversity district of Western Ghats. The traditional agro disturbance regime based on clearing and burning has been abandoned in many places in the district during the last few decades due to socio-economic and political changes. Uttara Kannada (Central Western Ghats) has 3 agro climatic zones (fig. 1) and has 11 taluks and has the unique distinction of having highest forest cover in Karnataka. The coastal region, which has hot and humid climate (rainfall varies between 3000-4500 mm) and comprises the taluks of Karwar, Ankola, Kumta, Honnavar and Bhatkal. The Sahyadri interior region of the Western Ghats (500-1000 m high), which is very humid to the south (rainfall varies from 4000-5500 mm) and comprises the taluks of Sirsi, Siddapur, Supa and Yellapur. The plains are regions of transition, which are drier (rainfall varies between 1500-2000 mm), and comprises the taluks of Mundgod and Haliyal [4].

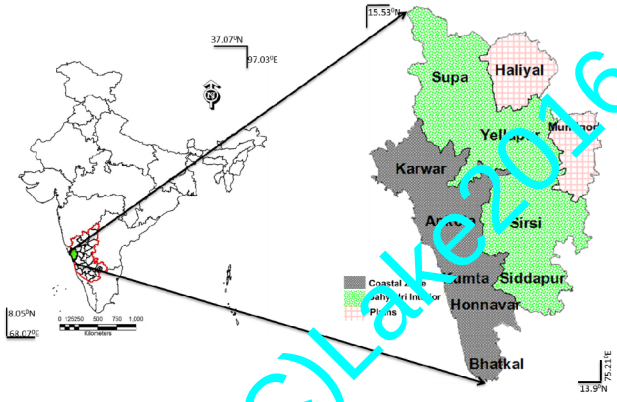

Fig. 1. Uttara Kannada district with agro climatic zones

III. METHOD

A. *Prioritisation of regions rich in ecology and diversity:*

Study region was divided [4] into 5'x5' grids (9 x 9km). Grids were assigned the weightages based on the variables listed in Table 1 and equation1. A weightage metric score based on multiple data sets (fig. 2 and table 1) were considered to priritise the regions at panchayath levels for conservation and management planning. The weightage is defined by:

$$Weighatge = \sum_{i=1}^{n} W_i V_i$$

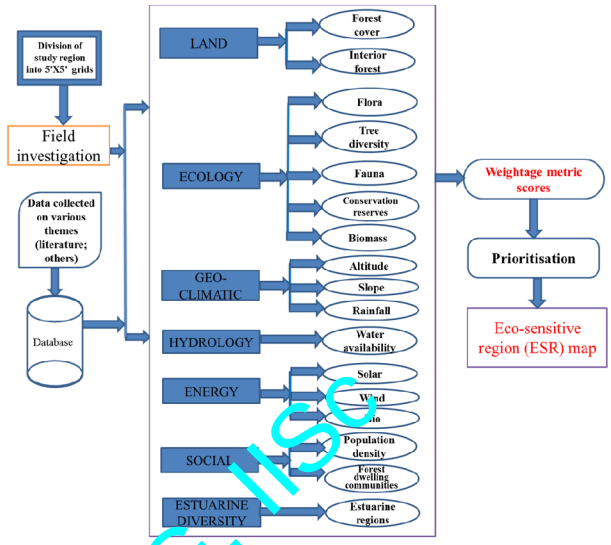

Fig. 2. Schematic representation of method adopted for the analysis

Where n is the number of data sets, V_i is the value associated with criterion i, and W_i is the weight associated to that criterion. Each criterion is described by an indicator mapped to a value normalized between 10 to 1. The value 10 corresponds to very higher priority for conservation whereas 1 is converse to above. The value 7, 5 and 3 corresponds to high, moderate, low levels of conservation.

B. *Landscape dynamics*

Temporal remote sensing data have been classified through Gaussian Maximum Likelihood Classifier [GMLC]. Landsat data available in the public domain corresponding to the study area were classified into eleven land use categories: Evergreen forest to semi evergreen forest, moist deciduous forest, Shrub lands/grass lands, Dry deciduous forest, Acacia/Eucalyptus/ other hardwood plantations, Teak/Bamboo/ other softwood plantations, Coconut/Areca nut plantations, Built-up, Water, Crop lands, Open fields. Table 2 lists land use details during 1973 to 2013. Figure 3 depicts land uses during 1973 and 2013. Comparative assessment of land use categories reveals the decline of vegetation cover in the district during 1973 to 2013. The reduction of area under evergreen forests from 67.73% (1973) to 32.09% (2013) due to anthropogenic activities involving the conversion of forest land to agricultural and horticultural activities [5, 6], monoculture plantations and land releases for developmental projects. Transition of evergreen-semi evergreen forests to moist deciduous forests, and some have been converted into plantations (such as Teak, Areca nut, Acacia spp., etc.). Enhanced agricultural activities is evident from the increase of agricultural land use from 7.00 (1973) to 14.13 % (2013) and the area under human habitations have increased during the last four decades, evident from the increase of built-up area from 0.38% (1973) to 3.07% (2013). Unplanned developmental activities coupled with the enhanced agriculture

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and horticultural activities have aided as prime drivers of deforestation, leading to the irreversible loss of forest cover with the reduction of ecosystem goods and services. The increase in plantation of exotic species has led to the removal of forest cover and also extinctions of species. Acacia auriculiformis, Casuarina equisetifolia, Eucalyptus spp., and Tectona grandis have been planted widely in the district. Acacia and Teak plantations constitute 12.04% and 6.60% respectively in the district. The dry deciduous forest cover is very less (0.96%) and is found mainly in the north eastern part of the district in Mundgod taluk and partly Haliyal taluk. The collected field data is separated with respect to each category, 60% used as a training set and 40% used for verification. Accuracy of the classification ranges from 87 to 93% with more consistent results [5,6].

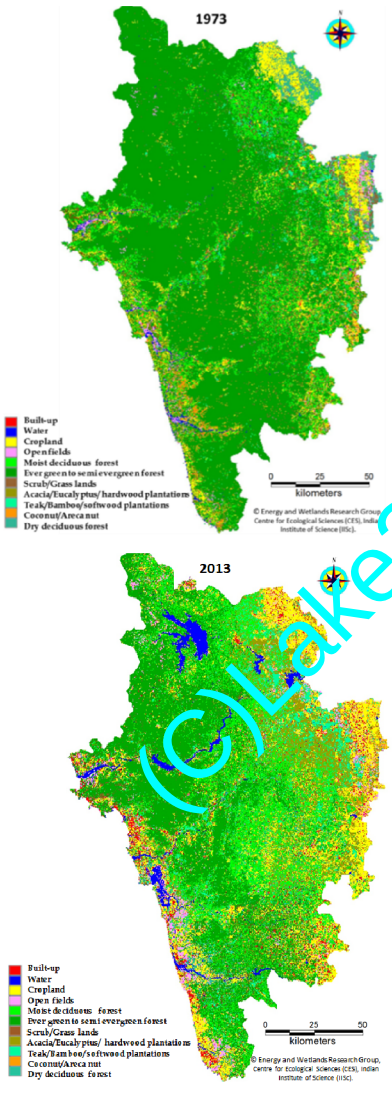

Fig. 3. Land use dynamics (1973 and 2013)

IV. CONCLUSIONS AND RECOMMENDATIONS

The study reveals that there is only a thin line difference between rain forests and deserts. Whereas the heavy rainfall of coast and malnadu taluks can potentially promote loftiest evergreen forests of Western Ghats many locations are characterized by poorer vegetation- poorer in biomass and in conservation ranking. The poorest savanna site exists on a hill top ironically in the Kathalekan forests of highest conservation value, dotted with Myristica swamps, by presence of lofty Dipterocarpus threatened and endemic plant and animal species (especially amphibians and LTM) [7,8].

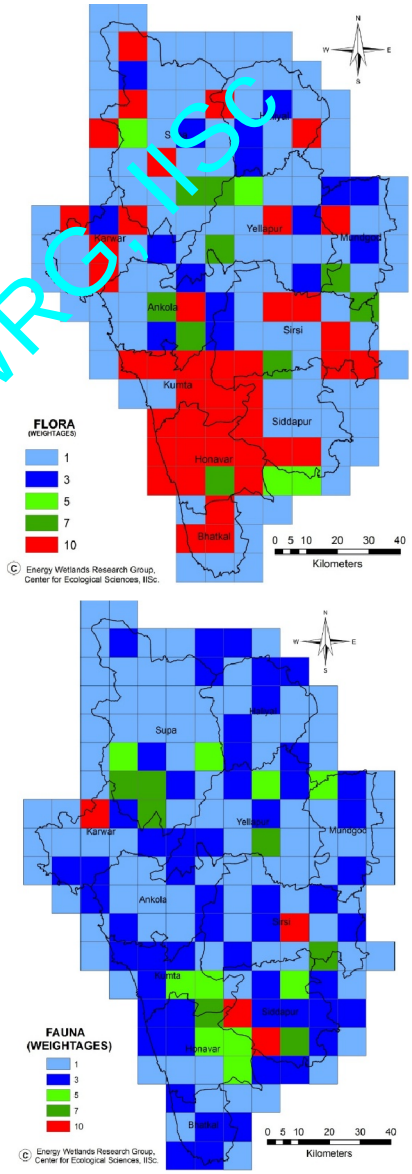

Fig. 4. Prioritisation of the district based on flora and fauna

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Village level biodiversity hotspots are to be identified and protected through the involvement VFCs/local Biodiversity Management Committees. Eventually these, through succession and vegetation enrichment will turn out to be local hotspots of biodiversity. Realizing the fact that depletion of forests of food resources and human induced vegetation changes in forests have adverse consequences on wildlife while increasing crop raids by animals' enrichment of secondary forests and poor grade tree plantations with food resources for forest herbivores is highly desirable. NTFP collection, that yields only minor revenue to the state, is being carried out in many forests with gay abandon causing destruction of the resource itself [7, 9]. VFCs and other forest dwellers in respective villages be organized and trained in scientific harvesting of NTFP which also serves as medicinal plants. Rampant collection of poles, cane, fuel wood etc., has been taking a heavy toll on forest resources particularly in the village vicinities. Most of the easily accessible areas with many medicinal plants are more prone to exploitation and get converted into scrub and thickets. Even the semi-evergreen and evergreen forests higher up in more inaccessible areas are also being exploited for fuel wood, timber etc., due to which many of these forests have thorny thickets as under-growths. We recommend conduct of sustained programs on biodiversity awareness.

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Table 1: Various attributes considered and their weightages

S.NO.	Themes	Weightages				
		1	3	5	7	10
1.	**LAND**					
	Land use	FC<20%	20<FC<40%	40<FC<60%	60<FC <80%	FC > 80%
	Interior forest	IF<20%	20<IF<40%	40<IF<60%	60<IF<80%	IF> 80%
2.	**ECOLOGY**					
	Flora	NEND	END<30%	30<END<50%	50<END<70%	END>70%
	Tree diversity	SHD<2	2<SHD<2.5	2.5 <SHD<2.7	2.7<SHD<3	SHD>3
	Fauna	-	NEND	-	-	END
	Conservation reserves (CR)	-	-	-	-	National parks, Wild life reserves, Myristica swamps, Sanctuaries
	Biomass (Gg)	BM<250	250<BM<500	500<BM<750	750<BM<1000	BM>1000
3.	**ENERGY**					
	Solar	-	-	<5 KWh/m^2/day	5-6 KWh/m^2/day	6-6.5 KWh/m^2/day
	Wind	-	-	2.4 to 2.55 m/s	2.5 to 2.6 m/s	2.6 to 2.7 m/s
	Bio	-	-	SD<1	1<SD<2	SD>2
5	**GEO-CLIMATIC**					
	Altitude					
	Slope	-	-	-	Slope > 20%	Slope > 30%
	Precipitation					
4.	**HYDROLOGY**					
	Stream flow	WA<4	4<WA<6	6<WA<9	9<WA<12	WA=12
5.	**SOCIAL**					
	Population density (PD)	PD>200	100<PD<200	100<PD<150	50<PD<100	PD<50
	Forest dwelling communities (Tribes)	-			Tribes are present then assigned 10; if no tribal population exists, then assigned as 0	
6.	**ESTUARINE DIVERSITY**					
	Estuarine regions	-	low	moderate	high	very high

FC-forest cover; IF-interior forest cover; END-endemic; NEND-non-endemic; BM-biomass; SD-supply to demand ratio; WA-Water availability

Table 2: land use variation from 1973 to 2013

Year / Category	1973		1979		1989		1999		2010		2013		Loss / Gain in area (1973-2013) (Ha)
	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	
Built-up	3886	**0.38**	9738	0.95	12,982	1.26	21,635	2.10	28,491	2.77	31589	**3.07**	27703
Water	7,681	0.75	18452	1.80	16,604	1.61	32,983	3.21	26,119	2.54	28113	2.73	20432
Crop land	71,990	**7.0**	103163	10.02	121,167	11.77	138,458	13.45	148,187	14.40	145395	14.13	**73405**
Open fields	14071	1.37	15988	1.55	34,783	3.38	21,945	2.13	30,812	2.99	37660	3.66	23589
Moist deciduous forest	**95,252**	**9.27**	**102967**	**10.01**	**143,849**	**13.98**	**179,075**	**17.40**	**166,266**	**16.15**	**161,996**	**15.74**	66639
Evergreen to semi evergreen	**696,978**	**67.73**	**589762**	**57.31**	**531,872**	**51.68**	**423,062**	**41.11**	**367,064**	**35.66**	**330,204**	**32.08**	**-366774**
Scrub/grass	38,109	3.70	58936	5.73	44,123	4.29	47,366	4.60	35,158	3.42	40402	3.93	2293
Acacia/Eucalyptus/ hardwood plantations	40,905	**3.97**	50321	4.89	55,694	5.41	73,977	7.19	119,717	11.63	122927	**11.94**	82022
Teak/ Bamboo/ softwood plantations	13997	**1.36**	20896	2.03	21,937	2.13	38,588	3.75	44,794	4.35	67111	**6.52**	53114
Coconut/ Areca nut / Cashew nut plantations	20,702	**2.01**	29675	2.88	32,227	3.13	43,623	4.24	53,646	5.21	53,993	**5.25**	**33291**
Dry deciduous forest	25,410	2.47	29113	2.83	13,848	1.35	8374	0.81	9008	0.88	9873	0.96	-15537
Total	1029086												

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