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SUSTAINABLE MANAGEMENT OF SACRED GROVES OF KODAGU DISTRICT OF KARNATAKA USING GIS TECHNOLOGY

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ABSTRACT

Sacred grove (SG) is an age old tradition 0f India which aims to protect the Biodiversity by providing protection to, patches of forests, which are dedicated to deities/ ancestral spirits. These patches of SGs are also considered as "Gene Banks. The Study area for the present work is "Kodagu District" of Karnataka state which is famous as "Hot Spot of "SGs". Due to anthropogenic activities SGs are under depletion, fragmentation and at the verge of extinction. But on the other side increasing attention is being paid to make use of these groves as potential tool and model for biodiversity conservation. This process, is challenging as data on SG is vast, scattered at various levels and exists in variety of forms. The capabilities of GIS technology fulfill the requirements towards the conservation. This paper describes building of Geodatabase, Categorization and analysis of distribution of the SG using GIS. Results show that totally 400 Species data was collected and stored in geodatabase and was analysed that 230 Medicinal, 43 vaulnerable, 12 critically endangered and 7 endangered plant species and 41 Animal species and 20 Bird species were preserved in SGs. Result has also shown different categories of SG and suggests conservation priority.

Key Words: Sacred Groves, Conservation, Biodiversity, Geodatabase, categorization, species analysis

INTRODUCTION

India is a mega diverse nation, housing around 6-12% of world's plant species. India also has a rich cultural heritage going back thousands of years. Much of Indian biodiversity is intricately related to the socio-cultural practices of the land. SGs are one of the most valuable of such legacies from the primitive practice of nature conservation, scattered throughout India and are the tract of sacred forests which have been completely or near completely immune from human interference, due to religious beliefs. (Madhav Gadgil and Varatak 1974). SGs are great heritage of diverse gene pool of many forest species having socio-religious attachment and possessing medicinal values. Sacred groves are ecologically and genetically very important. They are the abodes of rare, endemic and endangered species of flora and fauna. It is also considered to serve a variety of functions and constitute an important component of the mountain forest ecosystem. It helps in improving the soil fertility (Ashish Anthwal, et al. 2006) The present status of sacred groves everywhere is a matter of deep concern as they are gradually declining and disappearing from the countryside. The major reasons for this are such as their presence in agricultural lands, grazing, fragmentation of the grove-owning families and

erosion of cultural and religious beliefs and taboos. In view of this, and due to failure of pure legal protective measures in guaranteeing conservation, it has become imperative to search for alternative solutions based on indigenous knowledge of the people (R. K. Bhakat and U. K. Sen 2008) During the last few decades socio-economic, ecological and conservation importance of sacred groves has been recognized and it has been emphasized that immediate conservation of them is must. Several approaches and options could be adopted to conserve these scared spaces. However, most essential, but most neglected is the management of information on sacred groves,which would lead into planning of appropriate policies and action plan to save these groves from the clutches of both modernization and urbanization.(Gaikwad et al.,2004). In view of these above references and during the field study it was observed that the huge amount of information on different aspects of sacred groves is scattered in various levels which includes researchers, academicians, Literatures , the localities and, most of the information is in folklores and passed from a generation to generation, very clearly indicating the data about SG is not properly collected, stored and managed despite of the truth that we are in a era of Information technology. So the objective has been set to incorporate GIS technology to SGs where both spatial and non spatial data can be stored, managed, manipulated, visualized and can be disseminated using other GIS tools. This paper reveals how effective management of data upholds the present scenario of SGs which is alarming and calls for the policies and action plans in order to conserve these “Gene banks.”

STUDY AREA

Kodagu is located on the eastern slopes of the Western Ghats (Figure 1.1) and lies between 11°55' to 12°52' North Latitude and 75°22' to 76°12' East Longitude. Kodagu district has an area of 4102 sq.km and is one of the smallest districts of Karnataka. The district is bordered by Dakshina Kannada district to the northwest, Hassan district to the north, Mysore district to the east, the Kannur District of Kerala to the southwest, and the Wayanad District of Kerala to the south. It is a district with mountainous configuration. The elevation ranges from 900 metres to 1,750 meters above sea-level in the district. The prominent peaks in Coorg are Tadiyandamol (1750 m), Pushpagiri (1715 m) and Brahmagiri (1608 m). Several long and elevated ridges run west to east from this portion of Western Ghats. The mountains of Kodagu give birth to rivers such as Kaveri, Kabini, Laxmanathirtha, Ramathirtha and Hemavathi. Kodagu district comprises of Pushpagiri wildlife sanctuary, Talacauvery wildlife sanctuary and Brahmagiri wildlife sanctuary.

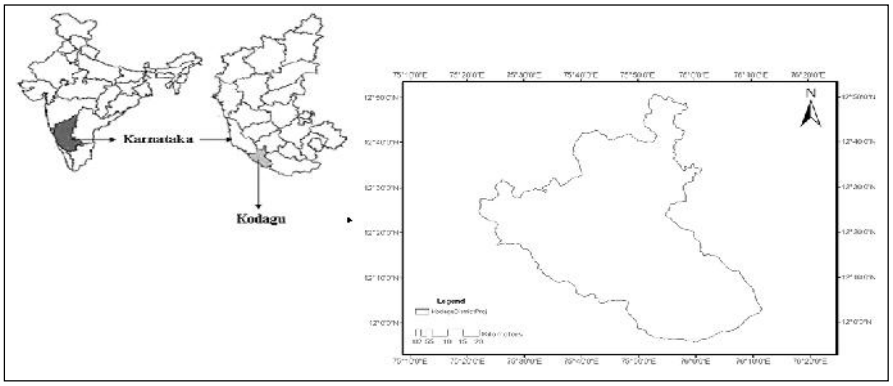

Figure 1: Study Area-Kodagu.

DATA USED:

Table 1: Shows the different types of data used to reach the objectives.

Sl. No.	Type of Data	Source	Purpose
1	Toposheets (1: 50000) VIZ. 48M13, 8P7,48P10, 48P11, 48P12, 48P13, 48P14, 48P15, 48P16, 57D2, 57D3, 57D4,58A1	Survey of India (SOI)	Base Map Preparation
2	Spatial data	GPS	Ground Truth Validation for Base Map.
3	Field Data Collection	Data Sheets	SG and Species Shapefiles Preparation.
4	Non spatial data	Literature	For Attribute data preparation

SOFTWARE'S REQUIRED: a) Erdas imagine 9.1- For rectification, subset, mosaic, and finally for Base Map preparation b) ArcMap 9.3 - For digitization of various thematic layers and creating MXD file) Arc-Catalog 9.3 - For development of Geodatabase Schema and for management of shp.files d) Mapsource – For Handling GPS data.

METHOD

Base Map Preparation: The base map was prepared by using SOI Toposheets of the study area. The methodology adopted for the preparation of base map is as follows: The spatial details like the District boundary, Forest boundary, major rivers and roads and drainage network were traced, scanned, registered and rectified in ArcGIS 9.3.Then individual Toposheets were subsetted and mosaiced in ERDAS IMAGINE so as to get the single image,. After this various spatial details like boundary, road network and river network were captured into different layers through digitization.

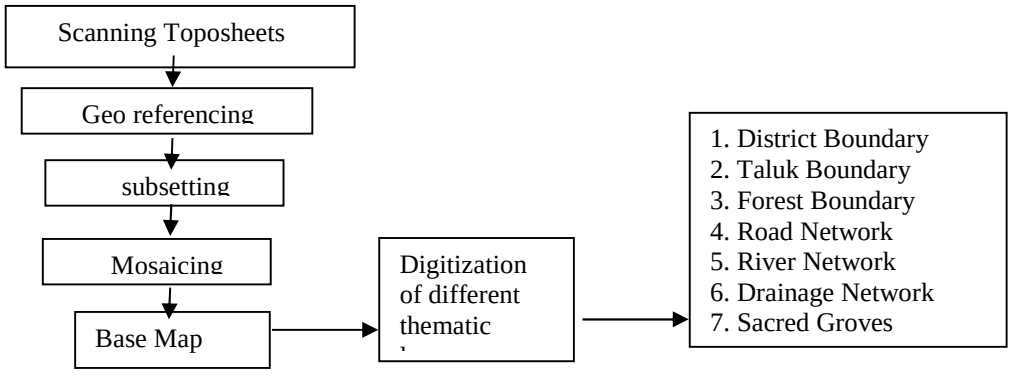

Figure 2: Flow Chart for Base Map Preparation

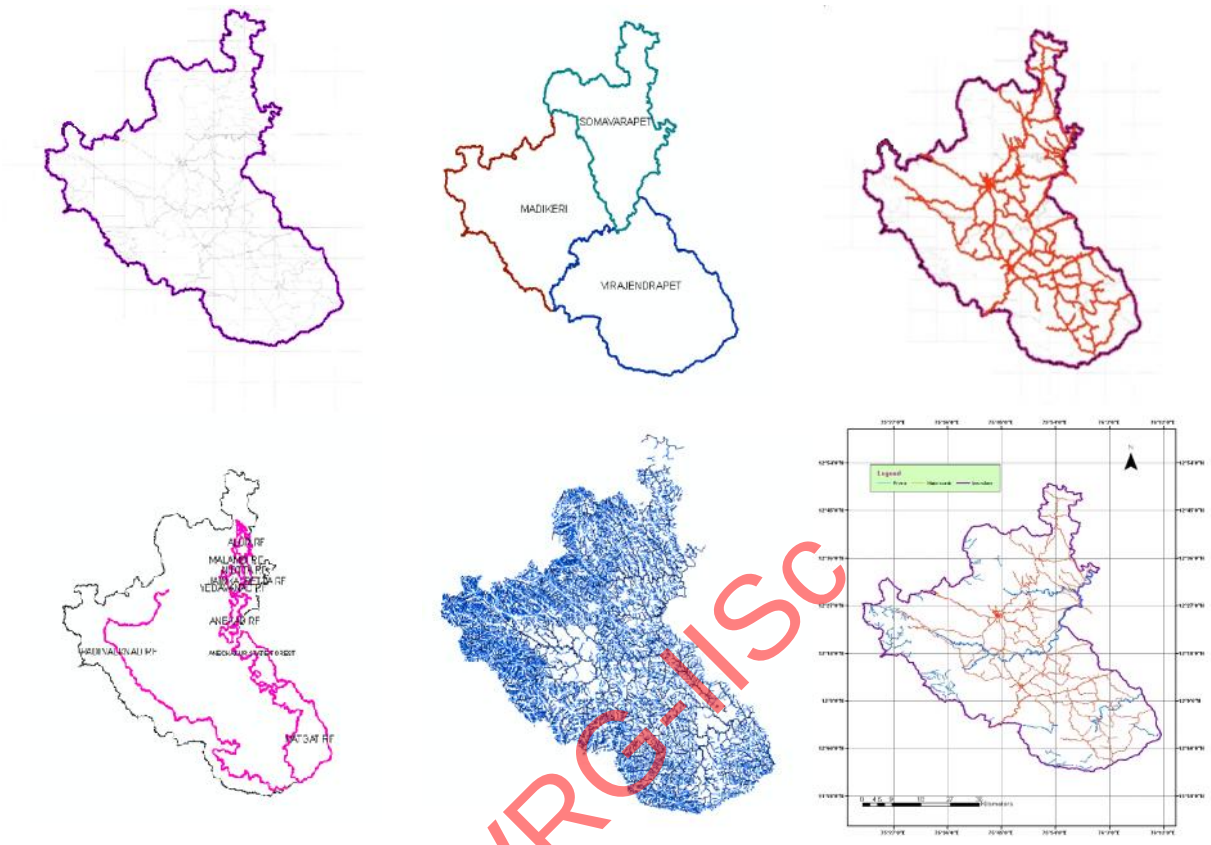

Figure: 3.Repesentaion of digitized boundaries of District and Taluk , major roads, reserved Forest boundary, Drainage network and Base Map of Kodagu District.

Geoatabase: A file based geo-database was created by using Arc GIS software. For this Design of the Geodatabase at first Schema was developed and then a new Geodatabase was created in Arc GIS environment. In definite GDB Structure spatial data was entered and additional properties for the data were defined. The Geodatabase of SG, developed in the prescribed manner included Feature Data sets of SG –Kodagu and SG INFO table. Feature Data set of SG-kodagu consists feature classes such as Boundary, Road Network, River Network, Sacred Grove locations, Geo locations, Annotation, Topology, Relationship class. Geodatabase has three Sub types viz, Madikeri, Virajpet, Somavarapet and for making the 'database content' search in a easier way and drainage network has 5 subtypes indicating different drainage order. The Geodatabase of SG holds spatial data of the SG and other Geographic location. It also contains attribute data regarding the 'Grove Name', name of the Deity to which SG is dedicated to, jurisdiction details of SG in respect to Taluk, Division, sub divison, Range, and information regarding biodiversity, species status according to IUCN (International Union for Conservation of Nature) Red List of Threatened Species and FRLHT (Foundation for Revitalisation of Local Health Traditions)-Herbarium.

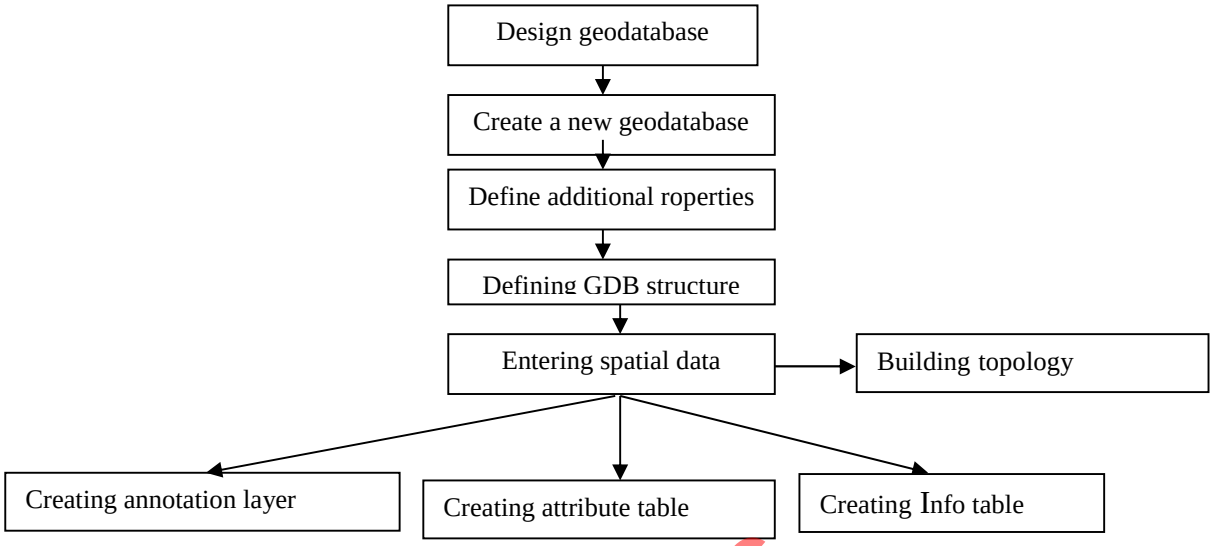

Figure: 4 Flow Chart for Methodology for Geodatabase

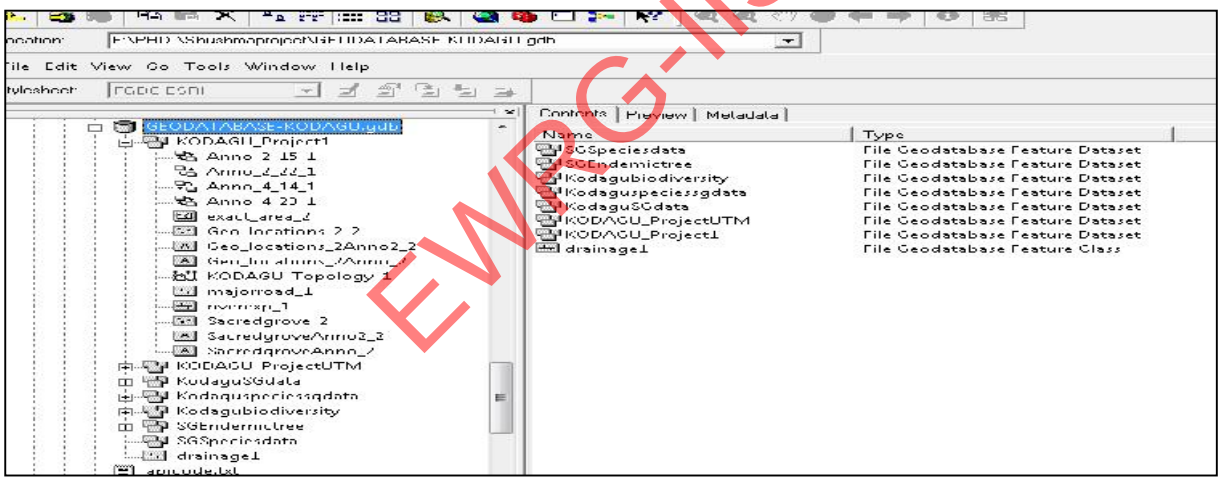

Figure: 5 shows the Geodatabase Schema

Categorization and analysis of species data: During the field visit, extensive survey has been undertaken for collecting the ground truth information and 25 sacred groves were visited and GPS data of location of the sacred groves were collected. Additional data such as survey numbers and area information of sacred groves were collected from the forest department. The table shows the locations of sacred groves of Kodagu and attribute data such as name and location of the sacred grove, name of the deity dedicated to, festival name and dates, cultural events and rituals observed during festivals, Devarakadu committee associated with the sacred grove, water sources, vegetation type, approach road to the grove, survey, fencing and existing threat faced by the sacred groves and data regarding species like local names of trees, medicinal plants, animals and birds present in each sacred grove were collected in a datasheet. And photographs of prominent tree species and medicinal plants were taken using digital camera. These species were identified and local names of those species were recognized by

forest guards and locals. The scientific names and conservation status of all the species were obtained from IUCN (International Union for Conservation of Nature) Red List of Threatened Species and FRLHT (Foundation for Revitalisation of Local Health Traditions)-Herbarium. The common names and scientific names of some species were derived from booklet "Sacred Groves of Kodagu - A tradition to conserve" published by CEE in 2003. All the data collected was brought into the GIS environment and incorporated in the Geo-database Structure. The Complete data sets were created in feature data sets in the form of shape files and for individual feature class attribute data is entered in the form of table are as shown in the figures 6 and 7 respectively.

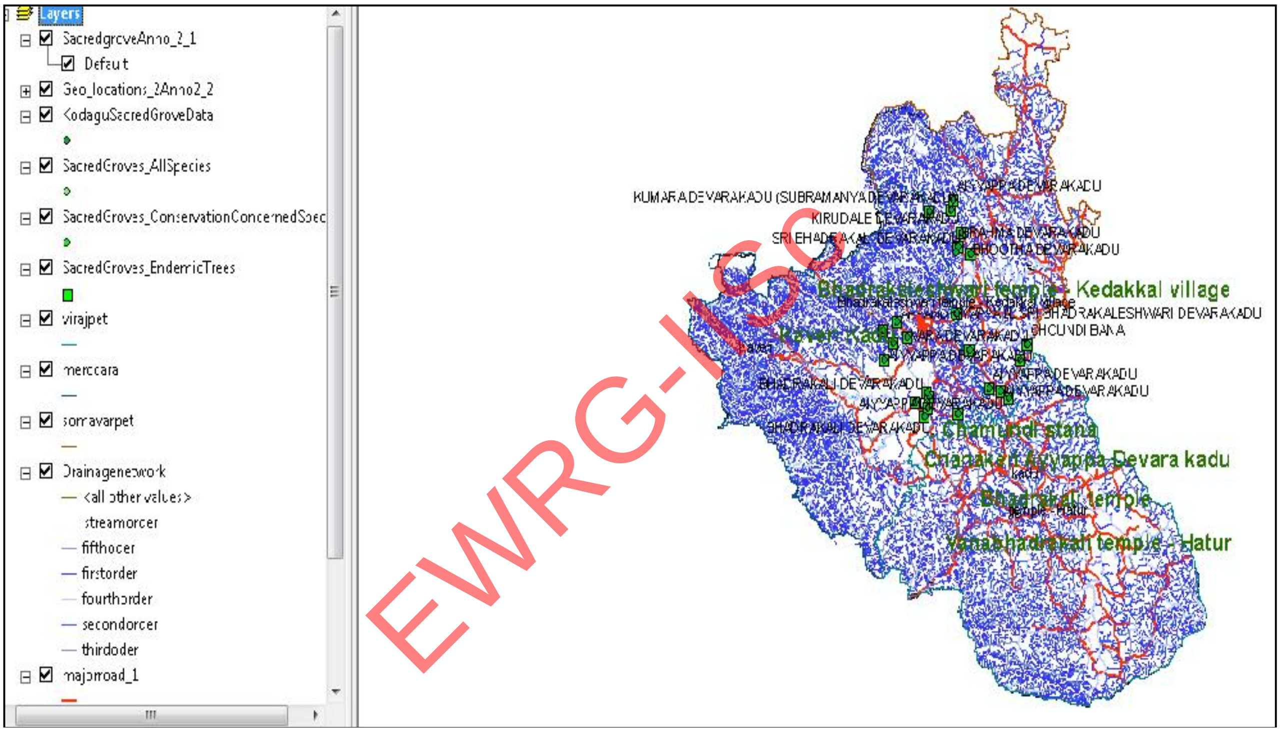

Figure: 6 Shows the map of Spatial Data about SG which are stored in different layers

SCIENTNAME	IUCNSTATUS	FRLHTSTATU	GROWHEI	ELEVRA
SAPINDUS EMARGINATUS VAHL.		LOW RISK-LEAST CONCERNED / REGIONA	up to 18 m	200m to 1!
SAPINDUS EMARGINATUS VAHL.		LOW RISK-LEAST CONCERNED / REGIONA	up to 18 m	200m to 1!
SAPINDUS EMARGINATUS VAHL.		LOW RISK-LEAST CONCERNED / REGIONA	up to 18 m	200m to 1!
SAPINDUS EMARGINATUS VAHL.		LOW RISK-LEAST CONCERNED / REGIONA	up to 18 m	200m to 1!
SAPINDUS EMARGINATUS VAHL.		LOW RISK-LEAST CONCERNED / REGIONA	up to 18 m	200m to 1!
SAPINDUS EMARGINATUS VAHL.		LOW RISK-LEAST CONCERNED / REGIONA	up to 18 m	200m to 1!
SAPINDUS EMARGINATUS VAHL.		LOW RISK-LEAST CONCERNED / REGIONA	up to 18 m	200m to 1!
DALBERGIA LATIFOLIA ROXB.	VULNERABLE	MEDICINALPLANTS	to 40 m	0 m to 150
DALBERGIA LATIFOLIA ROXB.	VULNERABLE	MEDICINALPLANTS	to 40 m	0 m to 150
DALBERGIA LATIFOLIA ROXB.	VULNERABLE	MEDICINALPLANTS	to 40 m	0 m to 150
DALBERGIA LATIFOLIA ROXB.	VULNERABLE	MEDICINALPLANTS	to 40 m	0 m to 150
DALBERGIA LATIFOLIA ROXB.	VULNERABLE	MEDICINALPLANTS	to 40 m	0 m to 150
DALBERGIA LATIFOLIA ROXB.	VULNERABLE	MEDICINALPLANTS	to 40 m	0 m to 150

Figure: 7 shows the attribute table of a selected feature class

In the field it was found out and documented that six types of threats were faced by sacred groves of Kodagu viz. small-holder plantations, encroachment, colonization, sanskritization, removal of biomass and cattle grazing. It was observed that some SGs are experiencing more than two types threats and these can lead to disappearance of the SGs in future Hence there was a necessity categorize these sacred groves and assign conservation priority the so as protect them from these threats for their conservation. After the preparation of Base Map, Geodatabase categorization has been done by giving the scores to each threat and rating has been done on basis of number of threats each SG has faced and the SGs has been categorized into 5 classes viz. Extreme, High, Medium, Low and Least based upon the threats they have faced. These categories are fed into the Geo-database.

Table 2: Shows the Threats scores and categorization of SGs

SG ID	SHP	ENC	COL	SAN	REM	CAG	TOTAL THREAT SCORES	CATERGORIZTION
SG-1	0	0	0	1	0	1	2	MEDIUM
SG-2	0	0	0	1	1	0	2	MEDIUM
SG-3	0	0	0	0	0	1	1	LOW
SG-4	0	1	1	0	0	1	3	HIGH
SG-5	0	0	0	0	0	1	1	LOW
SG-6	0	1	0	1	0	1	3	HIGH
SG-7	0	1	1	0	0	0	2	MEDIUM
SG-8	0	1	0	0	1	1	3	HIGH
SG-9	0	1	0	0	0	1	2	MEDIUM
SG-10	0	1	0	0	0	1	2	MEDIUM
SG-11	0	1	0	0	0	1	2	MEDIUM
SG-12	1	1	0	0	0	0	2	MEDIUM
SG-13	0	1	0	0	0	1	2	MEDIUM
SG-14	1	1	1	0	0	1	4	EXTREME
SG-15	1	1	1	0	0	1	4	EXTREME
SG-16	0	0	0	0	0	0	0	LEAST
SG-17	0	1	0	0	0	0	1	LOW
SG-18	0	0	0	0	0	0	0	LEAST
SG-19	0	0	0	0	0	1	1	LOW
SG-20	0	0	0	0	0	1	1	LOW
SG-21	0	0	0	0	0	0	0	LEAST
SG-22	0	0	0	0	0	1	1	LOW
SG-23	0	0	0	0	0	1	1	LOW
SG-24	0	0	0	0	0	1	1	LOW
SG-25	0	0	0	0	0	0	0	LEAST

Then analysis of Species was carried out to estimate the distribution of various species by opening the attribute table of feature class of SG_ all species and in that attribute table categorization field was Selected and each category of SG species data was summarized using the functionalities in the attribute table. And From that summarized report IUCN status and FRLHT status were extracted to evaluate the Species data found in all the categories of SG.

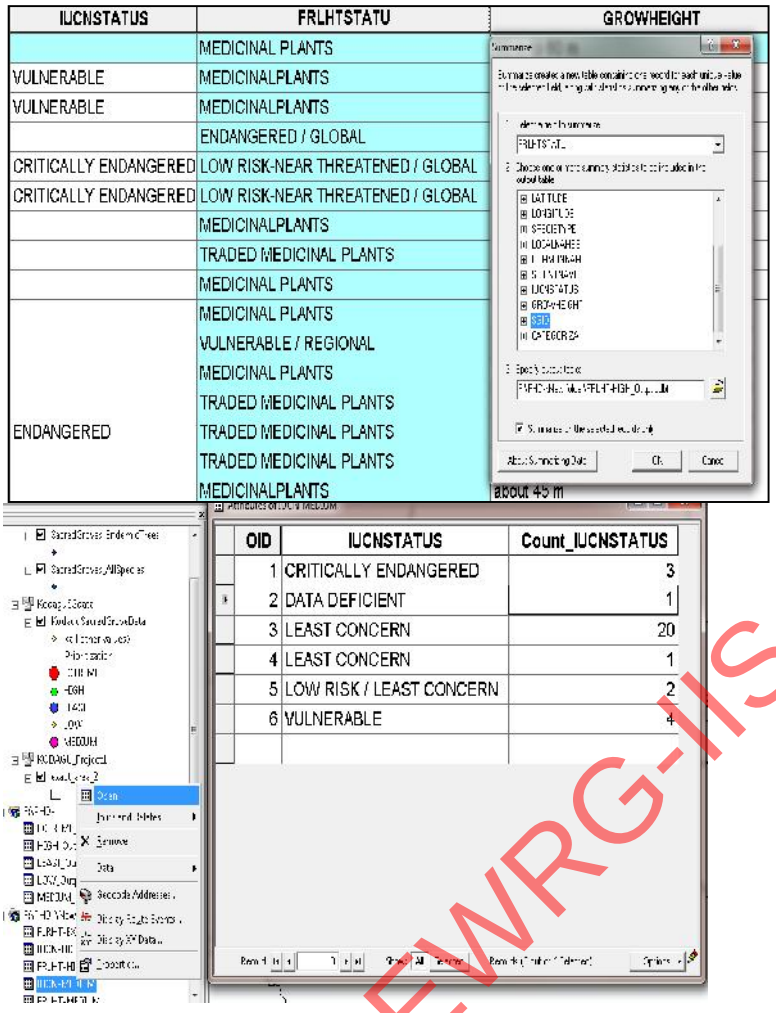

Figure: 8 shows analysis process in Geodatabase

RESULT AND DISCUSSION:

Categorization Of SGs: In the process of categorization 2 SGs fall under 'EXTREME' category , 3 SGs are under High Category ,8 SGs are under 'MEDIUM' category and another 8 SGs are under 'LOW' category, and 4 SGs are under 'LEAST' Category.

1. SGs of 'EXTREME' conservation priority category are facing threats such as growth of coffee plantations, encroachment and colonization to maximum extent.
2. The SGs of 'HIGH' conservation priority category are facing threats such as sanskritization of SGs, removal of bio-mass from the SGs area, encroachments and colonization.
3. The 8 SGs of 'MEDIUM' conservation priority category are facing threats such as sanskritization of SGs, encroachments and cattle grazing.
4. The 8 SGs of 'LOW' conservation priority category are facing threats such as encroachments and cattle grazing.
5. The 4 SGs of 'LEAST' conservation priority category are not facing any kind of threats. They are untouched, dense in vegetation and are far from human disturbance.

These categories indicates the priority of conservation it demands and with these data in the Geodatabase categorization Map can be prepared which shows the different categories above mentioned as shown in the Figure 9. Further query can be done to test the category to which each SG belong and the maps of SG can also be visualized as shown in the Figure.

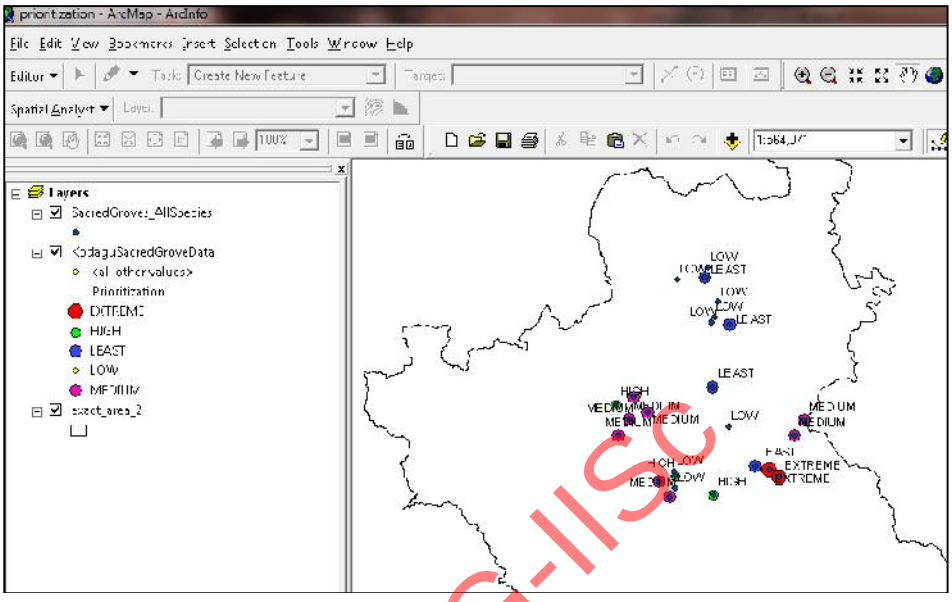

Figure: 9 shows categories of SG based on conservation priority

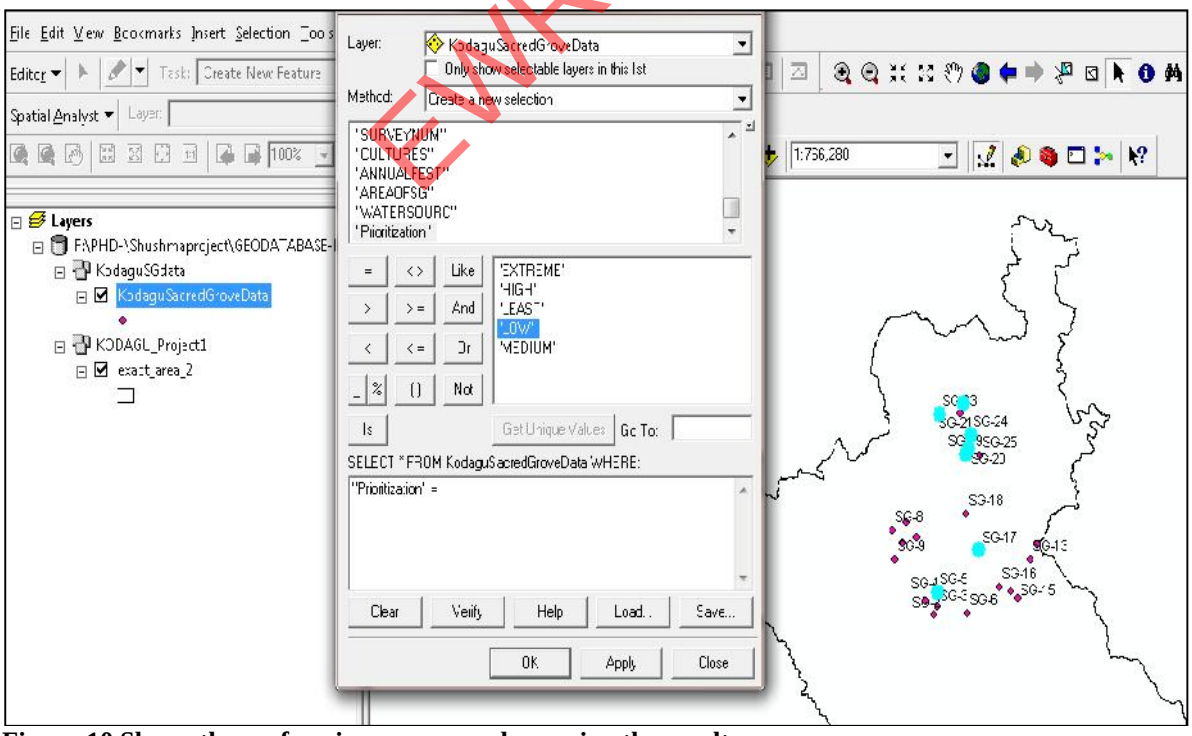

Figure:10 Shows the performing queary and mapping the result

Anlysis of Species distribution: The analysis of species data was done and out of 400 species data collected during field work and it was found that SGs preserve 230 Medicinal,

43vaulnerable, 12 critically endangered and 7 endangered plant species and 41 Animal species and 20 Bird species. This result also proves the fact that SGs are repositories of Medicinal plants and store house many vulnerable and Endangered Species as depicted in the figure 11. The species data were extracted from Geo-database and distribution of species were tabulated in the form of INFO table as shown in the table

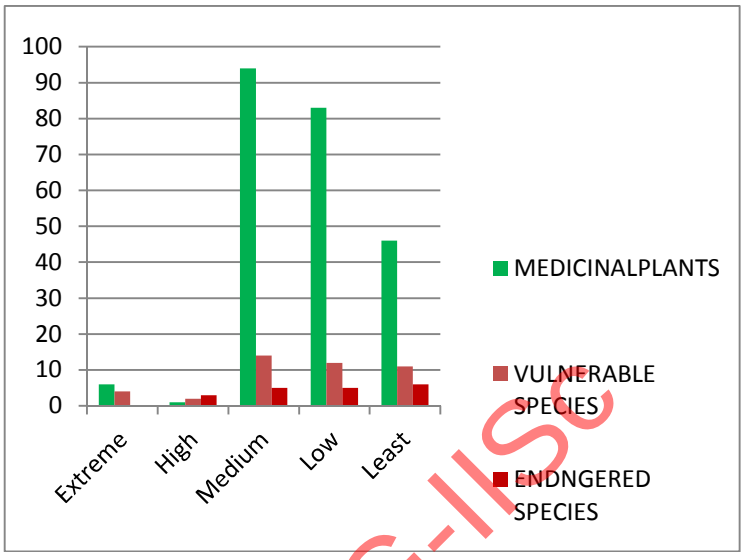

Figure: 11 Distribution of Plant species in various categories of SG

Table 3: shows the Disrtibution of Plant species in various categories of SG

LIST OF DISTIBUTION OF SPECIES IN SG		
GROVES UNDER EXTREME THREAT - 2		
FRLHT-STATUS	MEDICINALPLANTS	6
IUCN-STATUS	VULNERABLE	4
TOTAL-SPECIES-STUDIED		29
GROVES UNDER HIGH THREAT – 3		
FRLHT-STATUS	MEDICINALPLANTS	1
IUCN-STATUS OF	CRITICALLY ENDANGERED	2
	LEAST CONCERN	4
	VULNERABLE	2
	ENDNGERED	1
TOTAL-SPECIES-STUDIED		39
GROVES UNDER MEDIUM THREAT -8		
FRLHT-STATUS	COMMERCIAL TREE	2
	ENDNGERED/GLOBAL	2
	LOW RISK-LEAST CONSERNED/REGIONAL	2
	LOW RISK-NEAR THREATENED/GLOBAL	3
	MEDICINALPLANTS	32
	TRADED MEDICINAL PLANTS	62
	VULNERABLE/GLOBAL	9
	VULNERABLE/REGIONAL	1
IUCN-STATUS	CRITICALLY ENDANGERED	3

	LEAST CONCERN	21
	VULNERABLE	4
	/LOW RISK /LEAST CONCERN	2
TOTAL-SPECIES-STUDIED		145
GROVES UNDER LOW THREAT -8		
FRLHT-STATUS	COMMERCIAL TREE	1
	CRITICALLY ENDANGERED/REGIONAL	1
	LOW RISK-LEAST CONSERNED/REGIONAL	3
	LOW RISK-NEAR THREATENED/GLOBAL	2
	MEDICINALPLANTS	31
	TRADED MEDICINAL PLANTS	52
	VULNERABLE/GLOBAL	7
	VULNERABLE/REGIONAL	3
IUCN-STATUS	CRITICALLY ENDANGERED	2
	LEAST CONCERN	5
	VULNERABLE	2
	LOW RISK /LEAST CONCERN	2
	ENDANGERED	2
TOTAL-SPECIES-STUDIED		115
GROVES UNDER LEAST THREAT –4		
FRLHT-STATUS	LOW RISK-LEAST CONSERNED/REGIONAL	2
	LOW RISK-NEAR THREATENED/GLOBAL	4
	MEDICINALPLANTS	19
	TRADED MEDICINAL PLANTS	27
	VULNERABLE/GLOBAL	8
	VULNERABLE/REGIONAL	1
IUCN-STATUS	CRITICALLY ENDANGERED	4
	ENDANGERED	2
	LEAST CONCERN	1
	VULNERABLE	2
TOTAL-SPECIES-STUDIED		72
TOTAL-SPECIES-STUDIED DURING FIELD VISIT = 400		

CONCLUSION:

To maintain the Symbiotic relationship with the nature and to maintain ecological balance it is very important to follow the nature worship and preserve these SGs. In order to protect this essential requirement is the effective and efficient management of data about the tradition of SG. The effectiveness of any conservation strategy lies on the comprehensible nature of data, ease in handling and disseminating the data and accuracy of data. The GIS technology is definitely is the solution for the tedious task of conservation with its capability to collect, collate, manipulate, manage, analyze, visualize and disseminate the voluminous amount of spatial data and various other forms of data. It is suggested that the technology should made use to protect these 'Gene Banks' as it protects our mother earth.

REFERENCES

1) Ashish Anthwal et al. (2006), "Sacred Groves: Traditional Way of Conserving Plant Diversity in Garhwal Himalaya, Uttaranchal", The Journal of American Science, 2(2), , Anthwal et al, Sacred Groves: Conserving Plant Diversity.
2) Bhagwat, S., Kushalappa, C., Williams, P., Brown, N. (2005), "The role of informal protected areas in maintaining biodiversity in the Western Ghats of India". Ecology and Society 10(1): 8.
3) Boraiah, K.T. et al., (2002), "Regeneration of Threatened Flora Among the SGss of Kodagu, Karnataka, South India", My Forest, Bangalore, 38, 2, pp. 123 - 1
4) Chandrakanth, M.G., and Nagaraj, M.G. (1997),"Existence value of Kodagu sacred groves: Implications for policy",In: The Challenge of the Balance: Environmental Economics in India, Centre for Science and Environment, New Delhi, pp. 217 " 224.
5) Gadgil, M. and V.D. Vartak, (1976). "The SGss of Western Ghats in India. Economic Botany", 30:152–60
6) Gadgil, M. and V.D. Vartak (1974), "The Sacred Groves of India – A plea for continued conservation". J. Bombay Nat.His ,Soc 72(2).
7) Gaikwad, S. S. et al., (2004) "Digitizing Indian SGs – An Information Model for Web interfaced multimedia database. In: Focus on SGss and Ethnobotany", Ghate, Vinya; Hema Sane, and S. S. Ranade (eds.), Prisam Publications, Mumbai, India, pp. 123-128.
8) Mercedes Otegui-Acha 2007, Published by: Pronatura Mexico and the Rigoberta Menchu Tum Foundation in collaboration with IUCN-The International Union for Conservation of Nature, Gland, Switzerland.
9) R. K. Bhakat and U. K. Sen (2008), Ethnomedicinal Plant Conservation Through Sacred Groves - Tribes and Tribals, Special Volume No. 2: 55-58 (2008)
10) Sameer Punde (2010), Appliedt Environmental Research Foundation (AERF), Prioritising areas for Forest Conservation in the Konkan region of the Western Ghats hotspot (India) – a pilot study, 26-Oct-2010.
11) Shonil A Bhagwat and Claudia Rutte (2006), Front Ecol Environ 2006; Sacred groves: potential for biodiversity management 4(10): 519–524
12) Shushma Shashi.B et. al., (2014) "An open-source web-GIS application for prioritization and conservation of Sacred Groves of Kodagu district of Karnataka" IJASER31078-vol3issue42014:*pp763-775*
13) Shyamala Mani (2003), Sacred Groves of Kodagu-A tradition to conserve, published by CEE.
14) Soosairaj .S, John Britto.S, Balaguru .B, Nagamurugan .N, Natarajan .D (2007), "Zonation of conservation priority sites for effective management of tropical forests in india : A value-based conservation approach", Applied Ecology and Environmental Research 5(2):37-48
15) FRLHT Herbarium Website - http://envis.frlht.org/
16) http://www.ces.iisc.ernet.in/biodiversity/sahyadri_enews/newsletter/issue8/index.htm
17) http://www.unescobkk.org/fileadmin/user_upload/apeid/Conference/12thConference/paper/4B1.pdf
18) http://www.tropecol.com/pdf/open/PDF_44_1/44109.pdf
19) http://www.slideshare.net/vishwaschavan/sacred-grove
20) http://www.ecology.kee.hu/pdf/0502_037048.pdf
21) www.seroindia.org/articles/Article_MGC.pdf
22) http://www.sacredland.org/media/Gokhale-Traditional-Conservation-Practices-for-Karnataka.pdf
23) http://www.cogitofoundation.ch/pdf/2007/RutteS-110_06.pdf