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Scopus Compendex and Geobase Elsevier, Chemical Abstract Services-USA, Geo-Ref Information Services-USA, List B of Scientific Journals, Poland, Directory of Research Journals

International Journal of Earth Sciences and Engineering

April 2015, P.P.377-385

ISSN 0974-5904, Volume 08, No. 02

GIS for Conservation of Sacred Groves of Kodagu District – A Traditional Culture

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Abstract: India is a mega biodiverse nation and its biodiversity is intricately related to the socio-cultural practices of the land. One such tradition is that of Sacred Groves (SG) which provides protection to patches of forest/river body/mountains which are dedicated to local deities. The study area considered for the present work is Kodagu District of Karnataka State. Even though it is one of the smallest districts of the state, it is considered as a HOTSPOT for SGs as the district houses 1214 SGs. For the present work 30 SGs are randomly selected from the study area .The work describes how Geographic Information System (GIS) tools can be utilized for base map preparation, development of SG Geodatabase and Prioritization based on the principles used for prioritization of KBAs (Key Biodiversity Areas) as prescribed by IUCN (International Union of Conservation of Nature). The results shows that out of 30 SGs, Only one SG is undisturbed and out of the remaining 29 SGs, 9 S Gs are facing extreme, 2- High, 5- Medium, and 13-low levels of threats and they have been prioritized into Level-1 to 5 respectively. It can be concluded that the prioritization of SGs is the need of the hour and only timely and joint effort of technology, technical experts, local community, government, educational institutions and awareness among the young generation can save this ancient tradition.

Keywords: *Sacred Groves, Geodatabase, IUCN, Prioritization, Conservation*

1. Introduction

1.1. Sacred Groves (SG)

India is a mega bio diverse nation, housing around 10% of world's species. Much of Indian biodiversity is intricately related to the socio-cultural practices of the land. One such tradition is that of Sacred Grove (SG) or sacred natural site which provides protection to patches of forest/river body/mountains which are dedicated to local deities or ancestral spirits. These sacred groves are protected by local communities through social traditions and taboos that incorporate spiritual and ecological values. These SGs not only evidences the reverential attitude of our ancestors towards nature worship but also shows the concept of biodiversity conservation practiced based on the religious belief. Apart from this the customary rules established by these tribal groups, especially with respect to the sacred groves, have paved the way for conservation of biodiversity from the historical past. (C. Kala, 2011) SGs are considered as "Sacred Natural Sites" as per the definition provided by IUCN. India is the best surveyed country in terms of high density of sacred natural sites and sacred groves exist in 19 out of 28 states. It is estimated that there are between 100,000 and 150,000 Sacred Natural Sites in the country, along with many sacred rivers, waterfalls, meadows, and individual trees (Subash Chandran and Hughes 2000; Bhagwat and Rutte 2006). In India, SGs are found mainly in tribal dominated areas and are known by different names in ethnic terms such as Sarna or Dev in Madhya Pradesh, Devrai or Deovani in Maharashtra, Sarnas in Bihar, Orans in Rajasthan, Devaravana or Devarakadu in Karnataka, Sarpakavu and Kavu in Tamil Nadu and Kerala respectively , Dev van in Himachal Pradesh, Law Lyngdoh or Law Kyntang etc. in Meghalaya, Sarana or Jaherthan in Jharkhand and Lai umang in Manipur (Bhakat 1990). The SGs are referred to by different names in various parts of Karnataka such as Devarabana, Devarakadu, Hulidevarakadu, nagabana, Bhutappanbana, jatakappanbana, chowdibana. These SGs were well preserved in earlier days and present scenario is trending towards the disappearance/ fragmentation/ transition to only symbolic representation of SGs due to the declining traditional belief systems, rapid urbanization, developmental intervention, transformation of primitive forms of nature worship into formal temple/idol worship i.e, sanskritization, invasion by exotic weeds such as *Eupatorium odoratum, Lantana camara* and *Prosopis juliflora* pose serious threats to some of these groves.

(http://ecoheritage.cpreec.org/innerpageof.php?$mFJyBfKPkE6)

Despite their obvious contributions to biodiversity conservation, many sacred natural sites have not received legal protection and are currently threatened. Others have been taken over from their traditional owners and incorporated in formal protected areas, with mostly negative consequences.

1.2. Biodiversity and Conservation

Biodiversity - or biological diversity - is a term used to describe the variety of life on Earth. It refers to the number, variety and variability of living organisms (animals, plants, fungi, microbes, etc.), the genetic differences among them, and the ecosystems in which they occur.

Biodiversity is both essential for our existence and intrinsically valuable in its own right. Biodiversity provides the raw material for development & provides a healthy environment. Though biodiversity is very much essential for the wellbeing of ecosystem the present scenario is alarming and the escalating extinction crisis shows that, the diversity of nature cannot support the current pressure that humanity exerts on the planet. Every day species' extinction rate is increasing and is reaching up to 1,000 times or more than the natural rate because of habitat destruction, land conversion for agriculture and development, climate change, pollution and the spread of invasive species. (https://www.iucn.org/iyb/about/biodiversity_crisis/).

According to the International Union for Conservation of Nature (IUCN), the solution for biodiversity crisis can be handled by having better knowledge about biodiversity, the threats it faces and the measures that can be taken to conserve it. This kind of solution should be applied for the conservation of SGs. A Joint Task Force committee has been formed by IUCN in 2004 with the concept of prioritization of Key Biodiversity Areas (KBA). KBAs are sites of global significance for biodiversity conservation and are identified using globally standard criteria, based on the framework of vulnerability and irreplaceability which has been widely used in systematic conservation planning.

1.3. Conservation of SGs and GIS

Though the number of SGs is declining, increasing attention is being paid for Conservation of Sacred Groves because of the biodiversity value they hold. The conservation of SGs can be effectively supported by using GIS Technology as GIS holds the set of tools which facilitates efficient storage, management, retrieval analysis and display of spatial and non-spatial data and GIS is also capable of handling as well as manipulating complex data of various formats. Development of such a factual database would support the development of strategies for conservation and protection of these unique heritage ecosystems.

Such models would strengthen and support the national and regional biodiversity conservation programs elsewhere in developing nations where similar types of ecosystems exists. (S.S Gaikwad, S. N. paralikar, vishwas chavan and S. Krishnan, 2004).

The importance of biodiversity and the high value that SGs are holding for biodiversity and the present alarming status of SGs calls for the need of a technology/ a scientific approach which supports the conservation and management of these natural sites/SGs and this paper describes how GIS and systematic prioritization can be done which is very much needed for the conservation of this age old tradition of SGs.

2. Study area

The study area considered for the present work is Kodagu district of Karnataka state which is also known as Coorg. The district map as shown in Fig.1, occupies an area of 4,102 square kilometres in the Western Ghats of the south western part of the state. The district is bordered by Dakshina Kannada district to the northwest, Hassan district to the north, Mysore district to the east, Kannur district of Kerala to the southwest, and the Wayanad district of Kerala to the south.

It is a hilly district, the lowest elevation of which is 900 metres above sea-level. The highest peak, Tadiandamol, rises to 1,750 metres, with Pushpagiri, the second highest, at 1,715 metres. The main river of the district is Cauvery, which originates at Talakaveri and located on the eastern side of the Western Ghats, with its tributaries, draining the greater part of Kodagu.

The district is famous for the tropical evergreen forest, is the home for Devara Kadu /Devarabana. Sacred groves exist all over India and in the rest of the world but the SGs of the Kodagu makes the district unique as this little district has the highest density of SGs with about 1214 officially listed SGs. All the villages of the district have at least one Devara kadu. Each Devara kadu has the sanctum housing the deity, the forest (deva kadu) surrounding the deity (deva) and a small water source (Devakere) to support the sanctum worship.

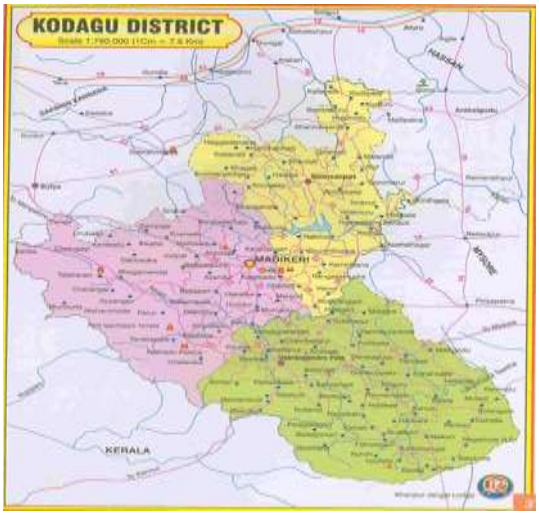


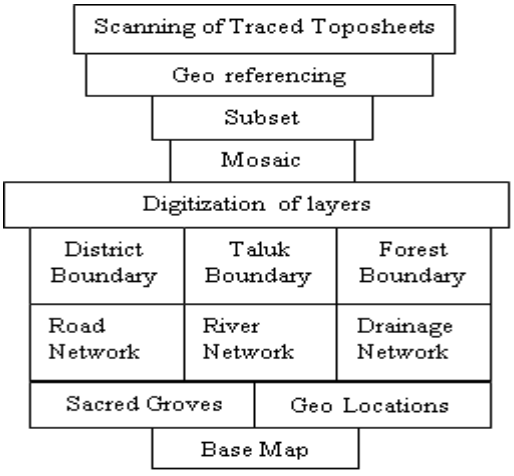
Figure 1: *Map of Kodagu District*

3. Data sets & Softwares Used

For the present work SOI Toposheets of 1:50,000 scale , GPS data, Ground truth data , information from localities and from various departments has been collected and recorded, stored, managed, analysed and visualised by using software such as Erdas imagine 9.1, ArcGIS 10.2, Garmin Map source.

3.1. Methodology for Base Map Preparation

For Base map preparation SOI Toposheets of the study area is traced and the scanned toposheets are Georeferenced by using WGS 1984 projection. Then it is reprojected into UTM 43N Projection. Each Subset is being processed to obtain single mosaic of the district. Later the details of district boundary, Taluk boundary, Road Network, River Network, Drainage Network were digitized and stored in different layers in the form of .shp file. Flow chart 1 represents the methodology adopted to prepare Base Map.



Flow Chart 1: *Base Map Preparation*

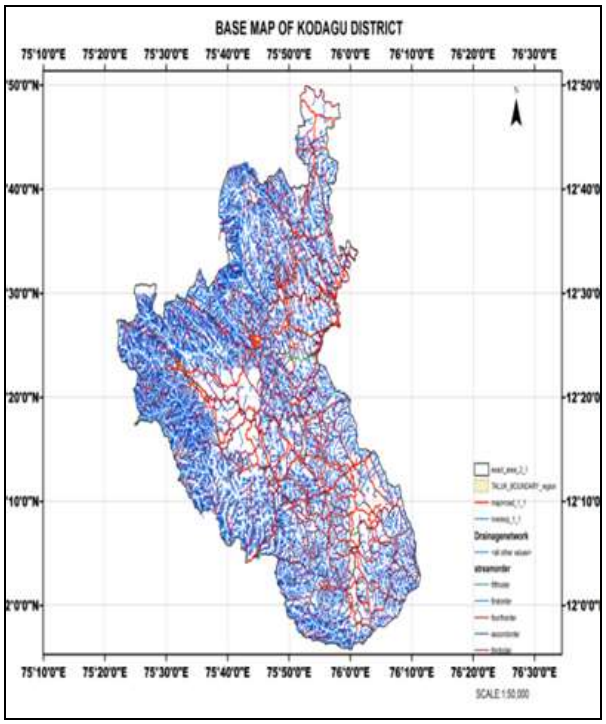
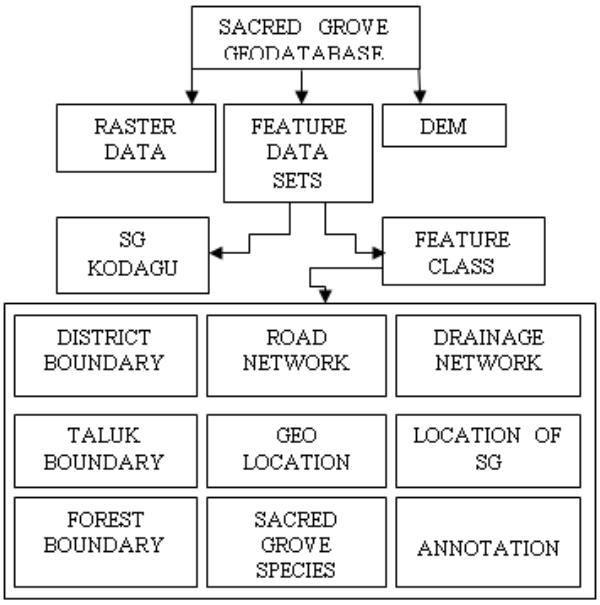


Figure 2 *Digitized Base Map of Kodagu District*

3.2. Methodology for development of SG Geodatabase

Geodatabase is a "container" used to hold a collection of datasets. File based database is one among the types of Geodatabase meant for single user and small workgroups which is capable of holding datasets scaling up to 1 TB in size. Geodatabase contains data sets such as Raster images, Digital elevation model (DEM) and Feature Data sets. In the present work, Geodatabase schema has been prepared aiming to store and manage both spatial and non-spatial data in the form of different Feature Dataset. These Feature data sets consist of feature class such as Sacred Grove locations, Geo locations, Annotation. Apart from these, the .shp files which are used for the preparation of base map were exported to Feature class. Feature class of Kodagu area will have Sub types viz, Madikeri, Virajpet, Somavarapet and Domains viz., Area and Deity which has been incorporated so as to make the 'database content' search in an easier way. Data for Individual SGs stored in such a Geodatabase will have spatial and attribute data such as name' of the Sacred Grove, Name of the deity associated with it, and Geographic location of the Grove, jurisdiction details with respect to the Taluk, local and scientific names of the flora and fauna species, growth height of the flora species, information regarding biodiversity and conservation status with respect to IUCN RED LIST and ENVIS-India.



Flow chart 2 *Methodology for developing Geodatabase of SG*

To follow the methodology shown in Flowchart 2, first the collected data is captured in digital format i.e., as excel files and later fed into the Arc GIS software by converting it into the shape files. After this, the shape files have been exported to the feature data sets in the form of different feature classes as shown in Fig 3.

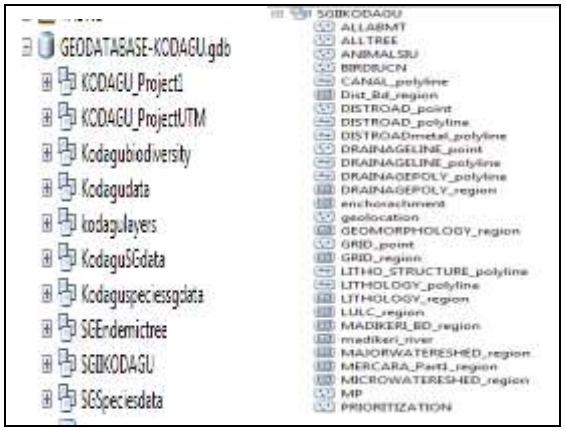
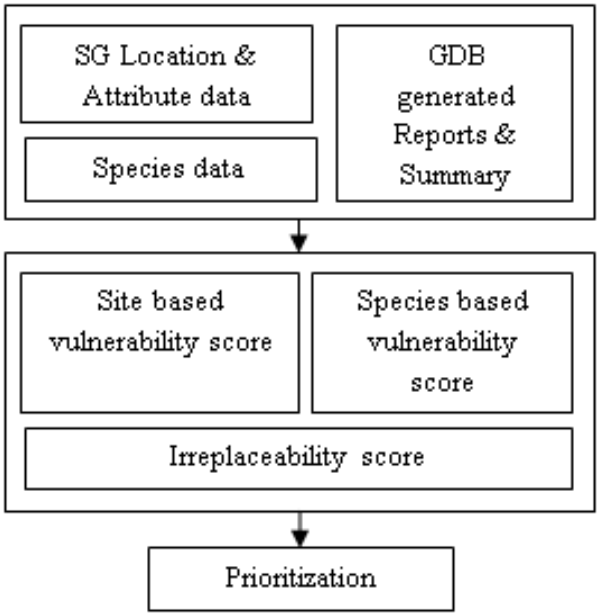


Fig.3. *Schema of Geodatabase*

The data stored in the SG Geodatabase has been used to generate and summarize the reports. This report and summary has been effectively utilized in prioritization of SGs. Prioritization of SGs has been done by adopting the principles used for prioritization of KBAs for conservation action as prescribed by IUCN as shown in Flow chart 3. In Prioritization of KBA, different priority levels will be assigned based on the criteria of species-based vulnerability, site-based vulnerability and irreplaceability. The process of prioritization has been broken down into four steps, as outlined below, for each species-site combination: 1) assign a species-based vulnerability score, 2) assign a site-based vulnerability score, 3) assign an irreplaceability score and 4) assign a priority level In this process of prioritization first each SG was analysed for species based vulnerability and classified into 4 classes such as Extreme, High, Medium, Low, and Least classes based on the IUCN Conservation status and then SGs were analysed for site based vulnerability and classified into 3 categories: High, Low and Least categories. These categories were assigned based on the scores each SG obtained. During this classification, not only the number of threats has taken into consideration but also parameters like Time, Scope and Severity of the threat selected were considered and finally, Impact score has been given for each SG. The scoring pattern adopted for prioritization is as shown in table 1, 2, & 3.



Flow chart 3: *The phases of prioritization*

4. Results & Discussion

During the field visit 30 SGS were studied. The location details of each SG corresponding to its Identity (SG ID) are shown in *Table 4*. A Total of 851 species were identified/recorded and among that 531 were floral species and 320 were faunal species. For these species a Geodatabase was prepared which is capable of performing various queries based on the area or attributes. Prioritization has been done based on the Threats they face such as sanskritization, small holder plantation/deforestation, colonization, encroachment cattle grazing, and removal of biomass and based on the conservation status of species. SGs and were categorized into 5 classes viz., 'EXTREME' 'HIGH' 'MEDIUM' 'LOW and 'Least".

From the study it is evident that only one SG encounters least disturbance and prioritization Level (PL) 5 has been assigned and out of 29 SGs, 9 SGs are facing extreme, 2 are facing - High, 5 are facing - Medium, 13 are facing-low levels of threats and based on the categorization they have been prioritized into Level-1 to 4 accordingly as shown in table 4. It has found that SGs are disturbed more by the small holder plantations, encroachment and then by colonization and sanskritization. Moderate level destruction has been observed in SGs due to sanskritization as shown in *Image 4*, Removal of biomass and cattle grazing. From the study it was also found that SGs of Kudlu Chettihalli, and Aivathoklu are well disturbed. SGs of Basavanahalli, Nellihudukeri, have remained only as a mere symbolic representation of age old tradition as shown in *Image 5 & 6* and the valuable biodiversity of SG has been completely devastated by plantations. *Image 1* shows the Name Board Placed by the Forest Department showing Location and extent details, *Image 2* shows base of tree species and *Image 3* shows panaromic view of Arekal –Aiyyappa Devarakadu.

5. Conclusion

The study was carried out for SGs of kodagu district with an objective to prepare a spatial data base which is capable for storing as well as managing both spatial and non-spatial data of SGs in one platform. This data base aids not only to enhance the knowledge about biodiversity but also eases decision making process towards conservation, by identifying the SG which needs utmost priority in conservation. This process also conceptualizes the time and rate of protection each SG needs. The present status of SGs calls for the need of technology which is cost effective yet supports conservation of these SGS. Out of all the SGs studied only Arekal remains free from human intervention. It is evident from the study that the GIS and its tools has the potential needed for the systematic management of spatial data regarding the SGs and GIS also leads towards the right direction in achieving the goal of conservation. It recommended that technology of GIS should be widely made use as valuable information about SG is scattered at various levels from local community to researchers should be brought into single platform such as Geodatabase . This kind of database should be made accessible in order to avoid unnecessary duplication/repetition of studies, to spread awareness among public and also to policy makers can enforce strict laws and to take up timely action which plays a very much essential role in conservation of this “Age old tradition” of SGs.

Image 1.*Well protected Arekal Aiyyappa Devarakadu*

Image 2. *Tree speciesArekal Aiyyappa Devarakadu*

Image 3. *Panaromic view of Arekal Aiyyappa Devarakadu*

Image 4. *Temple in Vishnumurthi Devarakadu Nellihudukeri*

Image 5.*Encroachment by Coffee plantation, in Mariyammana Bana Devarakadu Nellihudukeri*

Image 6.*Encroachment by Coffee plantation, in Mariyammana DevaraGudi, Nellihudukeri*

Table 1 *Scoring pattern of prioritization*

I. A.) Species-based vulnerability score	**Global threat status**
Extreme	Critically Endangered (CR)
High	Endangered (EN)
Medium	Vulnerable (VU)
Low	Near Threatened (NT),Least Concern (LC)
B). Site-based vulnerability	Impact score (Impact Score = Timing + Scope + Severity)
High	8–9
Medium	6–7
Low	0–5

Table 2 *Scoring pattern of prioritization*

II. Irreplaceability score	**'Population data' scenario**	**'No population data' scenario**
Extreme	Sites known or inferred to hold ³ 95% of the global population of a species	Sites holding a species endemic to the country/region that is not known to occur at any other site
High	Sites known or inferred to hold ³ 10%but < 95%	Sites holding a species endemic to the country/region that is only known to occur at 2–10 sites (OR)Sites holding a species that

	of the global population of a species	globally is only known to occur at 2–10 sites
Medium	Sites known or inferred to hold ³ 1%but < 10% of the global population of a species	Sites holding a species endemic to the country/region that is only known to occur at 11–100 sites (OR)Sites holding a species that globally is only known to occur at 11–100 sites
Low	Sites known or inferred to hold < 1% of the global population of a species	Sites holding a species endemic to the country/region that occurs at more than100 sites (OR)Sites holding a species that globally is known to occur at more than 100 sites

Table 3 *Asigning Matrix score*

Irreplaceability	**Species-based vulnerability**	**Site-based vulnerability**			**PRIORITIZATION**		
		High	**Medium**	**Low**	**High**	**Medium**	**Low**
Extreme	Extreme	1	1	1			
	High	1	1	1			
	Medium	2	3	4			
	Low	3	4	5			
High	Extreme	2	2	3			
	High	2	3	4			
	Medium	3	4	5			
	Low	4	5	5			
Medium	Extreme	3					
	High	4					
	Medium	5					
	Low	5					
Low	Extreme	4					
	High	5					
	Medium	5					
	Low	5					

Table 4: *Prioritization of SGs*

Sl. No.	**SG ID**	**Location of SG**	**NAME OF SG**	**SHP**	**ENC**	**COL**	**SAN**	**RMS**	**CAG**	**Total**	**IS**	**Categorization**	**Prioritization**
1	1	Arekal	Arekal ayyappa devarakadu	0	0	0	0	0	0	0	0	Least	PL -5
2	2	Monageri	Bhadrakali devarakadu	0	1	0	0	0	1	2	5	Low	PL - 4
3	3	Galeebeedu	Kundumale ayyappa devarakadu	0	0	0	0	0	1	1	3	Low	PL 4
4	4	Galeebeedu	Sri pooda devarakadu	0	1	1	0	0	1	3	8	High	PL -2
5	5	Mekere	Uru parambu sri ayyappadevarakadu	0	1	0	0	0	0	1	2	Low	PL -4
6	6	Kaggodlu	Bellichettimani aiyyappa	0	1	0	0	0	0	1	2	Low	PL -4
7	7	Kargonda	Aiyyappa Devarakadu	0	1	0	0	0	0	1	2	Low	PL -4
8	8	Kargonda	Ambala bhagavati Devarakadu	0	0	0	0	0	1	1	3	Low	PL -4
9	9	Aivatoklu	Aiyyappa Devarakadu	1	0	1	0	0	1	3	10	Extreme	PL -1
10	10	Aivatoklu	Medara ayyappa Devarakadu	1	0	1	0	0	1	3	10	Extreme	PL -1
11	11	B.Badaga	Baghavati Devarakadu	0	1	0	0	0	1	2	8	High	PL -2
12	12	B.Badaga	Baghavati Devarabana	1	1	1	0	0	1	4	11	Extreme	PL -1
13	13	Baghamandala	Sangama Devarakdadu	0	1	0	0	0	1	2	5	Low	PL -4
14	14	Padakal	Padakal Devarakadu	0	0	0	0	0	1	1	3	Low	PL -4
15	15	Basavanahalli	Doddammana bana	1	1	0	1	0	0	3	11	Extreme	PL -1

16	16	Nelli hudukeri	Vishnumurthy and Bhagavathi Devarakadu	1	1	0	1	1	1	5	14	Extreme	PL -1
17	17	Nelli hudukeri	Vishnumurthy Devarakadu (aiyyappa devarige serida bana)	1	1	0	1	0	0	3	14	Extreme	PL -1
18	18	Nelli hudukeri	Mariyamma Devaragudi	1	1	0	1	0	0	3	14	Extreme	PL -1
19	19	kudlu chettihalli	Mariyamma devarakadu	1	1	0	1	1	1	5	14	Extreme	PL -1
20	20	Kudlu chettihalli	Aiyyappa Devarakadu	1	1	0	1	0	1	4	14	Extreme	PL -1
21	21	Chikka tolur	Suggi Devarakadu	1	1	0	0	0	1	3	6	Medium	PL -3
22	22	Koothi	Suggi devarabana	0	1	0	0	0	1	2	5	Low	PL -4
23	23	Nagarahalli/ Nagaroor	Sabamma devarabana	1	1	0	0	0	1	3	5	Low	PL -4
24	24	Thalthere shethalli	Suggi Devarakadu	0	1	0	0	0	1	2	4	Low	PL -4
25	25	Bettadahalli	Beeradevara bana	1	1	0	0	0	1	3	7	Medium	PL -3
26	26	Kothanahalli	Brahma Devarakadu	1	1	0	0	0	1	3	7	Medium	PL -3
27	27	Kothanahalli	Byra Devarakadu	1	1	0	0	0	1	3	6	Medium	PL -3
28	28	Kunigana halli	Devarakadu	0	1	0	0	0	0	1	2	Low	PL -4
29	29	Haraga	chappeshwara devalaya	0	0	0	1	0	0	1	2	Low	PL -4
30	30	Thalthere .S	Bairaveshwara	0	1	0	0	0	1	2	7	Medium	PL -3

ENC= Encroachment, CAG = CATTLE GRAZING, SHP = Small holder plantation, SAN = sanskritization, RMS = Removal of biomass, COL = Colinization, IS = Impact score (Impact Score = Timing + Scope + Severity), PL= Priority Level

6. Acknowledgments

The author is very greatful to Sri. Shankara Naryan.S IAS., Director, Mines and Geology Department, Sri. Dhananjay, DCF and all the forest officials of Madikeri Division, Kodagu District for helping me to carry out the present work and author is also thankful to Sri. Anish and Sri.Yadhukrishnan, M.tech students, NITK-Surathkal for their support in bringing out this paper.

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