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Research Article

A Comparative Study of Land use Classification using Remote Sensing Techniques, in and around Selected Sacred Groves of Thiruvananthapuram District

Sandra Yesudasan Miranda, Vineetha P., Smitha Asok Vijayamma

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Abstract

Sacred groves are small forest patches or remnants of forests that are biodiversity-rich areas and revered in the name of God. Rapid urbanization and the concomitant development of infrastructure have taken a heavy toll on these unique ecosystems. The present study has identified and mapped seven selected Sacred groves in Thiruvananthapuram district and also analyzed the land use in the area using Remote Sensing data. The accuracy of unsupervised classification-based image and supervised classification-based predicted land use was compared and Kappa accuracy was assessed. The results showed moderate classification accuracy. The area-wise details of different land use categories were also obtained as part of the study.

Keywords accuracy estimation, biodiversity, remote sensing, sacred groves

Introduction

Sacred groves are patches of natural vegetation dedicated to local deities and protected by religious tenets and cultural traditions [1]. They are a rich source of biodiversity with a myriad of valuable ecosystem facilities and serve as exemplary study sites for addressing various ecological problems associated with forest ecosystem dynamics and management [2]. The degradation or disappearance of sacred groves not only represents the impairment of the flora and fauna but also the rich adornment of tradition related with the grove [3].

According to the report by Hughes and Chandran [4], the existence of sacred groves has been reported in many parts of Asia, Africa, Europe, Australia and America. In India, sacred groves exist in different parts of the country as reported by Ramakrishnan [5] and they are known by different names in different areas [6]. Furthermore, sacred groves in India have been reported from Western Ghats, North-Eastern India, and Central India [7-8]. Recently, moving towards scientific technologies, Gaikwad et al. [9] developed a web-interfaced multimedia database on sacred groves of India in order to build the comprehensive information resource documenting biodiversity status of sacred groves.

The present status of sacred groves is rather precarious. Increasing threats to biodiversity demand new conservation approaches highlighting the hidden values of conservation to local communities and generating a positive local attitude towards international conservation goals [10].

The objective of the present study was the mapping of selected sacred groves in Thiruvananthapuram District and to analyze the land use pattern within 2 km buffer zone in and around the area using remote sensing data.

Profile of the Study Area

Study area includes seven selected sacred groves in Thiruvananthapuram district. In addition to that 2 km buffer zone in and around seven selected sacred groves was also included in the study area, which encompassed a total area of 12.56 sq. km. Locations of the study area are shown in Figure 1. The buffer zones of 2 km around the groves are shown in Figure 2. The two major lakes involved in the study area are Kadinamkulam and Akkulam lakes.

S. Y. Miranda ✉, Vineetha P.
Centre for Geo Information Science and Technology, University of Kerala, Kariavattom, Thiruvananthapuram-695581

S. A. Vijayamma
Post Graduate Department of Environmental Sciences, All Saints' College, Thiruvananthapuram- 695007, Kerala

✉ sandramiranda88@gmail.com

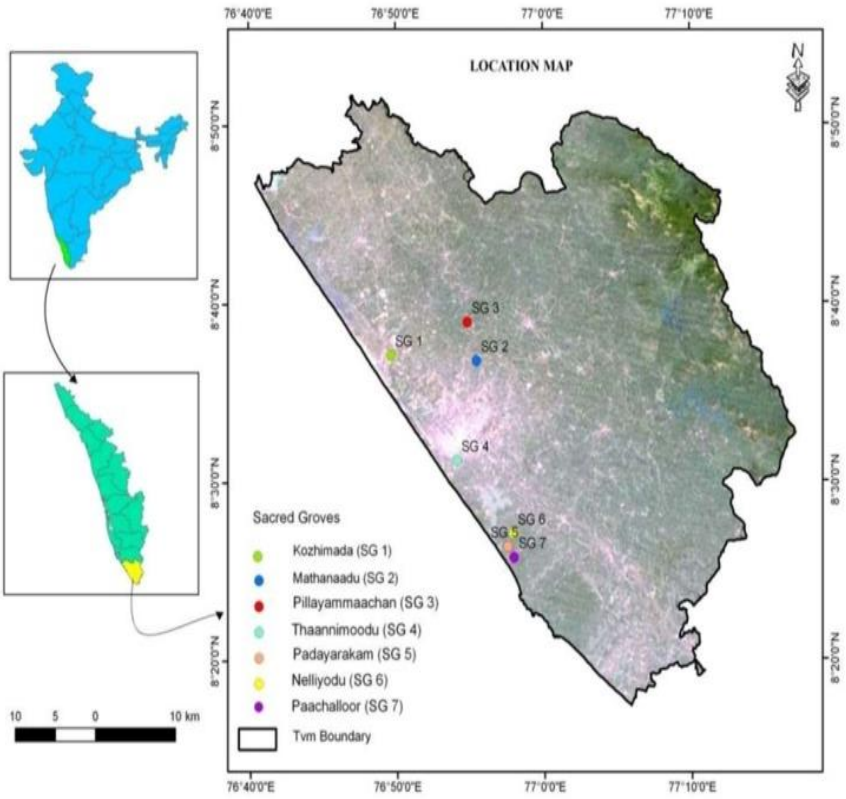

Figure 1: Location map of the study area (Source: Google Earth)

Material and Methods

The Survey of India toposheets numbered 58 D14 NW, 58 D14 SE1, 58 D14 NE1, 58 D14 SW1 and 58 D15 NE & D15 SE1 of scale 1: 25,000 area were used for the study. Expansive ground truth survey was conducted with the aid of GPS (Garmin Etrex 10 handheld GPS) measurements to collect data regarding the land use in and around the selected sacred groves. The softwares used in the present study were ArcGIS 9.3, ERDAS Imagine 9.3 and Google Earth. The remote sensing data used for the present study was LISS-IV of 2015 satellite image.

The Survey of India toposheets with scale 1: 25,000 covering the study area were geo-referenced in the GIS software ArcGIS 9.3. Then the satellite images were classified into different land use classes using unsupervised/supervised classification method in the image processing software, ERDAS Imagine 9.3. A flow-chart on the methodology adopted for the study is shown in **Figure 3.**

Classification

Image classification was executed in order to determine the land use analysis of selected sacred groves within 2 km buffer zone. Unsupervised classification of LISS-IV 2015 image was categorized into six numbers of classes. The training sets were identified with the help of Survey of India toposheets and unsupervised classification data. For the unsupervised/supervised classification, Maximum Likelihood Classification method (using ERDAS Imagine 9.3) was used. Each class (e.g. Built up, Water body, Plantation, etc.) was resoluted through training sets (that is selection of pixels with the same pattern) with the help of Google Earth. In total, 6 classes were assigned, namely built up, paddy, water body, vegetation, plantation and open scrub. The supervised classification-based images were then recoded to get the desired classes. The land use of the 2 km buffer zone around the sacred groves was also analyzed.

Training Set Identification

For training set identification stage, unsupervised classification of LISS-IV 2015 imagery was carried

Table 1: Confusion matrix

PLOTS		SUPERVISED IMAGE DATA						
		Built up	Paddy	Water body	Vegetation	Plantation	Open scrub	TOTAL
GROUND TRUTH DATA	Built up	29	3	0	3	0	1	36
	Paddy	0	0	0	0	0	0	0
	Water body	2	0	2	0	1	0	5
	Vegetation	4	2	0	5	0	0	11
	Plantation	1	0	0	0	2	0	3
	Open scrub	0	0	0	0	0	0	0
	TOTAL	36	5	2	8	3	1	55

out. Further, this was converted to vector form using ArcGIS. This vector form was converted to KML format using ArcGIS and overlaid in Google Earth to get an overview of the training sets for different classes. Then the supervised classification was done. Google Earth image was also used to prepare the location map.

Ground Truth and Editing

The field information played a very crucial role in the classification of LISS-IV imagery. In field study, ground truth locations were chosen using Global Positioning System (GPS). For that Garmin Etrex 10 Handheld GPS device was used. In order to evaluate the accuracy of the land use map, a confusion matrix was prepared [11] using the 55 ground truth locations (Table 1). Then based on this matrix accuracy was estimated (Table 2).

Accuracy Assessment

Accuracy assessment is important to check the accuracy of the classified map prepared from satellite images. Error matrix compares, on a

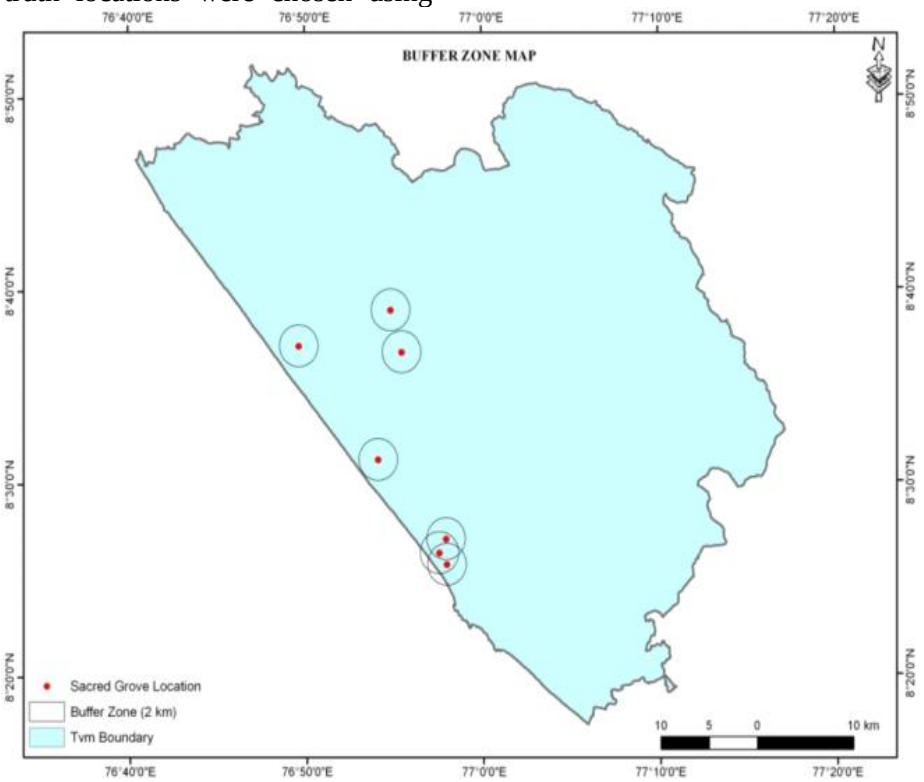

Figure 2: Locations of buffer zones in the study area

category-by-category base, the relationship between reference data (ground truth data) and the result of classification. Error matrix gives user's accuracy, overall accuracy, and producer's accuracy [12]. In addition, a nonparametric Kappa test was also performed to measure the extent of classification accuracy as it not only accounts for diagonal elements but for all the elements in the confusion matrix [13]. Kappa is a measure of the agreement between predefined producer ratings and user assigned ratings. It is calculated by the formula (Eq. (1)):

$$\widehat{K} = \frac{M \sum_{i=j=1}^{r} n_{ij} - \sum_{i=j=1}^{r} n_i n_j}{M^2 - \sum_{i=j=1}^{r} n_i n_j}$$

Where:
r = number of rows in error matrix
nij = number of observations in row i, column j
ni = total number of observations in row i
nj = total number of observations in column j
M = total number of observations in matrix

In order to determine the accuracy of each image, a random sample of 55 points was selected within the study area. Error matrix and kappa statistics were calculated for land use analysis. Being a digital classification, the spectral resolution and radiometric resolution have also contributed to the classification process.

Table 2: Accuracy table

Sl. No.	PLOTS	ACCURACY			
		User's Accuracy (%)	Producer's Accuracy (%)	Overall Accuracy (%)	Kappa coefficient
1	Built up	80.56	80.56	69.09	0.42
2	Paddy	60	0		
3	Water body	0	40		
4	Vegetation	37.5	36.36		
5	Plantation	0	33.33		
6	Open scrub	100	0		

Raster area calculation

Area for one cell = (cell size X) * (cell size Y) m^2/cell
Total area = (No. of cells) * (area of one cell) m^2

Area-wise details of the identified land use categories are given in Table 3.

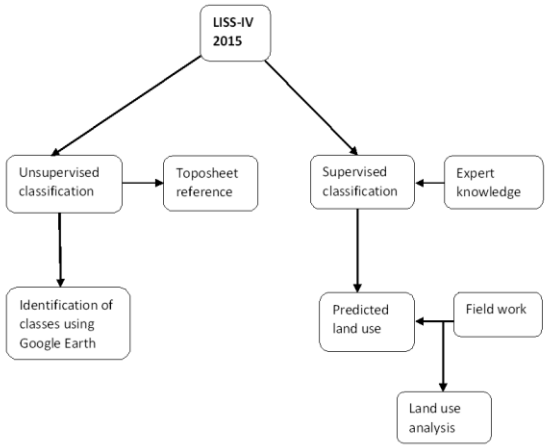

Figure 3: Flow-chart on methodology adopted for the study

Results and Discussion

The overall accuracy was 69.09 % and kappa coefficient was 0.42, which can be considered as moderately accurate. The variation in the accuracy is attributed to varied spatial resolutions of the data sets. The Kappa statistic (or value) is a metric that compares an Observed Accuracy with an Expected Accuracy (random chance). Kappa measures the diversity of the two classifiers and takes into account the values ranging from – 1 to 1. A Kappa value equal to 1 means that both classifiers agree in every example, i.e. the perfect agreement, and values around 0.8 are considered to be indicative of very good agreement [14]. A value equal to 0 means that there is no agreement above that expected by chance, and negative Kappa values mean that there is a disagreement between the classifiers.

Conclusion

Sacred groves are areas of unique characteristics and are of high ecosystem value. The present study analyzed the land use classification in and around seven selected sacred groves in Thiruvananthapuram district using both supervised and non-supervised methods of remote sensing data classification. The accuracy assessment carried out suggested moderate accuracy and the study also developed an area-wise database of the land use classes in these areas.

Table 3: Area wise details of land use classes in the seven sacred groves

Sl. No.	Sacred Groves	AREA (km2)							
		Water body	Built up	Paddy	Vegetation	Plantation	Fallow	Open scrub	Unclassified
1	Kozhimada	2.06	5.28	5.78	-	-	-	-	2.93
2	Pillayammaachan	-	6.40	-	2.56	5.28	-	1.79	-
3	Mathanaadu	-	5.68	-	3.91	-	-	-	6.62
4	Thaannimoodu	0.51	8.61	-	6.91	-	-	-	0.16
5	Padayarakam	2.29	0.50	5.12	3.05	-	-	-	5.07
6	Nelliyodu	0.13	9.33	3.23	2.34	-	0.90	-	0.12
7	Paachalloor	2.24	4.61	1.13	2.92	-	-	-	5.29

The results of the study have applicability in the conservation and management measures to be adopted in this fragile and exclusive patch of our natural ecosystem.

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