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Identification and spatial mapping of Mangrove species using SAM classification a case study from Aroor, Alappuzha District Kerala

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Abstract: ***The mangroves, most significant wetland vegetation execute various role in creation of effective social, cultural, medicinal, environmental and economic benefits. Like many other parts of India, in Kerala the coastal wetland vegetation is shrinking its stretch tremendously and attained an extremely endangered status. By considering these scenario, this study aims the identification and spatial mapping of mangrove species at Aroor, a village in Alappuzha District for proper documentation of the mangrove species for generating policy for its most sustainable rehabilitation in Kerala. Other than conventional field techniques, remote sensing studies are merely new in this region. For the current study Sentinel 2B, 10 m resolution data is used. A dense patch of mangroves that situated near and along the coastline of Vembanad Lake were selected for the study. Field based Spectral library creation followed by Spectral Angle mapper (SAM) classification method has been using for this study. The study enabled to discriminate and map the spatial distribution of five mangrove species such as Avicennia officicnalis, Rhizophora apiculata, Sonneratia caseolaris, Bruguira sexangula and Bruguira gymnorrhizha.***

Index Terms: ***Environmental System Research Institute, Geographic Information System, Global Positioning System, Near Infrared, Shortwave Infrared.***

I. INTRODUCTION

Mangroves are coastal vegetation known for saltwater resistance and extend in brackish water along coastlines and estuaries. Mangroves form a buffer between land and water bodies, offering a physical barrier against rising seas and disasters such as storm surges and tsunami. They exhibit tangled mass of roots and some of the roots exist above water level, resembling vertical branches and perform the role of aerating agents. The mangroves root system is a habitat for crab, shrimp, and molluscs. It provides a natural nursery for juvenile fish and can trap sediments flowing down rivers, helping to reduce coastal erosion. Mangrove forests offer sites for nesting and attract migratory birds. Mangrove has an unbeaten capability to catch atmospheric CO_2 and has the ability to store it in the subsurface soil for thousands of years. While these habitat destructed, these carbon can be released as CO_2 back into the atmosphere and that will aggravate global warming trends.

Now a days diminishing rate is much higher than that of reinstate rates, the mercenary process of fishing usually lead to over fishing and subsequent clear cutting of mangrove ecosystem without replantation. The main cause of deterioration of mangrove wetlands are due to both anthropogenic as well as natural processes. The deterioration of this ecosystem is very evident in Kerala. Agriculture, commercial activities, aquaculture are the inconsiderate explanation for this condition. Much public awareness is needed to overcome this situation.

In Kerala, there is no much evidence of studies about species recognition and mapping using the application of remote sensing techniques in the study area. Identification and spatial distribution of mangrove species are vital for making coastal wetland inventories and evaluation of its biodiversity. The objective of the study is to identify and spatial mapping of mangrove species at Aroor, Alappuzha District, Kerala using satellite imagery, Spectroradiometry and GIS mapping techniques.

II. LITERATURE REVIEW

Mcleod et al; (2011) studied various cause of deterioration of mangrove habitat and get in conclusion that about one third of mangrove extend have already been departed over the past several decades, as a result of reclamation, engineering and urbanization, transformation to aquaculture ponds and deforestation [5]. Kumar, et al; (2017) used various vegetation indices for distinguishing mangrove species over a region of Sundarban in India using Hyperion data. Five vegetation indices such as Shortwave Infrared Absorption Index, Normalized Difference Wetland Vegetation Index, Atmospherically Corrected Vegetation Index, Normalized Difference Infrared Index and Mangrove Probability Vegetation Index has been considered. By using these, developed a decision tree algorithm for mangrove extraction. After that full pixel classification like Minimum Distance, Spectral Angle Mapper. SVM given the best precision of 99.08% than other two classifications [4]. Green et al; (1998) performed study using CASI data and various digital processing techniques for the discrimination of 9 mangrove species. Bands obtained from Principal Component Analysis are used with supervised classification. It gives an accuracy (overall 96%) by discriminating mangroves from non-mangrove species and obtained an overall accuracy of 85% in mangrove by supervised classification in species differentiation [2].

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Verheyden. et al; (2002) experienced that the number of objects will be easily differentiated by higher spatial resolution data and similar profile of spectral signature, plays an important role in distinguishing mangrove species and any other vegetation that nearer to the mangroves have an essential role in the discrimination process [8].

Myint. et al; (2008) used an object-oriented approach with high resolution data to differentiate three mangrove species in Trang Province, Thailand. The result reveals the significance of high resolution data along with hard classification approaches [6].

Wang et al; (2009) acknowledged hyperspectral data have great probability for distinguishing mangrove canopies of various mangrove species composition and wave channels at 780, 790, 800, 1480, 1530, and 1550nm were recognized as the most suitable bands for mangrove species categorization [10].

Chakravortty; (2013) conducted study in Sunderban - West Bengal. From The Hyperion data, spectral profile of 7 species are taken and then library of spectra created [1].

Held et al*;* (2003) used CASI data for the exploration of mangrove species, hierarchical neural network classification and maximum likelihood classification performed. Based on structural information general mangrove zones are separated and then species are extracted using spectral differences [3].

Rodriguez et al; (2004) performed classification of wetland vegetation by considering intensity- hue- and saturation, Principal Component analysis and Normalized Vegetation Index to facilitate species discrimination of mangroves [7].

Vidyasagaran et al. (2014) studied the extent of mangroves in Kerala and its diversity. According to the estimation, the extent of mangroves of Kerala is 2502 ha and total of 15 pure mangroves species were recorded [9].

From the literatures it is understood that classification by PCA and SAM gives more accurate results when compared to other supervised classification techniques. Hence for the present study SAM classification technique has been adopted.

III. STUDY AREA

The study area (Mangrove patch) covers an extent of 0.0185 sq.km falls between latitude 9° 51′ 45″ - 9° 51′ 32″ N and longitude 76° 19′ 02 -76° 18′ 59″ E. Figure 3.1 showing the study area of the mangrove patch at Aroor, Alappuzha district. Alappuzha coastal area is rich with various types of mangrove habitats. Marshy areas and brackish water are very good system to grow wetland vegetation like mangroves in this area. Study area situated in the coastline of Vembanad backwaters near Aroor in Alappuzha district. Vembanad Lake is also known as Vembanad kayal and it is in number one position in India in terms of its length. This lake is the biggest lake in Kerala.

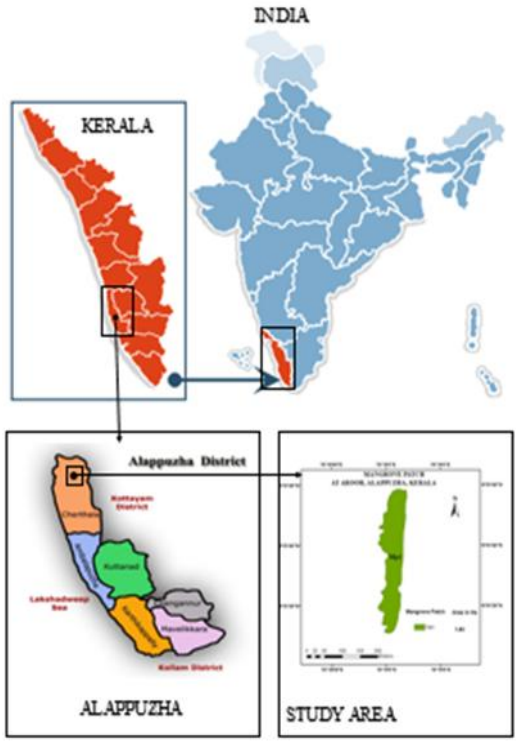

Fig. 3.1 Study area of mangrove patch at Alappuzha

IV. MATERIALS AND METHODS

Sentinel-2B is a European optical imaging satellite with wide swath high-resolution multispectral imager with 13 spectral bands of spectral range 443- 2190 nm and 10 m spatial resolution data used for the study. The data contained an applied radiometric and geometric corrections (including ortho-rectification and spatial registration).

ASD HandHeld 2 Spectroradiometer used for spectra collection of mangrove species. Its wavelength ranges from 325-1075 nm with an accuracy of 1nm, spectral resolution of <3 nm at a wavelength of 700 nm.

Environment for Visualizing Images (ENVI) is an image processing software fully integrated with ArcGIS. ENVI software is used for the processing and analysis of satellite imagery of the area under studied.

ArcGIS software platform from ESRI using for making maps with spatial information. ArcGIS provides mapping tools and it has a unique capability for the manipulation of data, data editing, data analysis and mapping.

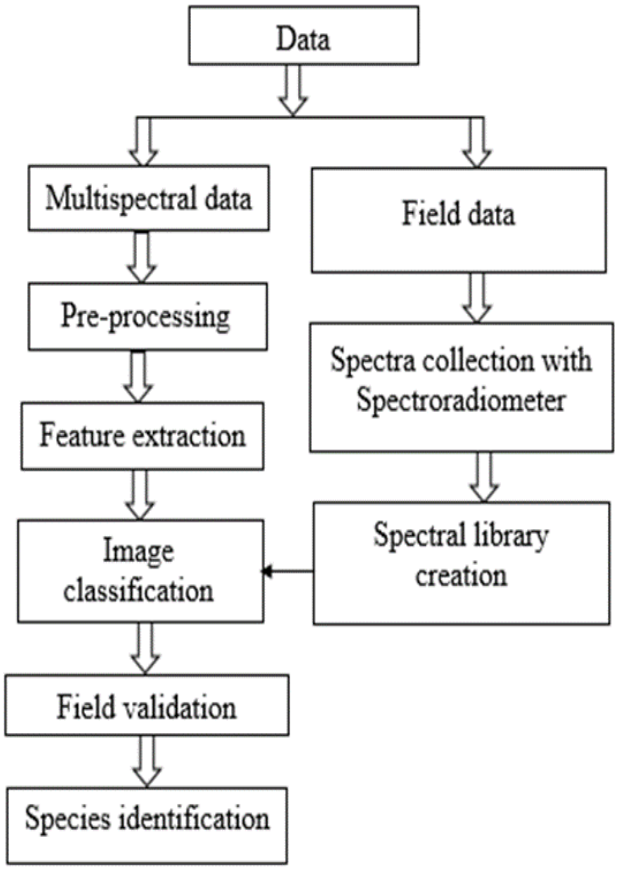

Fig.4.1 Flowchart of the methodology

Sentinel 2B image data with spatial resolution of 10 m has been used for this study. For false colour composite (FCC), 8, 4, 3 bands given as NIR, Red, and Green of sentinel data were used. The processed data has been classified by SAM with input spectra data collected by Handheld Spectroradiometer. The classified output thus created has been validated further by field techniques and the spatial mapping of mangrove species has been done with ArcGIS software. Flow chart of the methodology is shown in Figure 4.1

V. RESULT AND DISCUSSION

A. Field sampling

Field study conducted during September 2018 after the flood event occurred in Kerala. The area is covered with thick mangroves, few locations are inaccessible because the area is waterlogged due to the aftereffect of flood. It is noticed that mangroves that has seen in the location are mostly in the form of shrubs and in few area that grow in the form of medium size tree. Its entangled roots are visible above the ground. Most possible area has been covered and available species collected from that location. Five species collected and coordinate of each species location noted with the help of GPS. The species samples that collected from the study area are 1. *Avicennia officinalis, 2.Sonneratia caseolaris, Bruguira sexangula, Rhizophora apiculata, Bruguira gymnorrhiza.* Species collected from the field are shown as Figure 5.1

Fig.5.1 Mangrove species (1.*Bruguira gymnorrhiza*, 2.*Bruguira sexangula*, 3. *Rhizophora apiculata*, 4.*Sonneratia caseolaris*, 5. *Avicennia officinalis*)

B. Spectra generation with HandHeld 2 Spectroradiometer

Spectra of each species generated in most suitable environment with the help of HandHeld 2 Spectroradiometer. Figure 5.2 showing the spectra collection from the samples using HandHeld 2 Specroradiometer.

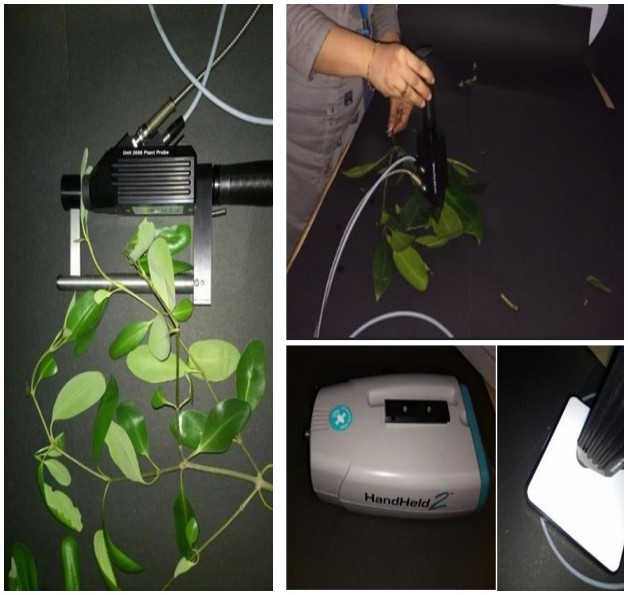

Fig.5.2 Spectra collection using HandHeld 2 Spectroradiometer

C. Spectral library creation

Spectral library of mangrove species created using ENVI software. Spectral signature of leaves are taken and because of spectral noises at the beginning (325-400 nm) and end (1000-1075 nm), that portion is removed while plotting. In the spectra, it is clearly evident that the spectra of mature leaf showing more absorption than tender leaves because of more chlorophyll content. Spectral signature of all species are shown in Figure 5.3

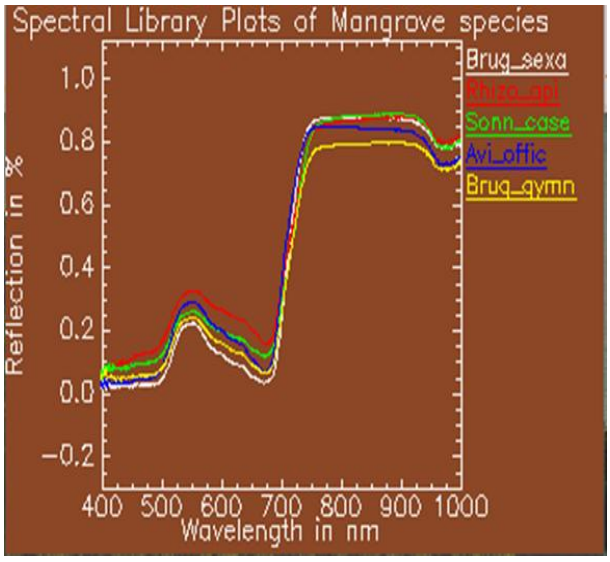

Fig. 5.3 Spectral signature of Mangrove species

D. Image classification- Spectral angle Mapper (SAM)

This is an image classification method that measure the angle between the pixels in the spectra and those having smaller angle are assigning to a class. In this method, a set of endmembers are giving as a reference data and each pixel is classified in to classes having spectral similarity. Spectral library created from the field samples are given as end member. Based on the reference data provided, system classified the mangroves as 5 classes. Analysis result shown in Figure 5.4

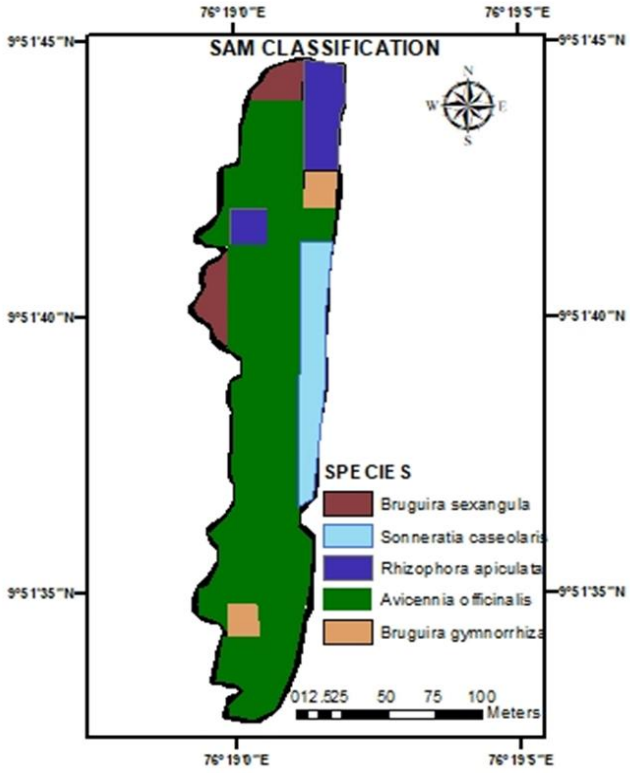

Fig. 5.4 Output of Spectral Angle Mapper Classification

Classified mangrove species are *Avicennia officinalis*, *Bruguira gymnorrhiza*, *Rhizophora apiculata*, *Sonneratia caseolaris* and *Bruguira sexangula*.

E. Spatial mapping of Mangrove species

Spatial extend of each species is determined from the process of vectorization of classified results and is mapped using ArcGIS. In Total extend of 0.0185 Sq Km, mangrove species *Avicennia officinalis* covered an area of (0.0133 sq.Km), *Bruguira gymnorrhiza* (0.0008 Sq.Km), *Rhizophora apiculata* (0.0014 Sq. Km), *Sonneratia caseolaris* (0.0017 Sq.Km) and *Bruguira sexangula (0.0013 Sq. Km)*. Spatial distribution of mangrove species in the study field is shown in Figure 5.5

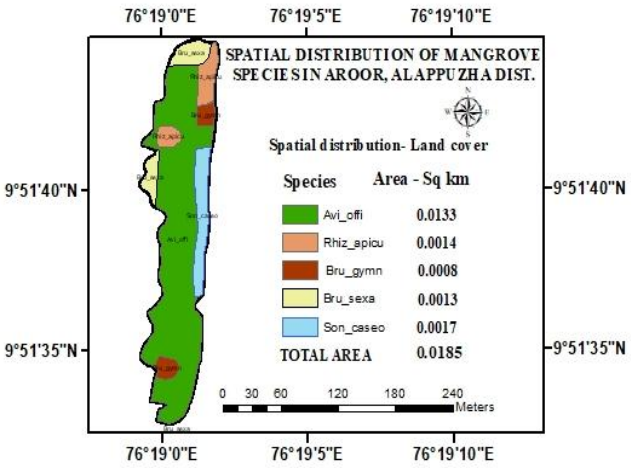

Fig. 5.5 Spatial distribution of Mangrove species

F. Field validation

Mangrove species identified by SAM classification method is field validated with the help of GPS and visual identification. It found that the identified five species are exactly present over the classified locations and more over there is no evidence of other species found in the area of study.

VI. CONCLUSION

Spectral library of mangrove species has been created by Spectroradiometer. Classification of the species has been done by Spectral angle mapper, in which the library spectra is used as the end member for the discrimination of mangrove species. The current study presents the spatial distribution of five mangrove species such *as Rhizophora apiculata*, *Sonneratia caseolaris*, *Bruguira sexangula*, *Bruguira gymnorrhiza* and *Avicennia officinalis* at Aroor at Alappuzha District, Kerala. This results are apt for the documentation and mangrove inventory preparation in the area and also for further local decision making in site protection.

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