APPLICATION OF MULTISPECTRAL REMOTE SENSING FOR MANGROVE SPECIES IDENTIFICATION OF JHARKHALI REGION, SUNDERBANS
Why Sundarbans .... ?

Sundarbans Biosphere Reserve:
• world’s largest single patch mangrove forest
• ecological niche’ for nearly 94 mangrove species
• Out of these, 5 species are extremely rare and 35 species endangered
• Designated as “World Heritage Site” by UNESCO in 1985
• only mangrove tiger land in globe
• IT IS IN PERIL
Study Background:

- Satellite data have been used for mangrove mapping but accurate discrimination of mangrove species was not possible with conventional sensors due to limited spectral and spatial resolution.

- Aerial photographs from airborne sensors proved cost prohibitive for mapping of large chunk of forest cover such as the Sundarbans of West Bengal.

Considering all factors, the present study aims to test and quantify the capability and potentials of MULTI SPECTRAL DATA.
WHY CHOSEN MULTI SPECTRAL ??

Higher spatial resolution with relevant advanced features can suitably substitute the higher cost of airborne surveys.

LISS IV data has spatial resolution of 5.8m with three bands in green, red and near infra-red range.

Cartosat-I and Cartosat-II are available in single panchromatic band with spatial resolution of 2.5m and 80 cm respectively.

Integration of LISS IV and Cartosat data can provide the benefits of higher spatial resolution of 80cm and multispectral information.
Importance of Mangrove Species Mapping

- Need to know about their extent, nature and distribution and map them accordingly.

- Mangroves is the most promising carbon sequester, having the highest net carbon productivity among all ecosystems.
Study Area

- Jharkhali island located between 88°40'0"E to 88°45'0"E and 22°0'0"N to 22°5'0"N, situated at south of Basanti island of Sundarbans (District: South 24 Parganas) (101 km from Kolkata).
- surrounded by Namkhana reserve forest and overviews the confluence of Bidya and Herobhanga river.
Objectives

- Classification of mangroves at species level using multispectral satellite image data using pixel based techniques
- Accuracy assessment of classification output
- Calculation of area covered by species identified after image classification
- Comparison of classification results in the study area.
Image Acquisition

IRS-P6 LISSIV image acquired on February 8, 2009 of Jharkhali was provided by National Remote Sensing Centre (ISRO), Hyderabad.
Ground Survey

- The accessible parts of mangrove vegetation of Jharkhali were visited and the geographical coordinates of the spots were noted with the help of GPS.

- Homogeneous patches of *Avicennia alba*, *Avicennia Marina*, *Pheonix*, *Heritiera Fomes*, *Bruguera Cylindrica*, *Ceriops* and *Aegialitis* were identified.
Vegetation Analysis

- Deals with vegetation interaction with radiation.
- Main keys:
  - spectral profiles,
  - scatter plot and
  - NDVI
Spectral Profile

Plot of the variations of reflected EM radiation as function of wavelengths.

Gives rise to the approach for identifying and separating different vegetation.

Spectral profiles of different species
Scatter Plot

- NIR and red values are nearly equal along diagonal
- represent urban areas and water bodies.
- Above and to the left is another set of pixels for which the NIR value is often well above the red value.
- This zone encompasses essentially all of the green vegetation.
Normalized Difference Vegetation Index (NDVI)

- Graphical indicator that can be used to analyze remote sensing measurements.

- Masks only vegetation area while discards the other land covers.

- Divergence between near-infrared (NIR) and visible (VIS) red reflectance values normalized over the sum of the two:

\[ \text{NDVI} = \frac{\text{NIR} - \text{RED}}{\text{NIR} + \text{RED}} \]
What does NDVI value actually mean?

- Always fall between -1 and 1.
- Negative values close to -1 usually correspond to water, like stream or lakes.
- Numbers closed to zero, like -0.1 and +0.1 correspond to barren ground.
- Low positive numbers from 0.15 to 0.4 indicates some plant life like grass or shrubs.
- High positive values close to +1 indicates dense mangrove vegetation.
NDVI Classification

- Calculated the NDVI values of different species to be classified
- Applied threshold value for masking Mangroves
Mahalanobi’s Distance Classification

- A direction-sensitive distance classifier.

- Uses statistics for each class.

- Assumes all class covariances are equal and therefore is a faster method.

- All pixels are classified to the closest ROI class unless distance threshold applied.

- Pixels may be unclassified if they do not meet the threshold.
Mahalanobi’s Distance Classification Output
Parallelepiped classification

- Based upon a standard deviation threshold from the mean of each selected class.

- Pixels having value between low threshold and high threshold of a class will be assigned to that class.

- Area that do not fall within any of the classes, designated as unclassified.
Parallelepiped Classification Output
Spectral Angle Mapper Classification

- An automated method
- Compares image spectra to a known spectra.
- Determines the spectral similarity by calculating the angle between the spectra

SAM Classification Output
Accuracy Assessment

- Created class confusion matrix for all the classified output using ENVI.

- Compared the outputs.

Spectral Angle Mapper Classification technique found to be more accurate with an accuracy of 86% and Mahalanobi’s Distance classification and Parallelepiped classifications are having an accuracy 73% and 83% respectively.
## Area Covered by each Species

- Single pixel covers 25 meter square.
- Counted the number of pixels for each species.
- Multiplied them and calculated area.

<table>
<thead>
<tr>
<th>Class</th>
<th>Pixel occupied by each class</th>
<th>Area occupied by each class (m²)</th>
<th>Area occupied by each class (km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khalshi</td>
<td>328,616</td>
<td>8,215,400</td>
<td>8.2</td>
</tr>
<tr>
<td>Hetal</td>
<td>31,517</td>
<td>787,925</td>
<td>0.8</td>
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<td>Fern</td>
<td>43,083</td>
<td>1,077,075</td>
<td>1.1</td>
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<td>Kakra</td>
<td>66,213</td>
<td>1,655,325</td>
<td>1.6</td>
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<tr>
<td>Keora</td>
<td>193,722</td>
<td>4,843,050</td>
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<td>Genwa</td>
<td>14,603</td>
<td>365,075</td>
<td>0.4</td>
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<tr>
<td>Kalobani</td>
<td>169,743</td>
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<tr>
<td>Bani</td>
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<td>6,501,875</td>
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<tr>
<td>Water</td>
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<td>Agricultural land</td>
<td>2,077,397</td>
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<td>51.9</td>
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<tr>
<td><strong>Class Total</strong></td>
<td><strong>3,535,671</strong></td>
<td><strong>88,391,775</strong></td>
<td><strong>88.3</strong></td>
</tr>
</tbody>
</table>

Total no. of pixels = 9431950  
No. of classified pixels = 3535671  
No. of Unclassified pixels = (9431950 - 3535671) = 5896279
References


[2] Multispectral imaging:
https://www.ll.mit.edu/publications/journal/pdf/vol14_no1/14_1remotesensing.pdf


http://www.asf.alaska.edu/~rgens/teaching/asf_seminar/corrections.pdf


[10] Accuracy Assessment of the Discrete Classification of Remotely-Sensed Digital Data for Land covers Mapping:
www.dtic.mil
THANK YOU