Wetland Mapping and Change Detection Using Remote Sensing and GIS

Kavyashree M.P¹, H. Ramesh²
Assistant Professor¹ ²
Department of Civil Engineering, Sahyadri College of Engineering and Management, Karnataka, India¹
Department of Applied Mechanics and Hydraulics, NITK, Karnataka, India²

Abstract:
Wetlands have great importance for more than one reason, most notably because they charge aquifers, conserve moisture, act as pollution filters, and are habitat for biodiversity. With global economic development and the expansion of the human living space, wetland resources were affected in varying degrees. Accurately mapping wetland types and monitoring their dynamic changes provide the scientific foundation for wetland protection and restoration. The main aim of this study is to mapping and change detection wetlands of west coast of Karnataka from Nethravathi river mouth to Sharavathi river using LANDSAT TM and LISS III images. In this study thresholding technique and the indices like NDWI (Normalized Difference Water Index) and NDVI (Normalized Difference Vegetation Index) are used to extract wetlands in this study area. The data used are LANDSAT images of years, 1998 and LISS III image 2008-09. The methodology consisted of classification of satellite image, generation of spectral indices and GIS integration and analysis. Unsupervised classification has been done using Erdas imagine software followed by spectral indices such as NDVI, and NDWI and water bodies were extracted. Then integrated landuse and wetland map has been generated by integrating the thematic layers. Finally change detection analysis was carried out to find the land use land cover change in the study area.

Key words: Wetlands, Extraction, Remote sensing and GIS, Change Detection.

INTRODUCTION

The wetlands encompass diverse and heterogeneous assemblage of habitats ranging from lakes, estuaries, river flood plains, mangroves, coral reef and other related ecosystems. Abundance of water at least for a part of the year is the single dominant factor. Ramsar is a city in Iran where the first World Convention on Wetlands was held on 2 February 1971.

The Ramsar Convention defines wetlands as follows: ‘Wetlands are area of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six meters.

Remote Sensing and GIS techniques are both increasingly valued as useful tools for providing large-scale basic information on landscape characteristics. They are used for habitat and species mapping, biodiversity determination, land change detection, monitoring of conservation areas, and the development of GIS layers. In many cases, remote sensing data can partially replace the often time consuming and expensive ground surveys. Also change detection of the earth’s surface can be investigated due to the availability of long-term data.

RESEARCH SIGNIFICANCE

Wetlands provide innumerable services like food storage, water quality maintenance and livelihood in terms of fisheries and recreation. It is therefore necessary to make an inventory of wetlands in an area, which will enable us to monitor the changes that are occurring over a period of time. In some of previous studies, remote sensing techniques were used for deriving information on the quantitative and qualitative status of wetlands. Most of those studies are focused on individual wetlands. But in this study delineation of wetlands is carried out for a large area and this can be further used for conservation and management of wetlands present in this study area.

STUDY AREA

The Karnataka Coastal Region, which extends between the Western Ghats, edge of the Karnataka Plateau in the east and the Arabian Sea in the West, covers Dakshina Kannada, Uttara Kannada and Udupi districts. The study area situated in west coast of Karnataka from Nethravathi river mouth to Sharavathi river lies between 13° 59.58’N to 14° 15’41.42’N over the north-eastern corner of the State, decreasing south-westwards towards the Western Ghat region and the Coastal belt. covers an area about 13901km². In May, mean maximum temperature shoots up to 40°C latitude and 74°16’38”E to 74°24’10”E
MATERIALS AND METHODS

The LANDSAT TM 1990 year cloud free data (Path/Row:145/51, 146/50 and 146/51) and LISS III images of the year 2008 and 2009 have been used to cover the entire study area in the present study.

The digital image processing has been carried out using ERDAS IMAGINE software and GIS analysis is carried out using ARC/INFO software. The methodology consisted of unsupervised classification of satellite images and then extraction of wetlands using remote sensing indices like NDVI and NDWI. Then integrated landuse and wetland map has been generated by integrating the thematic layers. Finally change detection analysis has been carried out to find the land use land cover change in the study area.

DELINEATION OF WETLANDS AND CHANGE ANALYSIS

The Unsupervised classification has done using ISODATA clustering algorithm. Using this classification technique land use/land cover map is prepared. Then water bodies including wetlands are extracted using NDVI and NDWI image by setting threshold values and those wetlands are extracted using ARC/INFO software. These indices are calculated using following equation no.1 and 2 respectively:

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NDVI = \frac{(\text{band 4} - \text{band 3})}{(\text{band 4} + \text{band 3})}
\]

\[
NDWI = \frac{(\text{band 2} - \text{band 4})}{(\text{band 2} + \text{band 4})}
\]

In an NDVI( the comparison of differences of two bands, red(band2) and near infrared(NIR)),the presence of terrestrial vegetation and soil features is enhanced while the presence of open water features is suppressed because of the different ways in which these features reflect these wave lengths. And for calculation of NDWI instead of red band, infra-red band has been used, and then the outcome also is reversed. The outcomes from NDWI equation are water features that have positive values while soil and terrestrial vegetation have zero or negative values. And change detection of land use land cover and wetlands are carried out using remote sensing time series data. To do this analysis post-classification techniques are used.

RESULT AND DISCUSSION

The unsupervised classified image for the year 1998 shows, maximum percentage of area is forest area and minimum is other and built up area. And for 2008-09 image, built up area is drastically increased and forest area is decreased compared to the previous year image. It has been found that total area of water bodies has decreased 1714.96 ha, Forest area 168015 ha and other areas 36296.87 ha from 1998 to 2008-09. The maps of classified image for the study area shows that due to the presence of cloud cover in some parts of the image has been misclassified as waste or other land. The area(hectares) under different land use and land cover classes for the year 1998 and 2008-09 is as shown in the graph below (Graph.1.)

The water body extraction from NDVI and NDWI image has been done using thresholding techniques and resulted maps
are as shown in the figure 6, 7, 8 and 9. The NDVI image has been misclassified the cloud as water bodies. In contrast to, using NDWI image extraction of water bodies gave good results. Analysis of satellite data shows that wetlands including water bodies occupy 28.28% to 27.45% of study area. The water bodies are decreased from 1998 to 2008-09 year at a rate of 982 hectares per year.

Graph.1. Area of classes in hectares.

Figure.4. Map showing unsupervised classified image of TM 1998 year of the study area.

Figure.5. Map showing unsupervised classified image of LISS III 2008-09 year of the study area.

Figure.6. Map showing water body extraction from NDWI image of TM 1998 year of the study area.

Figure.7. Map showing water body extraction from NDWI image of LISS III 2008-09 year of the study area.
CONCLUSIONS

Remote sensing technique provides fast, accurate and economic method for extraction of wetlands in an area. It has overcome the drawbacks of old traditional method like field survey, which is not only time consuming but also hard to undertake. From this study result shows that, thresholding technique can be used for wetland inventory and remote sensing index like NDWI is good to extract wetlands. And time series remote sensing data is useful for studying the land use and land cover change detection and wetland change. The multi-source data have complimentary value in mapping the wetlands. In addition, this study shows that with the increase in resolution of satellite image, accuracy of wetland extraction increases.

REFERENCES


BIOGRAPHIES

Ms. Kavyashree M.P, Assistant Professor, Department of Civil Engineering, Sahyadri College of Engineering And Management, Mangalore.

Dr. H. RAMESH, M.Tech., PhD. Assistant Professor, Dept. of Applied Mechanics & Hydraulics, National Institute of Technology Karnataka