GIS and Remote sensing technology in assessment of mangroves: A case study of Lankevani dibba Andhra Pradesh India

1. Jemima Undrajavarapu, Research scholar, JNTU Hyderabad.

2. Dr. M. Chandra Sekhar, Professor (retired), JNTU Hyderabad

1. Abstract

Multispectral Remote sensing imagery are used to depict the land use changes to the mangroves of Krishna delta region. As mangroves exhibit dynamic system, which cannot be studied physically that is not accessible therefore for estimating the quantity and quality of land use changes are calculated using satellite imagery.

2. Introduction

One of the major applications of remotely sensed data from earth-orbiting satellites is change detection (Anderson, 1977; Nelson, 1983). It is defined as the process of identifying differences in the state of an object or phenomenon by observing it at different times (Singh 1989). It is a useful technique to investigate environmental changes introduced as a result of man-made activities and natural phenomenon. Change analysis is in essence a spatial comparison of two or more land cover maps of the same geographic area produced from remotely sensed data that are recorded at different times (Gao 2009). The types of changes can range from short term phenomena like floods to long term phenomena such as desertification. Results from the change detection process show the spatial distribution of changed features within the study area. In the earth environment, natural and human induced changes occur in time and space (Lu et al. 2009). Effective detection and modeling of such change in the context of geospatial information technology are typically termed as change detection, which often includes the detection of changes of the objects on the ground or, more general, change of the environmental background (Richard et al. 2004). Remote sensing based change detection technique is an active topic of research due to its capability of monitoring the earth surface features. A variety of change detection techniques have been summarized and reviewed by Singh (1989), Mouat et al. (1993), Coppin and Bauer (1996), Jensen et al. (1997) and Yuan et al. (1998).

The most common change detection methods include image differencing, post-classification comparison, change vector analysis and image rationing. The present paper deals with two phenomena: Changes in landuse pattern in the eastern part of the mangrooves in guntur district of Andhra pradesh India, where landuse has been rapidly converted to rice plantation and shrimp farming. Changes in the position of the coastline in the study area is a serious concern. It is studied using impact of Land surface temperature studies.

3.0 Methodology

3.1 Data Selection

Selection of appropriate image data sources is an important prerequisite for land use classification using remote sensing. Considerations in data selection consist of two aspects: selection of images for detection and selection of reference data. Parameters that help in selection of suitable remote sensing datasets for change detection are understanding the study area, spatial distribution, spectral characteristics and temporal scale of the changing features (Sui 2008). To compare multi-temporal images it is often suggested to select images from the same type of sensors with the same spectral and spatial resolution. Preferably from the same season in order to minimize unwanted variations due to the changing factors such as the sun angle seasonal and phonological differences (Coppin & Bauer 1996). In reality, data selection is often restricted by many practical limits such as the availability of image data, cost of data and atmospheric conditions. Therefore, for real world applications one often has to face the trade-off between the constraints of available resources versus ideal data selection with consistent spatial and spectral resolutions and radiometric properties. In practice, the reference data should not have a lower spatial resolution than the primary data. Lunetta et al. (2004) studied the temporal resolution impact on landuse change detection and found that the accurate detection of the landcover change needs an observation at least every three or four years. They further stated that results can be significantly improved if the time interval is reduced to one or two years.

3.2 Data Source and description

The mangroves of coastal plains of Krishna delta include seven reserve forests covering up to a total area of 19,481 ha. From these seven reserve forest Lankivanidibba reserve forest is unique with a variety of species and covers a vast area of 5382 ha. of which 1974 ha. is covered with dense mangroves. The mangroves of Lankivanidibba have a sparse mangroves in land region and becomes thicker as we move forward seawards, due to remote access to the dense mangroves it is very difficult in classifying of the mangroves, hence an attempt is made for classifying and analysing using remote sensing data. Figure1 show the key map of the study area.

The vegetation is fairly thick. Species such as Avicennia marina, A.officinalis, Xylocarpus granatum, Excoecaria agallocha, Ceriops decandra, Rhizophora apiculata and Bruguiera cylindrical have been recorded. Large degraded areas are found in this RF. Anthrapological pressure is noticed from villages nearby such as Molagunta, Kottapalem, Patur, Nakshatranagar and Lankivanidibba. The soil in this RF is clayey. Prosopis invasion is high in some areas.

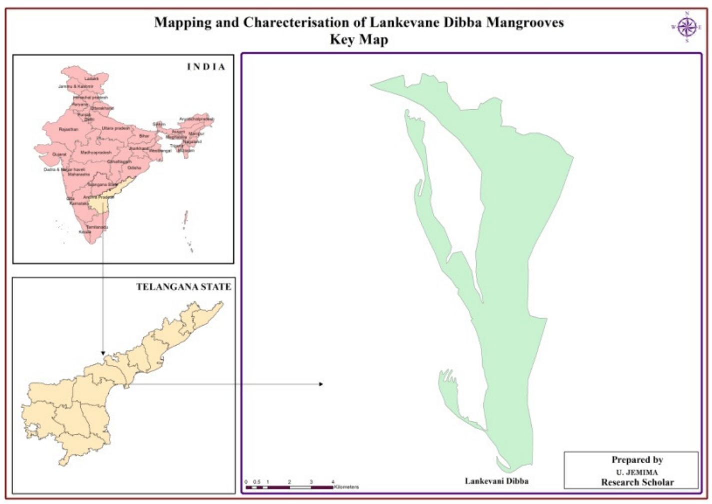
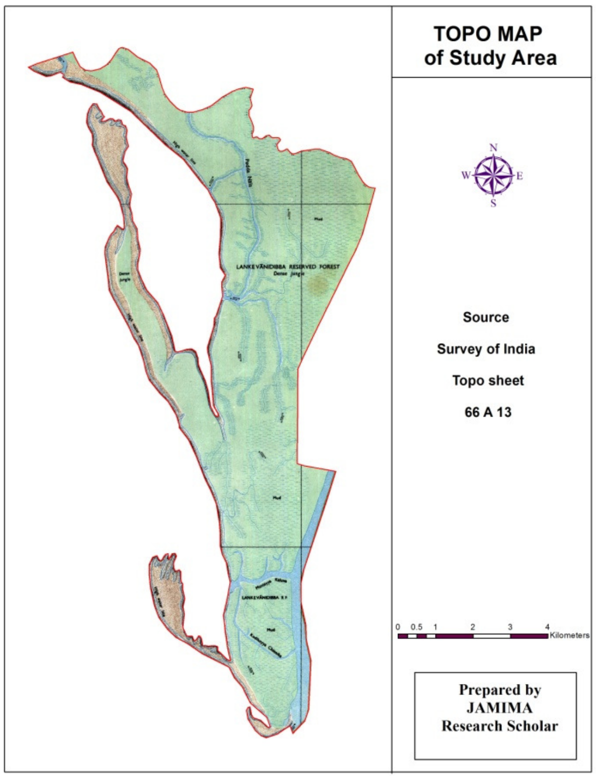


Figure 1: Showing the location map of the study area

3.3 Image Pre-Processing

Satellite image processing consists of procedures and techniques to preprocess the image data, enhance the image and extract information (Furtado et al. 2010). Data pre-processing includes radiometric calibration of the image for scene illumination, atmospheric conditions and correction for variations of the viewing geometry and instrument response characteristics (Schowengerdt 2007). The objective of geometric correction of the image is to rectify the distortions introduced by relief, atmospheric refraction, earth curvature and nonlinearities of the sensor's instantaneous field of view. Image enhancement increases the visual understanding and interpretation of the image by increasing the apparent distinction between the features in the scene (Acharya et al. 2005). Satellite images of the same geographic area contain different radiometric values due to changes in sensor calibration over time, differences in illumination conditions, observation angles, solar angle and atmospheric effects (Du et al. 2002). The radiometric correction for these radiometric effects is necessarily required before performing the image differencing change detection.



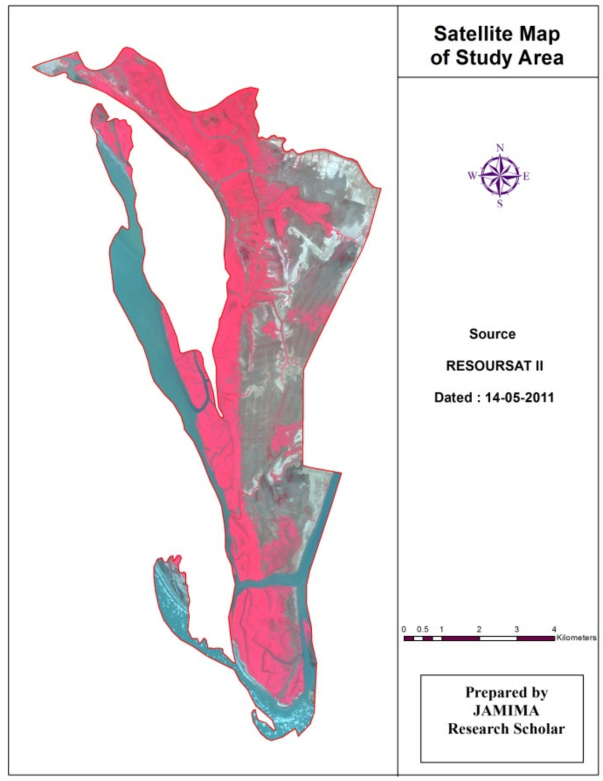


Figure 2: Topo map of study area **Figure 3 : Satellite map of study area**

3.4 Supervised Classification

Supervised classification depends primarily on the prior knowledge of the location and the identity of the landcover types that are present in the image (CCRS 2005). It is informally defined as the process of using samples of known identity (i.e., pixels already assigned to information classes) to classify pixels of unknown identity (i.e., to assign unclassified pixels to one of several information classes). Samples of known identity are pixels located within training areas (Campbell 2002). Selection of the sample or training areas is the key for supervised classification. Once the training areas are selected, image processing software is used to calculate the statistical parameters for each information class. The image is then classified by examining the reflectance for each pixel and making a decision about which of the information class it resembles the most. There are many potential sources of error associated with supervised classification (Campbell 2002). First, the analyst-defined classes may not match the natural classes that exist within the data, and therefore may not be distinct or well defined. Secondly, these classes are based on informational categories and spectral properties of the image. Classes may not be representative of conditions encountered throughout the image so the analyst can have problem in matching potential classes as defined on maps and aerial photographs. A band combination of 3, 2 and 21is selected for the RGB display of these images before performing any further image processing. Healthy vegetation gives an appearance of brighter green in this band combination. Grass land will appear as green, pink areas represent barren soil, orange and brown appearance in the image represents the sparsely vegetated areas. This band combination of IRS is useful for agriculture, geological and wetland mapping (Quinn 2001).

3.5 Land use / Land Cover Pattern

Remote Sensing in recent years has been established as most efficient and cost-effective tool for surveying, mapping, and monitoring of varied natural and man-made resources. It has become particularly indispensable in mapping and monitoring the dynamic aspects of earth's surface features including land use / land cover (LU/LC). Although land use at times is abstract, it can admirably be inferred from land cover, which is directly detected by remote sensing sensor and registered on the imagery. Variation in multi-spectral response of the different land cover categories enable detection, identification, and categorization of the different land use classes commensurate with the scale of mapping. Guided by these considerations, land use and land cover assessment of Vakilpalli mine study area was carried out by visual interpretation of Resourcesat 2 LISS 4 MX data acquired during Feb. and Nov. 2019 along with ground truth verification.

The major components of land use and land cover assessment methodology are:

- Rapid reconnaissance of core area and the buffer area
- Development of image interpretation key
- Image interpretation with concurrent integration of LU/LC classes
- Field validation
- Land use and land cover map finalization and statistics generation

The various steps involved are diagrammatically illustrated in Figure No.4

3.6 Procedural Steps

The various procedural steps and Land use and Land cover assessment comprise:

- Systematic image interpretation involving detection, identification, classification and codification of the Land use and Land cover assessment with reference to image interpretation keys and in conjunction with corresponding topographical and other ancillary maps.
- The extracted Land use and Land cover classes include cropland, fallows, plantations, scrub, built-up lands, various wasteland categories and probable perennial water bodies.
- Doubtful area, defining image interpretation keys were marked at each stage of interpretation for ground truth verification and assessment
- Ground truth verification

Ground truth verification involved collection, verification and record of the different surface features that create specific spectral signatures / image expressions on FCC. In the study area, doubtful areas identified in course of interpretation of satellite imagery were systematically listed and transferred on to the corresponding Survey of India topographical maps for ground verification. In addition to these, traverses were made with reference to Survey of India topographical maps to verify interpreted LU/LC classes.

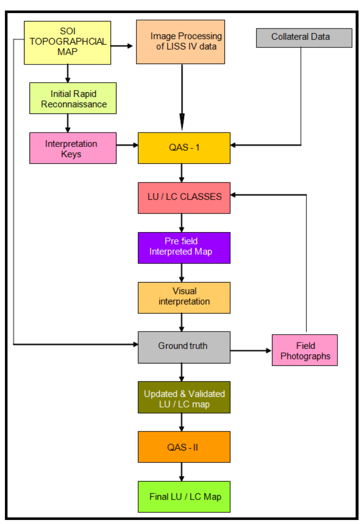


Figure 4 LULC flow chart

3.7 Collateral Data

Collateral data has been derived from Survey of India topographical maps. Also, local farmers and villagers.

4.0 Results and discussion

Knowledge about land use/land cover has become important to overcome the problem of biogeochemical cycles, loss of productive ecosystems, biodiversity, deterioration of environmental quality, loss of agricultural lands, destruction of wetlands, and loss of fish and wildlife habitat. The main reason behind the LU/LC changes includes rapid population growth, rural-to-urban migration, reclassification of rural areas as urban areas, lack of valuation of ecological services, poverty, ignorance of biophysical limitations, and use of ecologically incompatible technologies.

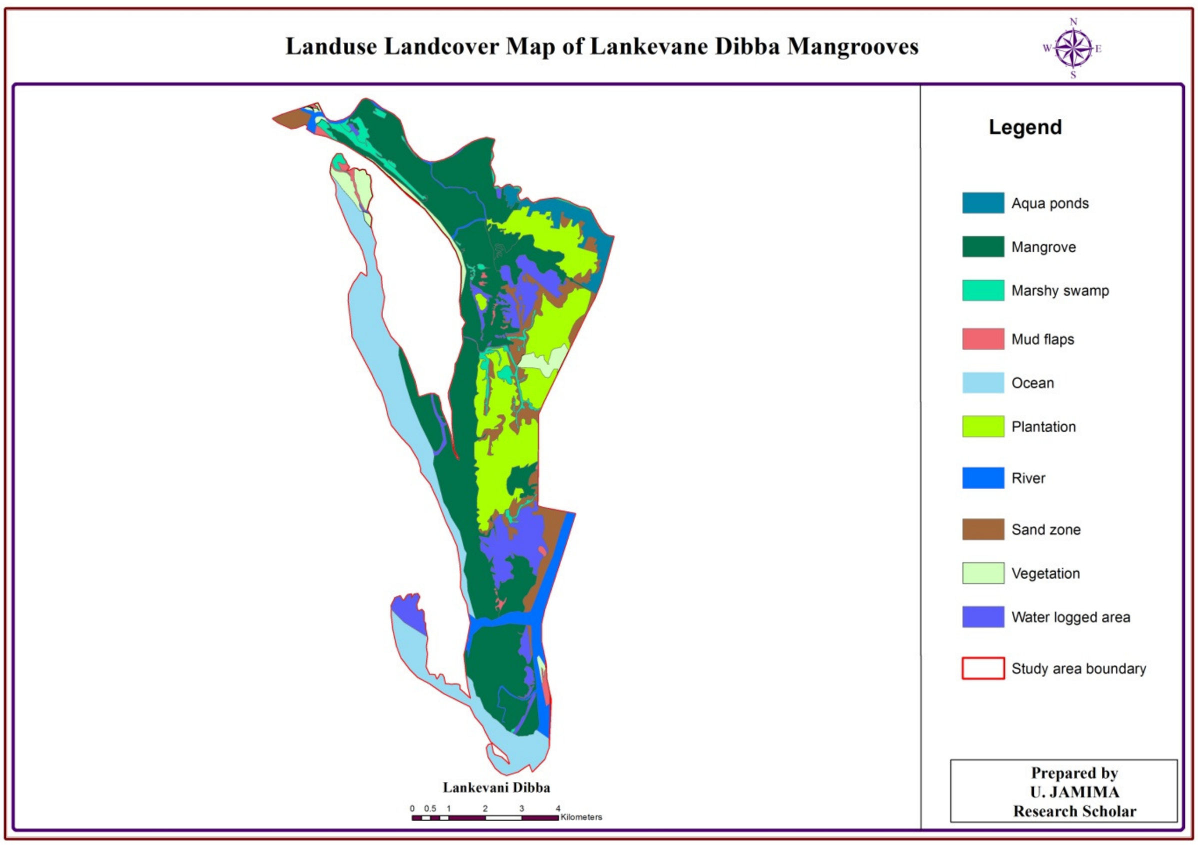
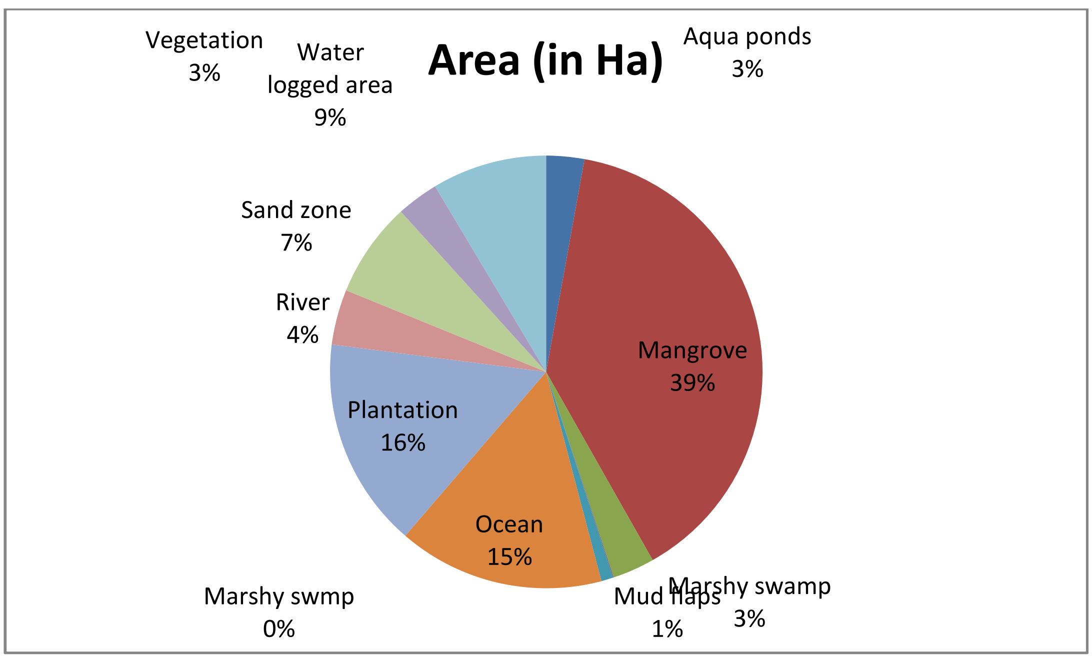


Figure 5 Land use Land cover map of study area

Table 1 Land use statistics

Land use class	Area (in Ha)
Aqua ponds	169.367
Mangrove	2339.092
Marshy swamp	191.58
Mud flaps	53.308
Ocean	923.976
Plantation	943.401
River	248.579
Sand zone	426.020
Vegetation	187.552
Water logged area	515.914

The mangrove of Lankevannedibba is highly dynamic and threatened by both anthropogenic and natural activities they played a key role for the last three decades, and was captured clearly by assisting with geospatial techniques and datasets of mangroves. As observed form the land use classification, the major portion i.e. 39% of the study area is covered with dense mangroves. It is also evident from the land use classification that most of the sandy zones in the mangrove areas are converted to Apart from the mangrove forest cover changes, the other major wetland classes such as salt pans, aquaculture farming, casuarina plantation, mud flat, sand, agricultural and water bodies also are in dynamic areas. These variations mainly because of anthropogenic factors in which land use and land cover conversion near agriculture, water bodies, mud flat, sandy and casuarina regions for salt\shrimp farming. Additionally, the natural disaster of tsunami also uprooted some casuarina trees on the coastline. A study by Gnanappazham (2007) confirmed that the degradation of mangrove forest mainly due to anthropogenic and natural factors which induce changes in the mangroves of Krishna delta which also includes the study area.



5.0 Conclusion

The study area showed a dynamic nature of land use seasonally. During the kharif season we can observe a huge water logged areas and there will be less anthropogenic activity in these areas. Also due to shore line changes the sea shore will be very dynamic and some time changes are observed on the same day, the inundations of sea in to land area will be more in this area. For further studying shore line changes with land surface temperatures this classification is considered along with species level classification using hyper spectral imagery. It can be concluded from this studies help in updating and giving a immediate attention and can be used for evaluation and analysis process during disaster periods.

6.0 References

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