Temporal Change Assessment of Oxbow Lakes in Kerala, India Using Geographic Information System

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Abstract: ***It is increasingly realized that the planet earth is facing grave environmental problems with fast depleting natural resources and threatening the very existence of most of the ecosystems. Serious concerns are voiced among scientists, planners, sociologists, politicians, and economists to conserve and preserve the natural resources of the world. An oxbow lake is a U-shaped body of water that forms when a wide meander from the main stem of a river is cut off, creating a free- standing body of water. Oxbow lakes are Shallow open waters. They are small bodies of standing or gently flowing water that represent a transitional stage between lakes and marshes. "Kanichan thura" at Vynthala is considered to be the only one naturally formed "Ox-bow" lake in Kerala. The need to monitor land cover is derived from multiple intersecting drivers, including the physical climate, ecosystem health, and societal needs. Tropical ecosystem has undergone rapid land cover changes especially in the last few decades. Land use and land cover are dynamic Land use/ Land cover changes also involve the modification, either direct or indirect, of natural habitats and their impact on the ecology of the area. The land-cover changes occur naturally in a progressive and gradual way, however sometimes it may be rapid and abrupt due to anthropogenic activities. Land use/cover change has become a central component in current strategies for managing natural resource and monitoring environmental changes. Present study analyses the change in oxbow lake due to natural and anthropogenic reasons. A good portion of this Oxbow lake- like structure has been either encroached upon or degraded. A small portion remains undamaged.***

Keywords: Oxbow lake, GIS, Kanichamthura, natural resource

1. Introduction

Landscape changes, transformations and conversions, are results of various pressures on ecosystems and have been progressing largely in concert with human settlements. Land use change is the modification in the purpose and usage of the land, which is not necessarily the only change in land cover. It also includes changes in intensity and management (Verburg, et al, 2000). Information about land use change is necessary to update land cover maps and for effective management and planning of the resources for sustainable development (Alphan 2003). The composition and structure of vegetation can serve as bio-indicators for environmental changes to ecosystems that echo the interactions between human activity and the natural environment (Zhang *et al.*, 2008). The land cover and landscape change in semi-arid and arid environments often reflects the most significant impact on the environment due to excessive human activity (Zhou *et al*., 2008a and Zhou *et al*., 2008b). Accurate and up-to-date land cover change information is necessary to understand and assess the environmental consequences of such changes. Over the years, remote sensing has been used for land use/land cover mapping in different parts of India (Gautam and Narayanan, 1983: Brahabhatt *et al.*, 2000). Accurate and up-to-date land cover change information is necessary to understand and assess the environmental consequences of such changes.

Vegetation mapping is a product of the development of remote sensing, initially through aerial photography, remote sensing technology, because of the benefits it offers wide area coverage, frequent revisits, multispectral, multisource, and storage in digital format to facilitate subsequent updating and compatibility with GIS technology proved very practical and economical means for an accurate classification of land cover (Lillesand and Kiefer, 1999). A large number of plants and animals are inhabited in this oxbow lake. It is biodiversity Sanctuaries especially in the dry seasons. During the drought period, these ponds are refugee for almost all the fresh water organism. These local biodiversity hotspots are ideal for detailed biological investigations. . They are cradles of biological diversity, providing the water and primary productivity upon which countless species of plants and animals depend for survival. Many of these plants and animals have specially adapted to living in wet places

The floral diversity of this oxbow lake is very significant. Freshwaters support a large diversity of biota representing almost all taxonomic groups. Macrophytes Dominate in the lake. .Large number of rare and endangered species of plants are inhabited in kanichamthura oxbow lake. Variety of medicinal plants, which are rare endangered inhabited in oxbow. Wide verities of trees are present along the banks of the lake. The present analysis of land use and land cover change involves a quantitative estimation of land use and also reveals the periodic change that occurs in the oxbow vegetation in the area and its extent in detail. "Kanichan thura" at Vynthala is considered to be the only one naturally formed "Ox-bow" lake in Kerala,

2. Materials and Methods

Four suitable cloud-free images were available for this study, spanning the period from 1973 to the 2014. A Landsat Multi Spectral Scanner (MSS) image dated 20th March, 1973 was downloaded from the Global Land Cover Facility site hosted by the University of Maryland (http://glcfapp.umiacs.umd.edu). IRS-1C Linear Imaging Self Scanner (LISS)-III satellite data of 19 March 2014 covering path and row 101/68 was obtained from the National Remote Sensing Agency, Hyderabad. LANDSAT-MSS data with a spatial resolution of 80 m and spectral bands (B1 0.5–0.6, B2 0.6–0.7, B3 0.7–0.8, and B4 0.8– 1.1

µm),and IRS-P6 LISS-III data with a spatial resolution of 24 m and spectral bands (B2 0.52– 0.59, B3 0.62–0.68, B4 0.77–0.86, and B5 1.55– 1.70 µm) was analyzed in the present study. The digital number (DN) values of the Landsat MSS, and IRS P6 LISS III data were converted into radiance values using the corresponding satellite sensor parameters.

Unwanted artifacts like additive effects due to atmospheric scattering were removed through a set of pre-processing or cleaning up routines. First-order corrections were done using the dark pixel subtraction technique (Lillesand and Kiefer, 1999). This technique assumes that there is a high probability that at least a few pixels within an image which should be black (0% reflectance). However, because of atmospheric scattering, the image system records a non-zero Digital Number (DN) value at the supposedly dark shadowed pixel location. This represents the DN value that must be subtracted from the particular spectral band to remove the first-order scattering component.

A hybrid approach combines the advantages of the automated and manual methods to produce a land cover map that is better than if just a single method was used. One hybrid approach is to use one of the automated classification methods to do an initial classification and then use manual methods to refine the classification and correct obvious errors. With this approach a reasonably good classification can be obtained quickly with the automated approach and then manual methods can be used to refine the classes that did not get labeled correctly.

Analysis of the satellite sensor data has been carried out using various digital analytical procedures. For the classification of the satellite sensor data, stack of maximum NDVI (Normalised Difference Vegetation Index) images were generated from the Landsat MSS, and IRS LISS III data. The NDVI images were examined, mean and standard deviation values were calculated and a thresholding technique (Long, 2007) was applied to separate different forest type. Also used supervised maximum likelihood classification method for the classification of all the images. Training sites were derived from the satellite images using reference maps. Based on the knowledge of the data and ground truth information, different land cover classes were identified in the study area Parametric signatures were used to train a statistically based (e.g. mean and covariance matrix) classifier to define the classes. Training sites were digitized within ERDAS Imagine (ERDAS, 2010), using the AOI tools. The inquire cursor was used to identify a single pixel (seed pixel) that represents the training sample then neighbours to the seed pixel were added to the training sites. After the signatures were defined, the image was classified using the maximum likelihood parametric rule. To deliver the appropriate support size of each category the required training set for each class was determine at least 10 times the number of discriminating variables used in the classified map. Maximum likelihood classifier assigns a pixel to a particular class based upon the covariance information and a substantially superior performance is expected from this method compared to other approaches (Richards, 1994). Landsat MSS, TM, ETM and IRS LISS III data are classified in the same manner. The different forest classes are classified based on the standard forest classification scheme (Champion and Seth, 1968).The classified forest cover map is then undergoing accuracy assessment.

Classified and accuracy assessed satellite images are used for the change detection analysis. for change detection analysis the raster image is converted in to corresponding land cover polygon by using ESRI Arc gis software. Arc GIS geographic analysis extension is used for change detection analysis, in this 'Union' operation is used.1973 land cover polygon is union with 2014 image to identify the land cover change that are occurs in 2014 compared with 1973. Each land cover union the land cover change from one land cover polygon to other is identified. A Boolean operation 'AND' was applied between the two binary land cover polygon to identify the unchanged areas in Arc gis. Based on the change detection analysis cover change of the year 1973 to 2014 was generated and area statistics calculated. In change table positive value indicates that the area of land cover is increased with previous year and negative value indicates that the land cover area is decreased compared to previous land cover image.

3. Results and Discussion

In the present study ,changes in the land use and land cover of kadukutty panchayath are evaluated from the differences between 20 years of period(1993-2013).As indicated in the methodology part of this paper the change detection was based on the Land use maps of 1973 and 2014.The findings of the present investigation are presented in figure-1 and figure-2.According to the land use maps 1973 the study area has been defined to have 4 land use land cover categories, which were Paddy field, Settlement area, Water body, Oxbow lake. As per the land use map 1973 there are 4 major land use categories. And the land use map of 2014 shows 5 land use categories; Paddy field, Water body, Settlement area, Oxbow lake and Sandunes.

The land use land cover classification of 1973 land use map showed that majority of the study area was under paddy field. And the next important land use type is the Settlement (built up) area, the next is water body and finally the oxbow lake. According to the land use map 1973 Paddy field is the dominant land use type. Paddy was the major crop cultivated in Kadukutty Panchayath in 1973. During the period from 1973 to 2014 a major change was noticed in the utilization of paddy fields, now the majority of the paddy lands were converted into settlement areas. There was a 20.43% decrease in the paddy field from 1973 to 2014.

The next dominant land use type in 1973 is the settlement (buitup)area. There shows a drastic increase in the settlement area from 1973 to 2014. This is due to the substantial increase in population, economic growth, and industrialization, and transportation activities . The next important land use type in 1973 landuse map is the Waterbody. The water body include the parts of Chalakudy river flows through the study area and fresh water ponds etc. The water body shows decreasing pattern of change. land use map 2014 shows that the width of the river is decreased by the erosion and deposition of huge quantities of sand along the banks of the river. The erosion and deposition of soil occurred by natural as well as man-made activities. And the river course is changed because of the sand deposits obstruct the free flow water through its natural course. The course of a river changes over time, as erosion caused by the flowing water and sediment sculpts the landscape around the river. Rivers erode land and carry it downstream towards the sea or lake it flows into. As eroded soil is carried downstream, it is deposited at areas where the river slows, especially where the river meets the body of water it flows into (often the ocean or a lake), forming a fertile river delta that has muddy swamps and/or sandbars

The oxbow lake land use and land cover category showed decreasing pattern of change during 1973 to 2014.The change detection matrix of 1973 to 2014 land use land cover change indicates that decrease in the area of oxbow lake was due to conversion in to settlement (built up)area and agriculture. A major part of the lake is converted to settlement (built up)area by the encroachment of the local people. The clay mining from the areas around the oxbow lake by the near by ceramic industries also another important cause of the destruction of the lake. When 2014 land use land cover classification compared with 1973 land use land cover classification. There is change that shows decrease or increase in particular landuse and land cover. The LULC categories that shows increase are Settlement (built-up)area. On the other hand the LULC categories like paddy field water bodys , Oxbow lakes showed decrease. There was a 20.43% reduction or decrease in the total paddy field of the study area. And a 22.5% increase in the total settlement area.2.3% decrease in the width of the river. The area of the lake is also show decreasing trend. The sand deposits are formed along the banks of the river.

The significant changes in the land use/land cover during the study period between the years 1973 to 2014. A general analysis of the changing pattern of land use in the study area shows that both the land use types and their spatial distribution have undergone drastic changes during the period the major changes occurred in Paddy field, Oxbow lake, Water bodies, Settlement area. The features namely Paddy field, Water bodies Oxbow lake indicated a decreasing trend. Where the settlement area indicated an increasing trend The land use pattern changes were analyzed in GIS platform during 1973 – 2014 and found that the large areas of agricultural land are being lost continuously to this irreversible developmental process. The major parts of the paddy fields are converted to settlement areas. The river course is changed by the erosion caused by the flowing water and sediment sculpts the landscape around the river. And the sand is deposited along the banks of the river that will reduce the width of the river. The extent of Oxbow lake is reduced by the encroachment by the local people. Results of Land Use/Land Cover analysis of Kadukutty Panchayath were clearly indicate that these lands deserving more and wide attention, that are able to penetrate to all zone of its degrading parts of ecosystems

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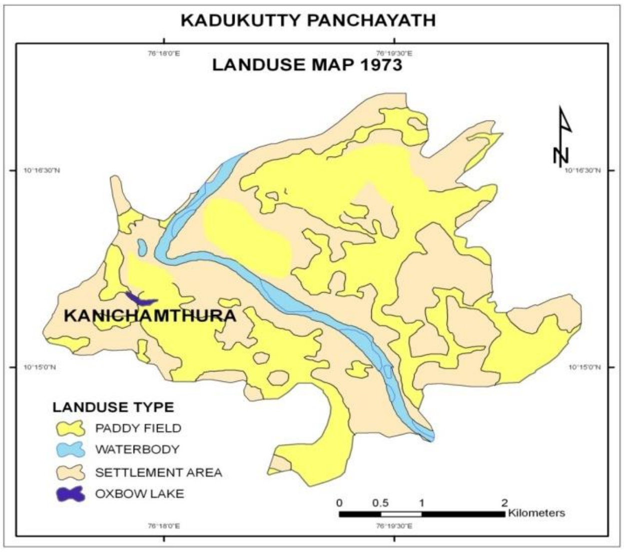
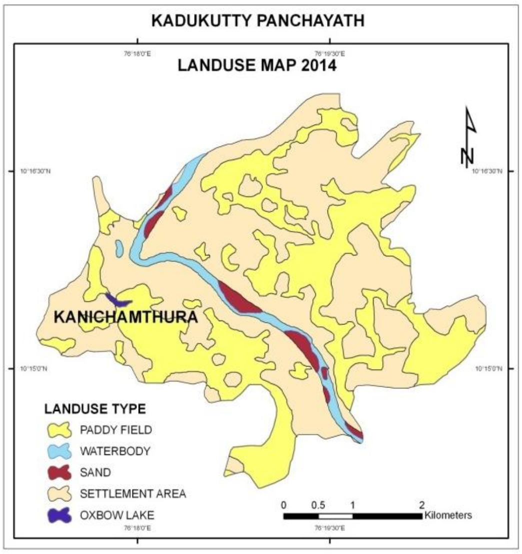

KADUKUTTY PANCHAYATH
LANDUSE MAP 1973
N
KANICHAMTHURA
LANDUSE TYPE
PADDY FIELD
WATERBODY
SETTLEMENT AREA
OXBOW LAKE
0 0.5 1 2 Kilometers


KADUKUTTY PANCHAYATH
LANDUSE MAP 2014
N
KANICHAMTHURA
LANDUSE TYPE
PADDY FIELD
WATERBODY
SAND
SETTLEMENT AREA
OXBOW LAKE
0 0.5 1 2 Kilometers