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Page: 1-7

A Study of Alkaleri Forest Land Cover Changes using Satellite Remote Sensing in Bauchi State

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Abstract: *Remote sensing and GIS tool has been used all over the Nigeria for Land cover and Land use mapping for the past few decades. Related tools and techniques have been used in this research for Land use mapping in Alkalari Local Government Area, Bauchi State. Supervised classification, which is one of the beneficial techniques of remote sensing, is used for three decades study. In this study three different Landsat images, comprising of temporal window of about three decade, along with survey points, has been used for accurate land use estimation. The study focused on change detection of four major land use consisting on Vegetation, Built-up area lands, Bare land the classified land cover data showed an overall depletion of forest cover when compared the results from 1990 to 2013. The conclusion derive from this study is that rate of deforestation is on the increase in Alkalari Local Government Area which is deeply affected due to anthropogenic activities. Reduction in forest is a main loss in ecosystem which also increases the possibility of drought occurrence in the study area. The result shows that a lot of vegetation was converted to a bare land as a result of farm clearing and fuel wood exploitation in the study area. Finally, recommendations were offered in order to manage the available land cover resources available in the study area.*

Key words: *Forest, Land cover, Alkaleri, Geographic Information System, Remote Sensing, Landsat Satellite Imagery*

INTRODUCTION

Mapping of land cover is one of the earliest applications of remote sensing (Abbasi, *et al* 2011). The process of change detection can be done by using dataset obtained on different dates. It is premised on the capability to determine temporal effects (Alvarez et al., 2003). Change detection can be done through the analysis of multi date satellite and aerial images (Alvarez et al., 2003). It is divided into two categories (FAO. 2009) i.e.

1. Change mask development which usually cannot identify what types of land use change have taken place between them commonly called Image differencing and Image ratio.
2. Categorical change extraction which can be performed by comparing two different time images commonly called Post classification comparison

With the launch of satellites it is possible to monitor land cover and land use change on regional and global scale (Siddiqui*, et al.,* 2003). Alvarez *et al.,* (2003) classified land covers of Mexico using three decades satellite images (Spalding, *et al* 2010). Two different data sets, real multi temporal data set and a synthetic dataset were used in that study. Real time multi temporal data set consist of two multi spectral image of the year 1995 and 2002 obtained from ETM+ sensor and in a synthetic data consist of China Brazil Earth Remote Sensing Satellite-1 multi spectral images and three synthetic change images (Lillesand, *et al* 2004).

This study aims is to examine three decades temporal change in Alkaleri Local Government Area using Maximum Likelihood Classification (MLC), which is one approach of supervised classification.

Forests are the most valuable resources of ecosystem. They are precious resource which provide climatic stability, environmental stability, and rainfall pattern and also contribute significantly to the economy (Lillesand, *et al* 2004).

Sader *et al.,* (2008) used Landsat TM/ETM+ data for forest mapping (Lenney *et al.,* 2001). They used eight Landsat TM and ETM+ images for WRS path 12 and row 28. Their study focused on forest inventory, wild life habitat modeling and biomass of carbon stock estimation and also regeneration spatial

pattern in updating forest maps. Change detection technique was applied on eight Landsat images and obtained a time series of harvest maps. Then the map was merged with 2004 forest type map and also with Geological survey's Gap analysis program of 1993 land cover map. Applying post classification techniques they obtained update land cover map of Gap analysis program of 2004 (Jianwen, and Yun, 2006).

Depression in forests means not only damage of trees but also it is a big loss to environment and ecosystem. Every year, there is a big change in natural land covers and extensive areas of agriculture and forestlands are ruined and slowly turned into waste land due to human activities or natural causes. There are several causes of deforestation such as urban development, forest fires, and agricultural expansion. Today, depletion in the forest cover is an important issue for the world (Akbar and Khatoon, 2008).

STUDY AREA

Alkaleri local government area is located on latitude 10°15'N and longitude10°20'E. The LGA has an area of 5,918 square kilometer and population of 329,424 people according to 2006 population census (NPC, 2006).The Local Government is bounded in the North by Gombe State; East by Kirfi Local Government Area; South Tafawa Balewa and West Bauchi Local Government Areas. BSADP (1996) reported that April is the hottest month of the year with temperature rising to about 40^0C. The coldest months are December and January, when the temperature may fall as low as 17^0C to 22^0C. The mean annual rainfall ranges between 1000-1200mm. The raining season extends from May/June to September/October. The dry season starts September/October, to April/May. The maximum humidity may increase drastically during the middle of raining season to about 96% in August and drop sharply to about 10% during harmattan around December.

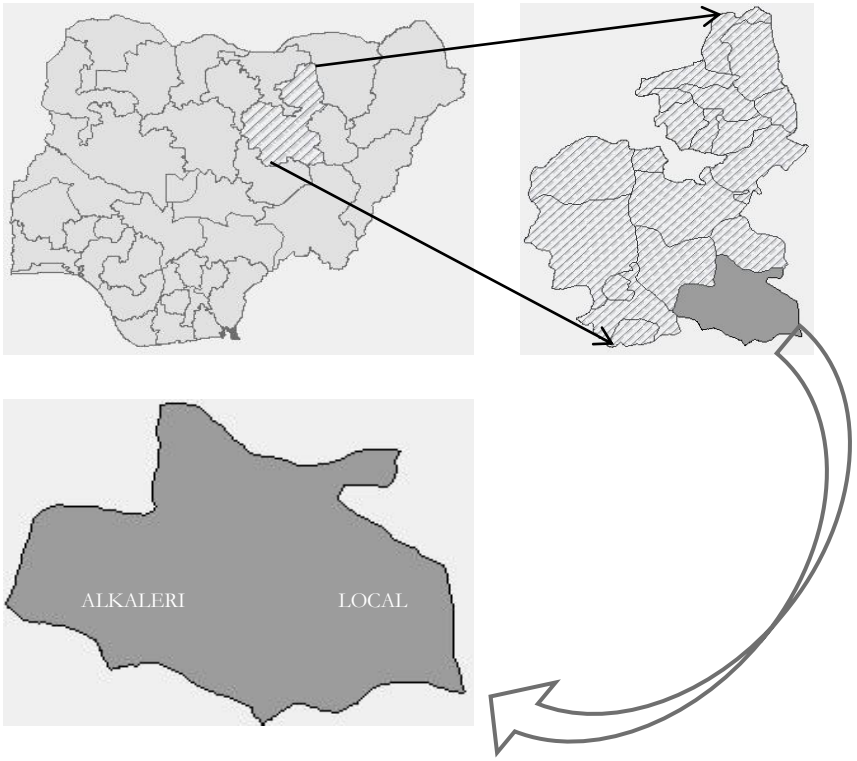

Fig.1. Location of the study area

METHODOLOGY

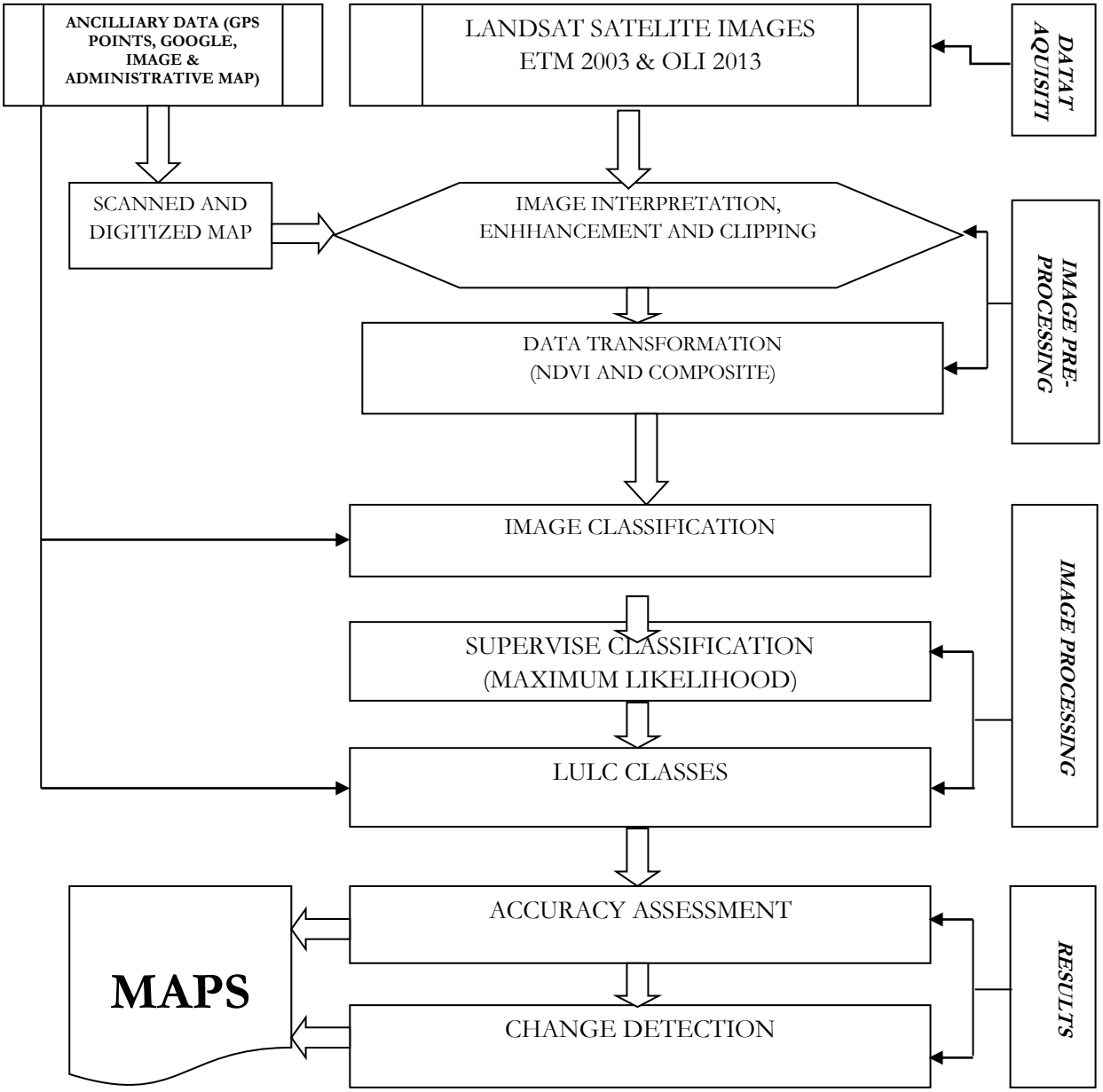

Figure 2: Flow Chart of Methodology

Different types of datasets were used for land cover mapping of Alkaleri local government area. These data included Satellites Data (Landsat Satellite Images, Google Earth Imagery and ASTER Images), Vector Data, Ground Truth Data and Local Area Information etc. For change detection of Alkaleri Local Government Area, temporal Landsat satellite images of Thematic Mapper (TM) sensor were downloaded from the (Universal Transverse Mercator) coordinates, with Spheroid and Datum WGS (World Geographic System) 84, zone 43 north. All the individual layers (bands) were stacked together to obtain multispectral (colored) image. Sixth official websites of USGS (United States Geological Survey) and GLCF (Global Land Cover Facility). Study area covers three different path/row of Landsat archive. Satellite images of suitable dates by considering tide height values and cloud cover percentage was downloaded.

The images were already Geo-referenced by the EROS (Earth Resources Observation Satellite) Data Center registered to UTM band of Landsat is thermal band (10.4-12.5 um) of relatively low resolution (30 meter) and hence it was not used for classification. The characteristic details of the satellite images are given in table 1.

Table 1: Dataset used for the year 1990- 2013

S/N	Data Type	Production Date	Scale	Source	Tide height (Meter)
1.	Landsat Image	07-01-1990	TM	USGS website	30m
2.	Landsat Image	29-04-2001	ETM	USGS website	30m
3.	Landsat Image	19-05-2013	OLI	USGS website	30m

Source: Authors Computation, 2019

A subset of the study area of Alkaleri Local Government Area boundary was generated from the images to separate out the area of study. This process is performed using subset utility of the ERDAS Imagine 9.1®. Various algorithms were used to enhance low contrast image to high contrast image so that image can be easily handled for interpretation and processing.

To improve enhancement, brightness control utilities were also applied. This technique was used to improve the image quality for better interpretation.

To classify Landsat image of Alkaleri Local Government Area supervised classification technique was prepared, because an extensive ground survey data of Alkaleri Local Government Area was available. In post classification method we can get the change through the comparison of three different classified images acquired on different dates (FAO.2009). Maximum likelihood classification is one of the best techniques because it gives us more accurate result but this method is good only when limited no. of cover types is present (Zhang *et al.,* 2001).

RESULTS AND DISCUSSIONS

Following changes were observed using Satellite images and output land cover map. The results obtained after applying the classification technique are listed in table 2

Table 2: Comparison Statistics of the years 1990, 2001 and 2013

Class Names	Area (Ha.) 1990	Area (Ha.) 2001	Area (Ha.) 2013
Vegetation	309627.0	271934.8	246170.7
Built-up Area	26244.0	45432.9	68850.0
Bare Land	311976.0	229330.8	243661.9

Source: Authors Computation, 2019.

i. Conversion of Forest into Built-up Area

With the increase in population in Alkaleri Local Government Area, large area is converted into agricultural land. The forest was deeply affected due to anthropogenic activities or natural causes. Due to anthropogenic activities, 37,692.0 hectares of forest disappeared. Large area of forest is now utilized in form of built-up area (Akbar, Dr. G. and Khatoon, Dr. S., 2008). In this research a large portion of forest was observed which were converted into built-up area.

ii. Cutting of Forest

Depletion in forest cover has an important impact on both ecological balance and socio-economic development. There are several causes of increase in deforestation level in Alkaleri Local Government Area such as urban development, expansion in agricultural area, illegal cutting, grazing of animal, increase in the demand of timber etc (Akbar, Dr. G. and Khatoon, Dr. S., 2008). In Alkaleri Local Government Area these changes were also observed.

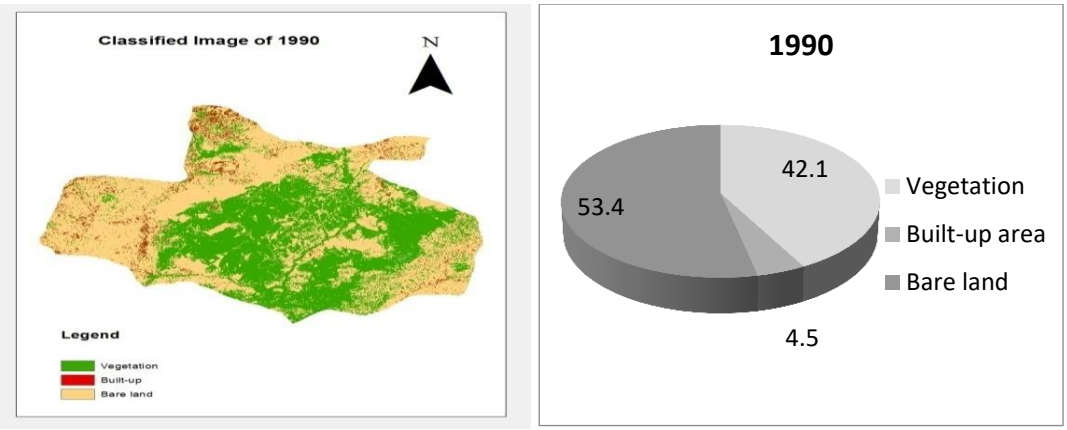

Figure 3: Land cover and pie chart of the year 1990

A classified image showing overlays of totals vegetation dynamics between 1990, 2001 and 2013. The differences were shown in hectares. Analytical (vegetation) Step One: In this step, the difference between the vegetation in Alkareli Local Government Area 1990 and that of 2001 were assessed. In 1990, the forest area was 309,627 hectares while in 2000 it was 271,934.8 hectares, the difference was 37,692.0 hectares.

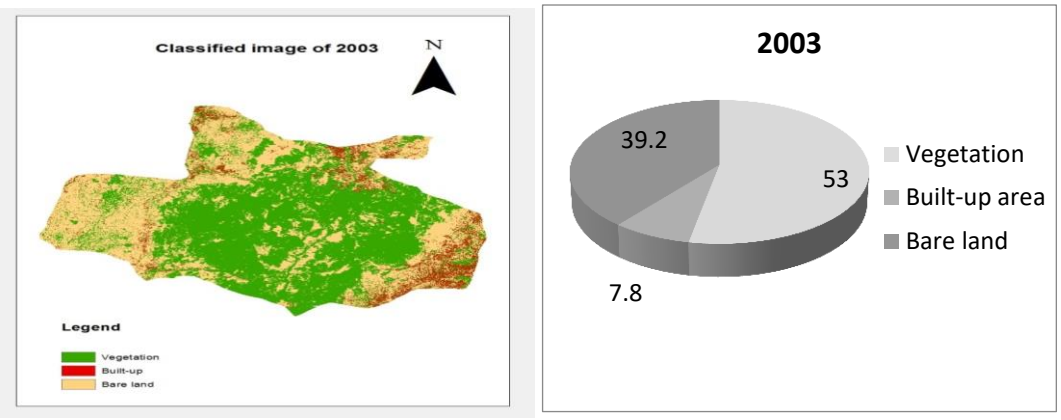

Figure 4: Land cover and pie chart of the year 2001

Analytical (vegetation) Step Two: This step tries to illustrate the difference between the vegetation in Alkareli Local Government Area 2001 and that of 2013. In 2001, the area was 271,934.8 hectares while in 2013 it was 246,170.7 hectares, the difference was 25,767.1 hectares.

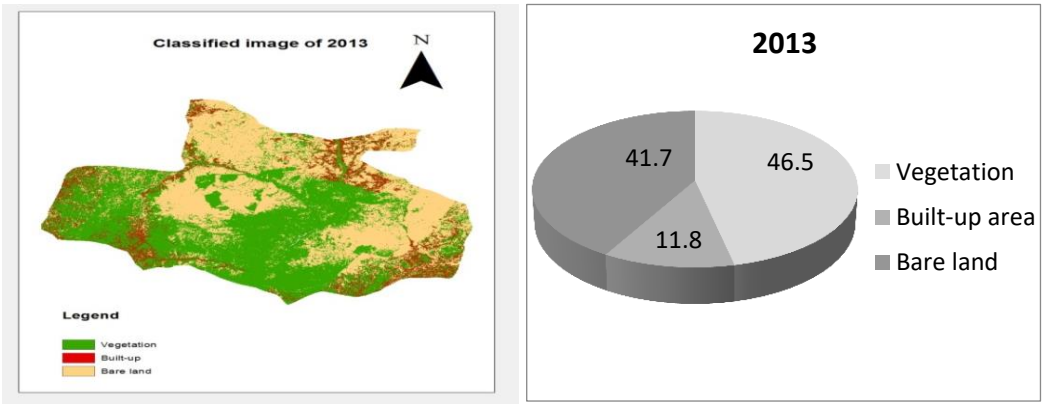

Figure 5: Land cover and pie chart of the year 2013

Analytical (Vegetation) Step Three: Here, the difference between the forest area in Alkareli Local Government Area 1990, 2001 and 2013 were assessed. In 1990, the area was 309,627 hectares; in 2001 it was 271,934.8 hectares, while in 2013 it was 246,170.7 hectares. The difference between 1990 and 2001 was 37,692.0 hectares. While the difference between 2001 and 2013 is 25,767.1 hectares. The total difference from 1990 to 2013 is 63,459.1 hectares.

It is evident from the foregoing analysis that there has been dynamics in vegetation area of Alkareli Local Government Area between 1990 and 2001; The classified images of 1990 and 2001 analysis shows that there are more exploitation because of its proximity to the inhabitant while the classified images of 2001 and 2013 show that there is less exploitation because of the distance forest increase from residential area.

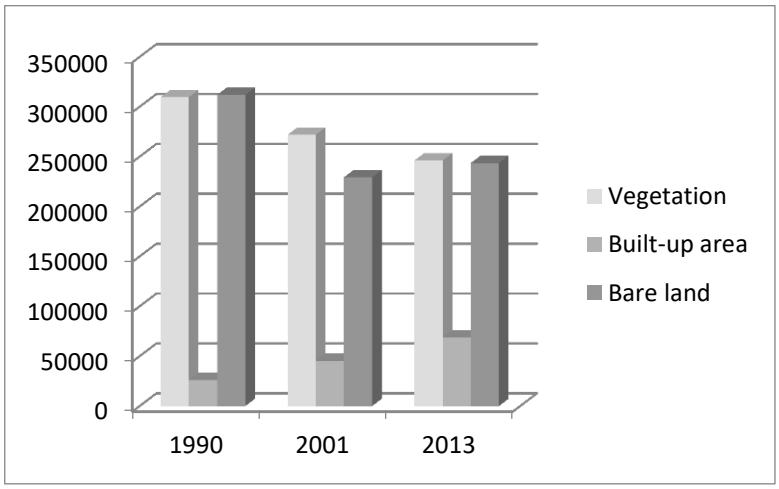

Figure 6: Comparison Statistics of Landsat Classified Images of the years 1990, 2001 and 2013

CONCLUSION AND RECOMMENDATIONS

In this research, three decades land cover change was detected in the Alkareli Local Government Area using supervised classification technique. Three land cover maps were produced as shown in Figure 3, figure 4 and figure 5, and the statistics of each class was calculated as in Table 2. As shown in the statistic it was evident that deforestation level increased in the past years in the Alkareli Local Government Area.

The 1990, 2001 and 2013 Landsat Satellite remote sensing data were used to identify, classify, assess and interpret activities of deforestation of Alkaleri area for the year 1990, 2001 and 2013 respectively. A land use / land cover categories of the area and their changes within 20 years (1990-2013) was generated and analyzed.

The result shows that; in general the vegetation in the area is under treat due to several human activities of man such as illegal felling of trees, farming activities and timber logging. The degradation can be attributed to the poor management of the vegetation. From this study, Landsat TM data are proved to be effective in mapping and monitoring the dynamics of land use / land cover of the study area.

RECOMMENDATIONS

Deforestation is not an unstoppable or irreversible process. Increased and concerted efforts in forest plantation 'rebirth' and rejuvenation will maintain our vegetation. In order to reduce the effects of deforestation in Alkaleri area, the study offer the following recommendations:

i. Government by way of policy should be strict in preserving vegetation from illegal occupation.
ii. Bare land should be given more emphasis when it comes to land development.
iii. Government should create awareness on environmental effect of deforestation.

REFERENCES

(1) Abbasi, H. U., Karas, I. R. and Baloch, M. A. Assessment of Deforestation of Riverine Forests of Nawabshah & Hyderabad Divisions Using Landsat Data. Sindh Univ. Res. Jour. (Sci. Ser.) Vol.43 (2) pp.185-188 (2011)

(2) Alvarez, R., Bonifaz, R., Lunetta, R. S., Garcia, C., Gomez, G., Castro, R., Bernal, A. and Cabrera, A. L. (2003). Multitemporal land-cover classification of Mexico using Landsat MSS imagery, Intrenational Journal of Remote Sensing, 24:12, pp.2501-2514 (2003).

(3) BSADP (Bauchi State Agricultural Development Programme 1996) Zonal and Development Area Agronomy Report.

(4) FAO. States of World Forests 2009. Food and Agriculture Orginization, Rome (2009).

(5) Siddiqui, M. N., Jamil, Z. and Afsar, J. Monitoring changes in riverine forests

(10) Akbar, Dr. G. and Khatoon, Dr. S., Natural vegetation assessment, WWF-Pakistan (2008).

(11) Sader, S. A. and Legaard, K. R. Inclusion of forest harvest legacies, a forest type, and regeneration spatial pattern update forest map: A comparison of mapping results, Forest Ecology and Management, Volume 255, Issue 11, 15, pp.3846-3856 (2008).

(12) Sindh Forest, 2010-2011, Retrieved Jan 2012, form www.sindhforests.gov.pk.

(13) Akbar, Dr. G.,Rehman, Dr. H., Hasnain, S. A., Rafique, M., Durranee J., Nawaz, R. Preliminary Environmental Baseline Study of the Indus for All Program Site (2012).

(14) Zhang, Y., Gao, J. and Wang, J., Detailed mapping of a salt farm from Landsat TM imagery using neural network and maximum likelihood classifiers: a comparison, International Journal of Remote Sensing, 28:10, pp. 2077-2089 (2007).

(15) Bakker, W. H., Janssen, L. L. F., Weir, M. J. C., Gorte, B. G. H., Christine, P., of Sindh-Pakistan using remote sensing and GIS techniques. Advances in Space Research, Volume 33, Issue 3, 2004, pp. 333-337 (2003).

(6) Spalding, Mark., Kainuma, Mami, and Collins, L., World Atlas of Mangroves, Published. Earth Scan (2010).

(7) Lillesand, T. M., Kiefer, R. W., Chipman, J.W. Remote sensing and image interpretation, fifth ed. John Wiley and Sons (Asia) Pte. Ltd., Singapore (2004)

(8) Lenney, M. P., Woodcock, C. E., Macomber, S. A., Gopal, S. and Song, C. Forest mapping with a generalized classifier and Landsat TM data, Remote Sensing of Environment 77, pp. 241- 250 (2001).

(9) Qin, D., Jianwen, M. and Yun, O. Y. Remote sensing data change detection based on the CI test of Bayesian networks, Computers & Geosciences, Volume 32, Issue 2, pp. 195-202 (2006).

Woldai, T., Horn, J. A. and Reeves, C. V. Principal of Remote-Sensing, International Institute for Aerospace Survey and Earth Sciences (2001).

(17) WWF-Pakistan (2010). GIS/RS based monitoring of Indus Delta, A half century comparison. WWF (2010).