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Full Length Research Paper

Land use land cover change detection: A case study: Khartoum state, Sudan, 1972 -2006

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This study attempt to detect the land use land cover change in Khartoum state between 1970-2006 using remote sensing technology, geographical information system and multi temporal imagery to estimate the area of each class of land use in 1972, 1986, 2000 and 2006 . Observations of land use trend and land cover change lead to find the possible reasons behind these changes. The research findings showed 17.07% growth in settlement area while vegetation areas were decreasing 12.17%. 1972-2000. Recommendations were made for optimum benefit from the study in future land use planning and studies.

Keywords: Remote sensing, geographical information system, multi temporal imagery.

INTRODUCTION

Land use is the human modification of natural environment or wilderness into built environment such as fields, pastures, and settlements. The major effect of land use on land cover has been deforestation of temperate regions. More recent significant effects of land use include urban sprawl, soil erosion, soil degradation, Stalinization, and desertification.

Land cover is distinct from land use despite the two terms often being used interchangeably. Land use is a description of how people utilize the land and socio-economic activity – urban and agricultural land uses are two of the most commonly recognized high-level classes of use. At any one point or place, there may be multiple and alternate land uses, the specification of which may have a political dimension.

Changes in land use and land cover affect both environmental quality and the quality of life, two aspects that impact human wellbeing. Changes in habitat, water and air quality and the quality of life are some of the environmental, social and economic concerns associated with land use and land cover changes. Mirghani et al (1996) in a study to assess and map desertification in the western Sudan (Kordofan and Darfur). The Objective of the study was to develop a methodology using remote sensing and Geographic Information System (GIS) in assessment and mapping of desertification. The Western Sudan is of considerable importance to the Sudan's economy. It is ecologically vulnerable and has been exposed to recent desertification with very serious biological, social and financial losses. For these and other reasons the western Sudan has been chosen as a study area. This method has been developed from a number of previous studies (Ahmad, 1992, Monkolsawat and Thirangoon 1990, Wara-Aswapatti, 1990; Singh, (1986). Using this method, both actual and

Figure 1: Khartoum stat map

temporal changes in land use/land cover between different dates can be detected.

In order to extract the maximum information on land use/land cover in the study area, classification using the best band combinations of Landsat TM imagery was emphasized. As the classified images ware to be used as inputs for change detection analysis later, they had to be classified as accurately as possible Thirangoon (1990) and Ahmad (1912).

The main objective is to study the land use – land cover change that had taken place in Khartoum area in the time pirate 1970-2006. The specific objectives of this study are:-

-Produce a land use land cover classes map for the years of the study

- To determine the trend, location and magnitude of land use land cover change

MATERIALS AND METHODS

Study area

This research is conducted in Khartoum state (figure 1). The study area sited between latitudes 15° 00'-16° 00' N and longitudes 32° 15'-33° 30'E covers an area of 7200 Km^2.(figure 1: Khartoum stat map). It is a semi-arid area characterized by hot dry summer (April-June) and cold dry winter (November-February). The annual rainfall is 157mm, mainly during July to September. Most of the area is flat plain, where the surface elevation ranges between 380 to 400 m a.s.l. Elevated ridges and isolated inselbergs are encountered in the northeast, northwest and southwest of the area. The main watercourses are, Blue Nile, White Nile, River Nile and seasonal streams. The geologic setting is composed of Basement Complex, Omdurman formation, and Gezira formation. The basement complex consists of acid grey gneisses and granite. Omdurman formation is composed of a sequence of sandstone, conglomerate and mudstone, of more than 400 m thick, rests uncomfortably on the Basement complex Gezira formation covers the area between the Blue and White Nile, and small strip east of the Blue Nile. It consists of a sequence of unconsolidated interbeded clay, silt, sand and gravel layers. Calcrete, vaporate and salt rocks are Characteristic features of the upper part of Gezira and Omdurman formation. The hydraulic conductivity of the lower aquifer (21.6 m/d) is ten

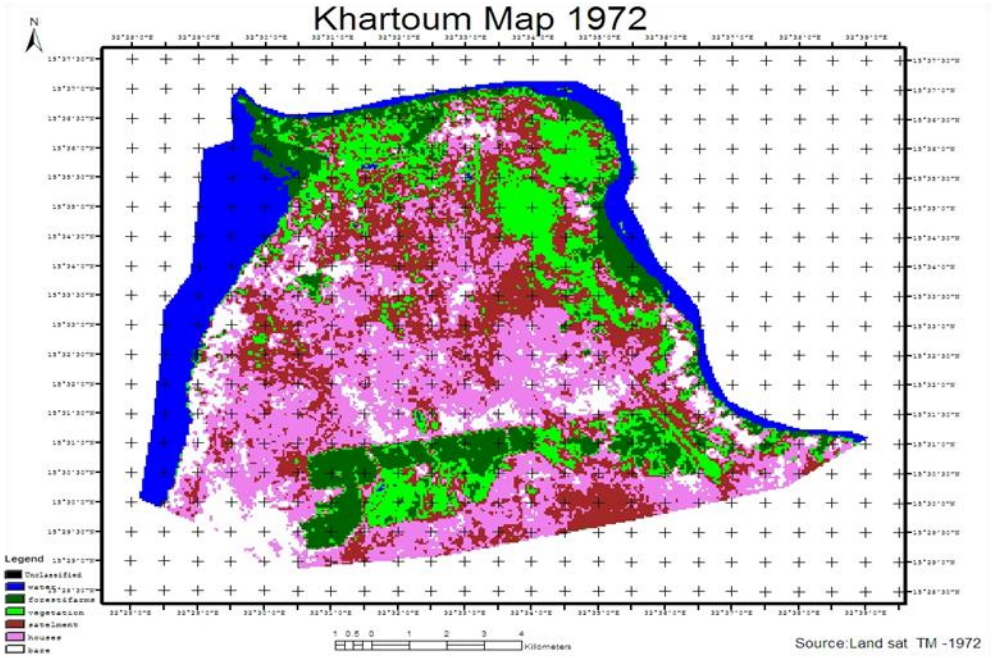

Figure 2: Khartoum map 1972

orders higher than the upper one. Aquifer systems are partially hydraulically connected. The groundwater flow direction is generally outwards of river courses with hydraulic gradient varies from 0.01 close the rivers to 0.0006at far distance.

MATERIALS

The material was used in this study are: **Hardwar**, personal computer: cup T2700 at 2.00GHz, 2.00GHz, 0.99GHz of RAM, digital camera. **Software:** Erdas Imagine 8.5 used for the classification process,Arc GIS 9.1 used for the geo-referencing, Microsoft Excel for the charts and presentation. **Data:** Efficient integration of temporal, spectral and spatial resolution information is important for accurate mapping of change, developing of land cover land use. The satellite data used in this study are:

-Land sat image Khartoum area 1972 (60m resolution)

- Land sat image Khartoum area 1986 (60m resolution)

-Land sat image Khartoum area 2000(30m resolution)

-Spot image Khartoum area 2006 (15m resolution)

METHODS

Generally the methods for the change detection can be divided into two main groups (pre-classification methods and post- classification methods) where both of them are being used approximately equally in practice. In this study the method used is the post classification comparison using exactly maximum likelihood unsupervised classification.

i. Arrange the band combination to make the images more recognizable.

ii. Apply an unsupervised classification to the four images using ERDAS imagin8.5.

iii. The maximum likelihood is selected as clustering parametric rule.

iv. Maximum number of alteration can be adapted (6 to20)

v. Convergence threshold is 0.95

vi. To calculate the area of each class can be provided by the raster attribute option (add area column)

DATA ANALYSIS

The data was analyzed and as a result of images classification the followings are digitally GIS-based land cover land use maps for the study area (1972-1986-2000-2006) each class highlighted by suitable color as shown in figures 2,3,4 and 5).

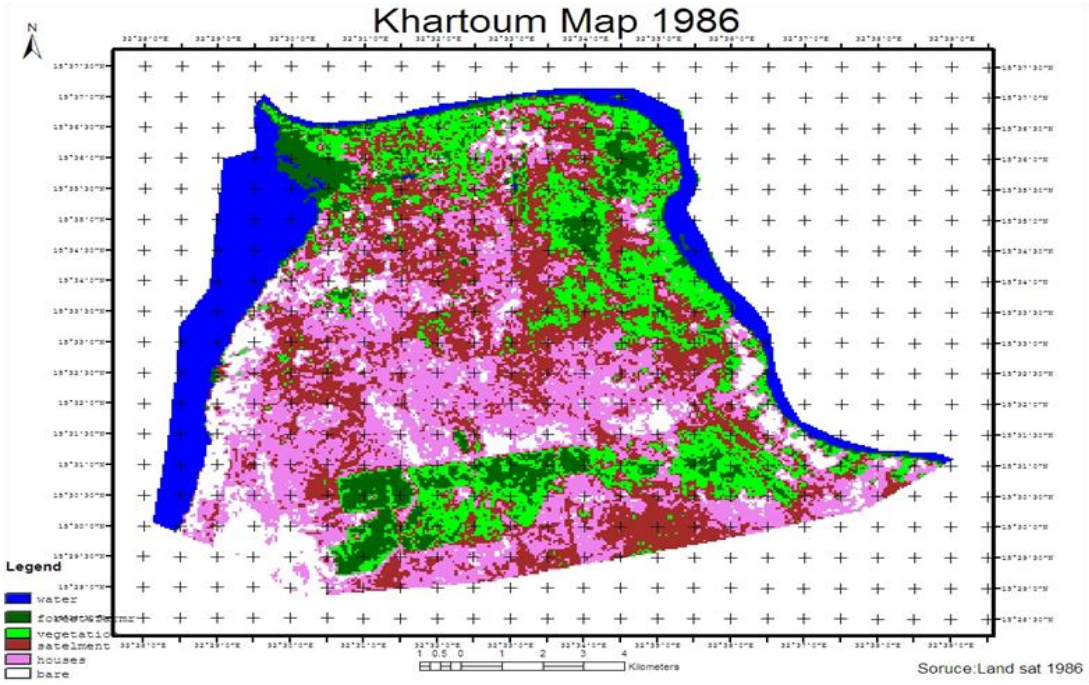

Figure 3: Khartoum map1986

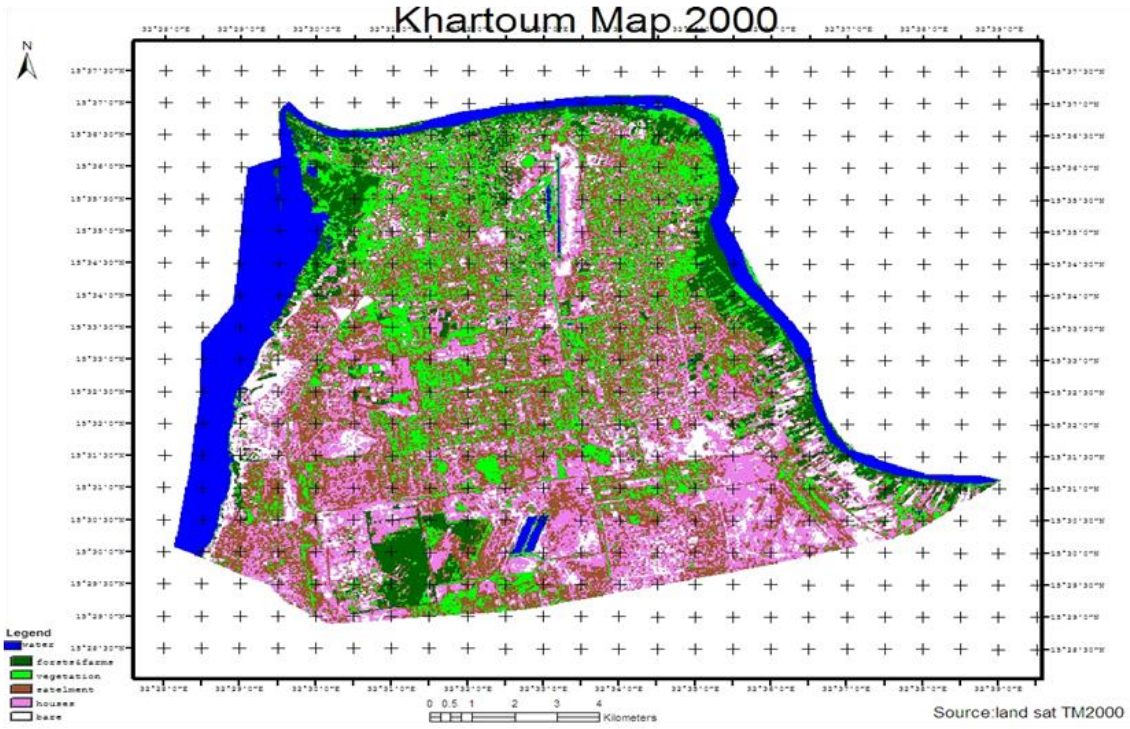

Figure 4: Khartoum map2000

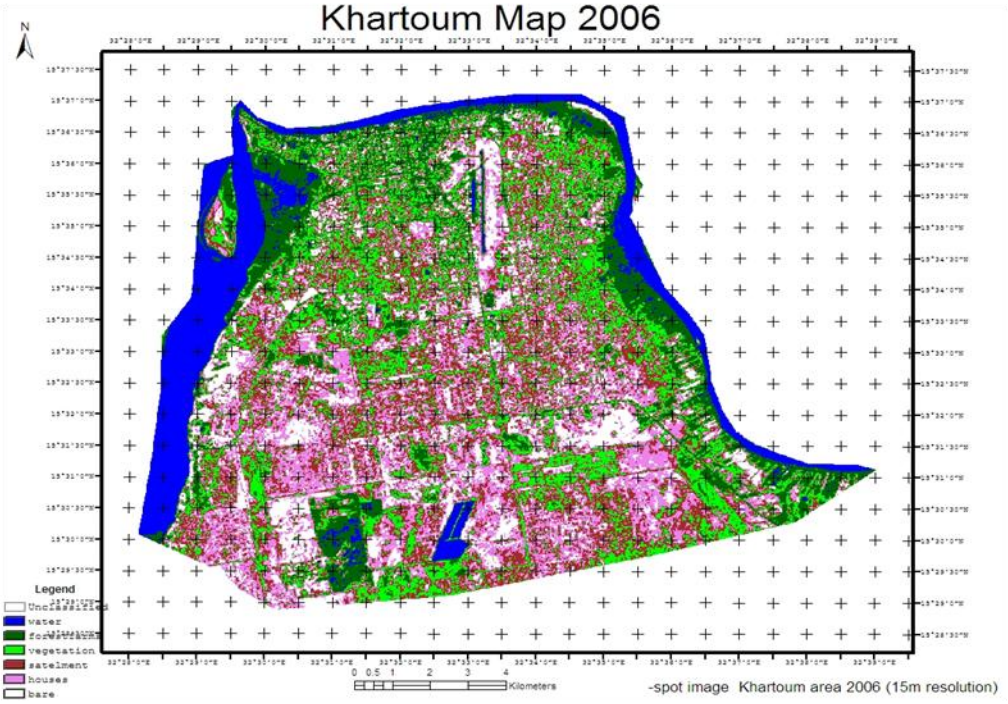

Figure 5: Khartoum map2006

RESULTS AND DISCUSSION

The images classification provide two outputs first spatial data which is the map in the previous chapter scanned area in hectare for each class of land use in each year in table 1. The numbers are the result of the image classification and they can give a very good indicator for land use land cover change.

Figure 6 represent the comparison of the land use during the period of the study.

Water surfaces are influenced by seasonal changes during flood\dray season so the numbers in the table are not an accurate indicator for permanent land use change. As shown in Figure 7 water body area in 1972, 1986, 2000.

Land cover by forest or used as farms are influenced by many factors, there seems to be a negative change a reduction in forest and farm land between 1972 and 1986. (Figure 8) forest ,farm ,vegetation area in 1972, 1986, 2000) This may be the change in the economic base of the city from farming and forest production to other jobs or economic resources as a result of the urban expansion or a result of deforestation, wood industry, and forest fire.

In the other hand there it seems to be a positive change in the farm and forest class after the year 2000-this may be the result of development in the farm production or forest protection politices.

The oil and gas exploration and production started to make a significant change in many ways around the year 2000, the most important is reducing the use of wood as an energy source and replace it with gas it is better, cheaper ,cleaner, easier, and now more available.

Area classified as settlement shows positive (Figure 9 settlement and house area in 1972, 1986, 2000) change between 1972-2000 that could be the result of many reasons: first of all population increasing because people need settlement homes, facilities and streets. Since Khartoum (the study area) is the capital of Sudan that made this city a special case. Settlement influenced by many factors migration, natural disaster, drought, dieses, civil war ….etc. All these enforce people to seek better life in the city better jobs, education, health care, and pace.

Table 1: land use classes area in hectares

	1972	1986	2000	2006
water	2333.43	2285.02	2185.03	2101.37
Forest farms	1904.23	1589.14	1672.34	2666.25
vegetation	2787.96	2977.38	3336.88	3676.09
settlement	4609.68	5146.09	5559.12	4542.19
houses	5987.90	5594.45	5014.01	4205.63
Bare land	1833.73	1864.60	1602.81	2144.75

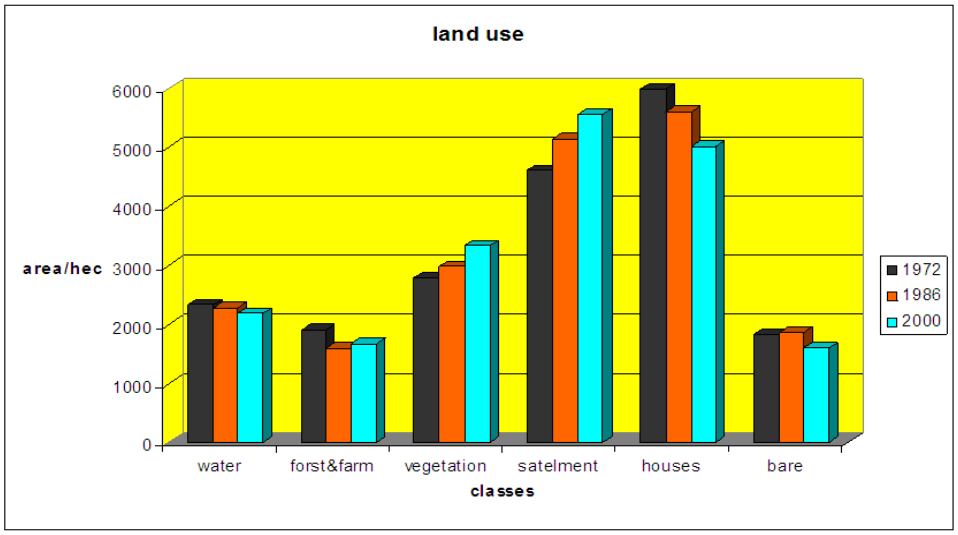

Figure 6: land use classes

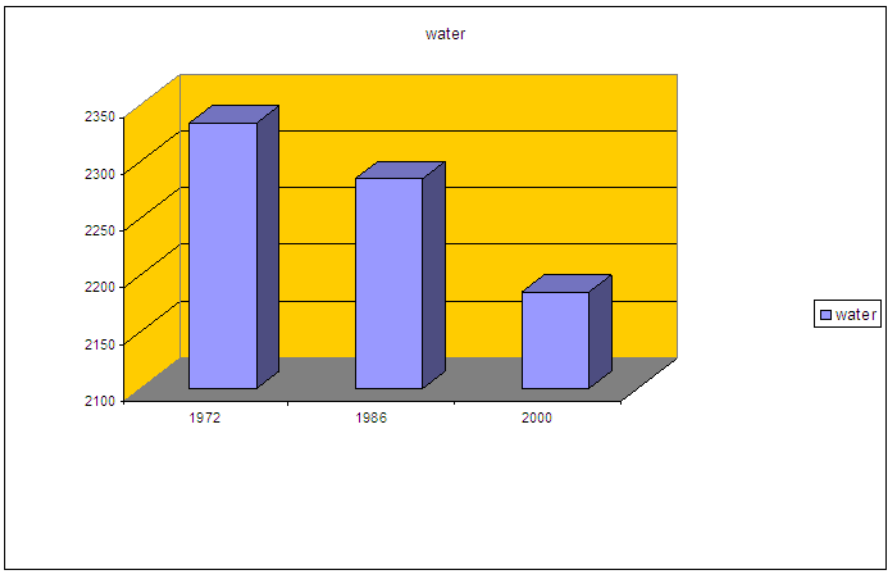

Figure 7: water body area in 1972, 1986, 2000

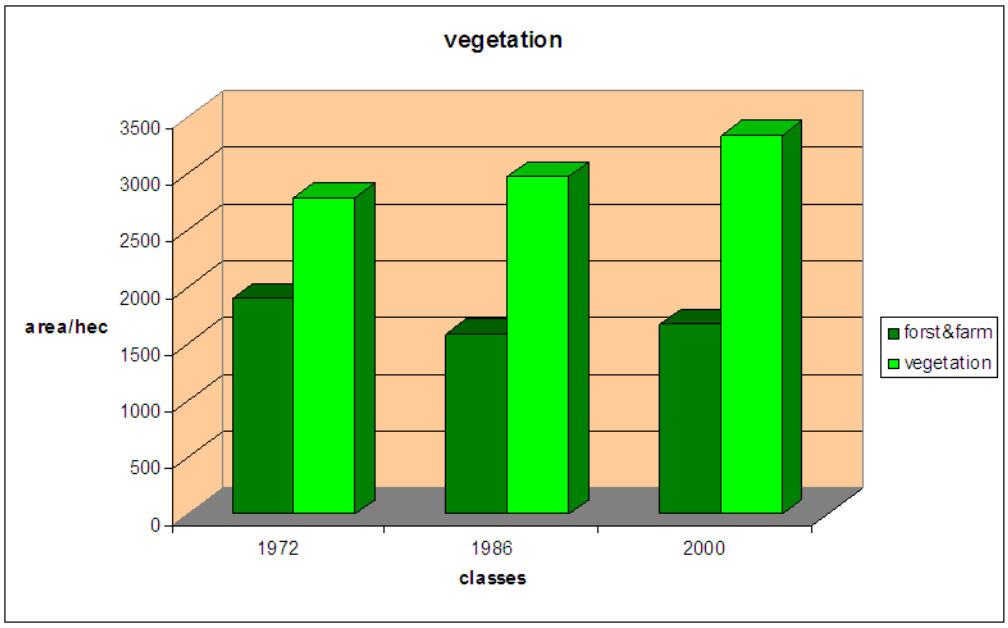

Figure 8: forest, farm, vegetation area in 1972, 1986, and 2000

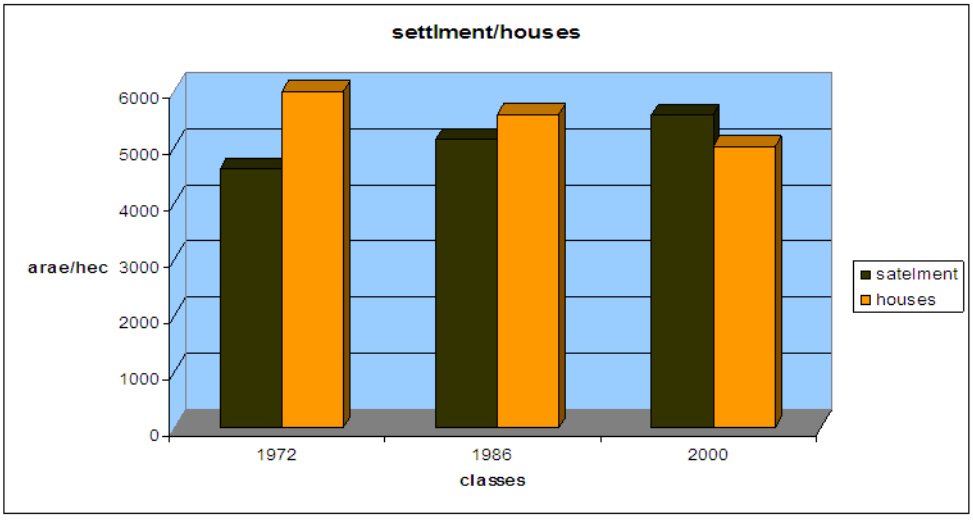

Figure 9: settlement and house area in 1972, 1986, 2000

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSION

This research afford did accomplish its goals by answering land use land cover change most important question like where, when, how mach and why land use land cover change had taken place in Khartoum area using geographical information systems and remote sensing techniques and multi temporal imagery.
All these questions are justified by importance of

land as a major recourse, to demonstrate that land sustainability is determined by how human use it and to avoid negative impact could've happened.

The research results showed 17.07% growth in settlement area while vegetation is decreasing.12.17% 1972-2000.

RECOMMENDATIONS

The following are recommendations:

-Result from modeling urban growth and land use change studies should be used by public land use planer and policy maker to anticipate and plan for the future.

-using the image classification as a methodology have some reservation because it is a design made by the software to cluster image pixels according to cartin range of its digital number into classes .

Digital number reflect brightness so feature may be classified wrongfully(e.g.) an air port run way classified as water, roofs made local soil may look like bare land. Therefore supervised classification with enough training samples is recommended for accurate results.

-Land use land cover researchers should consider population and their activities because it govern the way they well use land with therefore such studies should contain population, socioeconomic statistics but this information should be used carefully (e.g.) migration into the study area may increase settlement in the other hand their migration from it doesn't necessary reduce area of settlement unless there was a destruction because images shows building not people.

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