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# EFFECT OF LAND COVER CHANGE ON FRESH WATER ECOSYSTEM IN CALABAR MUNICIPALITY, CROSS RIVER STATE, NIGERIA.

***Offiong, R.A.[1], Offiong, V.E.[2], and Ekpe, I.A.[1]**
1. Dept. of geography & Environmental Science, University of Calabar, Nigeria.
2. Dept. of Urban & Regional Planning, Cross River University of Technology, Nigeria.

**ABSTRACT:** *The study examined the resultant effects of land cover changes on Anwatim River Located in Nkonib Clan, Calabar municipality. Anwatim River being a fresh water ecosystem that once served as a major source of drinking water and domestic water supply in the area is now lost due to land use and land cover changes. Data for the study was obtained from aerial photographs and was considered from 1980-2013. However, an interval of 10 years was used in determining the changes that have occurred alongside effects on the river size. Remote sensing and geographic information systems (Arc view GIS 9.3 software) technology was used in change detection analysis. From the study, it was revealed that from 1980-1989, the land cover was about 3,198,553.7 square meters with a river size of 883,463.5 square meters. Between 1990 and 1999, the land cover was reduced to 2,765,521.2 square meters which then reduced the stream size to 782,124.0 square meters. Similarly, in the years 2000-2009, further depreciation in land cover was observed to be 415,732.9 square meters. In 2013, land cover area of 72,390.4 square meters is now what is left with a corresponding river size reduction to 3677.9 square meters. Therefore, the total land cover loss of 3,126,163.3 square meters to built-up areas (housing and industrial development) have led to a total loss of 3,194,875.7 square meter of Anwatim River in size and extent.*

**KEYWORDS**: Effects, Land cover Change, Stream loss , Anwatim River, Calabar Municipality.

## INTRODUCTION

Land cover change is a conservation term that describes the gradual or swift removal of the natural vegetative cover of the earth surface. The purposes for which natural land covers are removed may include agriculture, mining or urbanization. This activity has great impact on the surrounding environment especially on nearby streams. According to Getachew and Melesse (2012) human health and welfare, food security and industrial developments are dependent on adequate supplies of suitable water; however, water resources are affected by many parameters. One of the parameters that affect the quantity of water flowing in a watershed is land use of the watershed area. Urban development near streams alters inputs (including nutrients, contaminants and sediment), flashiness of discharge, and temperature (Paul & Meyer 2001; Morgan & Cushman 2005).

A study conducted by Mutie, Mati, Home, Gadain, & Gathenya (2006), showed that such anthropogenic activities reduced water bodies' areal extent by 47%. This is because Streams collect runoff, heat, and sediment from their watersheds, making them highly vulnerable to

anthropogenic disturbances that result into loss of ecosystem structure and services (Nelson, Palmer, Pizzuto, Moglen, Angermeier, Hilderbrand, Dettinger, & Hayhoe, 2009).

Within the last two and a half decades, Calabar municipality has experienced unprecedented urban growth. This has led to alternation and alteration of several land uses. According to Atu et al (2012), in the past decade, the city's built up area burst outward in an explosion of sprawl that consumed former agricultural land at a break-neck pace. Thousands of hectares of agricultural land are covered by concrete and asphalt as new roads are created and existing ones are extended. Over 5,200.09 hectares of the former agricultural land at Ekorinim, Esuk Utan, Edim-Otop, Anantigha, and Ikot Efanga have been converted to low density residential, commercial and industrial uses as these areas are merged with the urban areas. This development is consequent on the growth of the population of Calabar. For instance in 1991, the population of Calabar was 328, 876, with a density of less than a thousand person per square kilometer. In 2006, it was 375, 196. At present, the population of Calabar is estimated to be over 399, 761 (National population Commission 2010) while the population density is above 1,237 persons per square kilometer (Cross River State Economic Blueprint 2007-2008). One of the mostly affected streams as a result of increased urbanization in Calabar municipality is the Anwatim River. This served as source of drinking water to the nearby communities before the rapid trend of urbanization and the consequent land cover change around the area came to the fore.

The effects of land cover change have caused the loss of fresh and portable water needs loss in the area alongside occupational dislocation. This is due to the fact that most of the inhabitants of the area were involved in fishing as a source of livelihood sustainability. In the same vein, the distance in which people travel to get water have also been on the increase, thus making water availability a problem in the area. In view of these, this study seek to evaluate the changes in land cover of this area and its resultant effects on physical attributes of Anwatim River vis-à-vis the resultant socioeconomic impacts on the inhabitants of the area.

## MATERIALS AND METHOD

### Study Area

The study area is Ikot Anwatim in Calabar Municipality. Calabar has a land area of about 30,355 square kilometers and a total population of 503,819 according to 2006 population census (Cross River State development project 2007). It is located on latitude $5^0 00^{'}$N and $5^0$10'and longitude $8^0$19' and $8^0$20'E. Calabar municipality is bounded to Odukpani L.G.A in the north, Akpabuyo L.G.A, to the south by the Atlantic Ocean and west by Calabar River. Calabar is affected by the weather conditions due to its unique coastal location and high rainfall associated with the tropical rainforest. It is characterized by rainfall which starts from the month of April to October, reaching its climax in the month of June and September. The remaining four month make up the dry season with the Harmattan wind blowing over the area. The rain falls averagely at 172mm with temperature of $29^0$C at warmest and $17^0$C at coldest (www.google.com Calabar weather report 2011). The vegetation of the study area is mainly riparian and fresh water swamp forests. Also, a few derived savanna vegetation, cultigens and ornamental/avenue tree/shrub species are present in the area. The dominant soil type is the clayey- loamy soils. The topography of the study area is the low lying coastal plain of the Calabar River and Great Kwa River. It is relatively undulating

with a few hills and valleys running east-west wards. Several rivers/streams exist in the area and are basically drained by the aforementioned rivers. The Geology of the area is mainly sand stone.

**Procedure for data collection**

Data was collected using stratified sampling. This was based on 10 years interval. This was done through the aid of aerial photographs of the area, obtained from the department of Geography and environmental science cartography unit, university of Calabar, Calabar.

Furthermore, the remote sensing and the geographic information system (GIS) technology and applications were applied in the determination of the land cover changes. The stepwise methodology was also used for careful examination of aerial photographs, development of an interpretation key, plotting of the stream area boundary, geo-referencing of digital data, interpretation of data, collecting of ground truth data, editing, finalizing of maps and extraction of statistical data for the different land cover (Njungbwen and Njungbwen, 2011;, Singh and Loshali, 2005; Gourmelon et al., 2004, Acevedo et al., 2003, Ashbindu et al., 2001 and Geomatics International Inc. 1996).

However, the Arc view GIS 9.3 software was used for the analysis of topology which was established among the lines and polygons and the coding of the various land cover. Appropriate colours were given to the different land covers. Layouts were developed for them and the final maps produced. Quantitative data for the different land cover for the different time periods were then extracted. The change detection analysis was carried out. This was done by subtracting the values of the previous inventory data from the current one and the rate of the changes was determined by calculating their respective percentage values (Woodwell et al. 1984, Williams 1984).

**Data Analysis**

The obtained was analyzed using tables and maps. The size and area of the land cover changes were calculated and represented in square meters. The rationale for these was based on the total size of the study area, being a small unit of the biophysical environment in Calabar Municipality.

## RESULTS AND DISCUSSION

Sequel to the general objective of this study, it was generally observed that there was an exponential growth in the city which have led to the quest for land, housing and other facilities/infrastructures that have given rise to changes in land cover, thus, reduction and loss of the Anwatim fresh water stream as shown in Table 1.

**Table 1: Land Cover Change in the Study Area**

| S/N | Year | Land Cover (Sq.M) | Built-up Area (Sq.M) | River Size (Sq.M) | Total River Loss (Sq.M) |
|---|---|---|---|---|---|
| 1 | 1980-1989 | 3198553.678 | 0.0 | 883463.516 | 0.0 |
| 2 | 1990-1999 | 2765521.165 | 433032.513 | 782124.000 | 101339.516 |
| 3 | 2000-2009 | 415732.945 | 2782820.733 | 39571.895 | 843891.621 |
| 4 | 2013 | 72390.387 | 3126163.291 | 3677.953 | 3194875.725 |

Source: Author's Computations (2013)

Between the years 1980-1989 it was observed that the natural land covers (vegetation components) was 3,198,553.7 square metres while the built up areas around the water body was almost 0.01 square metres. Also, the size of the Anwatim river was 883,463.5 square metres with a near zero loss as at the year of data collection. Considering urban expansion between the years 1990-1999, it was observed that there were changes in the land cover on the reducing end, and corresponding increase in built-up areas. Hence, the land cover of the area was reduced to 2,765,521.2 square metres, while the built up area increased to 433,032.5 square metres with a reduction in the size of the river to 782,124.0 square metres leading to a total loss of 101,339.5 square metres. Between the years 2000-2009, the land cover was further reduced to 415,732.9 square metres with a corresponding increase in built-up area with a value of 2,782,820.7 square metres. This increase thus, posed a significant effect on the size of the river as it further depleted to 39,571.9 square metres with a total area loss of 843,891.6 square metres as shown in figures 1-3.

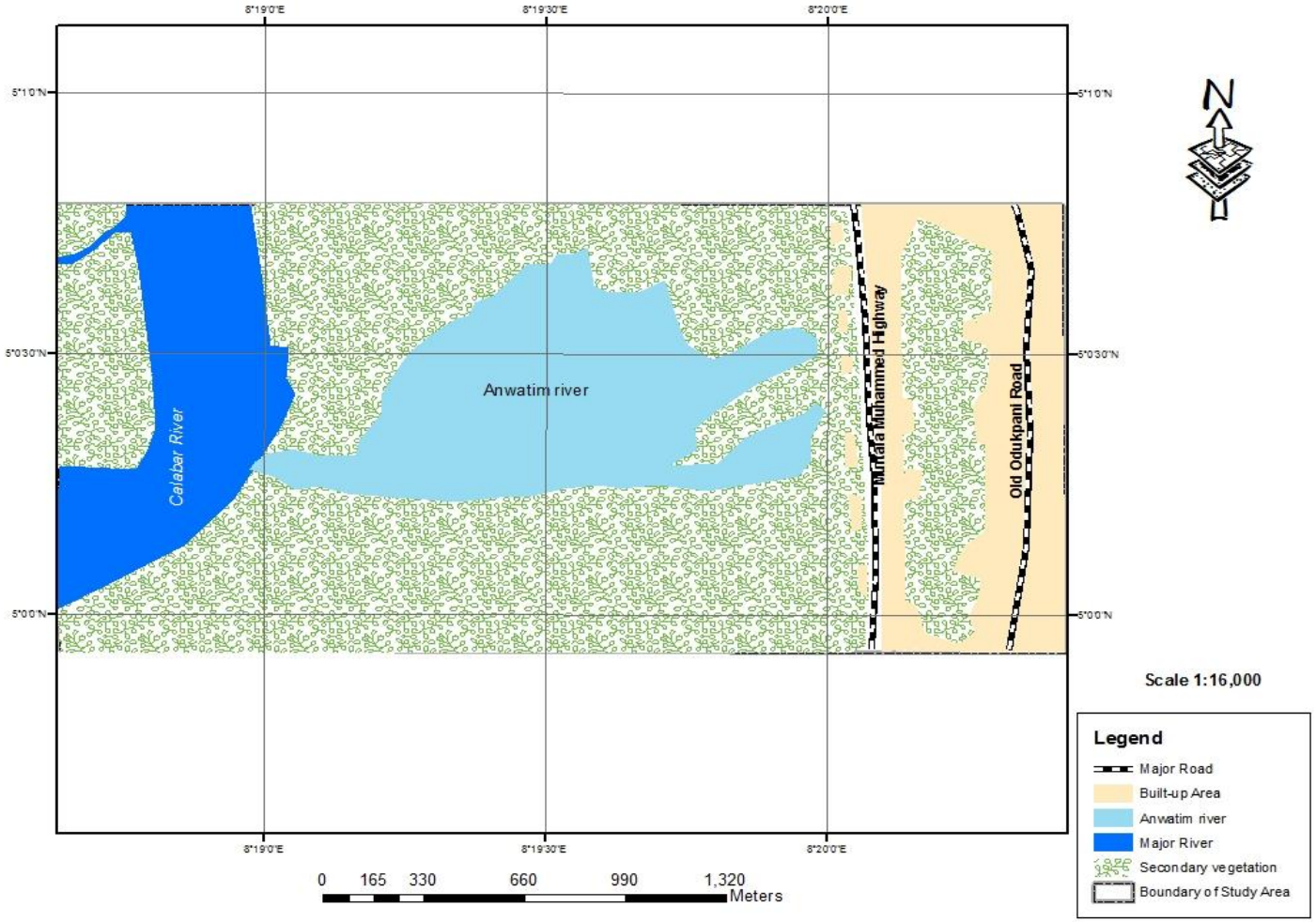


**Fig.1:**

**1980 – 1989 Land cover change**

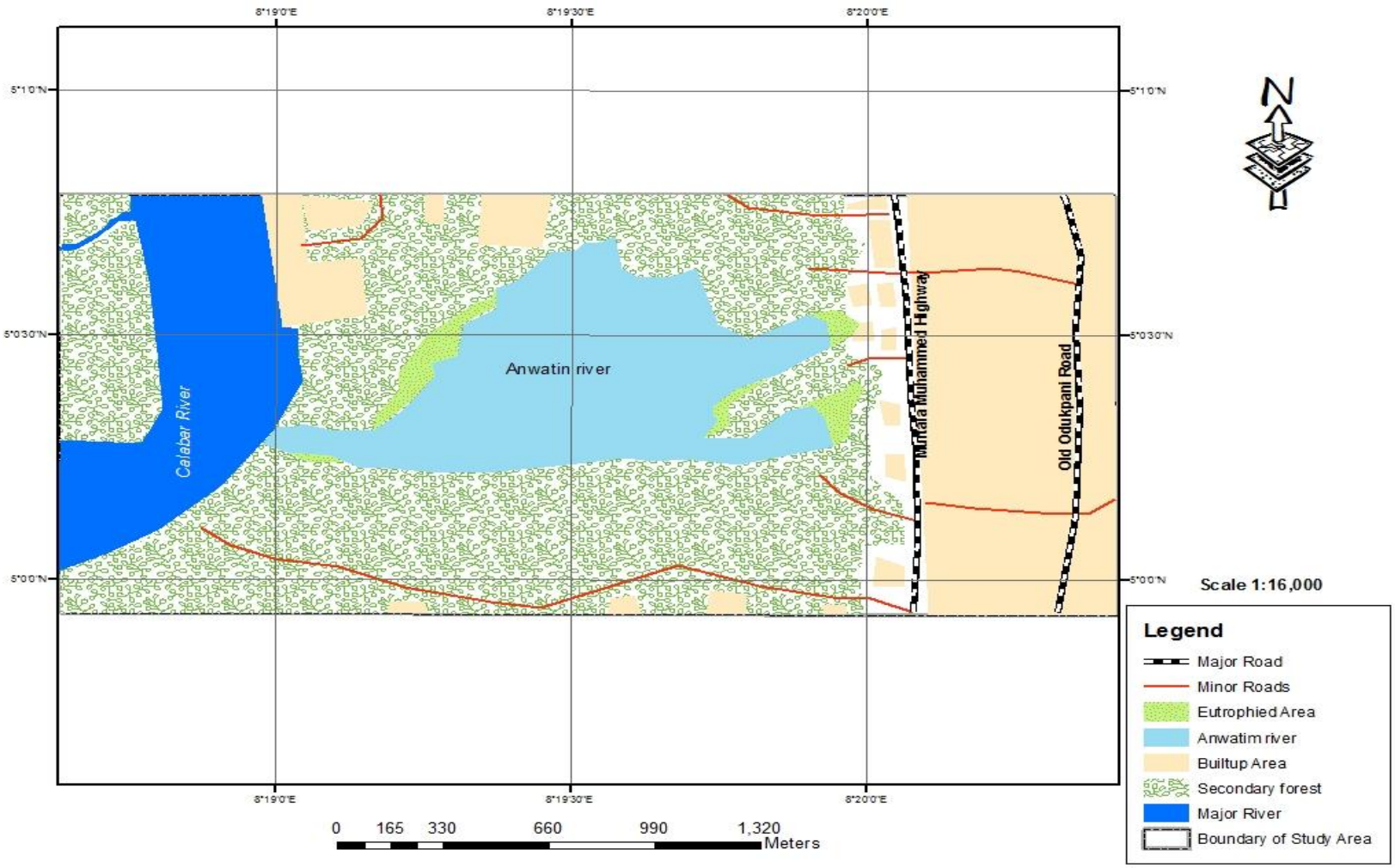


**Fig.2: 1990 – 1999 Land cover Change**

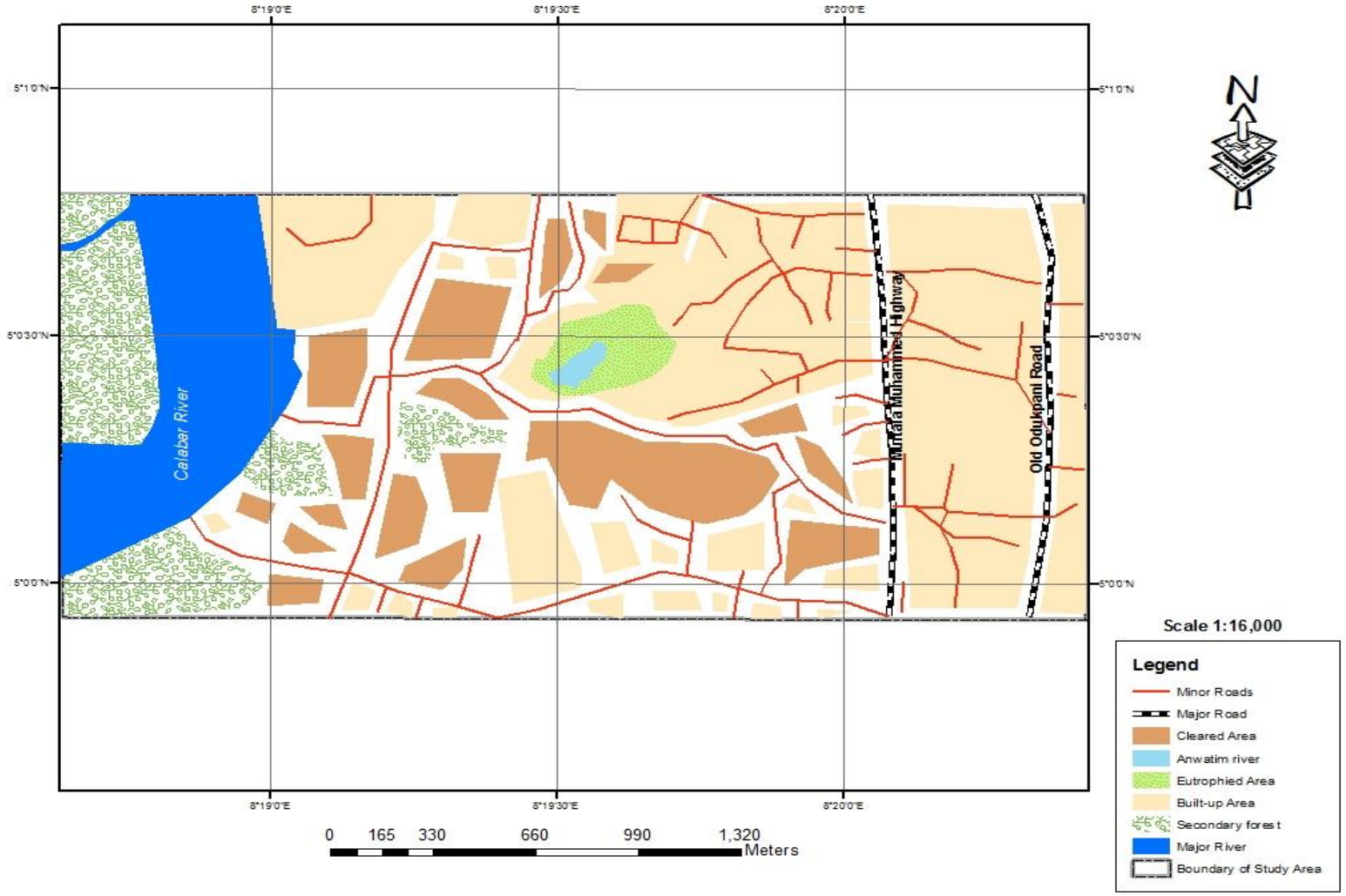


**Fig. 3: 2000 – 2009 Land cover Change**

Nevertheless, the researchers were also interested in seeing the possible impacts this changes in land cover in the study area must have caused as at June, 2013. Hence, it was observed that land acquisition and development projects are still ongoing as some individuals are almost building on the remaining minute water body. Based on these, it was seen that land cover had changed by further reducing to 72,390.4 square metres while the built-up area have dramatically increased to 3,126,163.3 square metres, thereby reducing the area covered by this stream to 3,677.9 square metres. However, these have brought the total area of the stream loss to about 3,194,875.7 square metres. This loss is a huge one and has pose a serious problem on the people of the area, especially in the aspect of fresh domestic and portable water provision for livelihood sustainability. This is presented in figure 4.

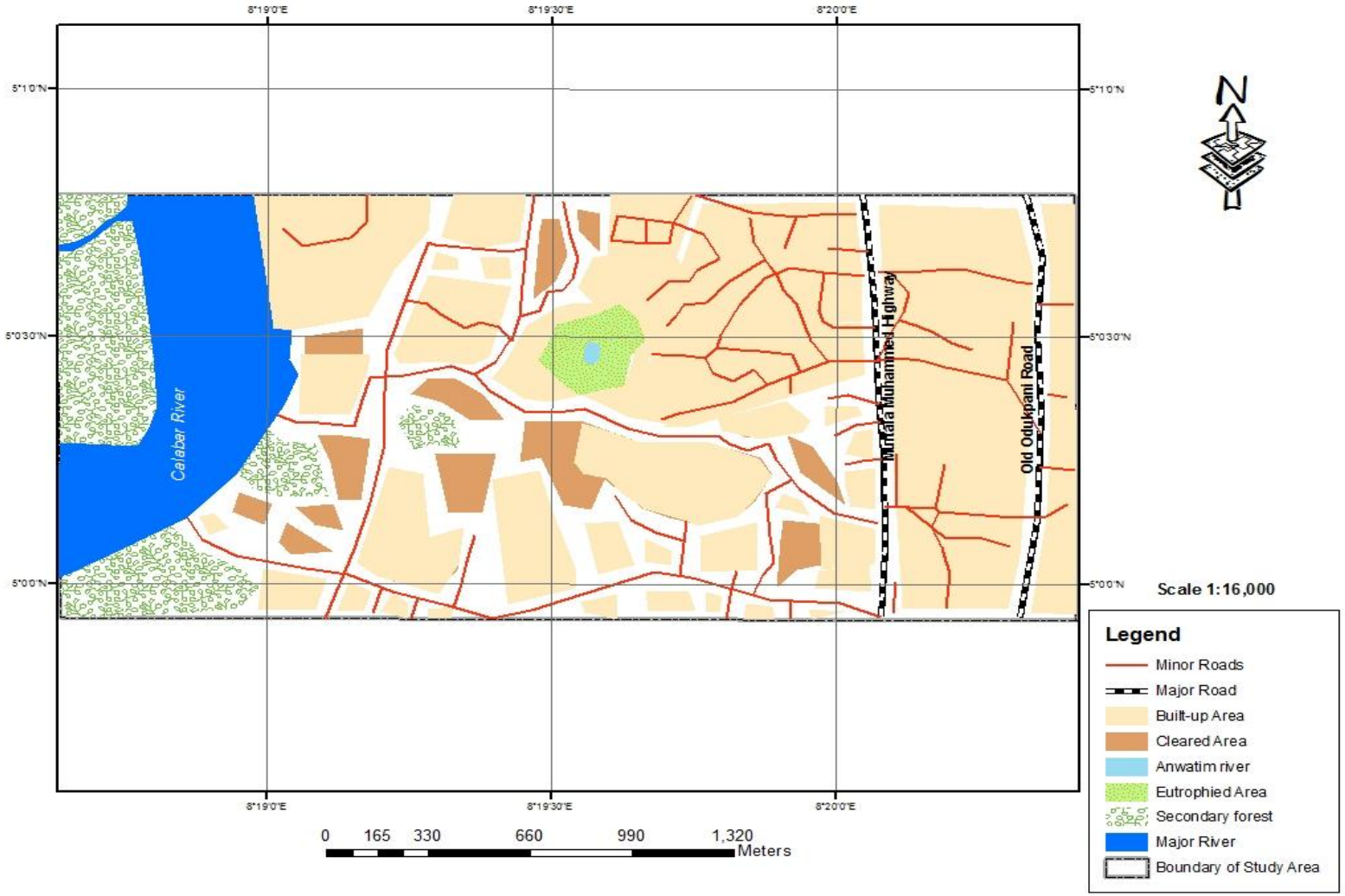


**Fig. 4: 2013 Land cover change**

Invariably, this stream loss is highly attributed to the recurrent disturbances in the area, especially on the vegetation cover of the area. This has disrupted the ecosystem, community, population structure and changes in resources, substrate availability and physical environment of the Anwatim River. This corroborates the studies carried out by Davis and Moritz (2001). However, the change in land cover in the area has enhanced the transportation and deposition of sediments and silts that have facilitated the loss of the stream through primary succession and eutrophication processes. Therefore, the once healthy Anwatim River is now gone in structure, size, extent, depth and quality (Noordwijk et al., 2004). This stream loss appears to be unmanageable as housing and industrial development in this region is uncontrollable by the authorities saddled with the responsibility of regulating housing/industrial developments are not effectively discharging their statutory functions.

## CONCLUSION

In this study, the changes in land cover from vegetation to built-up areas (Housing and industrial facilities) as determined by an integrated method using remote sensing and GIS showed that urban settlement expansion is on the increase from 1980 to 2013. This expansion has led to drastic loss in the Anwatim River with a total area of 3,194,875 square metres. This have now left the area available with water at 3,677.9 square metres at the present (2013). In addition, the water appears to be murky and polluted. In the same vein, since the urban population is on the rise, viz-a-viz quest for land, there is a possibility for further destruction of other streams in Calabar Municipality. Therefore, the ministries of lands and housing, commerce and industry, and ministry of environment should carry out a study on the available stream/rivers found in the area, and regulate housing and industrial development in these areas in order to ensure sustainable urban naturally occurring water systems and supplies.

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