AN EVALUATION OF THE INFLUENCE OF LAND-USE/LAND-COVER CHANGE ON THE SURFACE TEMPERATURE OF FEDERAL CAPITAL CITY (ABUJA) USING REMOTE SENSING AND GIS

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INTRODUCTION

The climate in cities and other built up areas is altered most by the modifications humans make to the surface of the Earth during urbanization (Streutker, 2002). City surfaces are typically rougher and often drier as naturally vegetated surfaces are replaced by buildings and paved streets.

An urban area is an area with an increased density of human created structures in comparison to the areas surrounding it. These areas may be cities or towns, created and further developed by the process of urbanization. Urban areas are highly dynamic and are continually undergoing rapid changes, one of which is changes observed in land-use/land-cover (LULC) also known as land change. The knowledge of land use/land cover change is important to understanding certain occurrences in the earth's biophysical composition. It entails a conversion of natural types of land to uses associated with growth of population and economy, transforming the landscape from its natural form to impervious urban lands termed cities and towns. According to Detwyler and Marcus cited in Griffith (1976), "cities are expressed as the nodes of man's greatest impact on nature, the places where he has most altered the essentially reserved resources such as land, air, water and even organisms. A city is the quintessence of man's

capacity to induce and control changes in his habitat. Through urbanization, man has created new ecosystems within which the interactions of man, his works and nature are examples". This goes to say that urbanization as a necessary process that leads to the formation of what we now have as urban areas is not without its consequences, one of which is the modification of land surface and atmospheric boundary conditions that lead to a modified thermal climate which leaves the cities warmer than surrounding non urbanized areas.

The aim of this study is to evaluate the effect of land-use/land cover changes on surface temperature in the Federal Capital City using remote sensing and GIS

STUDY AREA

Abuja, the Federal Capital Territory (FCT), lies between latitude 9°4′North of the equator and longitude 7°29′East of the Greenwich Meridian. It is a planned city in the centre of the country bordered to the north by Kaduna state, to the east by Nassarawa state, to the south-west by Kogi state and to the west by Niger state. The Federal Capital City (FCC) which is the study area is located at the north eastern part of the FCT on lat 09.00^0 – lat 09.12^0N and long 07.26^0 – long 07.32^0E. It covers about 52.9sqkm of the total land area of the FCT. The area is considered the most ideal and conducive for human habitation and settlement development within the FCT (Mabogunje, 1976). The FCC is rich in infrastructure such as expanding road network, drainage and sewage systems, pipe borne water, electricity, and communication networks. Due to its central location and accessibility, people from all parts of the country crowd into the city in search of better living.

Figure 1.1 shows a map of the federal capital city (FCC) and its position in the federal capital territory (FCT). The five district areas of the FCC can be located on the map, also displayed are some selected areas of greenery, buildings and roads.

MATERIAL AND METHOD

The main data used in this work were Landsat images gotten from the global land cover facility (GLCF) site. The data

collection of interest were chosen, in which case it is IMAGERY for this purpose, and then the LANDSAT header was selected from where an OVERVIEW page comes up. At this stage, the researcher looked through the archives for images available for the years of interest. Data (images) was downloaded to the C –drive of the computer in use, this was done through the Earth Science Data Interface (ESDI).

RESULTS

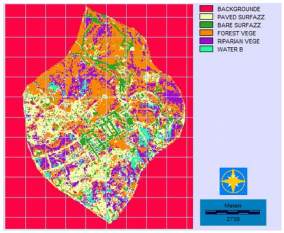


Figure 1.2 Land use/land cover map 1987

Figure 1.2 is the land use/cover map of 1987 and it shows the result of LULC classification of the study site for 1987, six classes are here identified with the background given a 0.00 value which makes it negligible in the course of the work. The main LULC identified are displayed and can be identified using the map legend.

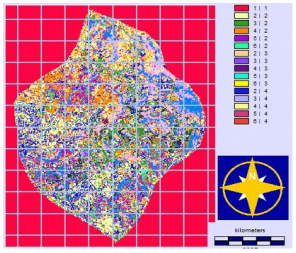
The comparison of the year 1987/2001, bare surface was more in 1987 than 2001 (%) difference of -46.18), implying that by the year 2001, such surface had significantly converted to other land cover In the same vein, sparse vegetation by 2001 converted to other land cover as the percentage difference shows (-12.11%), similarly some water body too changed (-80.34%) probably owing to seasonal changes in weather (period which image was acquired). These changes are not uncommon and can be explained by the fact that the FCT was officially made Nigeria's state capital only within the time (1991), development until this time was stunted so most of the land was used by the locals for agriculture while most other parts, even within the present FCC was forested. By the year 2001, paved surfaces had increased (18.57%) and the riparian vegetation too increased.

Land Use/Land Cover Change Analysis; 1987/2001.

Figure 1.3 show the changes that occured over 14 years between 1987 and 2001. The legend shows two rows of numbers, the first year (1987) representing year A is in the column while the second year (2001) representing year B is in the row.

The various colours in the boxes against the numbers represent each layer that has changed, for example, the first box which has figure 1/1 means that there has been no change from

class one in 1987(A) to class one in year (B). looking at the area where the colour comes up on the image shows this is true, i.e the background class remains the same for year (A) and year (B).

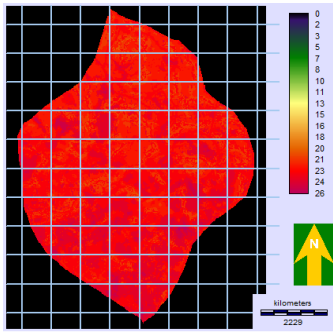


The second shows 2/2, this means built-up remained the same in the white region for both years. The third shows 3/2, now, here we have a variation displayed, meaning that areas with the green colour changed from bare surface (class 3) in 1987 to built-up (class 2) in 2001. this can be interpreted for all other parts of the legend. The Built environment, which is the main interest class in this study changed at one time to bare surface and at another to sparse vegetation which is possible as bare surface can be constructed on while vegetation can be cleared for buildings.

Surface Temperature, 1987

little below 16^0c to 26^0c

Emissivity of the various land use classes and black body temperature from band 6) generated this surface temperature. It can be said that 1987 was a relatively cool year with the highest temperature range at 26 degree Celsius, the effect of the green areas dominant at that time is evident. Figure 1.4 shows this clearly.



The series of land uses which have their individual emissivity, display these v

The purple colour, falling within 24^0c– 26^0c indicates the highest temperature for that year and this shows more in the built up areas while the range from 21^0c - 23^0c is the next highest and still falls within the paved areas, the range from 16^0c – 22^0c is the lowest temperature record for the region and it is noticed that the riparian vegetation and other vegetation reflect this amount.

Surface Temperature, 2001

Figure 1.5 gives a clear picture of the sharp rise

anthropogenic

changes in surface reflectance in the landscape.

The temperature range for 2001 is between 28^{0}c and 48^{0}c which is quite alarming as compared to previous year (16^{0}c to 26^{0}c). The vegetated areas, especially the dense riparian around the National Arboretum on lat has the lowest surface reflectance between 28^{0}c and 32^{0}c, another range between 33^{0}c and 39^{0}c is observed and this covers the built-up and other paved surfaces. A third range, falling from 40^{0}c to 45^{0}c covers the densely built areas and a final range 46^{0}c - 480c comes mainly fron

are also paved. The highest range of temperature for 2001 which is between 53^{0}c and 55^{0}c is hardly observed on any land cover except for a small portion of built-up in central area and as such is considered negligible.

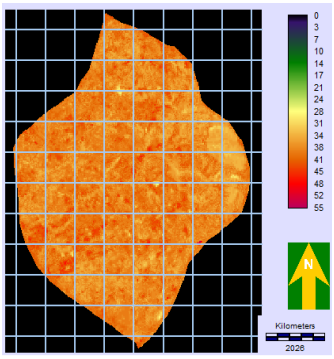


Figure 1.5 Surface Temperature Map 2001

Surface Temperature for Various LULC

The different types of paved surfaces; roofs, buildings, asphalt (roads), all have high but vsaried reflectance since they are all made from different materials and colours, and these affect the level to which each surface react to radiation. The general range of reflectance for all paved surface is summarized and an average value chosen for this work. Same goes for all other land uses in all the years.

Year 1987/2001

Table 1.2 gives a picture of what each land use class for 1987 and 2001 respectively generated in terms of surface temperature. It also gives the

The various surface temperatures reflected by each LULC identified in the study area for 1987 and 2001 is displayed. It is presented this way so that instant comparison can be made. As usual, background values remain 0.00. Just like sharp changes could be observed between both years for land use and land cover, so also is the variation of LULC with temperature. Paved surface gives a 24.50^{0}c reflectance for 1987 while by 2001, the same land use class reflects 41.80^{0}c giving a temperature difference of 17.30^{0}c between both years which is alarming. All other land use/land cover classes also recorded increased temperature in 2001 showing that the temperature over the city in

that year was generally higher than was obtained in the former year.

CONCLUSION

Variations in urban land use was greatly observed between the years 1987 and 2001, this impacted adversely on the surface temperature record of the later year with temperature rise ranging from 28^0 - 36^0 and 38^0-48^0in extreme cases (accounting for very negligible portion of the surface) in 2001 as compared to the tolerable and comfortable temperature range of 16^0- 21^0 and extreme of 22^0- 26^0 in 1987. This may be as a result of the governments consciousness towards implementing the master plan of Abuja city within this periods, several buildings and land cover were demolished in the process and some of these areas were converted to gardens and other aesthetical features often natural vegetation in the form of special trees and flowers along pavements, roads and built-up environments.

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