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Monitoring Water Resource Degradation Using Multiple Imageries and Techniques on Watersheds of Minna, Niger State, Nigeria

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Abstract

The resource basis for life and economic development are land and water. Severe stress and strain on water resources have caused watershed degradation. Eventual environmental and socio economic costs of sustaining watershed from the malaise need to be advanced. This paper targets advancing means to monitor so as to acquire level of watershed resources degradation using empirical data from satellite imageries. The watershed resource of Minna is assessed, land use impacts mapped out from which resources damages unveiled and solutions to sustain the resources provided. The data used are as generated from digitally processed Multispectral Scanner MSS, thematic mapper, TM and Landsat imageries of 1973, 1995 and 2007 as in Salahu (2010). By the use of ArcGIS, ArcView and Idirisi software, watershed analysis was carried out. Based on lanu use categorization following the study made in Anderson, (1976), EOSAT (1992), Meyer (1995), and the subsequent data collection, processing and analysis, it was observed that water shed seriously reduced from 22.18% in 1995 to 12.12% in 2007. It is therefore concluded that lack of resources data, research and development have constitute the major problems of water resources management in Nigeria.

Introduction

It is crucial to observe that there is severe stress on water resources which calls for the need for proper use and management of the resources. Utilization and productivity of the water resources have caused the deterioration of watershed in most parts of the world. Watershed is an independent flowing hydrological unit that its manipulation in any form will be noticed from its degradation. Watershed need to be properly managed using appropriate investment.

The development of remote sensing as a (n) (image) data source is useful to watershed in resource inventorying, monitoring and insights built-up into the complexity of natural environment. This research and development tool does not only provide solution to problems but it also provides the basic information necessary for arriving at solution.

Nigeria watershed has many problems such as population on water, continuums and uncontrolled exploitation of water, gully erosion in the south-east and the central states in the north, and coastal and marine erosion. We are also faced with other watershed problems such as oil pollution, industrial pollution, lands destruction and extensive deforestation as well as soil crust formation. Monitoring of the water resource to unveil the impacts of these problems is the thrust of the paper.

Means to Sustain Watershed Resources

To sustain watershed resources, Nigeria needs a coherent strategy and action plan to address the depletion of its natural resources as well as the growing environment problems. The aim of such approach is to assess the land use dynamics, determine level of the watershed shrinkage and make appropriate recommendation. These are the mission thrust of the paper.

The Study Area

The study is significant as a support to the arrest of effects caused by the intensified human pressure on the water resources in Minna. Minna is situated about 80 kilometers northwest of Abuja with an estimated population of 133,600 as in 1995 population census. It is located between latitude 9°3622"N of the equator and longitude 6°3315"E on a geographical base of the undifferentiated basement complex of gneiss and magnets. The city has a climatic depiction of middle belt zone.

The hydrological accounts of the area shows that River Chanchaga is the main source from the north central highlands and flows towards the western lowlands within the region and meeting River Kaduna at a point south West from the state capital, Minna. The river Chanchaga has an estimated length of 37 kilometers (Udo, 2002).

The climate of Minna shows that it is located in a tropical climate of wet (last within October and March) and dry seasons with an annual rainfall of less than 1000mm in the wet season that lasts between months of July and August. The temperature varies within the region annually with minimum below 20°C during harmattan period (late December and January) in the following year and above 26°C with maximum at about 30°C.

The vegetation is of tropical savannah type that changes annually. During the wet season and dry season the vegetation is evergreen and dries up, accordingly. The physiography of the area depicts that it is on a fairly high topography which decreases from the surrounding highland towards the main wide valley.

Materials and Methods

The study has used Multispectral Scanner MSS, Thematic Mapper, TM and Landsat imageries of 1973, 1995 and 2007. It has also used ArcGIS software for data display and processing, ArcView 3.2a software for image display, processing and enhancement and Idirisi 32 software for development of land use/land cover classes. Other materials used are Microsoft words software to present the research and Microsoft Excel software to produce the bar graph, as detailed in Salahu (2010).

The study also followed the methods of geo-referencing that established the spatial referencing system to which all the spatial measurements were related. Therefore, the measurements made by satellite of the irregular earth surface were progressively transformed to the flat surface of a map for ease of measurements and use of coordinate system. The study also involved image enhancement to ease visual analysis on the imageries by means of filtering and contrast stretching as haze and cloud were removed from the imageries. There is also image classification as given in the land use classes by Anderson, (1976), and also using computer-assisted routines to aid image interpretation of the water resources, manual delineation of the watershed boundaries and processing of the satellite imageries to Geographic Information System (GIS).

Results

The 1973 MSS, 1995 Landsat TM and 2007 Landsat ETM land use categories are presented in figure 1.0, 2.0 and 3.0 respectively. Details of the imagery characteristics can be found in Salahu (2010). The categories can be seen identified as dry vegetation, wet vegetation, bare lands and built-up land uses with their respective percentages as depicted on the graphs.

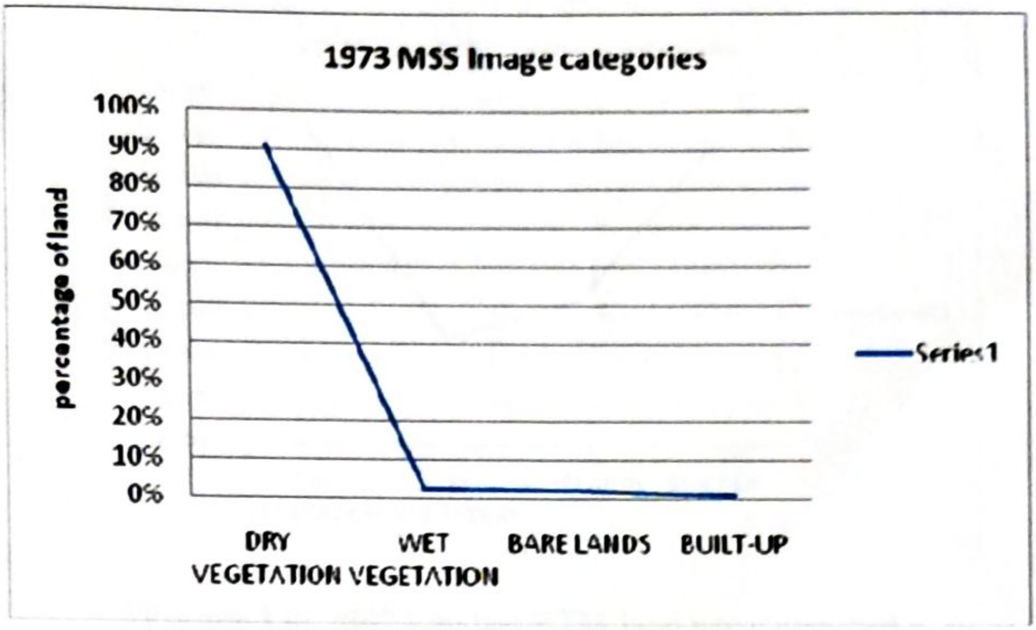

Figure 1.0: 1973 MSS land use categories

The dry vegetation has 403.13km or 91 percentage of the total land covered in the study. The wet vegetation has trapped up to 2.51%, bare land was 2.22% and the built-up or developed area was found to be only 0.96%.

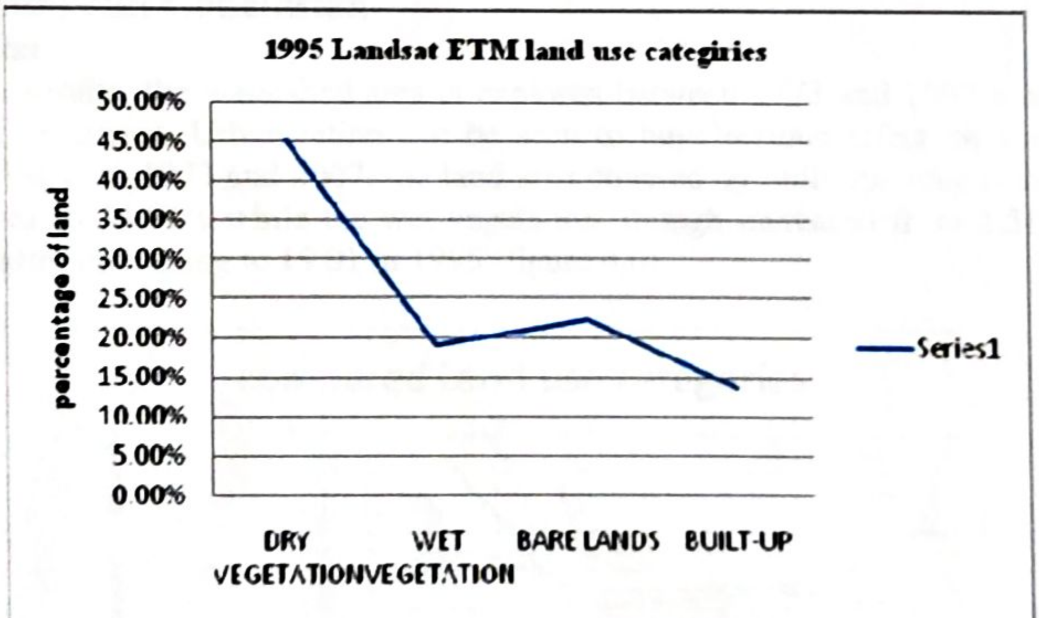

Figure 2.0: 1995 Landsat ETM land use categories

The wet vegetation has trapped up to 19.01%, the dry vegetation has 45.26 percentage of the total land covered in the study. Bare land was 22.18% and the built-up or developed area was found to be only 13.57%.

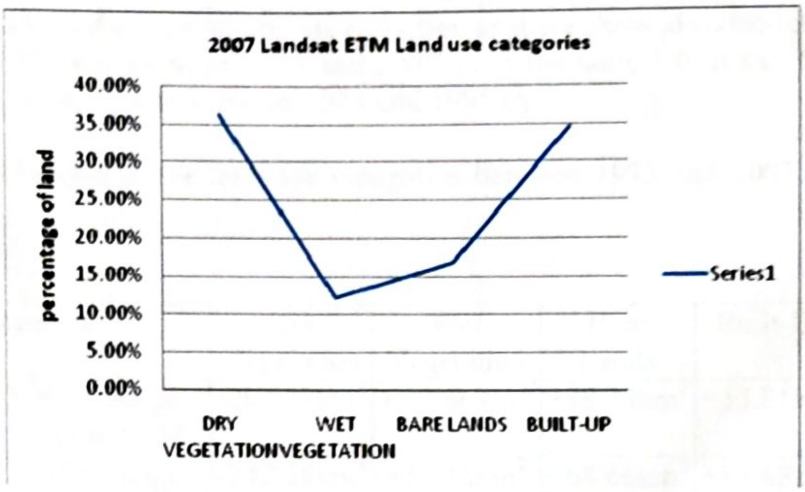

Figure 3.0: 2007 Landsat ETM land use categories

The categories captured can be seen to be 36.27 percent and 12.22 percent for dry and wet vegetations, respectively. The bare lands covered about 16.89% while the built-up area is 34.62%.

Discussion and Conclusion

Discussion

From the results, the watershed area is explored between 1773 and 2007 using three different imageries. Urbanization can be seen to have serious effect on watershed, because between 1973 and 2007, the land area covered by built-ups rose from 0.96% of the area to 34.62% while the wet vegetation, though increased from 2.51% to as 12.22% after increasing to 19.01 in 1995 (figure 4.0).

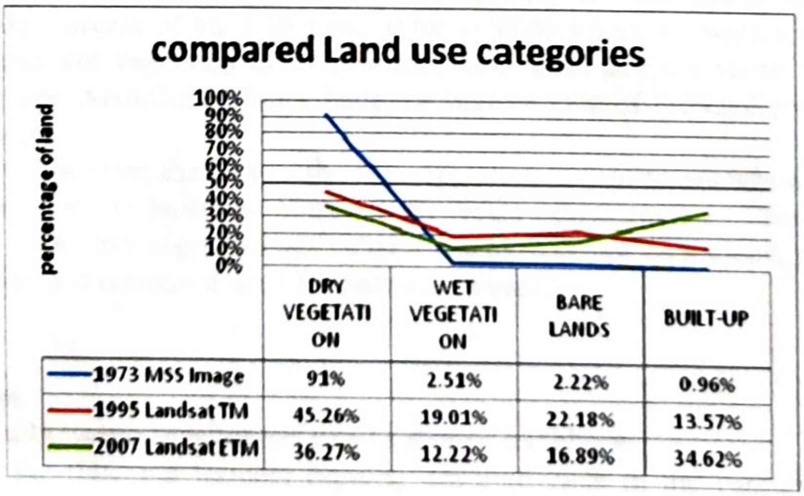

Figure 4.0: the landuse categories between 1973 and 2007

There is also indication of dryness reduction as there showed reduction from 91% to as low as 45.26% between 1973 and 2007 as in the table 1.0. it can be seen that there was reduced dryness between 1973 and 1995 by

Table 1.0: Changes in the land use categories between 1973 and 2007, among the imageries.

Categories	Dry Vegetation	Wet Vegetation	Bare Lands	Built-Up
1973 MSS Image 1995 Landsat TM	-202.71km^2	+ 81.66km^2	+88.38km^2	+55.85km^2
1973 MSS Image 2007 Landsat ETM	-242.28km^2	+51.68km^2	+68.66km^2	+88.69km^2
1995 Landsat TM 2007 Landsat ETM	-39.57km^2	-29.98km^2	-19.72km^2	+88.69km^2

From the table, the changes have been varied by year, that temporal variation. Between 1973 and 1995, there have been negative, or decreases only in the dry vegetation, that is loss of the vegetated area to increases gained in wet vegetation, bare lands and built-up areas. There was loss of a total of 202.71 kilometer square of area as high as 225.89 kilometer squares of the area were gained between 1973 and 1995 or 22 years. The largest land use category gained is the bare lands and great loss of dry vegetation.

From the image classification in 1973 and 2007, there was also loss of the area by the dry vegetated sector of the area. The loss was up to 242.28 kilometer square of land while up to a total land of 209.03 km^2 measure. The highest gain is of the built-up observed in the (1973 and 2007) or 23 years under review.

In the comparison between 1995 and 2007 or 12 years changes in the land use, there was only increase of built-up areas of up to 88.69 kilometer square with a mass loss of dry and wet vegetated as well as bare land areas that measured up to 89.27 kilometer square. Also the built-ups have the highest gain of the land are for the 12 years monitoring.

Generally, however, the loss of the dry vegetation is continuous while more areas are developed by the built-ups between the years under review. There are large conversions of the dry vegetated and other areas to built-ups as noticed, perhaps due to urbanization and increased need for personal houses.

Conclusion

From the study, some conclusions can be drawn as follow.

- That the GIS and Remote Sensing are able tools in the capture of spatio-temporal data, data analysis and to also determine trend of land use dynamics.
- The result of the study shows a rapid growth in built-up land between the 1973

and the 2007 or 24 years covered by the work, though between 1995 and 2007, there was reduction in this class of settlement.

- The available imageries of 1973, 1995 and 2007 complemented with ground truth survey, have show adequacy in providing bio-physical information in the assessment of development impact in a growing community such as Minna.
- From the study, various components mitigating against effective satellite imagery interpretation processes, prominent such as lack of data, data setting, data base and data bank.

Recommendation

From the study the following recommendation can be provided.

- Means to provide up to date facilities, materials, and imageries in Nigeria need to be invigorated by the public and private research, training and development sectors of the country.
- The imageries can be used by the public sectors in Niger State to provide data to aid hydrographical studies, and training and hydrological research and development.

References

[1] Anderson, T. (1976) A Land Use and Land cover Classification System for the use with Remote Sensor data. Geological Survey Professional Paper No. 964, U. S. Government Printing Office, Washington, D. C. p. 28.

[2] EOSAT (1992), Landsat TM Classification International Georgia Wetlands in EOSAT Data User notes, Vol. 7, No. 1, EOSAT Company, Lanham, MD.

[3] Meyer, W. B. (1995) Past and Present Land Use and Land Cover in the USA consequences, P. 24-33.

[4] Salahu, Sidikatu (2010). The Use of Remote Sensing Techniques in Assessing Watershed Management in Minna, Niger State, Nigeria, Master of Tech thesis, Federal University of Technology, Miina-Nigeria (Unpublished)

[5] Udo, M. E. (2002) Mapping and Analysis of Drainage Pattern of River Chanchaga from Aerial Photographs.