OBAFEMI AWOLOWO UNIVERSITY

GEOSPATIAL INVENTORY AND CHARACTERIZATION OF SURFACE WATER RESOURCES IN IFE AND ILESA AREAS, SOUTHWEST NIGERIA BETWEEN 1972 AND 2007

BY

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A THESIS SUBMITTED TO THE INSTITUTE OF ECOLOGY AND ENVIRONMENTAL STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENTS OF THE AWARD OF MASTER OF SCIENCE (M.Sc.) IN ENVIRONMENTAL CONTROL AND MANAGEMENT OF OBAFEMI AWOLOWO UNIVERSITY, ILE-IFE, NIGERIA

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CERTIFICATION

This is to certify that this research work was carried out by ORISADARE, Oluseyi Adewale (SCP09/10/R/0039) of the Institute of Ecology and Environmental Studies, in partial fulfilment for the requirement for the award of the degree of Master of Science (M.Sc.) in Environmental Control and Management of Obafemi Awolowo University, Ile-Ife, Nigeria.

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DEDICATION

This research work is dedicated to the Almighty GOD, the I AM that I AM, the giver of life, strength and wisdom. HE who is wiser than the wisest, that is bigger than the biggest, that is holy than the holiest and that is greater than the greatest, the beginning and the end.

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ABSTRACT

The study investigated the types, number and sizes of surface water bodies in Ile-Ife and Ilesa areas of Osun State between 1972 and 2007. It also identified the anthropogenic activities around each water body with a view to determining the spatio-temporal patterns of water resource variability in the study area.

The study was carried out in four Local Government Areas (LGAs) of Osun State, namely Ife Central, Ife East, Ilesa West and Ilesa East. The surface water resources in each LGA between 1972 and 2007 were identified using Land-use map and satellite imageries. The map was scanned and digitally processed in ArcGIS version 9.3 software using the processing techniques of georeferencing, clipping, mosaicing, sub-mapping, digitization and map presentation. The satellite imageries used included Landsat MSS (1972) of 80 m spatial resolution, Landsat TM (1986, 1991) and Landsat ETM+ (2002, 2007) each of 30 m spatial resolution. These were downloaded via the computer-based Window Explorer through the Geogateway of ILWIS 3.2 Academic and processed using the colour composite, image resampling, georeferencing, sub-mapping, image classification and segmentation techniques. The thematic maps were cartographically produced in ArcGIS version 9.3 software. Field survey (ground truthing) was carried out in each LGA during the dry and wet seasons to validate information on water bodies from satellite imageries. The coordinates of the surface water bodies were acquired with the Global Positioning System and observations made of anthropogenic activities within 100 m radius of each water body. Differences in number and

sizes of water bodies between groups were determined using the Student T-test or OneWay ANOVA, as appropriate. The relationship between identified anthropogenic activities and changes in the number and sizes of water bodies were determined using the Spearman's Correlation analysis.

Fifty surface water bodies were identified (35 streams/rivers, 9 pools, 5 reservoirs and 1 pond) in the four LGAs. Satellite image analysis identified all the streams/rivers and reservoirs but did not identify any of the ponds and pools seen by ground truthing. The water bodies were significantly ($p < 0.05$) distributed among the four LGAs (26 in Ife East, 9 in Ife Central, 4 in Ilesa West and 11 in Ilesa East). Analysis of the satellite imageries revealed that the total area of surface water resources in the two LGAs in Ile-Ife increased from 196.65 Ha in 1972 to 1112.94 Ha in 1986 but declined steadily thereafter to 605.52 Ha by 2007. Similarly in Ilesa, the total surface area of water resources increased steadily from 142.29 Ha in 1972 to 1668.51 Ha in 2002 before it declined sharply to 605.52 Ha by 2007. The human activities observed within 100 m radius of the water bodies were farming, house and road construction, car-wash, abattoirs, saw-milling, cement block making and petrol stations. GIS analysis showed that the surface area of the water bodies decreased as the area under farming and construction increased over the study period. Thus, land use/land cover fluctuated significantly over the period of 35 years in the study areas.

The study concluded that the remote sensing and GIS technologies are effective tools for surface water detailed inventory. Also, anthropogenic activities such as farming, human settlement, and deforestation are the major factors driving the surface water resources' size and number dynamic in Ile-Ife and Ilesa.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Surface water is water collecting on the ground or in a stream, river, lake, wetland or ocean. Surface water is naturally replenished by precipitation and naturally lost to evapotranspiration and sub-surface seepage into the ground. Water is one of the most important renewable and finite natural resources. It is used for several purposes including agriculture, industry and domestic purposes (Roy and Rao, 2007). As the only universal solvent known to mankind, it is also used to dissolve a wide variety of chemical substances, for industrial cooling and transportation, and agricultural production (Baroni *et al*., (2007). It is estimated that approximately 70% of fresh water used by humans goes to agriculture production.

On earth, about 96.5% of all water is saline and found in the oceans while the remaining 3.5% is freshwater and found in various environments on the continent. Of the freshwater, 1.74% is locked up in glaciers and icecaps, mainly in Greenland and Antarctica while an almost equal amount, 1.7% is found underground. Thus, only about 0.3% is found in the inland water bodies such as streams, rivers, lakes, etc. which constitute the most available and accessible water for day to day human use (Gleick, 1993; UNEP, 1995). This therefore implies that surface water resource is less than 0.0075% of the total earth's water resources.

Fresh water resources though renewable and finite, its availability both in space and time is limited. According to Kulshreshtha (1998), the world population will face severe water stress and water-based vulnerability by the 2025. This stress will be unevenly distributed around the

world with some nations of the developing world, especially in the sub-Saharan Africa experiencing the most severe threat.

To achieve proper assessment and management of this invaluable resource, information on processes both natural and anthropogenic that affect fresh water distribution and its patterns of interaction with other environments is necessary. It is also advantageous to adopt a holistic and systematic approach for a proper fresh water resources management, since understanding the processes and products of interaction in fresh water environments is very complicated. One of such processes is the dynamic changes that occur in the size and number of surface water resources over time and space. A good knowledge of this process will form a major milestone for effective management of surface water resources. This will also provide important information on fresh water resources inventory required for an effective and sustainable utilization. All these can be achieved only through the collection of accurate, reliable and comprehensive set of scientific data.

Remote sensing technology in recent years has proved to be of great importance in acquiring data for effective resources management and hence could also be applied to fresh water environment monitoring and management (Ramachandran, 1993; 2005; Ramachandran *et.al*., 1997, 1998).

According to Wilkie and Finn (1996), remote sensing (RS) and Geographic Information System (GIS) are now providing new tools for advanced ecosystem management. The collection of remotely sensed data facilitates the synoptic analyses of earth - system function, patterning, and change at local, regional and global scales over time. Such data also provide an important link between intensive, localized ecological research and regional, national and international conservation and management of biological diversity.

Further, the application of GIS in analyzing the trends and estimating the changes that have occurred in different themes helps in management decision making process. GIS has also been very beneficial in mapping and data analysis, and thus greatly aiding in the understanding and decision making in water resource management (Biniam, 2006).

1.2 Statement of Research Problem

Surface water resources management requires detailed inventory. The uses of analogue techniques have been found deficient in adequately capturing, analyzing and monitoring surface water resources in any given area. However, the advent of Remote Sensing and GIS Technologies has provided a new opportunity for a detailed inventory that can be relied upon, hence this study.

1.3 Justification for the Study

Several studies have shown the effects of applications of geospatial techniques in the land cover land use change detection (Ujoh *et al.*, 2 10; Adediji and Ajibade, 2008; Mohamed and Bahrain, 2003), little or no attention has been paid to dynamics of size and number of surface water resources and the resultant surface water resources loss. As already stated, this is indispensable in sustainable water resources management, especially in Ile-Ife and Ilesa areas of Southwest Nigeria. The rate of surface water resources loss in the area is not known with any accuracy. This study was therefore carried out to provide information on changes in size and number of surface water resources in the areas to show the effect of anthropogenic activities in the areas that are likely to have driven any observed changes.

1.4 Objectives of Study

The specific objectives of the study are to:

(a) examine the spatio-temporal pattern of surface water resources between 1972 and 2007;

(b) examine the spatio-temporal pattern of anthropogenic activities around each water body; and

(c) determine the relationship between identified anthropogenic activities (human settlement, farming and deforestation) and changes in the number and size of the surface water resources.