Chapter 4.5
Application of Remote Sensing Technologies and Geographical Information Systems in Monitoring Environmental Degradation in the Lake Victoria Watershed, East Africa

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ABSTRACT

Accurate information on the state of water resources in the Lake Victoria watershed is crucial for planning and sustainable development in the East African region. This region largely depends on its natural resource-base for economic development, and therefore comprehensive information on its resources dynamics is key in implementing poverty alleviation strategies, improving human condition and preserving the biological systems upon which the region's population depends. This chapter focuses on key issues, which have emerged as a result of population growth and development in the region. The research on which this chapter is based aims to address the concerns on land use and settlement trends in the study sites, vulnerability of the communities to water stress and sustainability of the livelihood systems in the watersheds of Nzoia River Basin (Kenya), Nakivubo Wetland (Uganda) and Simiyu River Basin (Tanzania). These communities engage in unique land use practices that have intensified environmental degradation in recent times. The research adopts a multi-disciplinary approach in bringing to the fore the various processes affecting watershed resources use and management in the selected wetlands of the Lake Victoria Drainage Basin (LVDB). The data presented covers trends in vegetation cover loss, pesticide pollution and general water quality parameters. Geographic information systems (GIS) and remote sensing

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techniques were employed to unveil land use patterns that have resulted in the degradation of the watershed. Wetland degradation levels have been characterized using secondary data generated by analytical techniques. New emerging challenges of environmental degradation caused by industrial, domestic and agricultural activities are presented and discussed. The potential of the new science of hydroinformatics in integrated watershed management through mathematical modeling, geographic information systems analysis and water supply management is highlighted.

INTRODUCTION

The riparian countries of the Lake Victoria Region have in recent years seen the Lake as a resource that requires rational management to protect it from pollution and degradation (Klohn and Andjelic, 2001). For this reason the countries have formed research teams to assess the resources and the problems of the Lake, to develop management tools and to establish adequate institutional capacity in research. With the growing population and urbanization the multiple activities in the lake basin have increasingly come into conflict with ecological principles. This has contributed to rendering the lake environmentally unstable. The problems have arisen in the surrounding basins due to population pressure on environmental resources and associated human activities. The overall objective of this chapter is to present new emerging challenges of pollution and possible solutions. The on-going research on which this chapter is based is to examine current trends in *environmental degradation* and design interventions based on democratic community participation in the implementation of sustainable and environmentally sound land use and cultural practices that control soil erosion, water pollution, maximize *biological diversity*, sustain stream-flow as well as promote community livelihoods.

Visual interpretation of satellite data products coupled with field checking is a very useful technique of finding out the physical growth of urban centres. The expansion of urban centres is very fast and conventional ground methods are slow and in-accurate because by these methods, delineation of built-up area is difficult. Mapping and monitoring the urban sprawl, as a result of urban decay of city centre, at regular intervals is very essential for urban planners to understand the trend of development on the urban periphery and subsequently to regulate it. In this chapter various data products like Landsat MSS, TM, Topo sheets are used to find out the growth of built environment over a given period of time. Thematic Mapper imagery are used to prepare broad landuse/land cover maps. These technologies are very useful in finding out the potential, as well as shortcomings of satellite data products in various urban aspects such as water management models.

In related studies, Landsat Mult-Spectral Scanner (MSS) and Landsat Enhance Thematic Mapper (ETM) data have been used to analyze different habitats which are under different forms of land use (Harris 2003). Analysis of environmental and agricultural change can be used to further understand the implications of change at river basin levels.

Remote Sensing (RS) and GIS can also be used in the development of groundwater resources. However, one aspect of the limitations of applying GIS and RS to groundwater exploration and development is a current incompatibility between hydrological and hydrogeological models (Hawari *et al* 2007). There is need for a common platform that is compatible with both GIS and hydrological/ hydrogeological models. Other issues of concern are in the areas of land surface temperature from thermal infrared data, surface soil moisture from passive microwave data, selecting groundwater recharge sites, simulation of groundwater systems, water quality using visible and near-infrared data, and estimating landscape surface roughness using radar and assessment of natural resources of