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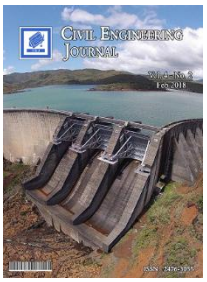

Integrating System Dynamics and Remote Sensing to Estimate Future Water Usage and Average Surface Runoff in Lagos, Nigeria

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Abstract

The goal of this study was twofold; first analyze the patterns of water consumption in Lagos, Nigeria and use them in a System Dynamics (SD) model to make projections about future demand. The second part used remote sensing to quantify the contribution of extensive land use/cover change to urban flooding. Land use/cover dynamics over the past decade was analyzed using satellite imagery provided by Landsat Thematic Mapping (TM). Unsupervised classification was performed with false color composite using the Iterative Self-Organizing Data Analysis (ISODATA) technique in a Geographic Information Systems (GIS). The study area was divided into four different land use types during image classification: bare land, built-up area, water bodies, and vegetation. For water demand, two different scenarios of population growth including 5.5% and 2.75 % annual increase were considered. The results showed that water demand dropped by 67% of its current value when losses in distribution were reduced by 20% and population annual growth rate kept at 2.75% over the study period. Bare land and water bodies lost 1.31% and 1.61% of their current area respectively while built-up area grew by 1.11%. These changes in land use/cover changes led to a 64% increase in average surface runoff, mostly attributable to increasing surface imperviousness and the absence of an adequate urban drainage system.

Keywords: Urbanization; Water Supply and Demand; Flooding; Climate Change; System Dynamics.

1. Introduction

The social, economic, and environmental development of a country mostly depends on energy availability and water supply. The overall water consumption by humans has increased significantly over the past 50 years and further increase is expected before the end of the century [1]. Today, approximately half of the world population is without access to freshwater [2]. A large proportion of the planet's available freshwater is subjected to a great deal of stress by overwhelmingly increasing anthropogenic activities such as agriculture, industrial production, and residential demands. If the current rates of water consumption remain unchanged it is projected that by 2025 five out of height people will not have enough water for their basic needs [3]. Water shortages have disastrous consequences on human health and ecosystems and can also be a source of conflict between communities [4]. The increasing demands on water supplies are closely related to population size and more precisely the concentration of human habitation. In 2001, about 50% of the world's population were living in cities causing a huge bump of urban water consumption [5]. The increase in global

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