Geophysical Research Abstracts
Vol. 15, EGU2013-3930, 2013
EGU General Assembly 2013

Modeling Urban Growth Spatial Dynamics: Case studies of Addis Ababa and Dar es Salaam

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Rapid urbanization, and consequently, the dramatic spatial expansion of mostly informal urban areas increases the vulnerability of African cities to the effects of climate change such as sea level rise, more frequent flooding, droughts and heat waves.
The EU FP 7 funded project CLUVA (Climate Change and Urban Vulnerability in Africa, www.cluva.eu) aims to develop strategies for minimizing the risks of natural hazards caused by climate change and to improve the coping capacity of African cities. Green infrastructure may play a particular role in climate change adaptation by providing ecosystem services for flood protection, stormwater retention, heat island moderation and provision of food and fuel wood. In this context, a major challenge is to gain a better understanding of the spatial and temporal dynamics of the cities and how these impact on green infrastructure and hence their vulnerability.
Urban growth scenarios for two African cities, namely Addis Ababa, Ethiopia and Dar es Salaam, Tanzania, were developed based on a characterization of their urban morphology. A population growth driven - GIS based - disaggregation modeling approach was applied. Major impact factors influencing the urban dynamics were identified both from literature and interviews with local experts. Location based factors including proximity to road infrastructure and accessibility, and environmental factors including slope, surface and flood risk areas showed a particular impact on urban growth patterns.
In Addis Ababa and Dar es Salaam, population density scenarios were modeled comparing two housing development strategies. Results showed that a densification scenario significantly decreases the loss of agricultural and green areas such as forests, bushland and sports grounds. In Dar es Salaam, the scenario of planned new settlements with a population density of max. 350 persons per hectare would lead until 2025 to a loss of agricultural land (-10.1%) and green areas (-6.6%). On the other hand, 12.4% of agricultural land and 16.1% of green areas would be lost in the low density development scenario of unplanned settlements of max. 150 persons per hectare. Relocating the population living in flood prone areas in the case of Addis Ababa and keeping those areas free from further settlements in the case of Dar es Salaam would result in even lower losses (agricultural land: -10.0%, green areas: -5.6%) as some flood prone areas overlap with agricultural/ green areas.
The scenario models introduced in this research can be used by planners as tools to understand and manage the different outcomes of distinctive urban development strategies on growth patterns and how they interact with different climate change drivers such as loss of green infrastructure and effects such as frequent flooding hazards. Due to the relative simplicity of their structure and the single modeling environment, the models can be transferred to similar cities with minor modifications accommodating the different conditions of each city. Already, in Addis Ababa the results of the model will be used in the current revision of the Master plan of the city.

Keywords: GIS, modeling, Urban Dynamics, Dar es Salaam, Addis Ababa, urbanization