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Greening the Urban Environment Using Geospatial Techniques, A Case Study of Bangkok, Thailand

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Abstract

Urbanization is one of human induced activities causing land use changes. In recent years, various land use transformations in Bangkok influenced the city's ecological sustainability in all means, i.e., diminishing the city's cultivated land and greenery. This study investigates lack of green spaces due to extreme urban growth in the mega city. To do so, first, land use transitions are modelled through two different images; one from Landsat 5 Thematic Mapper for the year 1994, and second from HJ-1A CCD for the year 2012. Next, the Multi-Layer Perceptron Markov Model (MLP-Markov) is applied to predict land use change for the year 2030. The MLP neural network is trained to model land use transitions through creating transition maps. Markov Chain predictive model is applied with sufficient accuracy to process the transition maps for the prediction process. The results indicate that 348km^2 of green areas are transformed into built-up areas for the period 1994-2012, with a considerable loss of greenery (42%). The MLP model predictions show 4% increase in built-up and 6% decrease in greenery for the period 2012-2030. The study highly recommends conservation of green spaces and green corridors in the city. Future research can include analysing green plot ratio for suitable green patches in vulnerable sites. The research output will benefit urban planners to implement long term planning strategies for securing natural environment in mega cities.

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1. Introduction

Urbanization is one of major problems in all over the world. It is estimated that over 65% populations will be residing in urban areas in the year 2025 [1]. Moreover, there is a direct relationship between environment and land use change induced by human beings, e.g., built-up lands often occupy natural vegetations [2]. Urban sprawl is generally associated with the construction of new buildings, route planning, designing development plans around the suburb and central business districts, and emerging new towns around suburbs. Moreover, a poor land use planning influences the urban ecology. For instance, heat islands and air pollution within metropolitan cities are often associated with urban sprawl [3].

Rapid urbanization often influences a common's well-being and quality of life in metropolises. Among many factors, the common's well-being in urban areas is explicitly quantified with green or open spaces. Green infrastructure being unique among urban services expands the commons well-being through ecological sustainability. However, urban expansion often causes demise of existing vegetation around the cities, while natural greens rises mostly nearby the city centers, and suburb. To this end, a term urban public green spaces (UPGS) is used for facilities like various types of parks including, gardens, private garden and backyards, community gardens, street trees, unplanned vegetation, rock walls resting places, recreational areas providing active & passive relaxation, green roofs, vacant lots, school grounds, channel of storm water, rock walls, walking and cycling routes, shared vacant places around the apartments, riparian areas sporting fields. Such UPGS may overcome the challenges related to environmental sustainability in big cities [4, 5]. Nevertheless, many cities are scrambling for protecting the existing greenery, for instance, flood mitigation, food provision, cooling urban temperatures, suppressing noise and dust pollution, protecting urban wildlife, decreasing stress and nervousne**ss** [4].

To avoid reduction in greenery and to attain a sustainable environment, frequent assessment in land transformations in mega cities has become immense important. Trend assessment can be quantified through different models of spatio-temporal land use changes in cities [3, 4], for example, Cellular-Automata (CA) - Markov of land use change and predictive model have been designed to protect the environmentally sensitive areas. [6, 7]. Moreover, by applying CA the model can simulate urban growth at both local and regional levels, which is the most precious application for urban planners in building policies for future actions. Applying such models however is challenging, as it requires projecting complex and inter-connected processes in space and time [8].

The main objective of this study is to quantify the urbanized part of the city of Bangkok resulting from vegetation and cultivated lands. To do so, the study assesses the greenery losses irrespective of uncontrolled urban sprawl in Spatio-temporal domain. The results can be used to monitor greenery in adaptation patterns by long-term planning strategies at the local and regional level.

1.1. Study Area

Bangkok (Krung Thepmahanakorn) lies at East-West of the river Chao Phraya. People reside nearby the river along canals. Due to tourism and trading canals, the city is also famous as Venice of the East. Over time, development in road ways declined the waterways. These roadways along riverside became economic centers that widen the Southern part of the city. Migrants are another cause of abrupt population growth in Bangkok (i.e., 16-fold between 1944 and 2002) [10]. Trade and tourism activities in the city attracted people from all around the world for better opportunities of job, heath, education etc. Consequently, the city undergone through tremendous changes, particularly, increases in built-up areas caused decline in open green spaces that further affected the natural environment [12]. Built-up areas mostly emerged from the construction of new transportation networks, flyovers, link roads, air ports, and railways around small urban centers. The city of Bangkok is therefore a perfect case scenario to quantify the land use change