

# **Urban Process and Future Development of Colombo Metropolitan Area, Sri Lanka: An Application of Geospatial Techniques**

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# **Urban Process and Future Development of Colombo Metropolitan Area, Sri Lanka: An Application of Geospatial Techniques**

A Dissertation Submitted to  
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# Abstract

The Colombo Metropolitan Area (CMA), which surrounds the well-known port city of Colombo, is the only metropolitan area in Sri Lanka that has experienced rapid urban growth over the last two decades. Due to the urbanization pressure, the CMA has been facing serious socioeconomic and environmental challenges in recent years. In such context, investigating the spatiotemporal pattern of urban process and future potential urban development is essential for introducing sustainable urban planning strategies. This research aims to investigate the spatiotemporal pattern of urban process since the 1990s and future potential urban development. Remote sensing and geographic information system (GIS), land-change intensity analysis, spatial metrics, morphological spatial pattern analysis (MSPA), fieldwork techniques, and land-change modeling were applied mainly in order to characterize the urban process and predict the future urban development potentials.

In this study, urban land use (ULU) mapping method was developed using MSPA through neighborhood interaction rules of the surrounding area. Results indicated that the urban land in the CMA has increased over the last two decades (1992–2014) with a higher area dominance of sparse growth. However, it could be identified the changing percentage of urban dense (275%) is higher than urban sparse (192%) from 1992 to 2014. The produced ULU mapping indicated that the urban dense was 3,968 ha, 7,953 ha, and 14,881 ha in 1992, 2001, and 2014, respectively, while the urban sparse was 7,197 ha, 11,439 ha, and 20,994 ha in 1992, 2001, and 2014, respectively. ULU change intensity analysis indicates that the ULU change was rapid in the 2000s (0.54%) compared to the 1990s (0.39%), which mainly coincided with the trends of population, economic growth, and several underlying socioeconomic factors.

Moreover, the spatial metrics that connect to the diffusion–coalescence urban growth theory revealed that the CMA experiences more diffusion than coalescence in urban growth. Recent migration, motivated by the accessibility to administrative services and socio-economic opportunities, has been the major factor of this sparse urban diffusion. The capturing the non-urban space located outside the urban core and fringe area of the CMA, showing leapfrog (outlay pattern) growth pattern in both time intervals could be significantly identified rather than infill growth and extension growth. Moreover, the annual growth intensity (AGI) of leapfrog pattern increased from 0.17% in the 1990s to 0.25% in the 2000s, AGI of infill increased from 0.16% in the 1990s to 0.19% in the 2000s, and AGI of extension increased from 0.06% in the 1990s to 0.10% in the 2000s. The analysis of the questionnaire survey data indicated that the migrants' history and reason for migration for each thematic zones (core, fringe and outside) are significantly different. Specifically, the recent migration into core area has recently declined, while fringe area and outside area, which are mainly visible in suburban areas are attracting more migrants. This significant level of attraction basically has been dominated by the accessibility to urban facilities and increasing price of the lands in core area rather than by urban planning initiatives in the suburban area.

The ULU change prediction results revealed that the ULU will increase into 53,510 ha in 2030. The major transport corridors and the growth nodes will have a great influence in the future spatial patterns of urban growth, and the urban lands will be dense due to infill development. Prediction results further indicated that there are some limitation in introduced urban planning scenarios of the government's master plan due to its less consideration regarding the spatial pattern of future urban growth pattern. Thus, the consideration of the results of this research will be important in forming future urban planning scenarios.

From a scientific standpoint, this empirical study not only has identified past, present and potential future urban process, but also introduced new methods and techniques that can be applied to detect the urban process in a data-sparse urban environment, which is advantageous for developing countries.

**Keywords:** Colombo Metropolitan Area; Land-change intensity; Spatial metrics; Driving factors; Land-change modeling; Remote Sensing; GIS

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# Abbreviations

<b>CMA</b>	Colombo Metropolitan Area
<b>GIS</b>	Geographic Information Systems
<b>ULU</b>	Urban Land Use
<b>GPS</b>	Global Positioning System
<b>UN</b>	United Nation
<b>GDP</b>	Gross Domestic Product
<b>BC</b>	Before Christ
<b>DCSS</b>	Department of Census and Statistic, Sri Lanka
<b>JICA</b>	Japan International Cooperation Agency
<b>DMSL</b>	Department of Meteorology, Sri Lanka
<b>MMWD</b>	Ministry of Megalopolis and Western Development
<b>LKR</b>	Sri Lanka Rupee
<b>UDA</b>	Urban Development Authority
<b>CEA</b>	Central Environmental Authority
<b>SDSL</b>	Survey Department of Sri Lanka
<b>USGS</b>	United States Geological Survey
<b>MSPA</b>	Morphological Spatial Pattern Analysis
<b>ACI</b>	Annual change intensity
<b>UI</b>	Uniform Intensity
<b>FDI</b>	Foreign Direct Investment
<b>EPZ</b>	Export Processing Zones
<b>PB</b>	Pixel-based
<b>OB</b>	Object-based

<b>CBD</b>	Central Business District
<b>Area_MN</b>	Mean Patch Size
<b>CONTAG</b>	Contagion Index
<b>ENN_MN</b>	Mean Euclidean Nearest Neighbor Distance
<b>Frac_AM</b>	Area-weighted Mean Patch Fractal Dimension
<b>LSI</b>	Landscape Shape Index
<b>PD</b>	Path Density
<b>PLAND</b>	Percentage of Landscape
<b>SHDI</b>	Shannon's Diversity Index
<b>CA</b>	Cellular Automata
<b>MLP</b>	Multi-layer Perceptron
<b>NN</b>	Neural Networks
<b>FoM</b>	Figure of Merits
<b>ROC</b>	Receiver Operating Characteristic
<b>AUC</b>	Area Under the Curve