

Urban Expansion Delineation Using Time Series Impervious Surface Data: A Case Study of Tokyo Metropolitan Area

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Impervious surface (IS) possess distinct artificial features and could be detected and quantified by remote sensing over time to delineate and examine the dynamics of the urban process. Impervious surface is closely related with urban and rural development. The ever-changing urban process results in a noticeable fluctuation of impervious surfaces coverage. The fastest growing urban region is one of the most important dimensions of environmental changes in the Tokyo Metropolitan Area (TMA) during the last several decades. For characterizing and capturing the spatial pattern and changes in the urban dynamic of TMA, the variation of the impervious surface area was derived from Landsat multispectral imageries of the last three decade periods (1987~2017). The final Land Use/Land Cover (LULC) outcomes were produced by agglomerating land surface spectral index analysis, K-means unsupervised clustering analysis, Linear spectral mixture analysis (LSMA) and Decision Tree (DT) classifier.

Subsequently, the urban spatiotemporal variations in the TMA were investigated at the pixel scale, administrative unit scale and concentric circle buffer zone scale in different directions. The impervious surface changes were also interrelated with topography, urban transportation network, population distribution, etc. for exploring the driving forces of the urban dynamics. The LSMA outputs and urban LULC classification results indicated that Tokyo and its surrounding area exhibited internal urban land transformation and outward urban expansion. The account of the impervious surface area showed the typically spatial pattern from the highly dense area in the downtown to the low-density area on the outskirts. In the urban center, low-density urban areas decreased, and high- and moderate-density urban areas increased with the significant growth of urban impervious surfaces. Besides, the urban expansion in TMA presented different features in various directions and was affected by multiple driving factors in different years.

Keywords: Urban Spatiotemporal Dynamics, Urban Expansion, Impervious Surface (IS), Linear Spectral Mixture Analysis (LSMA), Decision Tree (DT), Tokyo Metropolitan Area