Urban Land Use Modelling and Developing a framework of Spatial Decision Support System for Indian Cities

Indian cities have been experiencing tremendous pressure on urban land use management and continue to be influenced due to economic liberalisation and industry-oriented development through projects, policies, schemes and missions promoting urban rejuvenation, having a huge impact on land use and land cover (LULC) changes in the cities and surrounding regions. Researchers have invariably adopted geospatial techniques to delineate, relate, quantify, validate, and predict urban growth, its effects and hence finally arriving at providing real-time solutions for these issues faced by emerging megacities. In this context, considering the spatio-temporal patterns of urban growth and visualisation of future growth patterns through the development of land use models and spatial decision support system (SDSS) constitutes the primary goal of the proposed research. The objectives were realised towards providing a holistic approach and developing a unique web-based interface, assisting directly in decision making and navigating planning agencies towards sustainable development opportunities. The analysis of land use and land cover dynamics were targeted to address emerging LU change pattern of Indian cities using integrated satellite data and GIS techniques. LULC analysis revealed cities have consistently lost vegetation cover and experienced rapid transition of urban category over the years. Results depicted a clumped urban growth with a minimum scope for infill type of development. To examine the city's relative position in the hierarchy among the selected cities, clustering analysis was performed to represent the relationship among similar cities. The study concludes that most of the cities have spurted out of city limits that is, mostly unplanned and immediately needs informed decisions for better utilisation of land resources for the next generations. Once the patterns were understood the next challenge is to develop visualisation of land use change in next decade. Urban growth modelling includes implementation of Cellular Automata based SLEUTH model, demonstration of brute force method to predict near-future urban growth by validation through statistical fit measures. A novel effort to integrate CA model with nature-inspired techniques such as Genetic Algorithm (GA) and particle swarm optimisation was developed. These algorithms aimed to improve the calibration process and to obtain optimised values reducing the computation time. Remarkable improvement in terms of optimum SLEUTH metrics were observed as a part of routine validation check. Types of urban growth, such as organic, spreading, and spontaneous were observed at various places, providing insights towards sustainable planning. Further, an agent-based model was developed considering the strengths of integrating it with GA. The GA-ABM model outperformed traditional CA with significant improvements in results and achieving better accuracy with respect to Kappa indices of agreement. Finally, a framework of Spatial decision support system was established along with the functionality of web-based GIS analysis system, tested using localhost with successful operation. The decision-making process aided by spatial data along with various development scenarios, helps policymakers and planners to obtain optimum and best solution based on problem definition to the desired outcome in terms of best decision alternative.

Keywords: Urbanisation; LULC change; Sustainable development; Urban growth model; Agent based model; Spatial decision support system.

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