Improving Performance of Cellular Automata Model by Logistics Based Regression Using Socio- Economic Agents for Intra-City Growth Modeling

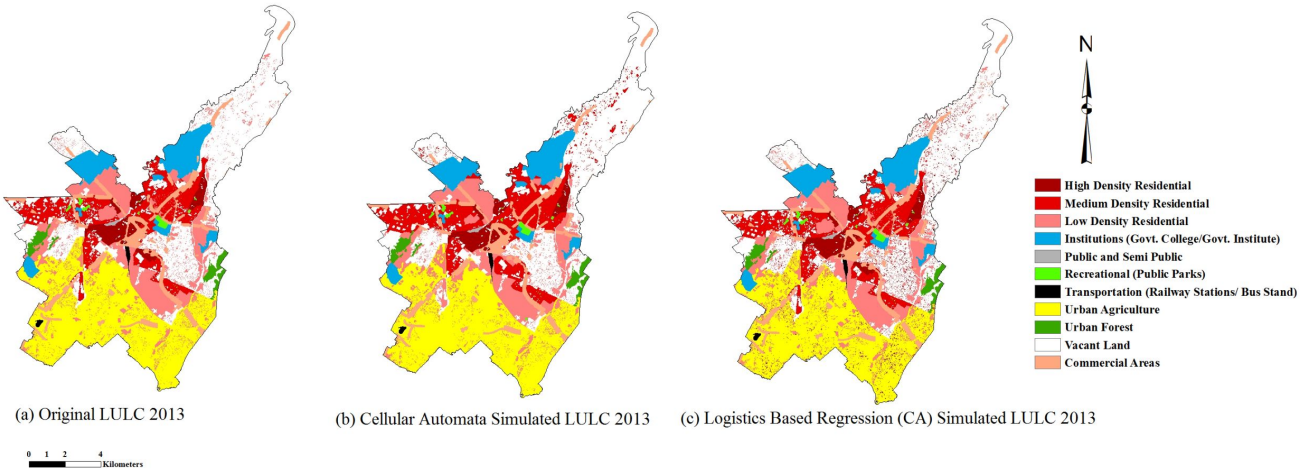
Vivek Kumar Singh[1], Ashutosh Kumar Jha[2], Kshama Gupta[3], S. K. Srivastav[2], Vaibhav Kumar[4], *Shweta Bhati[1]

1. Centre of Atmospheric Sciences, Indian Institute of Technology Delhi, Hauz Khas, Delhi, India, 2. Geo-informatics Department, Indian Institute of Remote Sensing, Indian Space Research Organisation, Dehradun, India, 3. Urban & Regional Studies Department, Indian Institute of Remote Sensing, Indian Space Research Organisation, Dehradun, India, 4. Centre for Urban Science & Engineering, Indian Institute of Technology Bombay, Powai, Mumbai, India

Urban land use dynamics are studied in terms of quantitative analysis as well as spatial analysis for prediction of urban growth. Earlier urban expansion studies were based on change in the Land Use Land Cover (LULC) pattern with respect to time. However, socio-economic drivers of the city such as population density, literacy rate, household density, distance to road, commercial centers etc. also act like agents and play an important role in the expansion of urban growth. Many Urban Cellular Automata (UCA) models are developed based on spatial resolution and neighborhood properties that affect the urban growth, but implementation of unidirectional nature of socioeconomic parameters in the model are difficult task to implement to give results both quantitatively and spatially. In this study, neighborhood effect with the weighted rule mechanism of socioeconomic effect on each LULC class are calculated. A logistic based regression model is developed to evaluate the expansion data of Dehradun City, India. Collection of socioeconomic data and validation of LULC classes is done using field data. A 3 X 3 simulation window of the model has been considered to evaluate the change in each grid. Simulation based on transition rule and neighborhood effect resulted in improvement of accuracy of representation of built-up classes from 84% to 89 %. However, after incorporating socioeconomic drivers, this improves from 89 % to 94 % in 3 built-up classes i.e. low density residential, medium density residential and commercial classes. Sensitivity study of parameters and relative window size for simulation indicated optimal growth in the northeast and south part of the city. Small patches of growth are also observed in central and southwest part of the city. The study highlights the growing importance of incorporating socio-economic drivers for evaluating urban growth in the city in comparison to just change in land use land cover.

Keywords: Urban land use dynamics, socio-economic data, Logistics based regression model, Urban Cellular Automata model, land use land cover

Comparison of accuracy of cellular automata and logistics based cellular automata for a period of 2001-2013



(a) Original LULC 2013 (b) Cellular Automata Simulated LULC 2013 (c) Logistics Based Regression (CA) Simulated LULC 2013

2013	Reference	User's Accuracy (%)	Producer Accuracy (%)	Overall Accuracy (%)	Kappa Coefficient	Area accuracy (Relative Error)	Spatial accuracy
Simulation with Cellular Automata	Built-up Cell	84	85	87	0.76	10.62%	83.72%
	Non Built-Up Cell	88	87				
Simulation with Logistics Based Regression Cellular Automata	Built-up Cell	89	90	89	0.81	8.78 %	87.64%
	Non Built-Up Cell	84	85				

