

Capturing built-up expansion patterns in the major cities of South and Southeast Asia using GIS and RS techniques

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The purpose of this study is to capture the built-up expansion patterns in the major cities of South and Southeast Asia for the last two decades using GIS and Remote Sensing (RS) techniques. The major cities considered in this study include Bangkok (Thailand), Dhaka (Bangladesh), Hanoi (Vietnam), Jakarta (Indonesia), Manila (Philippines) and Yangon (Myanmar). The RS satellite data (LANDSAT) were downloaded from <http://earthexplorer.usgs.gov/> and <http://glovis.usgs.gov/>. The best available images (i.e. with minimum cloud cover or cloud-free) were prioritized in the image selection. The epochs considered in the analysis were 1990, 2000 and 2010. Except for the 1990 time period for Jakarta and Manila, all the capture dates of the satellite images for all the cities were close to these time periods.

In this study, we considered only two land cover categories, namely built-up and other lands. The built-up category includes buildings, roads and all paved areas and concrete structures, while other lands include vegetated areas, water bodies, among others. The land cover classification was accomplished by employing the Iterative Self-Organizing Data Analysis Technique (ISODATA) unsupervised classification algorithm available in ArcGIS software. Using this technique, 30 clusters or classes were first generated for each satellite image for each time period for all the cities. This is the optimum number of classes we found through empirical examinations. After generating these classes, each class was individually examined whether it belonged to built-up or other lands category by visual interpretation and with the aid of Google Earth maps especially for the latter time periods. The classes that belonged to the same category were eventually merged.

Based on the extent of our study area for each major city, the initial results revealed that from 1988 to 2009, the built-up area of Bangkok has expanded by 95,641 ha; 59% of which occurred between 1999 and 2009. For the case of Dhaka, its built-up area has increased by 10,566 ha from 1989 to 2010; of which 61% happened between 2000 and 2010. For Hanoi, its built-up area has expanded by 8,553 ha from 1989 to 2009; 62% of which occurred between 1999 and 2009. Jakarta has also experienced rapid urban growth in the last decades. From 1994 to 2010, its built-up area has increased by 39,729 ha, of which 67% happened between 1994 and 2001. For Manila, its built-up area has increased by 21,643 ha for the past 12 years (1996-2008); 57% of which occurred between 1996 and 2001. And for the case of Yangon, its built-up area has grown by as much as 15,382 ha from 1989 to 2009, of which 56% happened between 1999 and 2009. These results show that among the six major cities, two of them (Jakarta and Manila) exhibited a comparable trend, i.e. greater increase in their respective built-up areas during the 1990s. In contrast, the other four major cities showed a similar trend, i.e. greater increase in their respective built-up areas during the 2000s. In terms of the rate of built-up increase, Bangkok had the highest rate (4,554 ha/year), followed by Jakarta (2,483 ha/year). Hanoi had the lowest rate (428 ha/year), followed by Dhaka (503 ha/year).

Our future plan for this research is to examine the built-up expansion patterns for each major city along the gradients of spatial variables (e.g. distance to city center, distance to major roads and elevation). The resulting patterns will be used to calibrate a spatially explicit land cover change model, which will then be used to project future built-up expansions.

Keywords: GIS, remote sensing, urbanization, land cover change, South and Southeast Asia