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Remote Sensing of Urban Land Cover Change: Trends, Driving Forces, and Indicators

Authors : Wei Ji

Abstract : This study was conducted in the Kansas City metropolitan area of the United States, which has experienced significant urban sprawling in recent decades. The remote sensing of land cover changes in this area spanned over four decades from 1972 through 2010. The project was implemented in two stages: the first stage focused on detection of long-term trends of urban land cover change, while the second one examined how to detect the coupled effects of human impact and climate change on urban landscapes. For the first-stage study, six Landsat images were used with a time interval of about five years for the period from 1972 through 2001. Four major land cover types, built-up land, forestland, non-forest vegetation land, and surface water, were mapped using supervised image classification techniques. The study found that over the three decades the built-up lands in the study area were more than doubled, which was mainly at the expense of non-forest vegetation lands. Surprisingly and interestingly, the area also saw a significant gain in surface water coverage. This observation raised questions: How have human activities and precipitation variation jointly impacted surface water cover during recent decades? How can we detect such coupled impacts through remote sensing analysis? These questions led to the second stage of the study, in which we designed and developed approaches to detecting fine-scale surface waters and analyzing coupled effects of human impact and precipitation variation on the waters. To effectively detect urban landscape changes that might be jointly shaped by precipitation variation, our study proposed “urban wetscapes” (loosely-defined urban wetlands) as a new indicator for remote sensing detection. The study examined whether urban wetscape dynamics was a sensitive indicator of the coupled effects of the two driving forces. To better detect this indicator, a rule-based classification algorithm was developed to identify fine-scale, hidden wetlands that could not be appropriately detected based on their spectral differentiability by a traditional image classification. Three SPOT images for years 1992, 2008, and 2010, respectively were classified with this technique to generate the four types of land cover as described above. The spatial analyses of remotely-sensed wetscape changes were implemented at the scales of metropolitan, watershed, and sub-watershed, as well as based on the size of surface water bodies in order to accurately reveal urban wetscape change trends in relation to the driving forces. The study identified that urban wetscape dynamics varied in trend and magnitude from the metropolitan, watersheds, to sub-watersheds in response to human impacts at different scales. The study also found that increased precipitation in the region in the past decades swelled larger wetlands in particular while generally smaller wetlands decreased mainly due to human development activities. These results confirm that wetscape dynamics can effectively reveal the coupled effects of human impact and climate change on urban landscapes. As such, remote sensing of this indicator provides new insights into the relationships between urban land cover changes and driving forces.

Keywords : urban land cover, human impact, climate change, rule-based classification, across-scale analysis
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