Relationships between urban development levels and urban vegetation states: a global perspective

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Urban development exerts both benign and malignant impacts on urban vegetation. Mixed results have been reported regarding the responses of urban vegetation to urbanization. However, these results are limited by both sample size and location. It is essential to conduct global-scale research in urban areas with various development levels in order to acquire a more comprehensive understanding of the relationship between urban development and vegetation states. Thus, we firstly developed an urban development score to quantify the development intensity of 68,651 urban areas across 14 biomes by using nighttime light and population density data. We then classified each urban area into a relative development level according to the score and biome. Based on the urban development scores and levels, we determined the relationship between urban development and vegetation states, as represented by the remote-sensed vegetation index. Findings suggested that four distinct types of relationships exist across biomes, namely positive, convex (positive then negative), non-significant, and negative. The positive corrections were commonly found between urban development and vegetation states especially in less-productive biomes such as deserts and open shrublands. However, the positive correlations diminished and eventually turned negative as urban areas became more developed and/or were located in more productive biomes. Turning points of the relationship between urban development and vegetation states were detected in four biomes that have moderate productivity. Completely negative relationships were only found in highly productive tropical and temperate biomes. The results of this study call for a closer examination of the altered urban vegetation states as the result of human engineering.

Key words: vegetation states; urban development; global-scale; remote-sensing