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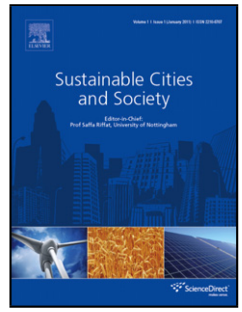

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Impacts of urban surface characteristics on spatiotemporal pattern of land surface temperature in Kunming of China

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Highlights

- The combination of MNDWI and NDVI is the best indicator of LST than others.
- Both UHI intensity and UHI strength index may be closely related to the surface water content.
- The regions that UHI intensity index is greater than 0.5 can be considered as key areas of UHI elimination.

ABSTRACT

To explore impacts of urban surface characteristics on spatiotemporal pattern of land surface temperature (LST), LST was retrieved from the thermal infrared band of satellite images and five indices were selected and extracted from remote sensing images in different time periods respectively acquired from 1992 to 2014. The correlation analysis (pixel by pixel) and linear regression analysis showed that although Normalized Difference Built-up Index (NDBI) and LST had the highest correlation coefficient, a combination of Modified Normalized Difference Water Index (MNDWI) and Normalized Difference Vegetation Index (NDVI) yielded the best regression results (the mean of R-squared value increased 0.1). These results showed that both NDBI and NDVI-MNDWI would be acceptable indicators of LST, but NDVI-MNDWI could be better. Moreover, urban heat island (UHI) intensity (represented by LST) analysis showed that the highest UHI intensity appeared in the April, while the lowest UHI intensity index emerged in June. These results suggested that both UHI intensity and UHI intensity index might be closely related to land surface moisture. Furthermore, the regions of UHI intensity index greater than 0.5 were unchanged essentially from 2000 to 2014. So, these regions would be considered as key areas where the UHI could be focused on elimination.

Keywords： Urban heat island; Urban surface characteristics; Land surface temperature; Remote sensing

1. Introduction

Over the past decades, population growth and economic expansion have been the primary drivers of land use/cover change (LUCC) in the developing countries (Li et al., 2009). In China, the urbanization process has been accelerated from the late 1970s because of the launch of economic reforms (Luo & Wei, 2009). The natural vegetation and agricultural land have been replaced by built-up areas (Van & Bao 2010). A series of environmental problems have been induced in urban (Roy et al., 2009). Because increasing temperatures in the urban area may lead to significant ecological and social consequences, Urban heat island (UHI) effect has been a concern for much more than 40 years, and become a research hot topic in urban climatology and urban ecology (Chen et al., 2006; Li, Zhou, & Ouyang, 2013). Generally, there are three types of urban heat islands: Surface heat islands (by measuring the infrared radiation emitted and reflected by surfaces, it is possible to identify the locations in a city where the surfaces are hottest); canopy layer heat islands (the canopy layer is the layer of air between the ground and treetops, or roofs of buildings, where most human activity takes place); and boundary layer heat islands (the boundary layer is located above the canopy layer). Canopy and boundary layer heat islands refer to air temperature (Oke, 1982; Li, Zhou, & Ouyang, 2013). As a major parameter associated with surface radiation and energy exchange, Land surface temperature (LST) is able to modulate the air temperature of the layer immediately above the earth surface (Zhou & Wang, 2011; Li, Zhou, & Ouyang, 2013). Consequently, LST retrieved from infrared remote sensing imagery has been widely applied to study the spatial pattern of surface temperature UHI and its relationships with urban surface characteristics. Commonly, LUCC can affect the local thermal environment because each land