Recent Advances in Remote Sensing of Urban Heat Islands

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Remotely sensed imagery has been increasingly used to study the urban heat island (UHI) phenomenon by deriving and analyzing land surface temperatures. The technology of remote sensing has the advantage of providing a time-synchronized dense grid of temperature data over a whole city region and distinctive temperature measurements for individual buildings. Moreover, some remote sensing images have high temporal resolution, in addition to being cost-effective. A key issue in the application of remote sensing technology is how to use land surface temperature measurements at the micro-scale to characterize, quantify, and model heat islands observed at the meso-scale.

This talk will focus on the findings from our funded project by US National Science Foundation, which aims to examine the effect of urban surface composition and structure on urban surface energy budgets and to better understand the thermal behavior of urban landscapes and the heat island phenomena. This project synthesizes optical remote sensing of urban construction materials and the composition, thermal remote sensing of land surface temperatures, and the landscape ecology approach. Through use of physical modeling, statistical analysis, and fractal geometry, a protocol has been established to study the interactions among urban surface characteristics, the thermal behavior of urban landscapes, and urban heat islands. The study is being conducted in Indianapolis, United States, with satellite images from sensors of various spatial, spectral, and temporal resolutions, including Landsat TM, ETM+, Terra's ASTER, and MODIS thermal infrared data. Specifically, this talk will illustrate the following three case studies.

- To investigate the relationship between land surface temperature (LST) and quantitative surface biophysical descriptors, which are sub-pixel measurements derived from spectral unmixing of medium-resolution satellite images;

- To examine the scaling-up effect on the relationship between land use and land cover (LULC) and LST patterns by the use of landscape metrics; and

- To relate micro-scale (pixel) measurements of LST to meso-scale UHI measurements of the entire city (so as to derive UHI parameters: magnitude, the spatial extent, the orientation, and the central location).

The concept and scientific procedure developed in this project are expected to provide an explicit methodology by which such type of research may be applied to other cities in the world, and be conducted by using other Earth observing sensors and next generations of sensors.