Assessment of vegetation effect for Urban Heat Island in Osaka City using high resolution remote sensing imagery

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Key words: Remote sensing, Vegetation, Land cover classification, Surface temperature, Urban heat island, Shadow

ABSTRACT

Urban environments are generally made of impervious man-made materials such as concrete and asphalt. Along with overheating of the air and pollution by human activities, environment of city compensates a phenomenon called urban heat island (UHI). Osaka city also suffers with the UHI problem. Statistics show that the number of true summer days (temperature exceeds 30 ℃) in Osaka was the highest among majors cities in Japan in the past decade. Vegetation plays a significant role as a temperature-sink in Osaka. High resolution remotely sensed images were implemented to access vegetation effect on urban heat island in Osaka City.

Land cover classification was an crucial image processing to define each targeted surface material class in this research. Four representative components of the Osaka City were employed in this research. They were water, vegetation, bare ground and urban (impervious material such as concrete and asphalt). Using a combination of land cover classification techniques with maximum likelihood and decision tree classifier with auxiliary data, land cover image could reach to a more accurate result by removing shadow and correctly identify vegetation. Also, vegetation indices such as Normalized Difference Vegetation Index (NDVI) and Simple Ratio (SR) were implemented in the decision tree classifier to accurately extract vegetation. The accuracy assessment in this research showed that decision tree classifier as a post image processing indicated a higher Kappa coefficient 0.9631 in removing shadow originally misclassified as water than maximum likelihood classification with a Kappa coefficient 0.8507.

Selected radiating bodies in specified classes emit only a certain proportion of the energy. Emissivity correction of the brightness temperature images was necessary to obtain the true surface temperature maps of Osaka city. Use of a 4m land cover classified image could enhance spatial resolution of a 90m thermal image. The results showed that emissivity corrected surface temperature map in 4m showed higher correlation with official air temperature data from air pollution monitoring station of Osaka Prefectural Government than in 15m with coefficient of determination (R^2) of 0.456 and 0.07793 in a linear regression analysis respectively. Also, using a shadow correction jointly with the 4m surface temperature image, the effectiveness of discovering vegetation in small covers under shadow could be optimized. As a result, 2.49% of vegetation under shadow misclassified as water by unsupervised classification originally unavailable to show on a surface temperature map became detectable. A total of 19.68% vegetation then was implemented in a surface temperature map of Chuo-ku to illustrate the vegetation effect on UHI. The surface temperatures of vegetation were in the range of 26.0 °C to 33.8 °C while impervious material classified as “urban” were in between 37.6°C to 41.5°C on a sunny day of July 28th, 2005.