Estimation of Urban Evapotranspiration through Vegetation Indices Using WorldView2 Satellite Remote Sensing Images

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Abstract: Irrigation management necessitates better understanding of the water demands of various plants in order to decrease environmental risks and increase water use efficiency. The difficulty in measuring evapotranspiration (ET) from urban landscape plants inhibits the development of sustainable irrigation management strategies. In warm climates, evapotranspiration as the main component of irrigation needs to be quantified accurately. Traditional methods of ET estimation are mostly time-consuming, relatively expensive and lack the coverage required for large areas. Recently, ET estimation has been benefitted from advances in remote sensing (RS) and GIS techniques. Different algorithms and models have been introduced that employ GIS/RS application in order to study various biophysical parameters of vegetation. For instance, the Normalized Difference Vegetation Index (NDVI) is often recommended as a useful indicator to study ET rates. NDVI quantifies the photosynthetic vegetation response to red radiation absorption and near infrared reflectance.

This research explores the potential relationship between urban vegetation ET and RS vegetation indices in an urban park; Veale Gardens (VG) within the Adelaide Parklands, Australia. A data set of cloudless WorldView2 imageries of three consecutive seasons in 2012 were used to quantify NDVI values. ERDAS IMAGINE was employed to image processing, geo-referencing, atmospheric correction and NDVI map generation. NDVI maps were clipped to the borders of VG and then imported to ArcGIS for zonal statistical analysis. ET rate for VG was estimated using an observational-based approach, namely Water Use Classifications of Landscape Species (WUCOLS). A short description of the WUCLOS method is provided, which is then applied to the study area. In-situ weather and vegetation data were collected and irrigation monitoring data were provided by the local water authority. A panel of horticulturists assessed and rated the most common plant species in the park in terms of drought tolerance.

The relationship between RS-based NDVI and ETWUCOLS was investigated. Results showed a strong positive correlation ($R2 = 0.95$, $P < 0.01$) between RT of urban landscape vegetation and WorldView-2 remotely sensed NDVI. The outcomes indicate that remotely sensed NDVI may be an efficient indicator of the water demand of urban landscape vegetation. However, further research is required to verify this finding more broadly.

Key words: NDVI, WUCOLS, urban landscape vegetation, RS/GIS application