AWRA 2011 ANNUAL WATER RESOURCES CONFERENCE
Albuquerque, New Mexico
November 7-10, 2011

ESTIMATING THE LOCATION AND RATE OF URBAN IRRIGATION IN SEMI-ARID CLIMATES USING REMOTE SENSING

Tyler Johnson, Ken Belitz *

ABSTRACT: Urban irrigation is an important component of the hydrologic cycle in many areas of the arid and semiarid western United States. This presentation describes a new approach that uses readily available datasets to estimate the location and rate of urban irrigation. The approach provides a repeatable methodology at 1/3 km^2 resolution across a large urbanized area (500 km^2). For this study, Landsat Thematic Mapper satellite imagery, air photos, climatic records, and a land-use map were used to: (1) identify the fraction of irrigated landscaping in urban areas, and (2) estimate the monthly rate of irrigation being applied to those areas. The area chosen for this study was the San Fernando Valley in Southern California. Identifying irrigated areas involved the use of 29 satellite images, air photos, and a land-use map. The fraction of a pixel that consists of irrigated landscaping (F_{irr}) was estimated using a linear-mixture model of two land-cover endmembers: impervious (airport buildings, runways, and pavement) and fully-irrigated landscaping (golf courses and parks). Estimating the rate of irrigation required identification of a third endmember: areas that consisted of urban vegetation but were not irrigated. This "nonirrigated" endmember was used to compute a Normalized Difference Vegetation Index (NDVI) surplus, defined as the difference between the NDVI signals of the irrigated and nonirrigated endmembers. The NDVI signal from irrigated areas remains relatively constant throughout the year, whereas the signal from nonirrigated areas rises and falls seasonally due to precipitation. The grassy areas between airport runways were chosen to represent the non-irrigated endmember. Water-delivery records from nearly 1,800 homes, were correlated with the NDVI surplus (r^2=0.94).

In the absence of water-delivery records, which can be difficult to obtain, a surrogate was identified: the landscape evapotranspiration rate (ET_L). ET_L was used to scale NDVI surplus (which is dimensionless) to irrigation rates using an exponential scaling function. The monthly irrigation rates calculated from satellite and climatic data compared well with irrigation rates calculated from actual water-delivery data using a paired Wilcoxan signed-rank test (ρ = 0.0063).

* Geographer, USGS, 4165 Spruance Rd. Suite 200, San Diego, CA 92101 USA, Phone: 619-225-6100, Email: tyjohns@usgs.gov