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A New Remote Sensing Based ET Algorithm for Estimation of Crop Water Use in Australia

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Around 90% of the precipitation that falls on the land in Australia is returned back to the atmosphere through actual evapotranspiration (ET) process at the continent scale. However, despite its significance nationally, it is almost impossible to measure or observe it directly at a meaningful scale in space and time through traditional point-based methods. Since late 1990's, the optical-thermal remote sensing satellite data has been extensively used for mapping of actual ET from farm to catchment scales in Australia. Numerous ET algorithms have been developed to make use of remote sensing data acquired by optical-thermal sensors mounted on airborne and satellite platforms.

Australian environmental conditions are unique. ET algorithms using RS data created in other parts of the world need adaptation to successfully work in Australian conditions. A novel algorithm for calculating ET from remote sensing is being implemented within Australia, for Australian irrigation systems initially, where crop water consumption is a crucial part of the water ordering decision-making.

This article concentrates on the Murrumbidgee catchment, where ground truth data has been collected on a fortnightly basis since 2007 using two Eddy Covariance Systems (ECS) and two Large Aperture Scintillometers (LAS). Their setup absorbed variability in the landscape to measure ET-related fluxes. The ground truthing measurement data includes leaf area index (LAI) from LICOR 2000, soil heat fluxes from HuskeFlux, crop reflectance data from CROPScan and from a thermal radiometer. UAV drone equipped with multispectral scanner and thermal imager was used to get very high spatial resolution NDVI and surface temperature maps over the selected farms. This large array of high technology instruments have been used to collect specific measurements within various micro-ecosystems available in our study area.

These high-tech observation system are used to collect specific ground truth data to develop new empirical and semi-empirical relationship for creating a Spatial Algorithm for Mapping ET (SAM-ET) dedicated to Australian agro-ecosystems. SAM-ET is a two source energy balance algorithm based on thermodynamic flux and radiation equilibrium within the Earth skin surface. This article concentrates on the evaluation of SAM-ET algorithm for mapping of actual ET over various land use classes in irrigated catchment using time series of Landsat 5 TM satellite images. Results of SAM-ET algorithm from Landsat 5 TM satellite images are validated with LAS and Eddy Covariance flux towers for irrigated maize and rice crop. Such estimates can underpin crop water use, crop water productivity, food security, carbon sequestration and environmental flow requirements to enhance the sustainability of agricultural systems. The next frontier is to integrate ET output with water balance and crop yield information for mapping crop water productivity of irrigation system.