

MODELING SOIL MOISTURE AND PLANT STRESS UNDER IRRIGATED CONDITIONS IN SEMIARID URBAN AREAS

Thomas Volo, Arizona State University, 480-965-3589, thomas.volo@asu.edu

1. Thomas J. Volo, School of Sustainable Engineering and the Built Environment, Arizona State University
2. Enrique R. Vivoni, School of Sustainable Engineering and the Built Environment, Arizona State University; School of Earth and Space Exploration, Arizona State University
3. Chris A. Martin, Department of Applied Sciences and Mathematics, Arizona State University
4. Stevan Earl, Global Institute of Sustainability, Arizona State University

Climatological and hydrological models typically ignore anthropogenic irrigation, despite its notable effects on water, energy and biomass conditions. This omission is noteworthy in semiarid cities, such as Phoenix, Arizona, where native and exotic vegetation in urban landscapes are well watered, inducing changes in their phenology and productivity. To our knowledge, the impact of irrigation on urban ecohydrology has yet to be addressed in a quantitative fashion. This study adapts a point-scale model of the soil water balance and plant stress by including seasonal irrigation patterns applied through different techniques. The model is applied to an experimental neighborhood on the Arizona State University campus where soil moisture observations have been collected for several years under multiple landscape and irrigation treatments. Nearby daily records of potential evapotranspiration and rainfall as well as metered irrigation data are utilized as model forcing. An automated optimization technique is then used to calibrate the model to soil moisture readings by varying local soil and vegetation parameters within physically plausible ranges. We apply the calibrated model as a basis to study the sensitivity of soil moisture and plant stress on such factors as soil classification, vegetative cover, meteorological forcing, and irrigation amounts and schedules that are representative of the conditions found in the broader metropolitan area of Phoenix. Two outcomes are obtained through this analysis: 1) an evaluation of the effectiveness of irrigation on mitigating plant water stress under varied conditions, and 2) the development of irrigation guidelines that optimize plant water use. Our results are intended to inform water and landscape managers in making decisions regarding the relationship between water use rates and plant water stress for different landscape treatments, based on a quantitative model. Future work will incorporate irrigation scheduling and its impact on water stress into a fully-distributed hydrological model applied at the scale of entire neighborhoods and cities in the Phoenix area.