

Scientific Developments in Quantifying Consumptive Use and Crop Water Requirements for Washington State

Understanding crop water requirements is essential for water planning and management, irrigation system design and scheduling, and hydrological modeling. This project developed a new database of estimated crop water requirements for a wide variety of crops and areas across Washington State, researched remote sensing methods of consumptive water use, and looked into consumptive water losses from sprinkle irrigation.

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This research highlight is based on a published work (see last page).



Consumptive Use and Irrigation Water Requirements for Washington State

Estimates of crop water requirements under various climates across the state are necessary for water planning and management, irrigation system design, simple irrigation scheduling, and hydrological modeling. There was a paper-only printed version of mean historical crop water use requirements for various areas of the state, but it was not available in electronic form, was done using out of date methods, limited data, and out of date methods. To this end, a new database was developed of estimated crop water requirements

for all relevant crops across Washington. The database has been published in a usable online tool at: <http://irrigation.wsu.edu/Content/Calculators/Historic/StationCropDOY.php>. The website (Figure 1) is being widely used for water right planning and management, irrigation system design, simple irrigation scheduling, and hydrologic modeling.

Adapting Satellite-based Estimates of Crop Water Use to Drone-Based Imagery

There are several existing models that use multispectral images from satellites to estimate crop water use. One such model is the METRIC model. However, these have a

maximum resolution (pixel size) of 30 meters by 30 meters (100ft x 100ft). This is too large to find problem areas in a particular field to inform management decisions. They also only are available when the satellite passes over, which is about every 10 days, and only when there is no cloud cover. Using drone based imagery can drastically increase the temporal and spatial resolution of crop water use estimates and is independent of cloud cover. The METRIC model was adapted for use with much higher resolution (in time and in space) imagery from drones (Figures 2 and 3). The drone-based estimates of ET were compared to satellite-based estimates of ET and shown to be similar.

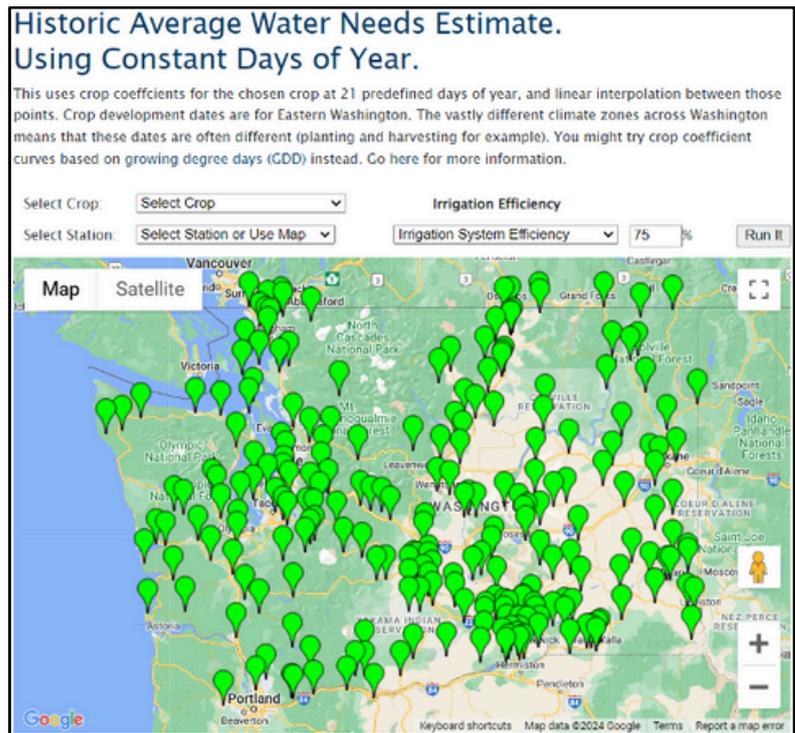


Figure 1. Estimated crop water requirements website developed by Troy Peters.



Figure 2. Dr. Abhilash Chandel and Dr. Behnaz Molaei use portable artificial reference surfaces to make sure that the infrared camera on the drone included valid hot and cold reference surfaces. Photo credit: Behnaz Molaei

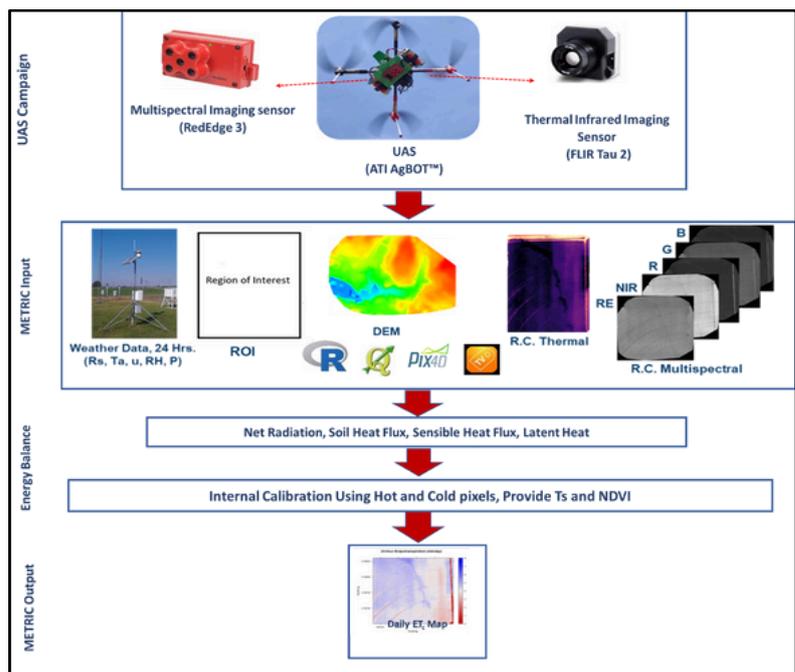


Figure 3. Demonstration of how multispectral and thermal infrared images can be used to create crop water use maps. Image created by Behnaz Molaei.

Do Water Losses from Sprinkler Irrigation Reduce Crop Water Use Downwind?

Estimating total water requirements based on consumptive use estimates requires estimates of irrigation system efficiency (Figure 4). Many say that the water losses from sprinkler irrigation are not all losses as they reduce crop water use downwind of the operating sprinkler due to microclimate changes (lower temperatures and higher humidity). It was demonstrated that water losses from sprinkler irrigation cools and humidifies the air and this results in lower crop water demand downwind of the sprinklers (Figure 5). This reduced evapotranspiration (ET). However, this suppression of ET did not compensate for the large water losses from sprinklers due to wind drift and evaporation. The calculated reduction in ET was small (1%) compared to the measured water losses from sprinklers (around 30%). This scale of error is also small in comparison to the variances in total water losses due to weather fluctuations. So bottom line, people shouldn't worry too much about modifying their consumptive use estimates for ET suppression caused by temporary micro-climate changes due to water losses from sprinkler wind drift and evaporation.

Investigation of Artificial Hot and Cold Reference Surfaces for Drone-Based Estimates of Crop Water Use

Drone-based estimates of ET are important as it can capture crop water use on high spatial and temporal resolution. A technical



Figure 4. Setup to measure weather and crop water use estimates of high water loss sprinklers (mid elevation spray application, or MESA) and low water loss sprinklers (low elevation spray application or LESA). Photo credit: Behnaz Molaei

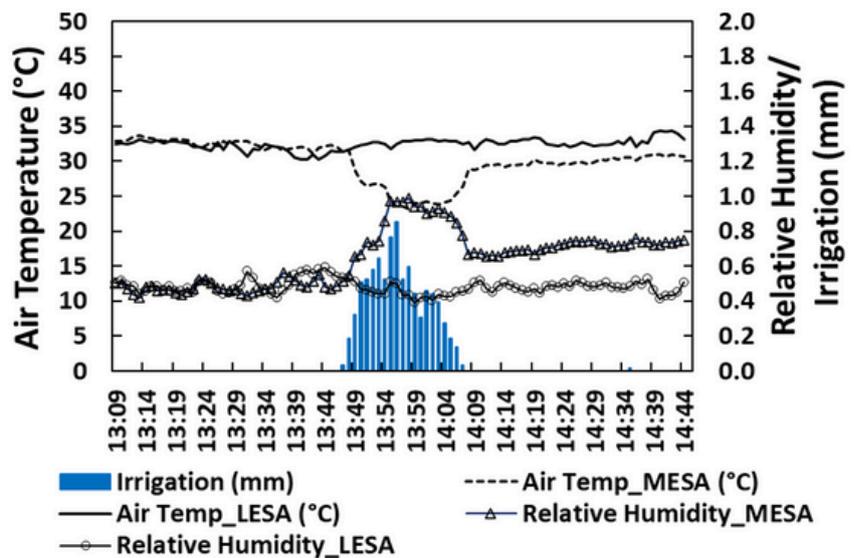


Figure 5. Shows how air temperature, and relative humidity change over time under mid elevation spray application (MESA) sprinklers compared to low elevation spray application (LESA) sprinklers as the pivot passed over. This results in a small reduction in the calculated reference evapotranspiration, but it does not compensate for the large losses of water from the sprinklers. Graph developed by Behnaz Molaei.

issue with this compared to satellite-based methods is that they can't guarantee the necessary fully-transpiring and non-transpiring surfaces (cold and hot references). To this end, portable and artificial hot and cold

reference surfaces were tested and correlations were run with ideal hot and cold reference surfaces (Figure 6). Ideal surfaces turned out to be shallow water or a wet sponge for the cold surfaces, and dry mulch for the hot surface.



Figure 6. A setup to compare sensed temperatures of portable artificial hot and cold reference surfaces for use with drone-based imagery for estimating crop water use. Photo by Behnaz Molaei

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Full paper available at:

Pickering, Nigel, Abilash Chandrel, Lav Khot, Minglian Liu, Troy Peters, Sunil Kadam, Behnaz Molaei, Jonathan Yoder, Kirti Rajagopalan, Claudio Stockle, and Georgine Yorgey. 2021. Evapotranspiration Estimation. *The Water Report* 208(June):10-19.

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