Publications

TR-418

Evaluation of the CRITERIA Irrigation Scheme Soil Water Balance Model in Texas

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- Full Text

The CRITERIA model was created in the 1990s in Italy, and is based on the soil water balance computation procedures developed at the Wageningen University in the Netherlands in the 1980s. CRITERIA has been used as an analysis and regional water planning tool (e.g seasonal crop yield and water use predictions, impact of climate change scenarios), and is currently used in Northern Italy to update the regional water balance on a weekly base. The model can handle a multilayered soils and computes daily average values related to the soil water balance (actual evaporation and transpiration, water flow between layers, deep percolation, surface runoff, and subsurface runoff). Automatic algorithms allow for calculation and scaling of data which may not be available such as detailed meteorological data and soil-water properties. Outputs can be readily used in a Geographic Information System (GIS). The required

inputs are precipitation, air temperature, soil texture, and crop management data (planting and harvesting dates, irrigation method and applied volumes). The model allows for input of additional data such as actual ET, soil conductivity, and soil-water characteristics. If this data is not available, the model can estimate them. The model requires calibration using a combination of measured soil moisture and actual ET.

The purpose of the study was to:

- Evaluate the performances of CRITERIA in predicting soil water moisture
- Evaluate its potential for predicting crop water requirement in real time within irrigation schemes using minimal input data

We calibrated the model for two (2) sites: the Texas High Plains with conditions representative of the southern Great Plains, and the semi-tropical Lower Rio Grande Valley (LRGV). Additionally, we evaluated the model without calibration for use at the irrigation district level, by simultaneously simulating many fields with different crops and water management strategies.

In the Texas High Plains, the model was calibrated and compared to lysimetric data for soybean production at the USDA-ARS Laboratory, Bushland, on soybean, over a two year period (2002 and 2003). In the LRGV, data was collected from a 27-ha sugarcane field within the Delta Lake Irrigation District, over a three years period (2007-2009). As sugar cane was not present in the CRITERIA database, we used one of the available crops (Actinidia) and we modified the default values for some parameters. Data on ETo and soil-water characteristics were not available, therefore we estimated them with the model. We also measured soil-water characteristics in laboratory from undisturbed soil cores collected in the field, and compared them to the values estimated with CRITERIA, and the Soil Water Characteristics Calculator (SWCC), an easy to use tool by USDA and Washington State University. The developed district scale evaluation was carried out at the Brownsville Irrigation District (BID) over a season’s worth of data (year 2010) for approximately 170 individual fields.

Soil moisture prediction at the Bushland and Delta Lake sites was in good agreement with measured data (R2 of correlations ranged between 0.7 and 0.8). At the Bushland site, the root growth model did not describe well the actual soybean growth below 30 cm of depth, probably due to the existence of the thick clay layer at 30 cm of depth which caused an atypical shaped root zone.

When applied at district scale, CRITERIA accurately predicted changes in soil moisture with estimated input data such as crop planting and harvesting dates, and actual irrigation volumes. One product of this study was a soil moisture status map that could be updated on a daily base.

CRITERIA needs additional improvements for application at field level in Texas conditions, particularly the crop management component (e.g. add crops and irrigation methods, improve root growth model). In order to apply the model as real time decision support system at regional scale, additional improvements are needed, including in the scaling algorithms and the automation of data and GIS output. Finally, further evaluation should be carried out to evaluate model algorithms currently used to estimate soil water properties.

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