American Water Resources Association
2015 SUMMER SPECIALTY CONFERENCE
Climate Change Adaptation
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New Orleans, LA

Wednesday, June 17
3:30 PM – 5:00 PM
SESSION 21: Dealing with Agriculture and Vegetation Changes

An Evaluation of in Season Water Stress Sensitivity Using a Multiplicative Evapotranspiration - Grain Yield Model for Zea mays L. Growing in Mead, Nebraska, USA - Jane Okalebo,
University of Nebraska-Lincoln, Lincoln, NE (co-authors: K. G. Hubbard, A. Kilic, R. Oglesby, M.Hayes.)

An empirical crop growth model was developed using long term corn-(Zea mays L.) experimental data from the University of Nebraska-Lincoln's Carbon Sequestration Project (CSP) at the Agricultural Research and Development Center near Lincoln NE. The model utilized the multiplicative approach to evaluating water demands expressed as the ratio of actual and potential evaporation at different periods of corn development. Total evapotranspiration measurements derived from eddy covariance measurements (EC), represented actual evapotranspiration while potential evapotranspiration (ETrp) was based on a modified Penman equation for Nebraska's climatic conditions. Several combinations of corn development periods were formulated where a period was comprised of more than one growth stage. The study herein tested the ET-yield model using several period combinations also known as models (A-E). Due to the nature of the evapotranspiration measurements made and the available data, the EC/ETrp was tested using 15 site-years. Model B which was comprised of three periods; VE-9, V10- V19 and V20-R3; resulted in a robust EC/ETrp relationship (RMSE= 1.067 Mg/ha) and was found to be reliable in estimating actual yields. The crop water sensitivity coefficients (λ i) generated using Model B were: 0.138, -0.048, and 0.935. The large value of $\lambda 3$ of 0.935 in the V20-R3 stages is proof that the reproductive stages of growth including pollination are most sensitive to water stress during the growth and development of the plants. As suggested from the dataset and models tested, the characteristically small and negative sensitivity coefficients at the mid vegetative growth stages were proof that yield increased with water stress. This concurs with the underlying theory that promotes deficit irrigation practices through the extension of roots to lower lying depths, lateral root development, crop water productivity and water use efficiency. The study examined only water use sensitivity and did not address other stresses such as heat, insect and/or pest stresses and their impacts on the overall yield of crops. Improved estimations of both actual and reference evapotranspiration will prove useful in enhancing the efficiency of empirical crop-weather models in estimating crop yields and scheduling irrigation events.

Resilient Bioenergy Production System Through Integrated Landscape Design in Iowa River Watershed, IA – Mi-Ae Ha, Argonne National Laboratory, Lemont, IL (co-author: M. Wu)

Nonpoint source pollution is the main source of nitrogen and phosphorus in agricultural watersheds. Environmental loadings can vary depending on land use and respond to future climate change. Some biomass-based energy crops such as switchgrass provide high production yield and reduce nutrient leakage into the water systems. Water sustainability in a watershed can be achieved through an integrated landscaping management strategy where crop land is designed according to soil property and land features and would provide desirable production while maintaining soil and water quality. In this work, a landscape design containing corn-soybean rotations and recently established switchgrass was implemented into a watershed model to investigate the impact on water quality under various climate scenarios. Switchgrass replaced low-productivity row crop and was grown in idle lands. Iowa River watershed, an agricultural dominant region, was the focus of this study. The Soil and Water Assessment Tool (SWAT) was used to simulate twelve years of crop yields, stream flows, nutrients, and sediment loads. The model was further applied with alternative land use design and various future climate scenarios. Regional climate models from downscaled global climate models (Intergovernmental Panel on Climate Change (IPCC) climate model projection) were spatially and temporally distributed over a calibrated and validated hydrologic model to evaluate the impact of climate changes on sustainable bioenergy production in these agricultural areas. The results show that nutrient and sediment loads were generally reduced under the integrated landscaping management scenario compared with current land use; that future climate could have positive impact on the water quality in the watershed; and that the extent of changes in loadings varied under different regional climate scenarios. Water availability represented by water yield in the Iowa River watershed varies significantly depending on future projections.

Interactions of Vegetation and the Hydrologic Cycle - Static Parameterizations May be Misleading in a Changing Climate - Jonathan Quebbeman, Kleinschmidt, Fort Collins, CO

Remotely sensed land cover data is critical in the development and parameterization of vegetation within large-scale hydrologic models, which provides an indication of the current vegetation given the previous climate. Although less critical for event- based simulations, continuous -simulations (decades to centuries using hourly or daily timesteps) using climate projections require an increased degree of vegetal parameterization. Many Global Circulation Models (GCMs) project significant changes in our climate up to year 2100 and beyond. Assuming that land cover will just remain static, and also that vegetation will respond similarly year-after-year is a naíve approach. Extremely powerful tools are available at various scales to simulate dynamic vegetation, but they are generally beyond the reach of the general industry. This presentation will raise awareness of the requirements for vegetal parameterization in continuous simulation hydrologic models, highlight the potential affects and consequences of incorrect parameterization on the hydrologic cycle, and offer high-level first-order solutions.

Targeting and Measuring Water Quality Improvements from Conservation Practices under Uncertain Climate - Drew Kessler, Houston Engineering, Inc., Maple Grove, MN (co-authors: M. Deutschman, J. Lewis, J. Jazdzewski, T. Erickson)

Many watersheds within the Upper Midwest are experiencing increased intensity and duration of precipitation events. Minnesota is a prime example of an area impacted by these climatic variations which leads to increased contribution of sediment, nitrogen, and phosphorus to lakes, rivers, and streams. This presentation will highlight new methods that have been developed to utilize Hydrologic Simulation Program-Fortran (HSPF), Soil and Water Assessment Tool (SWAT), and airborne light, detection, and ranging (LiDAR) data to target locations to place Best Management Practices (BMP) and estimate the resulting water quality improvements (i.e., reductions in sediment, nitrogen, and phosphorus) at the BMP and downstream surface water resource under uncertain climate regimes. The presentation will focus on a case study within the Root River Watershed, a pilot watershed in a new state led integrated watershed planning effort.