Evaluating the Integration of a Virtual Evapotranspiration Sensor into the Annualized Agricultural Non-Point Source Model

Greg Easson, Dath Mita, Lance Yarbrough, and Henrique Momm
The University of Mississippi GeoInformatics Center

geasson@olemiss.edu

Goal

To investigate the use of satellite remotely sensed evapotranspiration data in watershed pollution prediction model and improve the efficiency and effectiveness of the model.

PROJECT OVERVIEW

This project was designed to improve the efficiency and effectiveness of a pollution prediction model, the Annualized Agricultural Nonpoint Source Pollution (AnnAGNPS). This model (developed by USDA) is commonly used to simulate point and non-point source quantities of sediment, nutrients, and pesticides in runoff water from a land surface (Figure 1). Successful watershed management and conservation programs rely on such models to provide accurate and timely information. The model can also be used to evaluate Best Management Practices (BMPs).

Figure 1. Environmental models, such as AnnAGNPS, are important in watershed management and conservation of natural resources.

The AnnAGNPS watershed simulation model, like most environmental models, is dependent on a number of data inputs, like evapotranspiration (ET). Currently, however, ET data is derived by a complex and time consuming process. That involves the computation of actual ET as a function of potential ET and soil moisture content using the PENMAN equation (Figure 2). To run the equation requires several climate data input variables that are collected from ground meteorological stations.

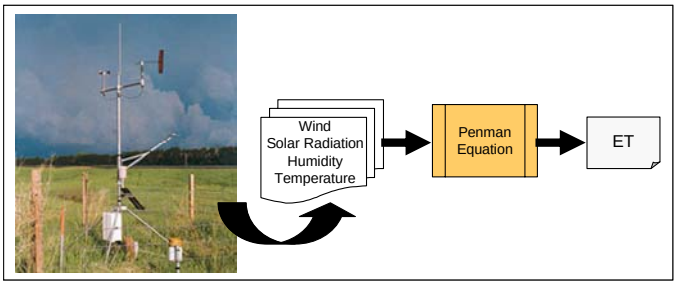

Figure 2. Calculation of ET: Schematic depicting how ET is determined using ground weather stations data (wind, solar radiation, temperature and humidity) and the Penman Equation.

In certain regions, with limited or sparse ground weather stations and historical data, gathering sufficient climate data can be a challenge and lead to limited and generalized watershed simulation (Figure 3). The problem of sparse climate weather stations may be alleviated by the use of satellite data.

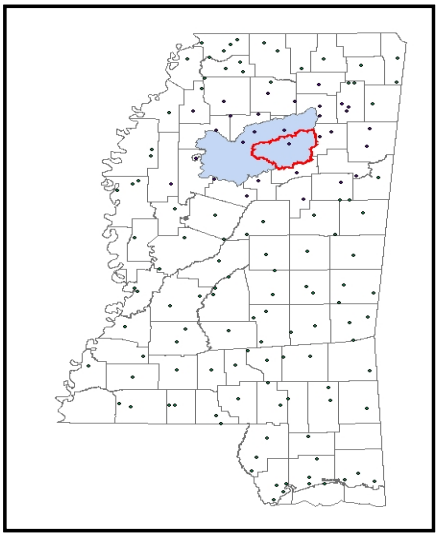

Figure 3. Mississippi County map showing the study area (Yalobusha watershed) and the distribution of weather stations. The ground weather stations in many regions are relatively few and sparcely distributed.

APPROACH

The project was conducted in the Yalobusha watershed in the Upper Mississippi region (Figure 3). The major tasks were: (1) collection and analysis of historical climatic data for the period 2000 - 2005 in order to process field-based evapotranspiration (ET) data, (2) acquiring and pre-processing of MODIS satellite data for generating satellite-based ET values, (3) development and evaluation of an algorithm for generating satellite-based ET, and (4) running AnnAGNPS watershed simulation

experiments in order to compare the performance of field-based and satellite-based ET data.

CONCLUSIONS

The use of MODIS satellite information provided the capability to significantly increase ET observation points within the study area (Figures 5 and 6). The expanded distribution of data collection points, "Virtual" weather stations (Figure 6), increased the scale of ET observations from approximately 1:45 km to 1:5 km. We also found that the MODIS ET values were significantly closer to actual ET measurements than potential ET.

Finally, these findings have led to the modification of AnnAGNPS model in order to adopt the direct input of ET data. A total of nine climate variable inputs can now be replaced by one single input, MODIS ET (Figure 6).

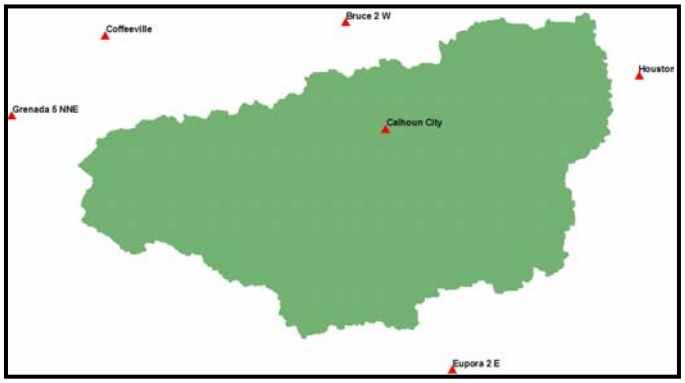

Figure 4. The study area map showing the distristibution (few and sparse) weather stations.

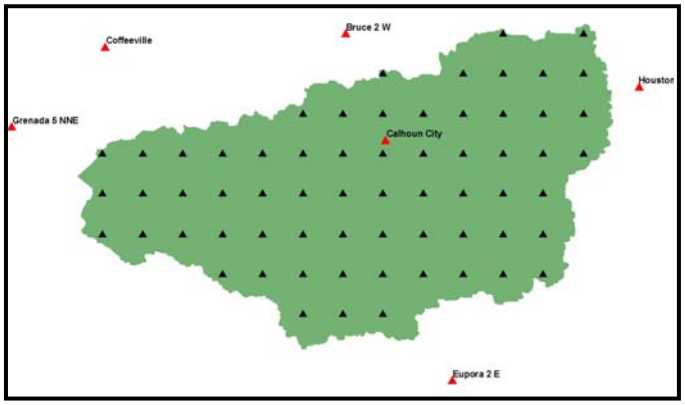

Figure 5. The study area map showing the increase in the distristibution of ET observation (virtual) stations generated by using MODIS satellite data.

EXPECTED IMPACTS

The increase in resolution, quality and volume of evapotranspiration (ET) information significantly contributes to improved and more accurate prediction of non-point source pollution loadings within agricultural watersheds. This in turn improves the design and implementation of watershed conservation programs. In addition, short and long term improvements in water quality management and human health are realized.

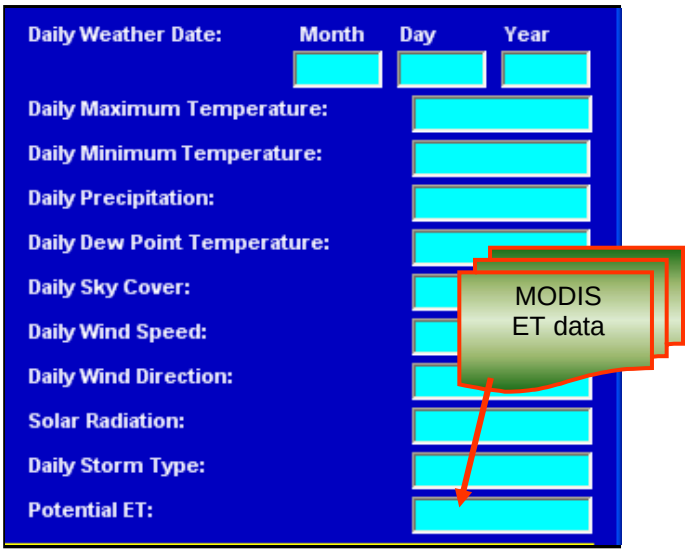

Figure 6. The research results added a direct ET data input entry in AnnAGNPS Climate Data Input Editor. When the ET is entered the rest of the inputs for ET estimation are automatically not required. This allows for a more effective and efficient data input and model processing.

Collaborators

USDA Agricultural Research Service, National Sedimentation Laboratory

The Institute for Technology Development (ITD)

Contact Information

For more information please contact Greg Easson.
Email: ***geasson@olemiss.edu***
Phone: (662) 915-5995
www.mmri.olemiss.edu – *umgc@olemiss.edu*