NATIONAL CONSORTIUM FOR REMOTE SENSING EDUCATION, RESEARCH, AND APPLICATIONS

IndianaView

PROJECT FACT SHEET

http://www.indianaview.org

Simulation of the Effect of Groundwater Storage and Withdrawals in the Wabash River Basin

***Ayomide G. Adepeju*, Purdue** University (E-Mail: aadepeju@purdue.edu)

Background: Increased water demand for industrial purposes in areas with limited water resources may lead to conflicts with historically water-rich areas. To enhance the management of surface water and groundwater resources in communities, it is important to study groundwater storage and withdrawals, integral parts of the water cycle often neglected by surface hydrological models. Improving a conventional macroscale hydrologic model such as the Variable Infiltration Capacity (VIC) model by adding an unconfined subsurface layer representing aquifer storage and a groundwater flow pathway to the model makes it possible to better represent the effect of groundwater resources in the water cycle. **The objective of the study is to show how streamflow changes with large groundwater withdrawals and interbasin transfers between tributaries of the Wabash River.**

The VIC Model: The VIC model takes soil, vegetation, and daily weather input to calculate the full water and energy balances for each model grid cell (Liang et al., 1994). In this study, six soil layers and a groundwater layer are used. The moisture storage in the first and second soil layers is used for deriving the surface runoff and infiltration capacity; the other subsurface layers describe the baseflow; and the groundwater layer describes the groundwater flow. The additional groundwater aquifer layer requires the following inputs: the initial water storage in the aquifer layer, mean monthly groundwater withdrawals, and the physical features of the aquifer.

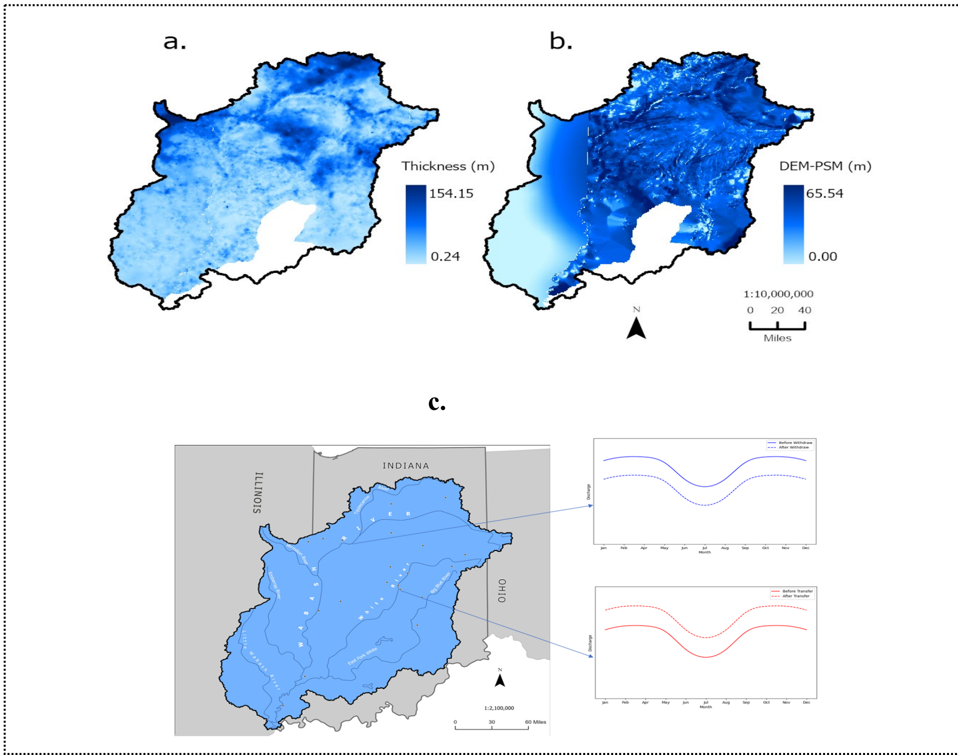

Figure 1. (a) Aquifer thickness (b) Depth to water table (c) In the future, the model will be used to evaluate the impact of interbasin transfers on streamflow

Data and Data Processing: The initial moisture content of the aquifer was computed by first getting the aquifer thickness layer from Bayless et al. (2017) (Figure 1a), estimating depth to water table (Figure 1b), by subtracting potentiometric surface (PSM) from elevation data (DEM), and interpolating for areas with no PSM. Saturated and unsaturated thickness were calculated using the equations below:

$T_{sat} = T_{AQ} + T_{SOIL} - (DEM\text{-}PSM)$ (1)

$T_{unsat} = T_{AQ} - T_{sat}$ (2)

$IM = (T_{sat} + T_{unsat} \cdot \theta_{cr}) \cdot \eta$ (3)

Where T_{sat} is thickness of the saturated layer, T_{AQ} is the total glacial aquifer thickness, T_{SOIL} is the soil thickness, and T_{unsat} is unsaturated thickness, IM is the initial moisture content, θ_{CR} is water at critical point, and η is porosity.

Expected Result:

- Streamflow changes with large groundwater exchanges between tributaries.
- Streamflow changes with large groundwater exchanges between tributaries. Streamflow in the tributary where water is withdrawn is expected to reduce, while it will increase in the tributary that receives water (Figure 1c).

References:

Bayless, E. R., Arihood, L. D., Reeves, H. W., Sperl, B. J. S., Qi, S. L., Stipe, V. E., & Bunch, A. R. (2017). Maps and grids of hydrogeologic information created from standardized water-well drillers' records of the glaciated United States: US Geological Survey scientific investigations report 2015–5105.

Liang, X., Lettenmaier, D. P., Wood, E. F., & Burges, S. J. (1994). A simple hydrologically based model of land surface water and energy fluxes for general circulation models. Journal of Geophysical Research: Atmospheres, 99(D7), 14415-14428.