JPUR
JOURNAL OF PURDUE UNDERGRADUATE RESEARCH

AGRICULTURE

Determining the Landscape-Scale Spatial Variability of Soil Available Water Storage for Use in Climate Change Modeling

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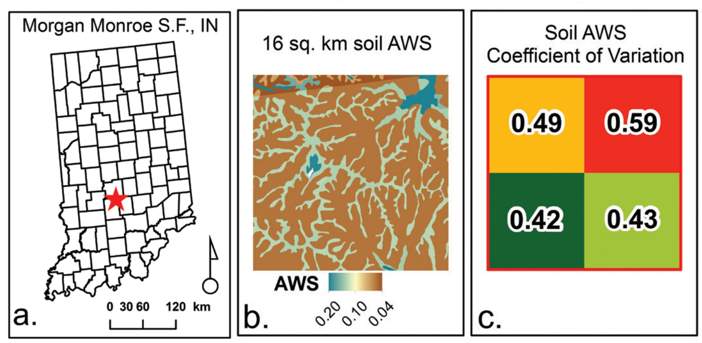
The threat of climate change has gathered an incredible amount of attention and scientific research in recent years. Understanding the landscape-scale spatial variability of soil hydrologic properties, especially soil available water storage (AWS), is important because this soil-water interaction has numerous implications in the biosphere and atmosphere, and strongly influences regional climate patterns. This research analyzed the spatial variability of soil AWS data within the soil root zone (1.5 m soil depth) at spatial resolutions of 16 km^2, 4 km^2, and 1 km^2 grids.

The goal of this research project was to add to a current study by evaluating the influence of AWS at different resolutions on the output and prediction ability of the Land Data Assimilation System (LDAS)–based dataset for regional hydroclimatic assessments over the U.S. Corn Belt.

The hypothesis was that the spatial variability of AWS results in coefficients of variation (CV) less than 60% (0.60) the scale at which the LDAS model is run (16 km^2 grids) due to homogeneous soil functionality of a largely agricultural region caused by extensive landscape engineering for drainage purposes.

Three sites used for ongoing LDAS data collection were chosen to determine the variability of AWS data in the U.S. Department of Agriculture's (USDA's) gridded Soil Survey Geographic (gSSURGO) database. The three sites chosen, and corresponding databases used, were located in Morgan Monroe State Forest, Indiana; Mead, Nebraska; and Mandan, North Dakota. To determine variability from gSSURGO, AWS data for a 16 km^2 square surrounding each site were extracted and aggregated, and block statistics were run using the Geographic Information System (GIS), ArcGIS (ver. 10.3). Maximum CVs at the 16 km^2 resolution for each site were as follows: Indiana, 0.592; Nebraska, 0.135; North Dakota, 0.251. These data corroborate LDAS's assumption that the variability of AWS in the gSSURGO database is less than 0.60 and is valid at the current 16 km^2 resolution for the purpose of regional climate modeling. The results are promising, providing real data to back up the claim of homogenous soil functionality and validating the gSSURGO database as a viable tool to be used for additional modeling efforts that incorporate soil AWS.

Research advisor Phillip R. Owens writes: "This student project focused on the very important issue of evaluating soil data input for regional models for predicting impacts of climate change. Many models use coarse resolution soil data with very little known about the fine resolution variability. Ryan took this challenge for an Honors class project and answered critical questions about soil data variability at multiple resolutions. This project benefited Ryan by providing a research opportunity and also the research program by providing a critical piece of research."



(a) The 16 km^2 grid-block around the Morgan Monroe State Forest, Indiana, study site location. **(b)** Reported gSSURGO available water storage (AWS) data within the upper 1.5 m of soil, displayed as m^3_{water}/m^3_{soil}; shallow soils on hillslopes result in low AWS values, while valley-bottom/riparian soils have high AWS values. **(c)** Resulting coefficients of variation (CV) of AWS when soils data were aggregated in 4 km^2 units within the 16 km^2.

Schroeder, R. (2016). Determining the landscape-scale spatial variability of soil available water storage for use in climate change modeling. *Journal of Purdue Undergraduate Research, 6,* 81–82. http://dx.doi.org/10.5703/1288284316196