Soil and Water Science
Research Brief
University of Florida Institute of Food and Agricultural Sciences

Rainfall/Runoff Analysis to Investigate Flowpaths in a Forested Watershed Utilizing Topmodel

Monika Tkaczyk and James Jawitz

Surface runoff or rainfall excess is a fundamental concept in water resources planning. The estimate of runoff volume is of primary concern in engineering design from urban development to hydraulic structures and flood prevention.

The rates of hydrologic input and output processes vary spatially and temporally over geographic regions at all scales. Data collection from large areas is difficult and expensive, so hydrologic models are often based on homogenous approximations of nature. As a result, a large basin (1,000 km^2) is modeled as a lumped system with average, representative or "effective" parameters for the entire area. With the advancement of computer technology however, spatially varied parameters like soil properties, rainfall, surface, topography, vegetative cover, and land use have become particularly significant in hydrologic analyses.

One goal of this study is to analyze rainfall runoff and subsurface flow in a forested watershed to predict runoff processes utilizing spatially varied soil properties. It is important to be able to model these processes accurately and estimate rainfall excess generated from the watersheds, stage of flooding in a river, or the volume of water a river can provide at any given time. Furthermore, surface runoff is of great interest in water quality issues as it carries nutrients and contaminants through the process of erosion, transport and deposition.

The project site is located at Ft. Benning, Georgia military reservation. Figure 1 illustrates the erosion effects in one of the watersheds impacted by military training.

Figure1. Erosion in Rowan Hill, Bonham 2 watershed.

A semi-distributed, topography-based model-TOPMODEL is utilized in this study. It predicts the flow paths in the watershed and their effects on the overall watershed response to precipitation.

The topographic information for the study area was provided in the form of a digital elevation map (DEM). This data was manipulated in the Geographic Information System (GIS) program ArcView. In addition, a digital soil properties map was manipulated in GIS to perform spatially distributed hydrologic modeling. Figure 2 shows different soil types for the two watersheds in the study area.

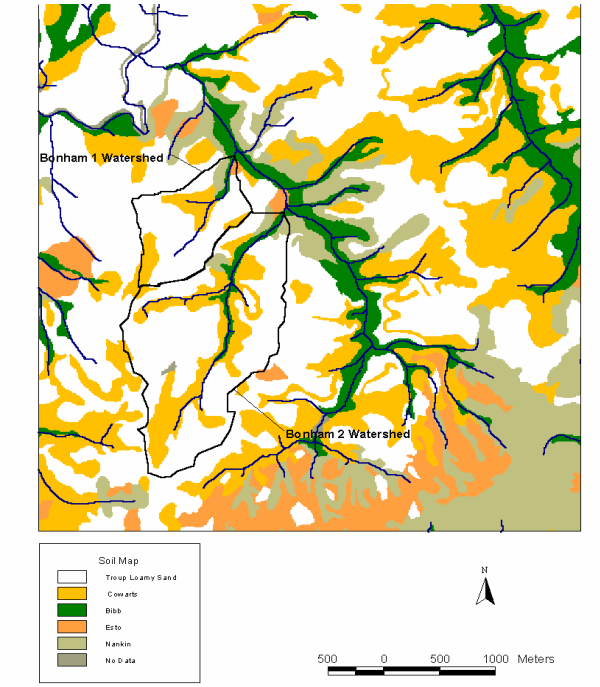

Figure 2. Spatial variability of soil in the study area.

The topographic index (TI) serves as a primary input information into the model, upon which the TOPMODEL computes the hydrologic response of the watershed. This study introduced a soil-topographic index (STI), incorporating soil hydraulic properties into it. Figure 3 compares the TI with the STI calculated for Bonham 2 watershed. The two curves result in a different range of topographic index values and aerial distribution for the two conditions modeled. As a result, the predicted saturated areas in the watersheds varied substantially.

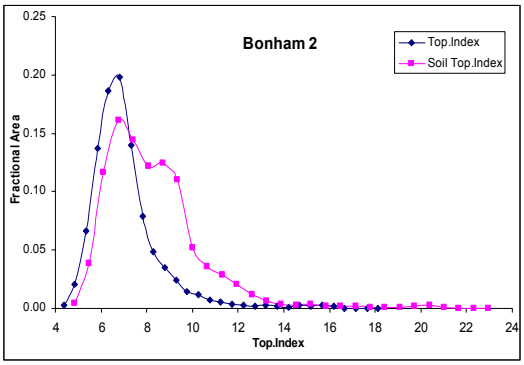

Figure 3. Topographic index for homogenous and heterogeneous soils.

Figure 4 compares TOPMODEL's simulations: increase in saturated areas for heterogeneous conditions (Fig. 4b and 4d) and also a more accurate location of these areas. A wetland coverage map was compared to identify wet areas and the saturated area near the stream, Fig. 4d, was well depicted by the basin's outlet.

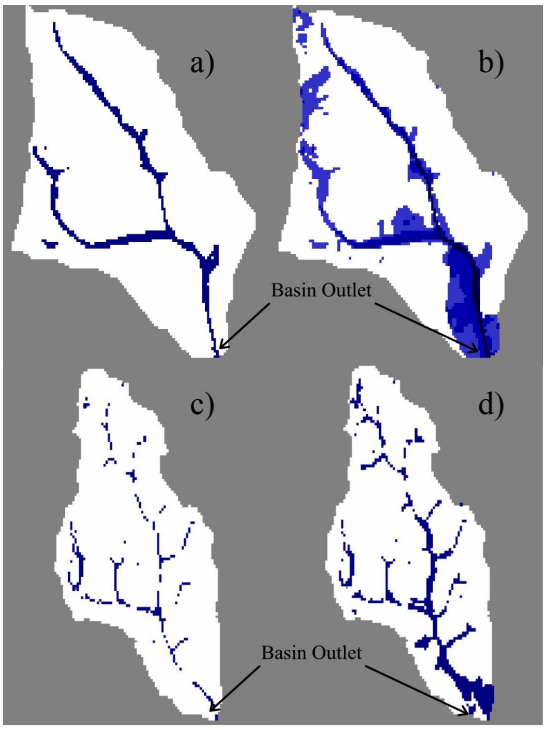

Figure 4. Comparison of the saturated areas for homogenous run a) and c): heterogeneous run b) and d).

This research enables improved management of water and land resources. Future studies will investigate more closely the dependence of soil heterogeneity on hydrograph response and estimated volume of watershed runoff, as more field data become available.

Authors:
Monika Tkaczyk, Graduate Research Assist.
James Jawitz, Assistant Professor,
University of Florida,
Soil and Water Science Dept.,
2169 McCarty Hall, P.O. Box 110290,
Gainesville, FL 32611,
monikat@mail.ifas.ufl.edu
jawitz@ufl.edu