# Development of Geospatial Modeling Tools for Watershed-based Water Resources Management in New Mexico

Enrique Vivoni, Earth and Environmental Sciences, NM Tech

*Project descriptors: Watersheds, hydrologic simulation, system dynamics modeling, Rio Grande, ungauged tributaries, probabilistic forecasts, web dissemination*

## PROBLEM AND RESEARCH OBJECTIVES

The project is developing new geospatial modeling tools for managing water resources in New Mexico using scientific knowledge on climate, surface and groundwater relations. The new technology will be designed to provide decision makers with probabilistic forecasts of water supply using ensemble techniques and address the potential for climate and land cover changes on hydrological quantities. While sophisticated, the modeling results will be made amenable to water managers through monthly web products in a similar fashion to existing drought maps. The specific objectives of the project are to:

a. Identify the hydrologic processes and feedbacks to be simulated in a system dynamics framework.
b. Design and implement watershed model in PowerSim (a system dynamics framework) with the linkages to a GIS and mathematical software (MATLAB).
c. Develop ensemble forcing and parameter estimation code in MATLAB to generate alternative climate and land-use scenarios.
d. Utilize existing data for Río Grande (topography, land/soils, rainfall, atmospheric observations) to obtain retrospective model simulations as a proof-of-concept.

## METHODOLOGY

The project will integrate various technologies for the purpose of hydrological forecasting in regional basins. The hydrological simulation code is being developed in a system dynamics (SD) modeling environment known as PowerSim; the geospatial products are stored, queried, displayed and archived in a geographical information system (ArcGIS); the ensemble generator and uncertainty estimator for climate/land-use changes will be developed in a mathematical software (MATLAB). We will spend considerable effort in integrating the three components to provide the user with seamless operation. The project will result in a semi-distributed hydrologic model to address the spatial and temporal dynamics of watershed processes, applied initially to the Río Grande from headwaters to the NM/TX state line. Through coupling to a GIS, the model will incorporate remote sensing observations of rainfall, topography, vegetation cover and soils to provide maps of hydrologic states (e.g., soil moisture, water table depth) and fluxes (e.g., evapotranspiration, runoff, recharge).

## PRINCIPAL FINDINGS

Over the course of the project, the system dynamics-based watershed model in Powersim has been completed and tested in the Rio Salado, a major ungauged tributary in the Rio Grande. The model development has been carried out using both Powersim coding and Visual Basic. In addition, tools have been developed in Excel, GIS and MATLAB to visualize model input and output. In addition to the model development efforts, we have also focused on collecting watershed data necessary to run the model for the Río Grande over the time period of interest. We have selected the Río Salado as our prototype case study and focused on the relevant data sets for this model application. Model testing has been completed and is summarized in a thesis by Carlos A. Aragon. The thesis includes a  description of watershed model equations, parameters and forcing; and a description of model testing at the Sevilleta Deep Well site and Rio Salado basin; and 3. Description of rainfall uncertainty propagation and climate change scenarios using the watershed model.