Tracy Langston El Dia Proposal Pitch

Modeling Storm Runoff in an Arid Watershed Using tRIBS: Performance and Parameter Sensitivity

This project tests whether the hydrologic model tRIBS (Triangulated Irregular Network (TIN) based Real-time Integrated Basin Simulator) can accurately simulate storm runoff in an arid watershed and whether the model's sensitivity to key parameters changes across different climate settings. Two related hypotheses will be explored: first, tRIBS can reproduce important characteristics of storm runoff in an arid first-order watershed, including peak discharge, total runoff volume, and the timing of the hydrograph; second, the model's parameter sensitivity depends on climate context, meaning that parameters that strongly influence runoff in humid regions may behave differently in arid environments.

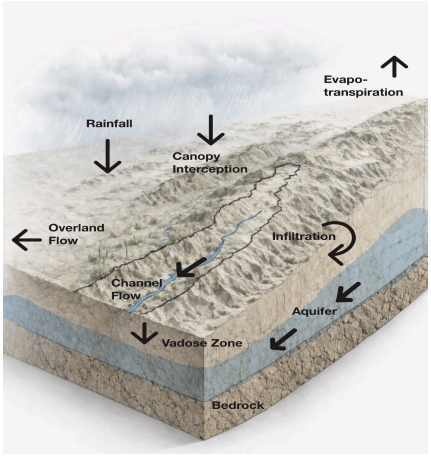
Although tRIBS has been widely used to explore hydrologic processes and surface–subsurface interactions, most published applications have focused on humid or temperate catchments. Arid watersheds present a different set of hydrologic conditions, including infrequent but intense rainfall events, highly variable infiltration, and rapid runoff responses. These characteristics make modeling more challenging but also potentially more informative. While model calibration has been examined in previous studies, how parameter sensitivity varies across climates remains less well understood. This project addresses both gaps by testing the performance of tRIBS in an arid watershed and examining whether model behavior differs from what has been reported in other environments.

Understanding how desert watersheds respond to large storm events is important both scientifically and practically. Intense rainfall in arid landscapes can produce destructive flash floods, but these events also represent rare opportunities for groundwater recharge. Because water resources are limited in arid regions, improving our ability to predict and understand these events has scientific value.

Better modeling tools can help communities prepare for extreme storms by identifying where runoff is likely to concentrate and how quickly water may move through a watershed. At the same time, modeling can help highlight conditions where stormwater might contribute to recharge rather than simply becoming overland flood flow. By improving our understanding of these processes, the results of this work may support better watershed management decisions and help communities balance flood risk with water resource opportunities.

An additional benefit of this work is that tRIBS is an open-source model that is fully distributed and physics-based. Because the model is accessible, flexible, and powerful, insights from this study could be applied to other watersheds ranging from small headwater basins to larger catchments. This makes the work relevant not only for researchers but also for practitioners interested in watershed planning, water management, and hazard mitigation.

The study area for this project is Pima Canyon Wash, a first-order watershed in South Mountain Park in Phoenix, Arizona. Several types of data will be used to construct and evaluate the model. Weather observations, including precipitation and other meteorological variables, will be obtained from a monitoring station located near the headwaters of the canyon. Streamflow observations from the watershed outlet will be used to evaluate model predictions during storm events. Geographic information system (GIS) data, including digital elevation models and surface raster datasets, will provide information about watershed topography and drainage structure. Vegetation characteristics will be represented using LANDFIRE vegetation data.



tRIBS Model Outputs
Streamflow / Channel Discharge
Surface Runoff
Infiltration
Soil Moisture
Evapotranspiration
Groundwater / Subsurface Flow
Water Table Depth
Watershed Water Balance

Figure: Surface-subsurface hydrologic processes over complex terrain may be modeled by tRIBS.

These datasets will be used as inputs for the tRIBS hydrologic model, which simulates surface and subsurface water movement over complex terrain. The model will first be calibrated using one well-documented storm event. After calibration, additional storm events will be modeled to evaluate how well the model reproduces observed runoff behavior. Model performance will be assessed by comparing predicted and observed hydrographs, including peak discharge, runoff volume, and timing.

The second part of the analysis will explore how sensitive model outputs are to different input parameters. Sensitivity results from the Pima Canyon model runs will be compared with parameter sensitivities reported in previous studies conducted in other climate settings. This comparison will help determine whether certain parameters play a larger or smaller role in arid environments.

Support for the first hypothesis would be indicated if the model reproduces observed storm hydrographs with strong statistical agreement. For example, high coefficients of determination (R^2 values above about 0.90) between simulated and observed discharge would suggest the model is capturing the main features of runoff generation in the watershed. Conversely, consistently low agreement between model predictions and observations (for example, R^2 values below about 0.70) would suggest the model is not adequately representing key hydrologic processes in this environment.

Support for the second hypothesis would occur if the sensitivity analysis shows that different parameters control model outputs in arid conditions compared with those reported in previous studies. For instance, infiltration-related parameters or soil properties might have greater influence in the desert setting than vegetation-related parameters that dominate in wetter climates. If the sensitivity patterns match those previously reported in other climates, the hypothesis that parameter sensitivity is climate-dependent would not be supported.

Timeframe	Early March	Mid March	Early April	Mid April	Late April
Milestone	Run tRIBS benchmark models; become familiar with model workflow	Gather and preprocess watershed data for Pima Canyon Wash	Build and run initial watershed model	Calibrate model and evaluate performance	Conduct parameter sensitivity analysis