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BEE 6740: Week 8 Assignment
Model Calibration
3/22/18

Purpose:
Hydrologic models must be designed and calibrated for each ecosystem in which it will be applied because parameters and analyses may be regionally appropriate. Algorithms designed to search the feasible parameter range for different calibration parameters can supply the "best" parameter value and NSE from Monte Carlo simulations. Precipitation, snow melt, evapotranspiration, soil water, and streamflow can then use the "best" parameter input for the "best" model prediction. However, certain models are limited in highly controlled watersheds, in which case observed flow is not the natural flow. Therefore, comparisons between observed streamflow data and modeled streamflow data are not useful because they are not direct comparisons. The Nash Sutcliffe Model Efficiency was calculated to compare USGS observed streamflow data and modeled flow.

Methods:
Using the "EcoHydRology" package and "SnowMelt" function in R, PET data for Albuquerque were calculated. USGS data for Rio Grande, Albuquerque, New Mexico was obtained for January 1st, 2000 through December 31st, 2009 from stream gage ID 08330000. Meteorological data for each location was obtained from NOAA "Global Summary of the Year."

The function "SnowMelt" calculated snowmelt and the "Lumped_VSA_Model" calculates the streamflow and saturated area percentage for variable source areas using a lumped model of the watershed and the Thornthwaite-Mather water budget.

Function inputs used are shown in Table 1. Daily date series, precipitation (rain and snowmelt), maximum temperature and minimum temperature were obtained from hydrological data and the "SnowMelt" model. The latitude used for Albuquerque, NM was 35.0844 degrees. AWCper was found using the Web Soil Survey.

Table 1: Function arguments and values for “Lumped_VSA_Model”

Function Argument	**Definition**	**Value**
Tp (hours)	Time to peak of hydrograph	5
Depth (mm)	Average watershed soil depth	2010
SATper (volumetric fraction 0-1)	Porosity of soil	0.5
AWCper (volumetric fraction 0-1)	Available water capacity	0.02
StartCond	Watershed conditions before the first day of runs	avg
Depth (mm)	Average watershed soil depth	1500

A DDS algorithm was run to determine the best parameters from the feasible parameter space as defined in Table 2. After the initial guess, parameter values were perturbed at each iteration to try to find overall “best”s. Multiple range changes to the function defaults were done to account for the large watershed, the sandy soil type, and the shallow soil depth.

Table 2: Parameter range for Monte Carlo simulations

	Minimum	Maximum	Initial Guess
Initial Abstraction, Ia	0.05	0.2	0.05
Forest Cover, fc (0-1)	0.1	0.9	0.1
Storage, Se	50	150	50
Maximal PET per day, PETcap (mm)	4	6	4
Curve number to Soil Water coefficient, C1	1	5	1
Baseflow recession coefficient, rec_coef	0.001	0.1	0.01
Time to peak hydrograph, Tp	1	100	1
Percent Impervious, (0-1)	0	0.5	0

The Nash Sutcliffe Model Efficiency (NSE) was calculated using

$$NSE = 1 - \frac{\Sigma[(observed - simulated)^2]}{\Sigma[(observed - \overline{observed})^2]}$$

at a daily timestep. The observed data was obtained using the "get_usgs_gage" function for Fall Creek and the simulated data was obtained from the "Lumped_VSA_model."

Conclusion:

The modeled flow calculated using snowmelt and variable source area calculations are not good at predicting observed flow for the Rio Grande in Albuquerque, NM watershed. The observed flow is highly controlled and is not natural. The modeled flow depends on energy balances and water fluxes, but does not take into account the high degree of control that the Rio Grande encounters. The "best" NSE calculated was -15.17 using the parameters and bounds defined above. While updating the model to account for the shallow and sandy soil was useful and provided more reasonable soil water storage results, it was not sufficient and shows that the "Lumped_VSA_model" is inappropriately applied to this watershed. Figures 1 through 3 show the results of modeled and observed flow comparisons. The model is more appropriate for watersheds and flows that are not highly controlled and are a result of natural variations.

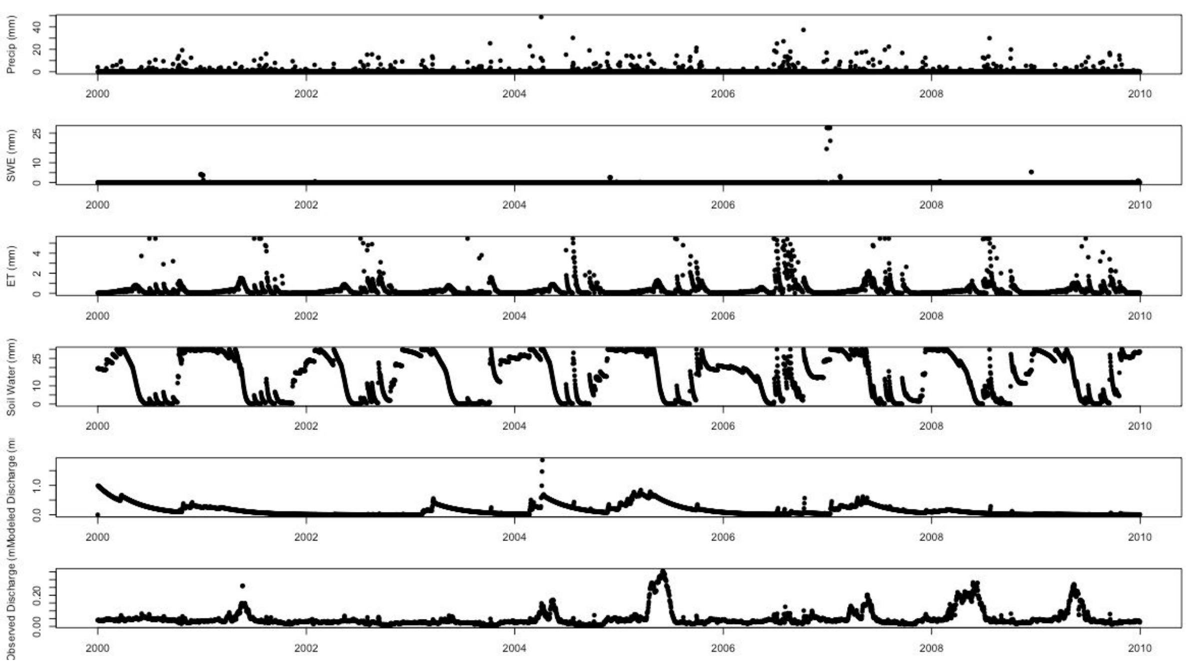

Figure 1: 10 years of data for precipitation, SWE, ET, soil water, modeled flow, and observed flow for the Rio Grande in Albuquerque, NM.

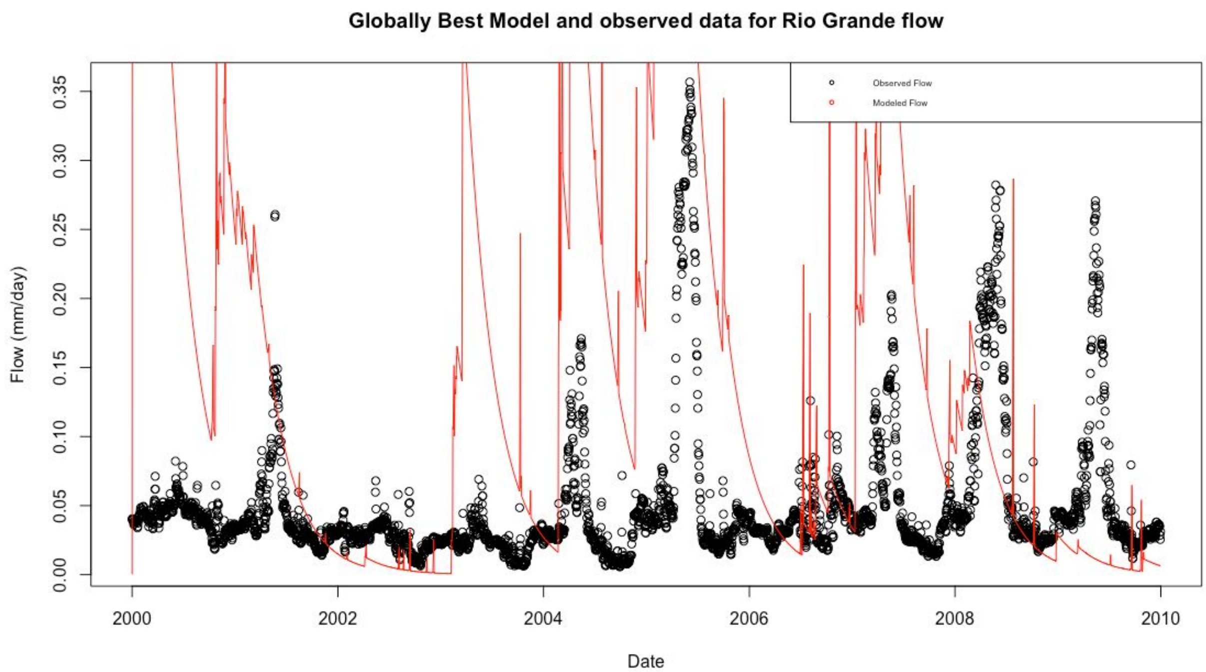

Figure 2: 10 years of data for observed flow and modeled flow.

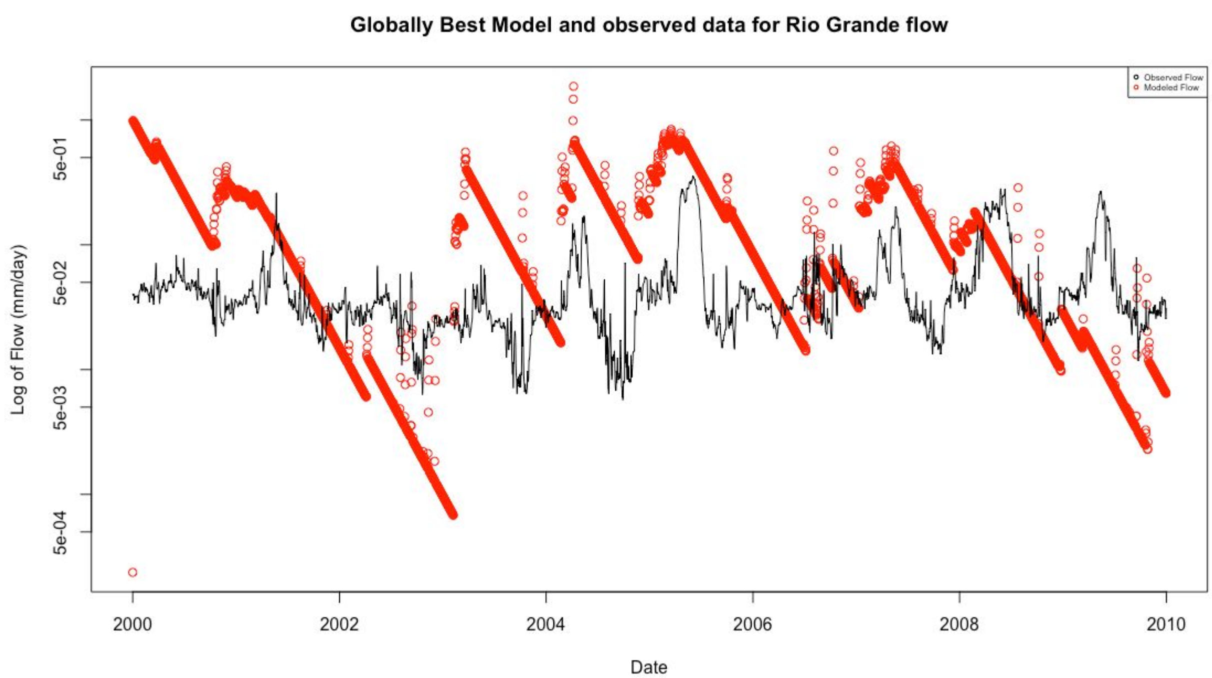

Figure 3: 10 years of data for observed flow and modeled flow on a semi-log scale.