SURFACE WATER AVAILABILITY MODELING OF KALAMAZOO RIVER BASIN UNDER PRESENT AND FUTURE CONDITIONS

Rabi Gyawali, Michigan Technological University, Houghton, MI, rgyawali@mtu.edu; Dr. David Watkins, Michigan Technological University, Houghton, MI, dwatkins@mtu.edu

Abstract Surface water flow modeling of Kalamazoo River Basin is a part of a larger effort to model and analyze the availability, use, and value of water in the Great Lakes region. The project will address water availability, water quality and associated energy use in the Great Lakes Basin, on a watershed-by-watershed basis. Given that the analysis of all watersheds in detail is ambitious, characteristic watersheds are selected to be studied in depth. Cluster analysis is used to classify similar watersheds, based on land use and climate/hydrology.

The Kalamazoo River Basin is one basin being studied in detail. It is located in southwest Michigan and drains 2036 sq. miles from 10 counties. The watershed is 162 miles long and 11 to 29 miles in width and drains to Lake Michigan near the town of Saugatuck. The river basin is being simulated using a semi-distributed model with six sub-basins, each draining to a USGS stream gages at its outlet. The delineated sub-watersheds within the Kalamazoo River Basin are obtained from Michigan Department of Natural Resources (MDNR). Thiessen polygons are drawn and weights assigned to precipitation gages based on watershed area intercepted by the polygons (Fig 1).

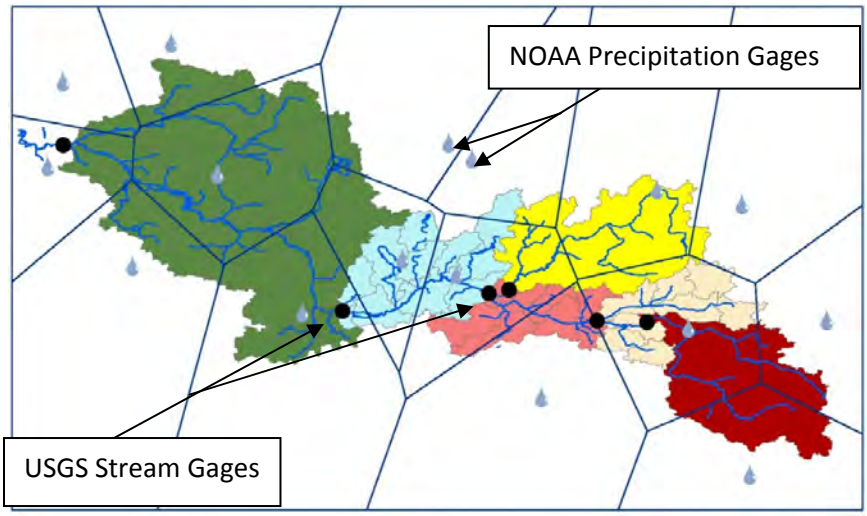

Figure 1 Kalamazoo river basin showing USGS stream gages and NOAA precipitation gages.

Daily USGS stream flow data and NOAA precipitation gage data, coupled with Large Basin Runoff Model (LBRM) snowfall data from years 2002 to 2005 is used for calibration. The validation period is from 2006 to 2009. Runoff and base flow are computed at a daily time step using a continuous Soil Moisture Accounting (SMA) algorithm in HEC-HMS. The model will simulate rainfall-runoff characteristics, ground water flow, and soil moisture. Simulated runoff and base flow for one of the sub-basins during the calibration period is plotted against observed flow in Fig. 2.

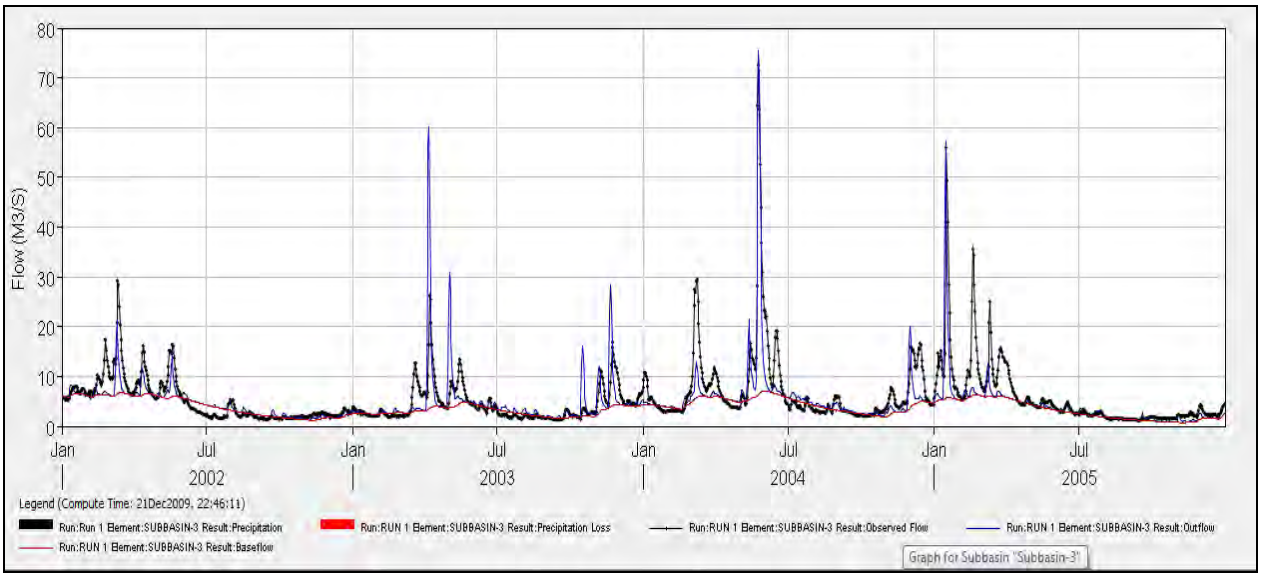

Figure 2 Calibration results for a sub-basin using SMA algorithm in HEC-HMS.

The validated watershed model will be linked to water quality models and used to simulate water availability under a number of land use and climate scenarios. National land use scenarios for climate change impact assessment and adaptation developed by the U.S. EPA/Global Change Research Program will be used to model land use change impacts. Two approaches will be considered to model climate change scenarios: 1) Constant change scenarios, in which the model simulates constant changes in precipitation and temperature (e.g., 10% increase in precipitation and 1 degree C increase in temperature); and 2) Downscaling of general circulation model or regional climate model outputs, with appropriate bias adjustments.

Model results will demonstrate integrated sustainability analysis of water resource systems, including evaluation of energy consumption associated with water withdrawal, treatment, and distribution; analysis of the impacts of water quality degradation on water and wastewater treatment costs; and potential economic inefficiencies in current water allocation policies.