



United States Department of Agriculture Agricultural Research Service

Development of APEXSENSUN Software for Uncertainty and Sensitivity Analysis of the APEX Model

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Rationale: Determining proper values for watershed model parameters is a crucial part of any modeling application. However, determining sensitive parameters, especially in large watersheds with high levels of temporal and spatial heterogeneity could be a difficult task. Development of a flexible software capable of performing uncertainty and sensitivity analysis would greatly assist watershed modelers and stakeholders to better allocate their resources to measure important model parameters and devise cost-effective measurement campaigns for different watersheds. In addition, sensitivity analysis can be used to quantify the contribution of change in model parameters to change in the magnitude of watershed outputs (e.g. flow, sediment load, yield, etc.). This feature would be very useful in identifying best management practices for achieving the desired objectives under certain constraints in a watershed. Moreover, the Monte Carlo-based uncertainty analysis modules of the developed software can be used separately from the sensitivity analysis modules to aid with calibration and in quantitative risk analysis studies for different watersheds under different agri-meteorological conditions.

Objectives:

- 1) Identification of important model parameters for model calibration using sensitivity analysis
- 2) Quantification of the contribution of change in model parameters to the change in the magnitude of model outputs
- 3) Automated or semi-automated model calibration and validation through a Monte Carlo simulation framework
- 4) Development of a flexible platform for watershed simulation using different sets of model parameters through a Monte Carlo simulation framework

What we are doing: A flexible software named APEXSENSUN is being developed using R language to streamline uncertainty and sensitivity analyses and calibration of the APEX model. The APEXSENSUN provides its users with a wide range of sensitivity analysis options that can be implemented for different watersheds depending on the availability of data, computational power, as well as the purpose of the sensitivity analysis.

Proposed Evaluations:

APEXSENSUN can be used in numerous watershed studies in order to provide reliable and rigorous answers to some of the questions that affect the modeling or management practices in watersheds.

The following summarizes two main domains of APEXSENSUN applications in watershed studies:

- 1) Sensitivity analysis on model performance with respect to observed data (e.g. Mean Square Error)
 - a. Reducing the number of uncertain parameters (i.e. identifying and fixing on-influential model parameters) for better resources allocation for measuring/eliciting model parameter values
 - b. Accelerating model calibration by reducing the dimension of unknown model parameters and autocalibration
 - c. Compiling a database containing influential model parameters and their typical values, considering climate and geospatial characteristics as well as management practices in different regions (very useful for the modeling of watershed with limited information on model parameters)
 - 2) Sensitivity analysis on model outputs (e.g. sediment load, N or P loadings from a watershed)
 - a. Identifying the important parameters affecting an output for watershed management
 - b. Determining the contribution of different model parameters (as a result of adopting a set of management practices) on the magnitude of model outputs (very useful for determining optimum management measures)
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