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Mohammad Adnan Rajib

Venkatesh Merwade

I Luk Kim

Shandian Zhe

Lan Zhao

See next page for additional authors

SWATSHARE – A WEB-PORTAL FOR HYDROLOGY RESEARCH AND EDUCATION USING SOIL WATER AND ASSESSMENT TOOL

MOHAMMAD ADNAN RAJIB (1), VENKATESH MERWADE (2). I LUK KIM (3), SHANDIAN ZHE (3), LAN ZHAO (4), AND CAROL SONG (5)
(1): Graduate Research Assistant, Lyles School of Civil Engineering, Purdue University, West Lafayette, IN 47907, USA
(2): Associate Professor, Lyles School of Civil Engineering, Purdue University, West Lafayette, IN 47907, USA
(3): Graduate Research Assistant, Rosen Center for Advanced Computing, Purdue University, West Lafayette, IN 47907, USA
(4): Research Scientist Rosen Center for Advanced Computing, Purdue University, West Lafayette, IN 47907, USA
(5): Senior Research Scientist, Rosen Center for Advanced Computing , Purdue University, West Lafayette, IN 47907, USA

Many hydrologic modelers around the world use Soil Water Assessment and Tool (SWAT) to simulate hydrologic processes, water quality loadings and testing agricultural management scenarios. Once these tasks are complete including publication of results, the models generally are not published or made available to the public for further use and improvement. Although publication or sharing of models is not required for journal publications, sharing of models may open doors for new collaborations, and avoids duplication of efforts if other researchers are interested in simulating a particular watershed for which a model already exists. For researchers, who are interested in sharing models, there are limited avenues to publishing their models to the wider community. Towards filling this gap, a prototype cyberinfrastructure (CI), called SWATShare, is developed for publishing, sharing and running SWAT models in an interactive GIS-enabled web environment. Users can utilize SWATShare to publish or upload their own models, search and download existing SWAT models developed by others, run simulations including calibration using high performance resources provided by XSEDE and Cloud. In addition to research, SWATShare enables sharing and using of SWAT model outputs that can be used for understanding the hydrology of different watersheds within a classroom setting.

INTRODUCTION

Significant advances have been made in the last two decades in the area of on computational resources, computing technology and the availability of digital data. Several initiatives are ongoing to harness the power of these advances for hydrology including the CUAHSI HIS in the United States and OpenMI in Europe. Aligned with these initiatives which mainly deal with data access and integration of modeling systems, there is a need to also develop cyberinfrastructure that can integrated both data and models in a cyber environment. To address this need, a prototype cyberinfrastructure, called SWATShare, is developed specifically for the

SWAT model (Neitsch et al., 2011). The SWATShare project was funded by a NSF CITEAM award and is now being supported by NSF SI2 award for developing hydrology data and model sharing platform called HydroShare. SWATShare (Fig. 1) provides the following functions for SWAT modelers and users:

1) Publication and sharing of SWAT models on the internet including input data and related output files with other researchers, educators and decision makers.
2) A cyber platform for executing SWAT models including sensitivity analysis and auto-calibration using the NSF XSEDE advanced computing resources (http://xsede.org).
3) A cyber platform for collaborating on research and other projects using a common SWAT model.
4) A cyber platform for students to use existing SWAT models to study about hydrology under different physical as well as climatic conditions.
5) A potential global repository of SWAT models that can be discovered through simple search involving geographic location and/or watershed name.

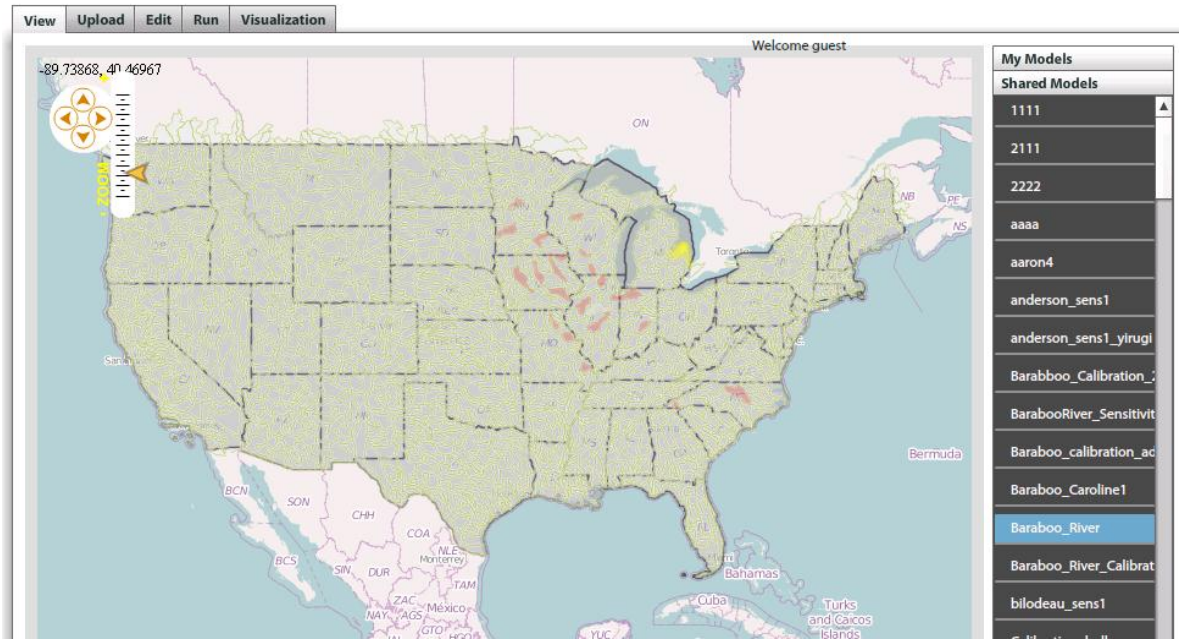

Figure 1. SWATShare Interface for exploring and downloading SWAT models and outputs. The tabs on this interface can be used to perform other functions including model simulations and visualization.

SWATSHARE ARCHITECTURE

SWATShare user interface is developed using FLEX, and it is deployed on WaterHUB, which is built using the HUBzero technology. The tool's access control defaults to the security layer provided by the HUBzero framework. A Tomcat web service is invoked to check authorization for all operations a user tries to perform. As described earlier, SWATShare supports five key functions for publishing, sharing, and executing a SWAT model. These functions include: View, Upload, Edit, Run and Visualize. The software architecture for SWATShare presented in Figure 2, and described below.

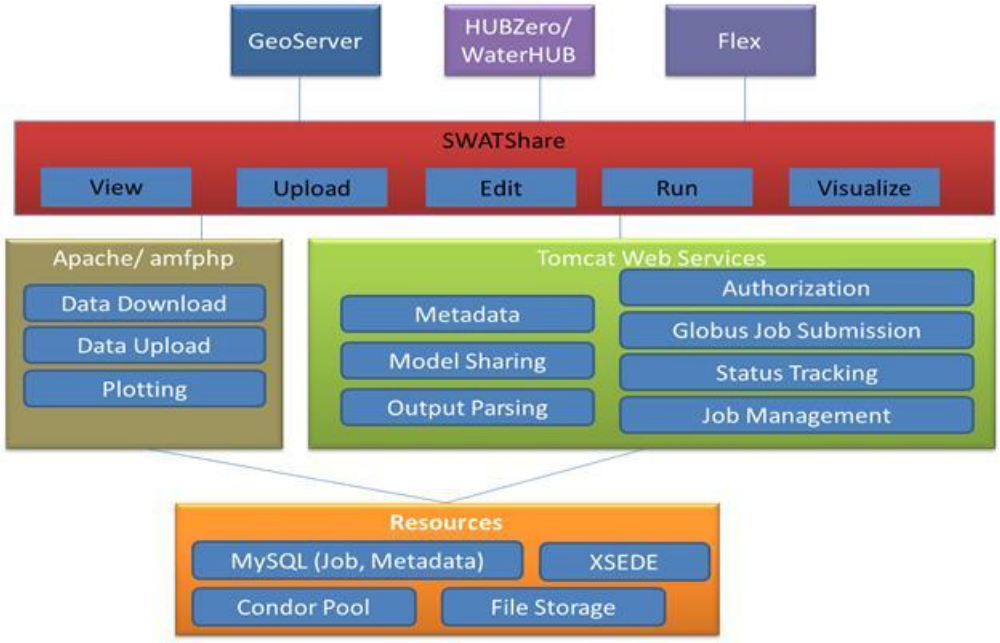

Figure 2. SWATShare Architecture

The view function uses Geoserver for rendering GIS layers and associated metadata so users can select an area to see if any model is available for the selected area. The metadata for available models is extracted from a MySQL database using tomcat web services. A user may also be able to download any shared model from the view interface using HTTP protocol via an Apache server.

The upload function enables a user to upload a SWAT model and its associated files in a compressed format (.zip or .tar). During this step a user provides necessary metadata such as the source of data used in creating the model, data resolution, and location, which is stored in the MySQL database. The actual upload of the data is enabled by using an Apache PHP service and the uploaded file is stored on a storage server. The edit interface is similar to the upload interface. A user can use this interface to edit metadata or change the input data for an existing model.

The run interface is used for running simulations of SWAT models. It invokes the tomcat web services to submit jobs to the Purdue Condor pool or an XSEDE resource, depending on the type of computation required, and to keep track of the simulation. All the outputs from the model are stored on the storage server. The run interface allows users to track the status of their jobs, access log files for debugging, and download the model output after a successful simulation.

Finally, the visualization interface enables a user to visualize plots of model results by selecting an appropriate output file, a variable of interest, and the time period. The plotting is enabled by extracting data from the model outputs using tomcat web services and then producing the plot using PHP.

SWATSHARE APPLICATION

Because SWATShare is still in its infancy, its capability are currently being tested by using it in a classroom setting with students uploading the SWAT models and collaborating for inter comparison of models for different watersheds. For example, SWATShare was used in Spring 2014 for a higher level computational watershed hydrology class with 19 students. Each student created a SWAT model for a different watershed within the Upper Mississippi River basin (see Figure 3) as a part of the coursework, and then all students uploaded their models on SWATShare for sensitivity analysis and auto-calibration. After the models were calibrated using XSEDE, each student used the outputs of their own model and another model (uploaded by fellow students in the same class) to study the effect of watershed size or land use on the streamflow output.

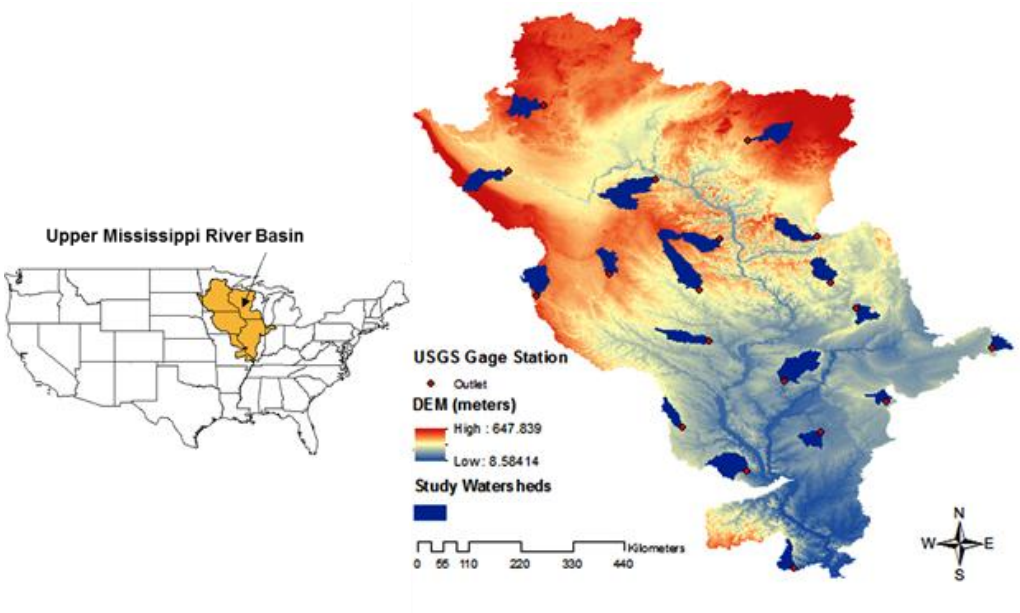

Figure 3. Study areas for SWATShare application

Such model sharing activity using SWATShare thereby presents a unique functionality where other users are no more required to repeat the modeling steps, if they want to work on the same models being created by the students across the Upper Mississippi basin. This can be of major advantage for any non-scientist policy maker who does not want to perform pre-fabricated 'black box' data pre-processing and modeling steps of complex hydrologic models (Voinov and Bousquet, 2010).

CONCLUSIONS AND FUTURE WORK

The implementation of SWATShare within a class-room setting has demonstrated the utility of SWATShare as a collaborative platform for conducting research and education. While the number of students (19) who used SWATShare is relatively small, all students used the system in parallel without any technical issues. This shows that multiple users can simultaneously execute SWAT simulation and calibration without using any personal computers. While the current functionality within SWATShare is capable of supporting all the computational tasks, the visualization of outputs in a meaningful manner is still missing. For example, a user can create a time series plots of streamflow output, but a spatial map of run-off volume or streamflow or pollutant load can be more powerful in a collaborative environment such as

SWATShare. The SWATShare team is now working on developing such visualization capabilities.

ACKNOWLEDGEMENTS

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