A Toolchain for Training Hydrological Modeling under Climate Change based on SWAT

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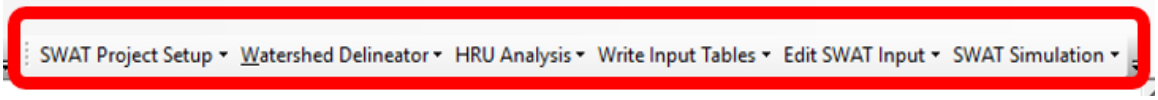
The Soil Water Assessment Tool (SWAT) is an integrated watershed model widely applied across the world to study hydrology, sediment, in-stream water quality, impact of land use, climate change and various water management interventions on water quantity and quality. A complete toolchain has been identified and can be applied to train hydrological modeling under climate change.

1. ArcSWAT

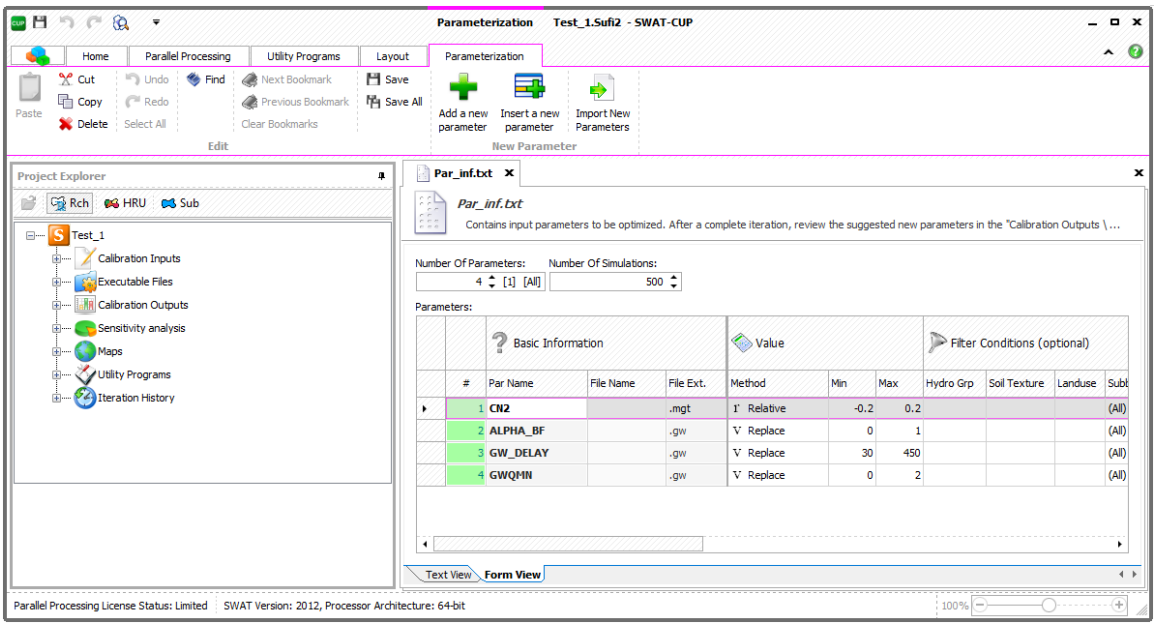
ArcSWAT is an ArcGIS-ArcView extension and graphical user input interface for SWAT.



- Watershed delineation
- Landuse and soil overlay
- HRU delineation
- Weather and remaining inputs to develop the SWAT model (including point sources)
- Review of summary outputs
- Carry out SWAT simulation using SWAT/ArcGIS interface
- Store multiple scenarios.

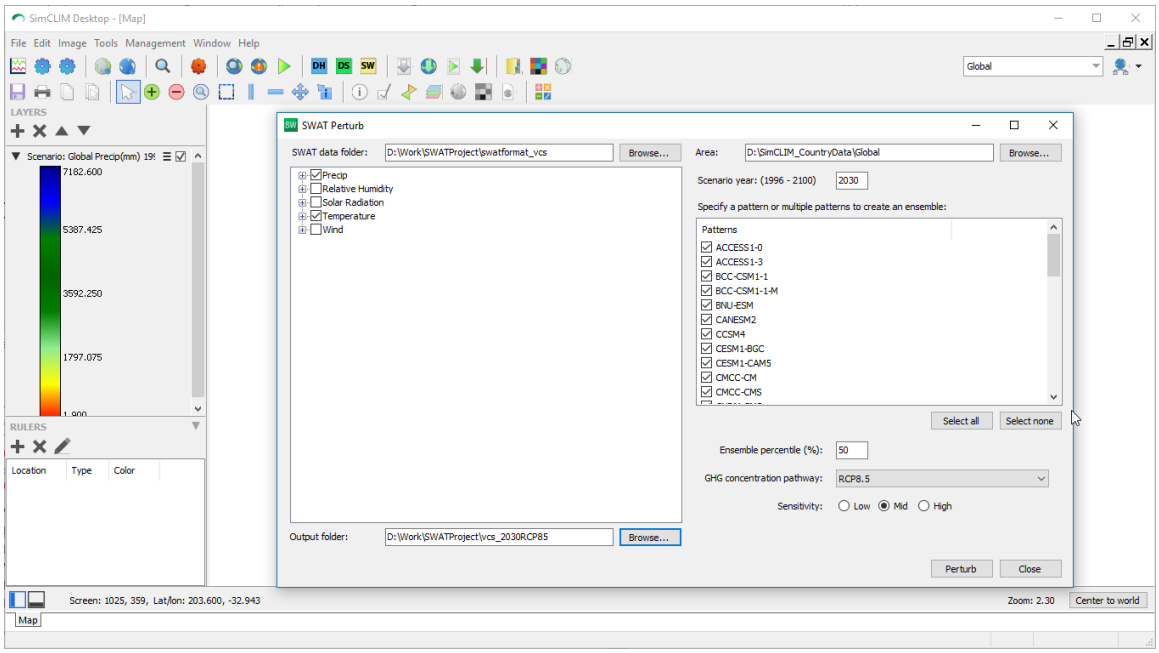
2. SWAT-CUP

SWAT-CUP is a calibration/uncertainty or sensitivity program interface for SWAT, which links SUFI2, PSO, GLUE, ParaSol, and MCMC procedures to SWAT. It enables sensitivity analysis, calibration, validation, and uncertainty analysis of SWAT models. SWAT-CUP also has graphical modules to observe simulation results, uncertainty range, sensitivity graphs, watershed visualization using Bing map, and statistical reports.



3. SimCLIM-SW

SimCLIM-SW is a plugin of the climate data management software of SimCLIM, which applies the simple Delta approach to perturb daily/month weather data to take GCM/RCM projections into account to assess the impact of climate change on hydrological process.

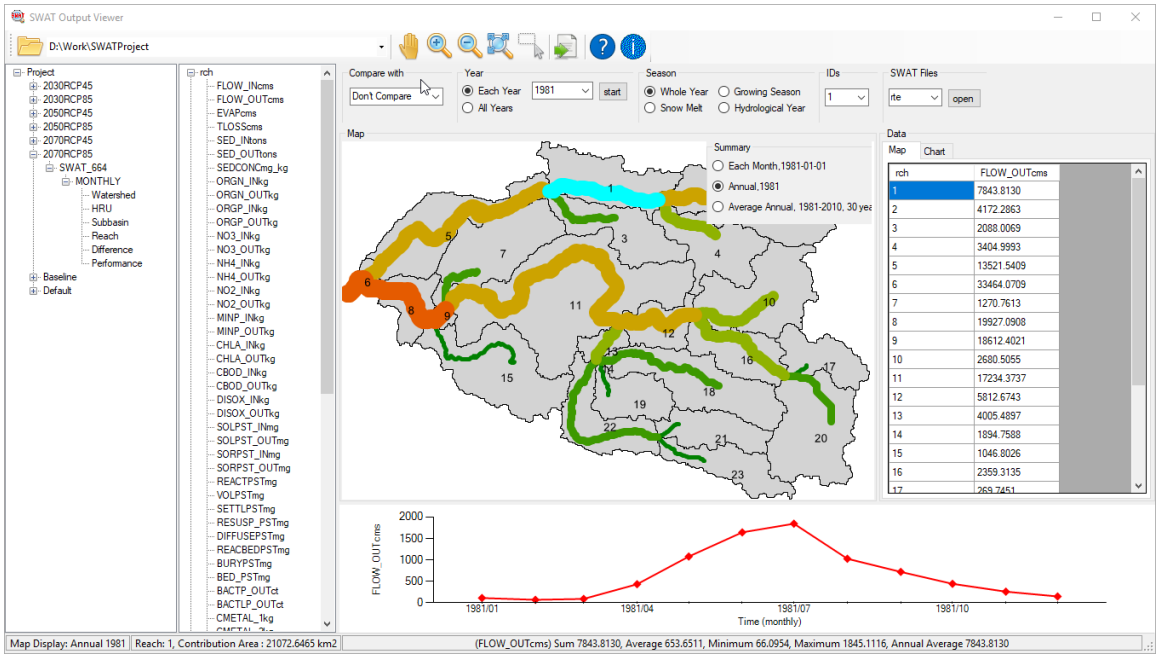


4. SWAT Output Viewer

SWAT Output Viewer is a tool to quickly view and analyze the outputs of a SWAT model on-the-fly. The main features includes:

- ✓ Thematic map for subbasins and reaches to show spatial distribution;

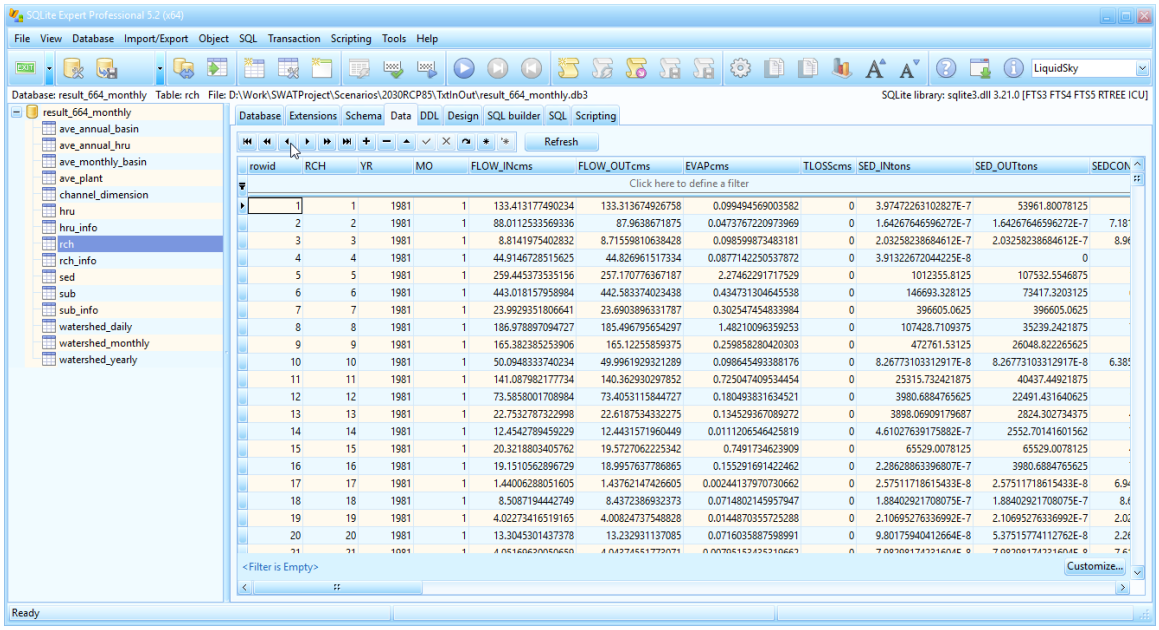
- ✓ Time series graph with ability to compare to observed data;
- ✓ Quick performance statistics against observed data;
- ✓ Quick comparison to observed data and/or outputs from other model engines or scenarios;
- ✓ Selecting SWAT components on map;
- ✓ Ability to work with ArcSWAT, QSWAT and MWSWAT projects;
- ✓ Help functions to run simulation and check model files.



5. SQLite Expert

In fact, the *SWAT Output Viewer* reread and then save the SWAT simulation into a SQLite3 database. As is the case, SQLite Expert-like software could be used to query and summarize the SWAT simulation if familiar with the SQL language. Or the SWAT simulation can be exported to other formats such as .xlsx and .csv, etc.

SQLite Expert is a powerful tool designed to simplify the development of SQLite3 databases. It is a feature rich administration and development tool for SQLite designed to answer the needs of all users from writing simple SQL queries to developing complex databases. The graphical interface supports all SQLite features. It includes a visual query builder, an SQL editor with syntax highlighting and code completion, visual table and view designers and powerful import and export capabilities.



6. Jupyter Notebook

It is easy to use Python to pull down the summarized data to further process on the client side in Python, or to merge with data from other sources using familiar Pandas data structures. *Jupyter Notebook* is a good tool for interactive programing and visualization.

The *Jupyter Notebook* is an open-source web application that allows you to create and share documents that contain live code, equations, visualizations and narrative text. Uses include: data cleaning and transformation, numerical simulation, statistical modeling, data visualization, machine learning, and much more. While *Jupyter* runs code in many programming languages, Python is a requirement (Python 3.3 or greater, or Python 2.7) for installing the Jupyter Notebook itself.