

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

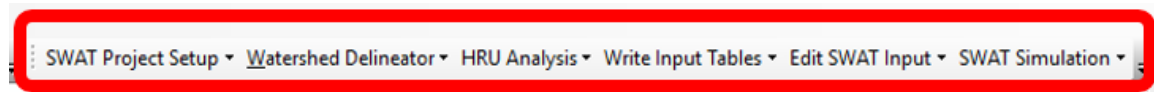
Dr. Chonghua Yin

Data Scientist@CLIMsystems.com

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

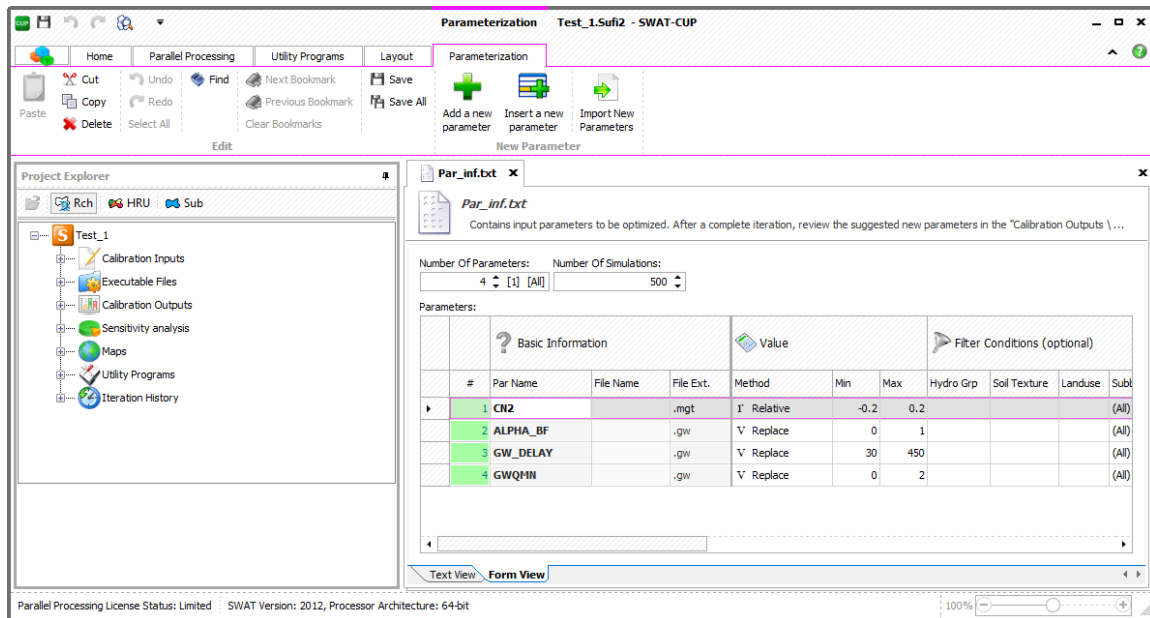
ArcSWAT is an ArcGIS-ArcView extension and graphical user input interface for SWAT.



- 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.

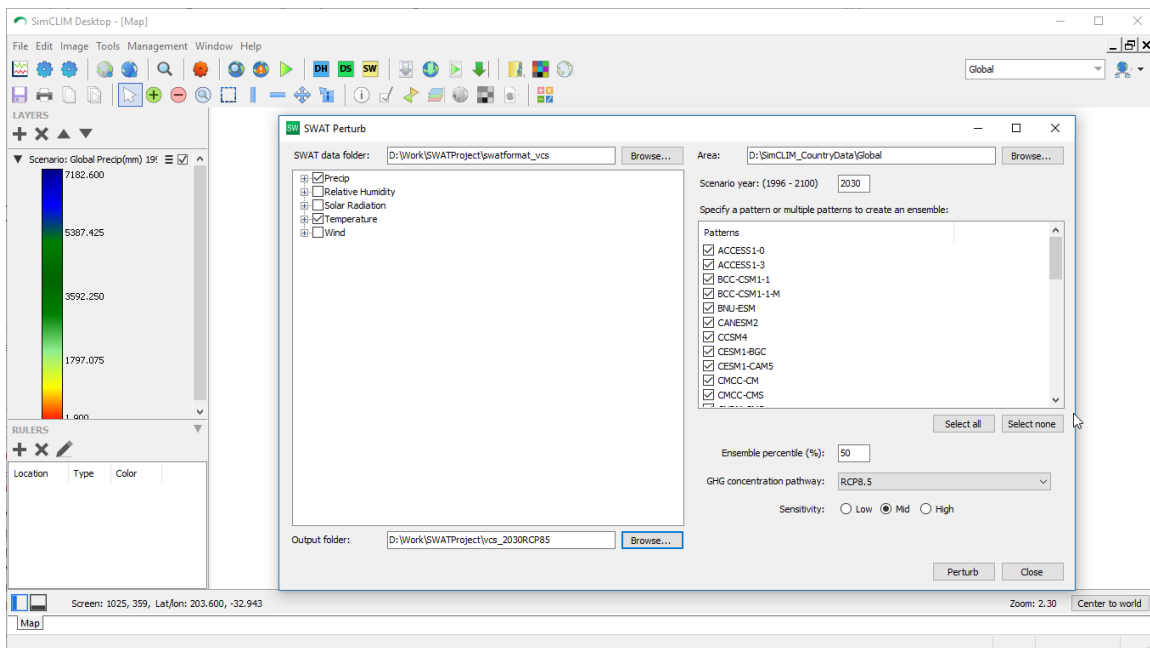
## 2. SWAT-CUP

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.

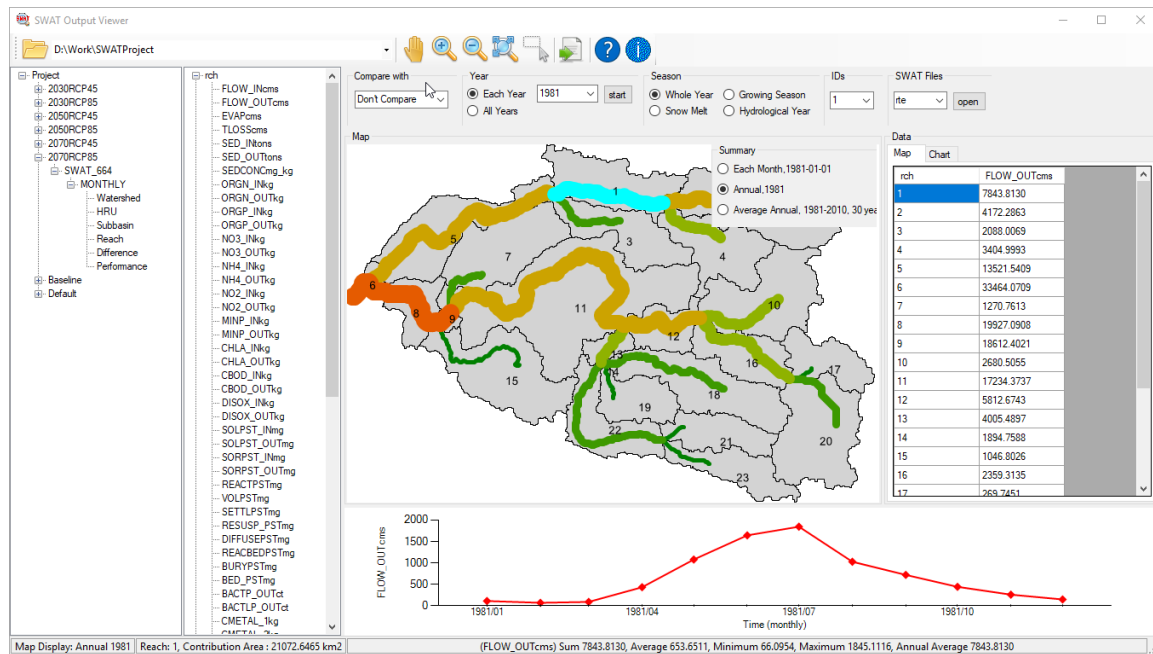


### 4. SWAT Output Viewer

*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.

Database: result\_664\_monthly Table: rch File: D:\Work\SWATProject\Scenarios\2030RCP85\TxdnOut\result\_664\_monthly.db3 SQLite library: sqlite3.dll 3.21.0 [FTS3 FTS4 FTS5 RTREE ICU]

rowid	RCH	YR	MO	FLOW_INcms	FLOW_OUTcms	EVAPcms	TLOSScms	SED_INtons	SED_OUTtons	SEDCON
1	1	1981	1	133.413177490234	133.313674926758	0.099494569003582	0	3.97472263102827E-7	53961.80078125	
2	2	1981	1	88.0112533569336	87.9638671875	0.0473767220973969	0	1.64267646596272E-7	1.64267646596272E-7	7.18
3	3	1981	1	8.8141975402832	8.71559810638428	0.098599873483181	0	2.03258238684612E-7	2.03258238684612E-7	8.94
4	4	1981	1	44.9146728515625	44.826961517334	0.0877142250537872	0	3.9132267204425E-8	0	
5	5	1981	1	259.445373535156	257.170776367187	2.27462291717529	0	1012355.8125	107532.5546875	
6	6	1981	1	443.018157958984	442.583374023438	0.434731304645538	0	146693.328125	73417.3203125	
7	7	1981	1	23.9929351806641	23.6903896331787	0.302547454833984	0	396605.0625	396605.0625	
8	8	1981	1	186.978897094727	185.496795654297	1.48210096359253	0	107428.7109375	35239.2421875	
9	9	1981	1	165.382385253906	165.12255859375	0.259858280420303	0	472761.53125	26048.822265625	
10	10	1981	1	50.0948333740234	49.9961929321289	0.09864549338176	0	8.26773103312917E-8	8.26773103312917E-8	6.38
11	11	1981	1	141.087982177734	140.362930297852	0.725047409534454	0	25315.732421875	40437.44921875	
12	12	1981	1	73.5858001708984	73.4053115844727	0.180493831634521	0	3980.6884765625	22491.431640625	
13	13	1981	1	22.7532787322998	22.6187534332275	0.134529367089272	0	3898.06909179687	2824.302734375	
14	14	1981	1	12.4542789459229	12.4431571960449	0.0111206546425819	0	4.61027639175882E-7	2552.70141601562	
15	15	1981	1	20.3218803405762	19.5727062225342	0.7491734623909	0	65529.0078125	65529.0078125	
16	16	1981	1	19.1510562896729	18.9957637786865	0.155291691422462	0	2.28628863396807E-7	3980.6884765625	
17	17	1981	1	1.44006288051605	1.43762147426605	0.00244137970730662	0	2.57511718615433E-8	2.57511718615433E-8	6.94
18	18	1981	1	8.5087194442749	8.4372386932373	0.0714802145957947	0	1.88402921708075E-7	1.88402921708075E-7	8.4
19	19	1981	1	4.022734716519165	4.00824737548828	0.0144870355725288	0	2.10695276336992E-7	2.10695276336992E-7	2.0
20	20	1981	1	13.3045301437378	13.232931137085	0.0716035887598991	0	9.80175940412664E-8	5.37515774112762E-8	2.24
21	21	1981	1	4.16181833333333	4.14374551777778	0.00706163495316623	0	7.09708174731646E-8	7.09708174731646E-8	7.4

## 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 programming 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.