Supplementary Materials

Title: Multi-gauge Calibration Comparison for Simulating Streamflow Across the Major River Basins In Madagascar: SWAT+ Toolbox, R-SWAT, and SWAT+ Editor Hard Calibration

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Appendix A: Overview of the data used, experimental design principles, and calibration methods

Table 1: GIS and weather input data used for modeling

Data	Map	Resolution	Availability
DEM	HydroSHEDS v1	3s resolution (10x10 degree tiles) raster	https://www.hydrosheds.org/hydrosheds-core-downloads
Landuse	ESA-CCI Land Cover time-series v2.0.7	300m raster (1995)	http://maps.elie.ucl.ac.be/CCI/viewer.
Soil	FAO	0-30cm and 30- 100 cm depth raster	http://www.fao.org/
Satellite Precipitation CHIRPS version 2	Daily Jan 1981- Dec 2021	0.25° x 0.25°	https://www.chc.ucsb.edu/data/chirps
Reanalysis Precipitation, Min. and max air temperature, Relative humidity, Wind speed, Solar radiation NCEP/CSFR version 2	Daily Jan1979–Dec 2014	38km grid	https://climatedataguide.ucar.edu/climate-data/climate-forecast-system-reanalysis-cfsr

Stream discharge	Monthly Jan1982–Dec 1999	Provided from individual gauge stations	https://portal.grdc.bafg.de/applications/public.html?publicuser=PublicUser#dataDownload/Home

Table 2: Code versions used

Code	Version number	Availability
SWAT+ Editor (interface)	2.3.1	https://bitbucket.org/swatplus/swatplus.editor/downloads/
SWAT+ Toolbox (Calibration tool)	1.0.5	https://github.com/OpenWaterNetwork/SWATPlus-Toolbox
R-SWAT (Calibration tool)	R version 4.1.1	https://github.com/tamnva/R-SWAT

Table 3: Experimental designs principles and objectives of each experiment

	Model	Objectives	Rainfall	Calibration Methods	Cases
1	・SWAT2012 ・SWAT＋	To evaluate the impact of model selection under different precipitation datasets	・CSFR ・CHIRPS	No calibration (default model setting)	Combination of 2 models and 2 precipitation datasets
2	SWAT＋	To investigate the impact of precipitation data selection on water balance components	・CSFR ・CHIRPS	No calibration (default model setting)	2 water balance components: precipitation and evapotranspiration
3	SWAT＋	To assess the impact of the calibration methods under different precipitation datasets	・CSFR ・CHIRPS	・SWAT＋Toolbox (DDS) ・R-SWAT(LHS)	Combination of 1 model, 2 precipitation datasets, and 2 calibration methods
4	SWAT＋	To examine the impact of precipitation data selection on the calibrated water balance components	・CSFR ・CHIRPS	・SWAT＋Toolbox (DDS) ・SWAT+Editor	2 water balance components: precipitation and evapotranspiration

- **Calibration method in SWAT+ Toolbox**

Figure 1: The main steps for conducting calibration and validation in the SWAT+ Toolbox

The first step was to open the SWAT+ Toolbox and create a new project. Once the project was set up, the next step was to run the model and check its initial performance. After that, parameters related to surface runoff were added to enhance the model's accuracy and performance. Nash–Sutcliffe efficiency (NSE) was chosen as the objective function. Sensitivity analysis and calibration were conducted to match the model with the observed data. Finally, the results were analyzed and visualized.

- **Calibration Method in the R-SWAT**

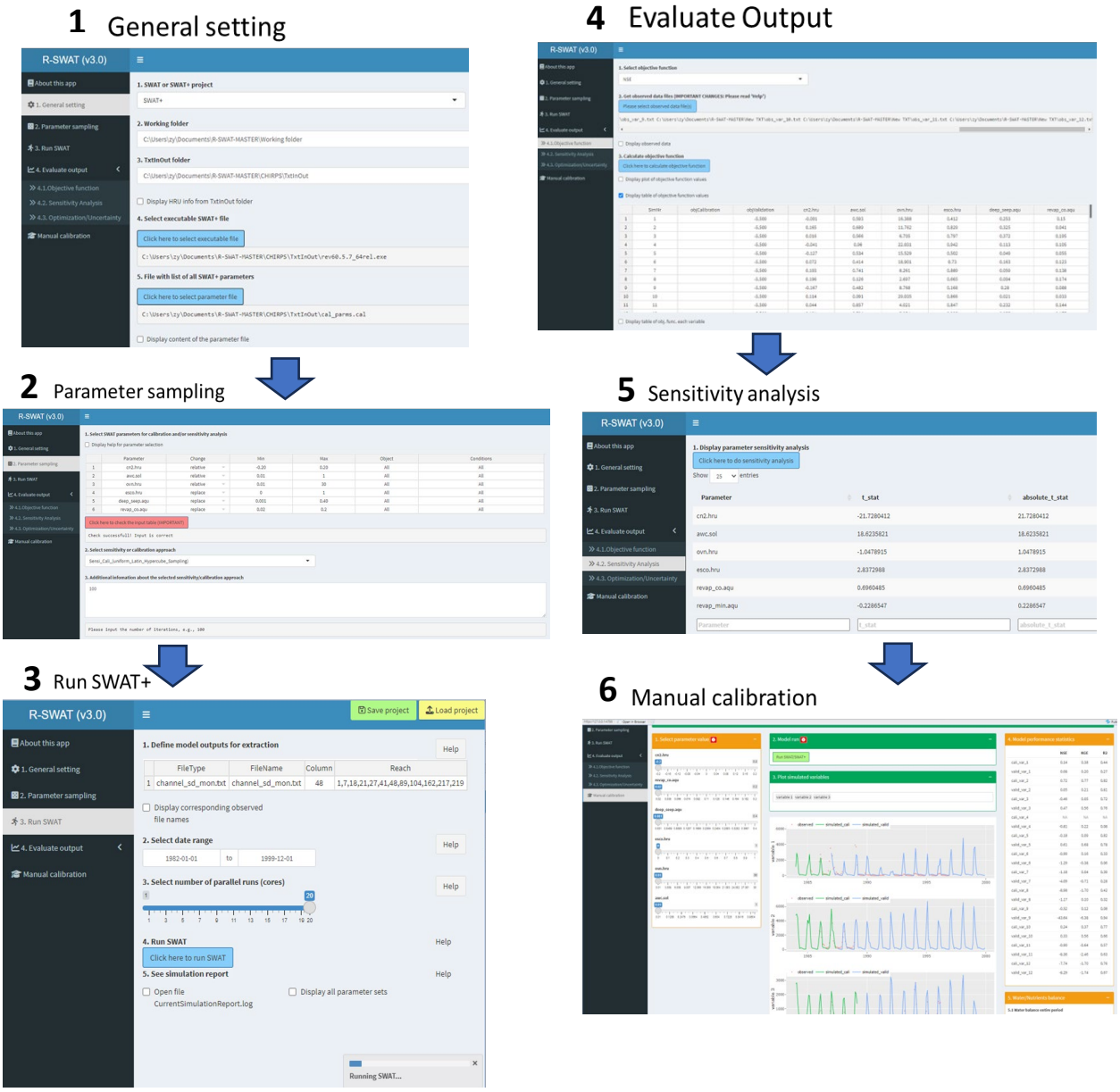

Figure 2: The main steps for conducting calibration and validation in the R-SWAT

As follows from the figure shown above, a successful calibration in R-SWAT is divided into six main steps. The first consists of launching the R-SWAT interface to set the stage. Then, parameters related to surface runoff were selected before running the model. These parameters were used for sensitivity analysis and calibration. After that, NSE was defined as the objective function to attain specific goals whereas parameter sensitivity analysis and calibration were conducted to fine-tune the model.

- **Calibration Method in the SWAT+ Editor**

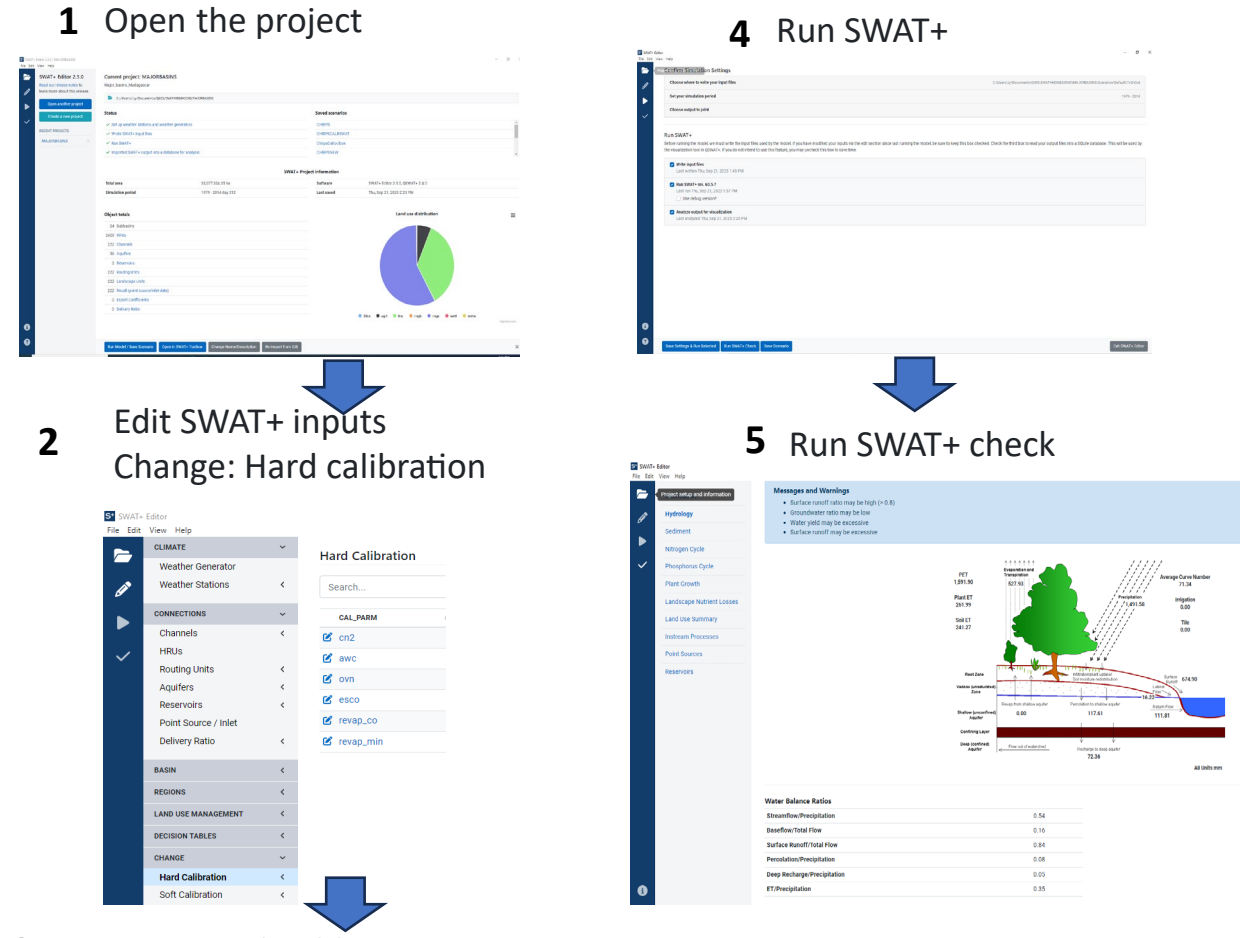

Figure 3: The main steps for conducting hard calibration in SWAT+ Editor

As shown in ***Figure 3***, the first step for conducting hard calibration in SWAT+ Editor was to open the SWAT+ Editor and the project. Then, the SWAT+ input was edited under "change". Hard calibration was chosen for the calibration method. After that, the calibration parameters were added, and new records were created. Finally, we ran the model, and the water balance was checked for spatial visualization.