Creating the SWAT Model and Calibrating it to Run Wildfire Scenarios

Written by Katie A. Wampler

Model Building

1. Use the code ***1-create-swat-files.R*** to download the data (climate, DEM, land use, soils) needed to build the SWAT model.
    a. You'll need to know the HUC or USGS site you want to model and the dates you want to run the model through.
2. Use the code ***2-create-PET-txt-file.R*** to download potential evapotranspiration data for the period you want to run the model through. You'll need this for model setup.
3. Open QGIS, set up QSWAT if needed and start to build the model.
    a. This is a good tutorial to follow if help is needed building the model: https://web.ics.purdue.edu/~vmerwade/education/qswat.pdf
    b. It's important for later to make sure to create a full hru shapefile during the HRU creation process.
    c. See Table 1 below for specifics in the model building.
4. Once the model is built, you'll want to make a few edits to the input files from the SWAT editor.
    a. Go to the subbasins and activate subbasin level snow parameters for all subbasins.
    b. Go to the management files, and for each landuse, remove the management operations, and set the initial landcover as the correct landuse for the HRU. Set LAI_INIT to 1, BIO_INIT to 1000, and PHU_PLT to 3500. This will have the correct plants growing when the model starts and not have things harvested that aren't in real life. Make sure to extent edits to all the HRU's of the same landuse.
    c. Go to basin and change the PET model to read in PET, set the file to the PET.txt file you created in step 2.
    d. Make sure to rewrite the input files.
5. Check the model runs from the SWAT editor using the default SWAT module.

Model Calibration *(see 0-swat-cup-utilities.R for handy functions while calibrating)*

6. Create the SWAT-Cup project using SUFI2 method.
7. Once project has been created, make the following changes to allow DOC/wildfire module to work. **Once changes are made, copy the revised folders into the backup folder so the changes are saved.**
    a. In the basin.bsn file, set CSWAT to 2.
    b. On lines 132-135 paste the following lines:
        i. 0 | fire: for wildfire scenarios: 1 fire, 0 nofire
        ii. 223 | fr_day: starting date for wildfire scenarios
        iii. 18 | fr_yr: starting year for wildfire scenarios
    c. Copy the model.in file from the data inputs folder into the swat-cup project and run swat-edit.exe to modify the starting carbon parameters.
    d. Copy over the correct swat.exe file. It's suggested to use the one with DOC units as mg/L for the calibration (swat-module-doc-mgL).

    e. Copy over the absolute_swat_values.txt file to the swat-cup project, which as some modified values to make the nutrient more realistic.
8. For calibration choose representative HRU's for each major landuse in the model to calibrate for ET. It's recommended to look at the HruLanduseSoilSlopeRepSwat.txt file to identify good candidates. Ideally, they should be relatively large, but also have relatively consistent ET across the HRU. You can explore this using the code ***3-ET-check.R***.
    a. From personal experience it's best not to use an HRU with a D class soil.
9. Run the script ***4-create-swat-cal-files.R*** to create the calibration and SWAT-Cup files needed to calibrate the model.
10. Calibrate model with SWAT-Cup. For directions on using SWAT-Cup see manual here: https://swat.tamu.edu/media/114860/usermanual_swatcup.pdf
    a. Calibration is going to be an individualistic process that depends on the model and the user, but overall I tried to start the calibration at a monthly scale for ET and flow, then moved to daily flow once the ET looked acceptable.
11. Once you're happy with your model, or while you're calibrating, run the script ***5-swat-check.R*** to generate data and plots on the model, allowing you to check the model for realism/potential errors.
12. In our case, we didn't have dissolved organic carbon or nitrate data in our modeled basin, so we used regional observations to determine the range of DOC and nitrate we'd expect in the model. Use ***6-get-wq-data.R*** to extract regional estimates.

Prepping and Running Fire Scenarios

13. Once you have a calibrated model you're happy with, run the script ***7-make-wildfire-file.R*** to create the wildfire scenarios.
    a. The fire scenarios in this paper were based on existing wildfires. If you're making a model without an existing wildfire this method won't work.
14. Next, you'll need to figure out how much the maximum LAI should change. To do this, run the script **8-*get-lai-change.R***. IMPORTANT: Before running this code, ensure that you model files have the correct calibrated parameters.
15. Finally, to run the wildfire scenarios you need to prep the precipitation scenarios, this can be done by running ***9-generate-precip-scenarios.R*** which will create 30 pcp.pcp files with different historic precipitation used for the year post-fire.
16. If you used the DOC module in mg/L for calibration, switch that out for the one with DOC is kg/day.
17. To run the fire scenarios, run ***10-run-fire-scenarios.R.*** NOTE: this script will take ~2 days to run depending on the model/your computer.

Analyzing Data and Making Plots

18. To clean the data outputs, run the script ***11-clean-model-outputs.R.*** NOTE: this script will also take a couple hours to clean all the model outputs.
19. To extract the data and make the plots used in the paper run **12-data-analysis**.

Table 1: Specific Values Used in Building the American and Tule Models

Parameter	**American River (12488500)**	**Tule River (11204100)**
Stream Threshold (km^2)	4	9
Slope Bands	20,40	
Soils	SSURGO	
HRU Thresholds (%)	10	12
Weather Generator	WGEN_US_COOP_1960_2010	