Questions & Answers Part 2 (Session A)

Please type your questions in the Question Box. We will try our best to get to all your questions. If we don't, feel free to email Ibrahim Mohammed (ibrahim.mohammed@nasa.gov) or Amanda (Mandy) Lopez (amanda.m.lopez@jpl.nasa.gov).

Question 1: We can use several tools for the same remote sensing analysis like R, Python, SPORT-LIS, SWAT, Earth Engine, etc. However, what about accuracy? How can we know which tool is able to perform more accurately than others? Or, what about their limitations?

Answer 1: (specific to this training)
In this training example, remote sensing data are used as inputs into the SWAT hydrological model. There is uncertainty associated with the remotely sensed input datasets (i.e., DEM, climate data, land cover), which is typically described in the data download portal and/or supporting documentation. In the calibration and validation steps, the SWAT model outputs are compared to in situ observations in an effort to assess how accurate the model simulations are. SWAT addresses uncertainty using a 95% prediction uncertainty band ("95PPU") in which the model simulated results are enveloped by a 95PPU band that is calculated between 2.5% and 97.5% of the modeled output variable cumulative distribution. Uncertainty characterization can look quite different between datasets and methodologies, thus it can be difficult to assess which method/tool is most accurate.

Answer 1: (general)
The tools you highlighted are different in terms of utility. R, Python, and Google Earth Engine are software programs that can be used for analyzing remote sensing data. SWAT and SPORT-LIS are physically-based models that have been developed to simulate water and energy fluxes. The user needs to know what is the question that he/she wants to answer and then get to know what tool is needed to solve the question. Learning about the data being processed and the tools being utilized help to know the accuracy. There is no single tool that can do everything so the user needs to enhance his awareness about the available tools and pick the right tool for the right analysis.

Question 2: In a time of climate change, especially approaching a "tipping-point," how does calibrating and verifying models make sense? If first- and second-order statistics are not stationary, how can a model accurately predict the future?
Answer 2: One way to account for variable climate conditions within a watershed is to run the SWAT model over a long study period, which provides plenty of “training” data to calibrate and validate the model with. The idea is to capture a wide range of conditions within the watershed (e.g., wet/dry seasonality) within the calibration/validation periods so that the modeler gains confidence that the model is capturing hydrological processes in the study watershed. Following this, the user could vary climate conditions and look at how the modeled variables change in response. In this way, the model has a “predictive” capability.

Question 3: Is there any model like SWAT for assessing the impact of climate change on forest fire?
Answer 3: There are many models that can be explored to assess climate change impacts on forest fires such as NASA LIS, RHESSys, DHSVM, Mike SHE and TopModel. Data availability, computing i availability, human capacity are all factors that should be considered in picking up the model for work. A literature review/search can help assess which other models are being used for this purpose.

Question 4: In the SWAT demonstration, an NLCD dataset is used with a California Geological Survey Burn Severity dataset. Are these datasets available for every state or are there other datasets available? How often are these datasets updated?
Answer 4: The NLCD is updated every 5 years or so. The CA geological survey generates burn severity data for some, but not all, fires in the state. Other burn severity datasets that include more fires are available such as Monitoring Trends in Burn Severity (https://www.mtbs.gov/) and Wildfire Burn Severity and Emissions Inventory (https://iopscience.iop.org/article/10.1088/1748-9326/ac80d0/pdf). Details about dataset updates are available in each respective data portal/supporting documentation.

Question 5: Are there SWAT tools that will run in ArcGIS Pro?
Answer 5: No, SWAT is not compatible with ArcGIS Pro at this time. More information about SWAT compatibility with ArcGIS (aka. ArcSWAT) can be found here https://swat.tamu.edu/software/arcswat/.

Question 6: Is it required to have Microsoft (MS) Access to use SWAT or can you just use Excel?
Answer 6: The SWAT executable would have all the needed libraries to run the program. Having a MS Access license would help in reading the MS database files generated by SWAT to store data.

Question 7: Could you please provide us with some resources to help with model calibration and verification for the tutorial presented today?
Answer 7: These SWAT-CUP tutorials by Dr. Karim Abbaspour (one of the SWAT-CUP developers) are a great place to start: https://www.youtube.com/watch?v=KutrnJ_oBoQ&list=PLjDkjZqbf4OtJ36tToupeMAbBCY9ffu00.

Also, take a look at papers by Dr. Abbaspour: https://scholar.google.com/citations?user=rIkplulAAAAJ&hl=en&oi=ao.

You can visit the manuscript that was highlighted today for more information in calibration and verification: https://doi.org/10.1016/j.jhydrol.2018.07.030.

Question 8: Given different soil characteristics and properties that vary area to area, can SWAT be applied to any geographical area?
Answer 8: Remember, SWAT is a tool and, based on inputs, it can be applied to the geographic area being studied. So, for any specific geographic area outside the USA, you need to supply SWAT with soil data characteristics. The example being shown in the slides from the Mekong required using soil data from different sources.

Question 9: Is there a version of QSWAT that is compatible with Mac OS?
Answer 9: Yes, check out SWAT+ https://swat.tamu.edu/software/plus/.

Question 10: In the climate change scenario, are you recommending a formal "Sensitivity Analysis" to see how the model performs, as PARAMETER values are changed or as input DATA values are changed [or both]?
Answer 10:

I do recommend both. Keep in your mind based on the analysis being conducted and the results obtained, a thorough review is warranted. Generaly, in climate change studies multiple scenarios are tested so that envelope of simulation results are obtained to account for uncertainty and stationarity issues.

You can do either or both. However, ensure that the base model is calibrated and validated before synthetically altering input data/parameters to reflect different climate change scenarios.

Questions & Answers Part 2 (Session B)

Please type your questions in the Question Box. We will try our best to get to all your questions. If we don't, feel free to email Ibrahim Mohammed (ibrahim.mohammed@nasa.gov) or Amanda Lopez (amanda.m.lopez@jpl.nasa.gov).

Question 1: What are the necessary input data to run the SWAT model? Are some input data optional, depending on the outputs we want to monitor?
Answer 1: SWAT requires the following input datasets: elevation, soil cover, land cover, and climate data (precipitation and air temperature). If you are simulating fire, then the following input datasets are also required: burn severity modified land cover (before setting up SWAT you would integrate a burn severity dataset with the land cover data).

Question 2: What is the minimum watershed scale/surface that could be monitored through the SWAT model?
Answer 2: There are studies with a few square kilometers of drainage area modeled with SWAT. The most important layer to begin with is the elevation (i.e., DEM). You need to have all of your input data spatial resolution matching your DEM spatial resolution.

Question 3: Are there more soil cover (soil information) datasets that are available that you can suggest?
Answer 3: SWAT comes loaded with soil information data for the United States from the Soil Survey Geographic Database (SSURGO) and the State Soil Geographic (STATSGO). There are other datasets such as Harmonized World Soil Database that could be used as well.

Question 4: Is there an ArcGIS tool for managing the SWAT model, as well as a QGIS interface shown in the demonstration?
Answer 4: Yes, there is an ArcGIS tool for managing SWAT and it is called ArcSWAT. For QGIS the SWAT tool is called QSWAT.

Question 5: Is SWAT considered to be a physically based model?
Answer 5: Yes, SWAT has many modeled processes such as evapotranspiration, runoff, and other water, carbon, nitrogen cycles.

Question 6: Based on case studies, how much does the impact of forest fires reduce the amount of available water in a water recharge zone?
Answer 6: This is a topic of on-going investigation and it will vary by watershed. Slides in the Part 2 presentation describe hydrological processes simulated by SWAT and refer to other studies in literature that address fire-related hydrology changes in case study watersheds. Please refer to those literature studies for additional detail.

Question 7: Do you have a SWAT guide focused on QGIS instead of ArcMap? If so, could you share the link to these materials with us? I do not have ArcGIS. Do you have a step by step video uploaded for QGIS as well?
Answer 7: An open source version on the SWAT model is available (QSWAT): https://swat.tamu.edu/software/qswat/.
Many steps are the same as in ArcSWAT. This is why the Part 2 exercise is optional for this training.
https://swat.tamu.edu/media/116334/qswatplus-tutorial.pdf

Question 8: How close is the ratio between SWAT simulation and field data?
Answer 8: This will vary from model to model. The match up will depend on the quality of the field data, SWAT model input data, calibration parameters, etc. Refer to the SWAT literature and YouTube tutorials to see examples of how SWAT simulations compare with in situ field data in case studies. The YouTube videos by Dr. Karim Abbaspour go into detail about SWAT model calibration, in which the user compares simulations to field data
https://www.youtube.com/watch?v=KutrnJ_oBoQ&list=PLjDkjZqbf4OtJ36tToupeMAbBCY9ffu00.