Part 2 Question & Answer Session

Please type your questions in the Slido/Question & Answer Box. We will try our best to answer all your questions. If we don't, feel free to email Amita Mehta (amita.v.mehta@nasa.gov) or Sean McCartney (sean.mccartney@nasa.gov). This document will be shared to the training webpage within one week.

1. **Question: The datasets introduced in this training appear highly useful for broad-scale monitoring, anomaly detection, and data-gap filling. However, their spatial and temporal resolution, together with the limited representation of local hydrological processes and reservoir operations, may constrain their direct use in detailed regional applications. Would it therefore be more appropriate to use these products primarily as screening, input, and validation data for physically based models? Also, what improvements would be required to integrate them reliably into regional water-management and water-quality decision-support systems?**
    a. It's appropriate to use these global products as forcing data to drive local, physically-based hydrological models, or as calibration and validation tools to ensure those models correctly represent the regional water mass balance. These global datasets are also excellent for broad screening, providing early warning for extreme events (e.g., floods) or filling gaps where local gauges are non-existent. The data shown in the training have coarse spatial resolution and cannot replace locally-calibrated models.
    To integrate these datasets into regional water-management and decision-support systems, higher spatial resolution altimetry data at 500 meters or higher, which is being provided by the SWOT mission, is helping to address this challenge. Developing higher resolution snow water equivalent (SWE) products will also help improve accuracy spring runoff forecasting.
    For adoption by water managers, accessible workflows must be evaluated to extract uncertainties and bias-correct satellite data against in situ data.

2. **Question: What are the main advantages and limitations of using NASA's global Earth observations and modeled datasets for regional reservoir management?**
    a. The main advantage includes availability of multiple parameters for regional reservoirs and watersheds where ground-based data may not be available or may not be adequate. Though spatial and temporal resolutions of Earth observations and model data are different (this is also a limitation), they can be converted to common resolutions. A major limitation for reservoir data is that we get one observation per reservoir – no matter what the size of the reservoir is. Though most NASA data are validated with available ground-based data, it is always recommended that they be validated for the region of your interest.

3. **Question: Would it be more appropriate to use these satellite and global modeled products as inputs, boundary conditions, or validation data for physically-based watershed and reservoir models rather than as stand-alone decision-making tools?**
    a. It is a good idea to integrate these data in watershed and reservoir models. For a stand-alone decision-making tool, it is important to first define what decisions have to be made and on what temporal/spatial scales. You may find it useful to analyze all these data available for multiple years along with regional, ground-based data and impact information to understand characteristics of watershed and reservoir behavior.

4. **Question: Because surface-water quality is influenced by streamflow, sediment, nutrients, groundwater inputs, and internal reservoir processes operating at different temporal scales, how far can the datasets introduced in this training be extended from water-quantity monitoring to reliable water-quality assessment?**
    a. One of the datasets introduced in this training, GEOGLOWS streamflow/discharge data, has 15-day predictions available. However, how far in advance we can predict water quality parameters will totally depend on regional watershed and land cover conditions. While all the datasets we introduced are global, their applications have to be developed keeping local conditions in mind.

5. **Question: What are the available methods and data sources for obtaining soil moisture (water stored in the soil) data? I need this data to calculate the green water component of the water footprint.**
    a. In Parts 1 & 2 of the training we provided different examples of webtools and APIs to access, download, and work with soil moisture data in the cloud. We recommend you go back through the slides and recordings for demonstrations on how to obtain soil moisture data.

6. **Question: For small reservoirs in Burkina Faso, what spatial resolution would you recommend (30 m, 10 m, or finer) to effectively monitor changes in water surface area?**
    a. It will depend on the reservoir size. Open source data we shared here are available at 30m resolution. Monitoring changes in surface area is always useful. Also, note that there are commercial satellite-based data with higher resolution. Commercial satellite data can have smaller spatial resolution,

7. **Question: Which NASA Earth observation products are best suited for monitoring seasonal reservoirs in the Sahel that may dry up almost completely for several months each year?**
    a. MODIS/VIIRS and OPERA DSWx data would be able to monitor change in surface area. You can check if SWOT data are available for these reservoirs (resolution of SWOT data for reservoirs is 250x250 m^2) and can monitor water level height during the wet season and will most likely not have data on water elevation for dry seasons.

8. **Question: How can natural hydrological changes be distinguished from human-controlled reservoir operations using Earth-observation data?**
    a. This is an important question. Without knowing human-controlled factors for a reservoir, natural hydrology data alone can not be used. We will see this in our next session, where water surface levels in a highly controlled lake do not reflect what you get from watershed hydrology components.

9. **Question: How accurately can reservoir storage be estimated from satellite-derived water-surface elevation and surface-area observations?**
    a. Estimating absolute total storage is difficult. The fundamental limitation is that satellites cannot see below the water's surface to measure the reservoir's bathymetry (underwater topography). Therefore, unless local,

high-quality bathymetric surveys are integrated into your models, satellites can only reliably measure relative storage variations—how much water is gained or lost between observation dates. Absolute total storage is difficult unless you have access to these datasets. SWOT data will include storage at some point in the future.

10. **Question: How should satellite observations and global modeled products be validated before they are applied to local watershed and reservoir systems?**
    a. Validating satellite observations and global modeled products for local applications requires a comprehensive approach centered on direct comparison with in situ data. One must pair satellite data with ground-based networks, such as automated streamflow gauges, reservoir forebay sensors, and local meteorological stations. For snow data, this means comparing satellite and modeled outputs against ground networks like SNOTEL or incorporating localized aerial data to verify snow water equivalent and low-elevation snowpack.
    Because global datasets contain regional biases, one must perform bias correction. This involves using statistical tools to extract uncertainty metrics and adjust the satellite data so its statistical distribution matches the reality of the ground observations. This workflow of acquiring, validating, and extracting bias is essential for water managers.
    Another thing to consider is coarse satellite resolution must be carefully aggregated to the specific boundaries of the local watershed, and the data's temporal frequency must be aligned with the local modeling time steps, whether those are daily power generation decisions or seasonal water supply forecasts.
    Finally, an effective way to validate these products is through historical hindcasting. By running the satellite and modeled data through local models over a multi-year historical period, managers can compare the simulated results against decades of reservoir heights and streamflows. This confirms whether the global data can accurately recreate known seasonal shifts, anomalies, and other extreme events.

11. **Question: Could AI-integrated GIS platforms combined with Earth observation data improve real-time reservoir monitoring and support early warning systems for water resources management in arid and semi-arid regions?**

   a. Yes, traditional ground monitoring networks are often sparse, and sudden extreme events require swift analysis. AI algorithms are efficient at processing massive volumes of satellite data quickly and identifying complex patterns that traditional physically-based models might struggle to compute in real-time. Another benefit of integrating AI and GIS platforms is data fusion and downscaling. This allows one to take coarse global data and downscale them to finer spatial resolutions needed for local reservoir management. Trained machine learning models also execute faster than computationally heavy hydrological models, allowing to rapidly forecast floods or dangerous drops in reservoir levels.

12. **Question: Did these time series water level data come from USGS gauges?**
    a. No, GEOGLOWS does not use USGS gauge data. But USGS streamgauge time series data. Are available from: https://www.usgs.gov/programs/groundwater-and-streamflow-information-program/streamflow-monitoring

13. **Question: In the River Forecast system, is the retrospective data based on actual measured flow data? If not, why not use actual measured data? How does it compare to measured data?**
    a. Actual measured flow data is not integrated into the GEOGLOWS river forecast system, as the platform generates streamflow predictions. The retrospective datasets provided are simply past model forecasts. Whenever available, prioritizing actual in-situ streamflow data is highly recommended.

14. **Question: Which kind of NASA datasets are suitable as predictors/covariates for basin scale analysis of long-term spatio-temporal analysis of nutrients and metals in a large river in Europe?**
    a. You can analyze soil moisture, precipitation, land cover, and runoff data. Specifically, the runoff data will indicate the volume of water actively flowing into streams and rivers.

15. **Question: Can the water footprint, particularly the green water footprint (water from precipitation), be calculated using soil moisture data obtained from remote sensing?**
    a. I don't have the exact answer for your specific question right now, but we will check to see if that approach is feasible.

Please see [this paper]for more information.

16. **Question: What are the main limitations of using NISAR data for groundwater investigations, particularly for monitoring groundwater depletion, recharge, and aquifer dynamics? Under what hydrogeological conditions is NISAR expected to provide the most reliable insights, and where should its observations be complemented with in-situ measurements or groundwater models?**
    a. The primary limitation of using NISAR for groundwater investigations is that it does not measure groundwater directly. Instead, NISAR uses interferometric synthetic aperture radar (InSAR) to measure ground surface deformation—specifically the subsidence or uplift of the land surface that occurs when underlying aquifer pressure changes. Because it measures a surface proxy rather than the water itself, NISAR cannot directly determine the depth to the water table, absolute groundwater volume, or water quality. Furthermore, the relationship between ground deformation and water volume is complex; if groundwater depletion causes permanent compaction of clay layers, the ground will not rebound even if the aquifer is later recharged, making it difficult to accurately track recharge cycles. To translate NISAR's surface deformation measurements (in centimeters) into actual groundwater volume changes, the satellite data must always be complemented with in situ measurements and local groundwater models.
    To learn more about NISAR, please see our recent training:
    [Harnessing NISAR: Next-Generation Radar Observations for Earth Applications]

    To learn more about Groundwater data, please see our recent training:
    [Monitoring Groundwater Changes for Water Resources Management]

17. **Question: Is it possible to upload a vector of a river to make the same analysis if the river does not appear on the database of SWOTviz?**
    a. No, it is not possible to upload a vector file for rivers in SWOTviz. SWOT will resolve streams which are 100 m in width and wider. So if the river is narrower than 100m, it will not be resolved.

18. **Question: Can GEOGLOWS Hydroviewer be calibrated using local hydrological observations to improve forecast accuracy for a specific watershed?**
    a. Yes, that is doable. You can compare GEOGLOWS discharge with stream gauge data you may have locally to assess differences and correct the GEOGLOWS data.

19. **Question: As climate change alters historical hydrological patterns, how does GEOGLOWS Hydroviewer ensure its forecasts remain reliable, and are there plans to incorporate dynamic climate projections into its forecasting framework?**
    a. Answer: The GEOGLOWS River Forecasting System (RFS) uses the ECMWF weather reanalysis model to drive both its hydrology and river routing models. Because this reanalysis data assimilates satellite and ground-based observations, the system inherently captures environmental changes driven by climate change. GEOGLOWS is specifically designed to predict streamflow and floods on a near real-time to medium-range (15-day) timescale. While long-term climate projections are not currently considered in the forecasts, you can visit https://www.geoglows.org/ to learn more or contact their team to ask if they have plans to incorporate them in the future.