Part 1 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: Is it correct that this can be used also for other types of operated reservoirs with irrigation dams, etc?**
   a. Yes, the datasets presented in this training can be applied to almost any type of reservoir, including those used for irrigation, municipal water supply, or flood control.

2. **Question: How do you currently estimate water volume from snow extent? How long do you think it will be until we have snow water equivalent measurements from satellite remote sensing?**
   a. Satellites with optical sensors (like MODIS or Landsat) can only measure Snow Covered Area (extent), not depth or volume. To estimate the actual water volume (snow water equivalent [SWE]), scientists use Land Data Assimilation Systems (like GLDAS or NLDAS) as presented in today's presentation. These systems take the satellite-observed snow extent and combine it with land surface models. The models use meteorological forcing data (temperature, precipitation, radiation) and ground-based observations (like the SNOTEL network) to simulate snow depth and snow density. By multiplying the modeled depth by the modeled density over the observed extent, they estimate the SWE (water volume).

3. **Question: Can I detect rainfall-related drought using these technologies?**
   a. Yes, IMERG precipitation estimates are an excellent product for detecting rainfall-related drought. Meteorological drought is a prolonged deficit in precipitation compared to the historical average. In Part 3 of this webinar series, we'll be showing you how to use the Earth Engine API to calculate anomalies in IMERG precipitation. This workflow can be adapted specifically for rainfall-related drought. We are providing the Earth Engine

JavaScript code used in Part 3 for you to adapt for your own project needs.

4. **Question: How do we harmonize differences in resolutions (spatial and temporal) among these data layers? Would this be one of the considerations in our next session?**
    a. This will be a consideration in Parts 2 & 3 of the webinar series. Because satellite instruments collect data at different frequencies, you can aggregate them to a common time step. This means setting a daily, multi-day, or monthly standard. For data with different spatial resolutions, you can upscale or downscale the resolution of varying products, depending on the type of analysis you are doing. There are also deep learning algorithms that one can use for this workflow. Another way to harmonize differences in resolution is to use zonal statistics–this aggregates spatial data to a common geographic boundary (e.g., river basin) which gives one average value for the whole basin per dataset. For information on how NASA harmonizes Landsat 8/9 and Sentinel-2, please refer to the following resource: HLS harmonization.

5. **Question: In the NISAR training, we learned that NISAR will provide Level-3 soil moisture products. Do you expect these products to complement or eventually replace SMAP soil moisture for reservoir and watershed management?**
    a. When using Earth observations, active radar (e.g., NISAR) and passive radiometry (e.g., SMAP) are viewed as complementary pieces of the hydrologic puzzle. Though NISAR provides an unprecedented spatial resolution (200m) it launched in July 2025 and does not provide a long-term baseline for assessing anomalies. There are also tradeoffs in temporal coverage, as the SMAP mission provides global soil moisture data every 2–3 days, while NISAR has a repeat time of 12 days. This allows SMAP to track rapidly changing antecedent soil moisture. All this being said, the two instruments complement rather than replace each other for reservoir and watershed management.

6. **Question: How can we obtain all this data programmatically via APIs? Do NASA data repos allow SQL queries by external users?**
    a. For programmatic data access and processing, external users typically use:

Common Metadata Repository (CMR) API: NASA's core API for searching the Earthdata catalog.
Python Libraries: Tools like `earthaccess` for authentication, search, and direct downloads.
Earth Engine API: We will cover this in Parts 2 & 3.
OPeNDAP & STAC APIs: For data subsetting and cloud-optimized discovery.
AWS Cloud Tools: As NASA moves to Earthdata Cloud, AWS users can use tools like Amazon Athena to query S3 datasets, as traditional direct SQL isn't standard.
You may find this website useful: https://www.earthdata.nasa.gov/engage/open-data-services-software/earthdata-developer-portal/earthdata-search-api.

7. **Question: Most examples are from North America. Are these workflows equally reliable in tropical mountain basins, where cloud cover and intense rainfall are common?**
    a. Yes, these global datasets and workflows apply anywhere, but tropical mountains pose challenges. Frequent clouds cause gaps in optical data (e.g., MODIS), requiring cloud-masking and compositing. Furthermore, IMERG often underestimates orographic precipitation, and models like GLDAS have higher uncertainty due to sparse in situ networks. Using these datasets requires local validation, bias correction, and integration of available ground data. Parts 2 & 3 will feature case studies in different environments: Lake Powell (U.S.) and Lake Itaipu (Brazil/Paraguay).

8. **Question: What is the spatial resolution (the size of the smallest visible detail) of this data? Is it sufficient for a small local reservoir, or only for large basins?**
    a. Please refer to slides 23–50 for spatial resolutions of all the data products presented on in today's training. If you are using the specific MODIS and VIIRS Water Reservoir Products, the data is currently limited to a highly curated list of 164 major global reservoirs (which account for about 46% of global man-made capacity. The OPERA DSWx (HLS and Sentinel-1) has a spatial resolution of 30 meters, which captures small municipal reservoirs. With the most recent mission SWOT, reservoirs with the size (250x250 meters) and larger can be resolved. Temporal coverage should also be a consideration.

9. **Question: How can satellite observations, hydrological models, forecasts, and reservoir operating rules be integrated into a reliable decision-support system without ignoring uncertainty, physical constraints, and local operational conditions?**
    a. Answer: Integrating satellite observations, hydrological models, forecasts, and operating rules into a reliable decision support system (DSS) is a complex challenge. A reliable DSS does not force reservoir operators to blindly trust satellite data. Instead, it uses Earth observations and model data to constrain hydrological models, applies real-world operational rules to the outputs, and clearly presents the remaining uncertainty so managers can make informed risk assessments.

10. **Question: We have more than 18-month sub-hourly multiparameter river monitoring datasets (e.g., temperature, conductivity, dissolved oxygen, pH, oxidation-reduction potential [ORP], turbidity, and total suspended solids). Which Earth observation products and integration approaches would you recommend for interpreting hydrological events and water-quality dynamics?**
    a. Answer: There are several sources of hourly data products - such as temperature (MERRA-2), precipitation (available at 30 -minute resolution from IMERG). Water quality data: turbidity, total suspended solids, and chlorophyll concentration (algal bloom indicator) are available at 3-5 day resolution. You may want to collect overlapping data - location and time - from your measurements and remote sensing data for comparison.

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13. **Question: Does the IMERG precipitation data handle orographic effects to accurately provide data in mountainous regions? This is a common issue with remote sensing data given the lack of gaging in mountainous regions for calibration/bias correction.**
    a. Answer: Satellite based estimates of precipitation in mountainous regions may be less accurate than ones in non-mountainous regions. For more information on the challenges of satellite-based precipitation estimates, refer to the following webpage: https://gpm.nasa.gov/resources/faq/what-effect-do-mountainous-orographic-regions-have-measuring-precipitation

14. **Question: What are the best NASA datasets and recommended workflow for developing a near real-time reservoir monitoring system using Google Earth Engine for water quality assessment and reservoir operation?**
    a. Answer: We will use GEE in the next two sessions - but in GEE often there is latency in data and near-real time data may not always be available. It is best to use NASA Earthdata and Worldview to get near-real time data and conduct analysis in QGIS or using software (such as python notebook). We will be addressing integrated reservoir monitoring and management (quantity and quality) in another training in near future!

15. **Question: How can we obtain all this data programmatically via APIs? Do NASA data repos allow SQL queries by external users?**
    a. Answer: For programmatic data access and processing, external users typically use:
       Common Metadata Repository (CMR) API: NASA's core API for searching the Earthdata catalog.
       Python Libraries: Tools like `earthaccess` for authentication, search, and direct downloads.
       Earth Engine API: We will cover this in Parts 2 & 3.
       OPeNDAP & STAC APIs: For data subsetting and cloud-optimized discovery.
       AWS Cloud Tools: As NASA moves to Earthdata Cloud, AWS users can use tools like Amazon Athena to query S3 datasets, as traditional direct SQL isn't standard.
       You may find this website useful: https://www.earthdata.nasa.gov/engage/open-data-services-software/earthdata-developer-portal/earthdata-search-api

16. **Question: Can this data be used for flood monitoring in the Niger Delta region of Nigeria?**
    a. Answer: Yes, the data presented today can be used for flood monitoring in the Niger Delta region of Nigeria. For a more focused training specifically on flood monitoring, I suggest you explore the following ARSET training: Monitoring and Predicting Floods Using Earth Observations for Planning and Preparedness

17. **Question: For small reservoirs, which datasets become the limiting factor because of their spatial resolution?**
    a. Answer: MODIS/VIIRS and altimeter data from the Jason series and Sentinel-6 have relatively low spatial resolution. Landsat, Sentinel-2, and SWOT have higher spatial resolutions and can resolve lakes as small as ~30x30 m to 250x250 m.

18. **Question: What are NASA datasets that can be used in Google Earth Engine for water quality assessment?**
    a. Answer: GEE is limited in NASA water quality data. We recommend using Worldview to get data such as water temperature, chlorophyll-a

concentration, and salinity. And use the STREAM tool to get chlorophyll-a , total Suspended Solid, and water transparency.

19. **Question: How reliable is GEOGLOWS in ungauged basins compared to basins with long-term streamflow observations?**
    a. Answer: You may want to refer to this paper (https://www.sciencedirect.com/science/article/pii/S1364815224002962). Since ungauged basins have no data for bias correction, accuracy is also low.

20. **Question: Most examples are from North America. Are these workflows equally reliable in tropical mountain basins, where cloud cover and intense rainfall are common?**
    a. Answer: Yes, these global datasets and workflows apply anywhere, but tropical mountains pose challenges. Frequent clouds cause gaps in optical data (e.g., MODIS), requiring cloud-masking and compositing. Furthermore, IMERG often underestimates orographic precipitation, and models like GLDAS have higher uncertainty due to sparse in situ networks. Using these datasets requires local validation, bias correction, and integration of available ground data. Parts 2 & 3 will feature case studies in different environments: Lake Powell (U.S.) and Lake Itaipu (Brazil/Paraguay).

21. **Question: How can NASA satellite data be combined with local ground observations to improve reservoir operation decisions in regions with limited monitoring infrastructure?**
    a. Answer: That depends partially on what type of in situ data are available. Local ground based data can be used to calibrate /bias-correct and validate satellite data. They can be assimilated together with satellite data in land surface models for better depiction of processes in the models.

22. **Question: Could InSAR be integrated into this workflow to monitor ground deformation around reservoirs, such as dam foundations, reservoir slopes, or landslide-prone areas?**
    a. Answer: Yes, InSAR (Interferometic Synthetic Aperture Radar) is a good tool for monitoring ground deformation, and its outputs can be integrated into your workflows to monitor dam stability, reservoir slopes, and landslide risks. For more information on InSAR, I suggest you explore the

following ARSET training: An Introduction to Synthetic Aperture Radar (SAR) and its Applications

23. **Question: Can Hydroviewer data be extracted using programming and APIs?**
    a. Answer: HYDROviewer River forecast data are available from AWS. Please see the ARSET training: Monitoring and Predicting Floods Using Earth Observations for Planning and Preparedness for more information. Specifically, Part-3 focuses on the GEOGLOWS Hydroviewer.

24. **Question: What are the spatial and temporal resolutions and the geographical extent of the river discharge data mentioned at the end of the presentation?**
    a. Answer: These are global data and about 9 million river segments are represented in the system. Please see GEOGLOWS River forecasting System information.

25. **Question: Are there any real-time datasets in the Saudi Arabia region at higher spatial resolution? Are these datasets covered in this region? Can they be downloaded?**
    a. Answer: All the datasets presented in this training provide global coverage, meaning they cover Saudi Arabia, and can be downloaded. You can access the data using the webtools and data portals shown in each part of the webinar series. However, there is an important trade-off between "real-time" and "high spatial resolution". The best NASA provides is near real-time, which has a latency of 3 to 24 hours. These data have high temporal resolution but lower spatial resolution (1 km–10 km). If you want near real-time data, you can access these products using NASA LANCE (Land Atmosphere Near real-time Capability for EOS), download them programmatically via the CMR API/earthaccess, or use NASA Earthdata Search.

26. **Question: Is it possible to use the available data in NASA websites in publications and to be downloaded?**
    a. Answer: Yes, all NASA data shown here are open source and can be downloaded and used in publications with proper acknowledgement.