NASA Earth Observations for Reservoir and Water Utility Management

Part 2: Accessing NASA Earth Observations for Reservoir Management

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Prerequisites

- Fundamentals of Remote Sensing
- Introduction to NASA Snow and Ice Data Products and Applications for Water Resources Management

Part 1 Review

- Reservoirs are vital on-stream or off-stream infrastructure, requiring managers to balance short/long-term operations, coordinate across borders, and monitor both watershed and reservoir conditions.
- **GPM IMERG** (rainfall) and **SMAP** (soil moisture) fill critical observation gaps, helping managers track extreme weather, assess basin saturation, and predict whether precipitation will absorb or cause rapid flood runoff.
- Measuring peak winter **Snow Water Equivalent (SWE)** is critical for forecasting the spring and summer snowmelt that drives seasonal reservoir inflows.
- For reservoir metrics, **MODIS and VIIRS** provide time-series data on area, elevation, and storage, while **SWOT** provides elevation and area measurements to estimate reservoir storage volume, hydropower potential, and river discharge.
- Tools like **LDAS** and **OPERA** integrate these satellite observations into models to track dynamic surface water extent and runoff and improve overall hydrologic forecasting.

Training Outline

Part 1

Data Requirements for Reservoir Management

August 4, 2026

Part 2

Accessing NASA Earth Observations for Reservoir Management

August 6, 2026

Part 3

Applying NASA Earth Observations to Hydropower Reservoir Management

August 11, 2026

Homework

Opens August 11– **Due August 25** – Posted on Training Webpage

A certificate of completion will be awarded to those who attend all live sessions and complete the homework assignment(s) before the given due date.

Part 2 – Trainers

Dr. Amita Mehta

Research Scientist/Trainer

(NASA/UMBC)

Sean McCartney

Scientific Analyst/Trainer

(NASA/STC)

Accessing NASA Earth Observations for Reservoir Management

Part 2 Objectives

By the end of Part 2, participants will be able to:

- Access and monitor watershed parameters in a river basin using web tools including NASA Earthdata Search and Google Earth Engine.
- Access and monitor water level data for reservoirs and inflow rivers using NASA Earth observations and webtools, including Global Water Measurements, SWOTviz, and GEOGLOWS.

Part 2 Outline

- **Data Access:** Navigating NASA Earthdata Search
  - **Brief Demonstration:** Access and download data
- **Case Study Locations for Demonstrations:**
  - Lake Powell (Colorado River Basin, USA)
  - Lake Itaipu (Paraná River Basin, Brazil-Paraguay)
- **Demonstration 1:** Watershed Parameters (Google Earth Engine)
  - **Delineation:** HydroSHEDS
  - **Precipitation:** IMERG
  - **Soil Moisture:** SMAP
  - **Snow Cover:** MODIS & VIIRS
  - **SWE & Runoff:** GLDAS
- **Demonstration 2:** Reservoir Elevation & Streamflow
  - **Water Elevation:** Global Water Measurements (GWM) & SWOTviz
  - **Streamflow (Inflow/Outflow):** GEOGLOWS

Glen Canyon Dam built by the U.S. Bureau of Reclamation forming Lake Powell.
Credit: Justjeffaz

How to Ask Questions

- **How to ask:** Submit questions at any time using the **Slido/Q&A** option (click the three dots "..." at the bottom right of your window or look for the Slido tab).
- **Live Q&A:** We will answer all **topic-relevant questions** at the end of the webinar.
- **Follow-up:** Any questions we don't have time for will be answered in the Q&A document and posted to the training website about a week after the training.

NASA Earthdata Search

NASA Earthdata Search

NASA Earthdata Search:

- Discover, visualize, and access petabytes of Earth observing data from all NASA Distributed Active Archive Centers (DAACs).
- Filter data by mission, keyword, spatial and temporal range, filename, etc.
- Central search engine for the petabytes of data housed across all NASA DAACs.

Earthdata Tutorials:

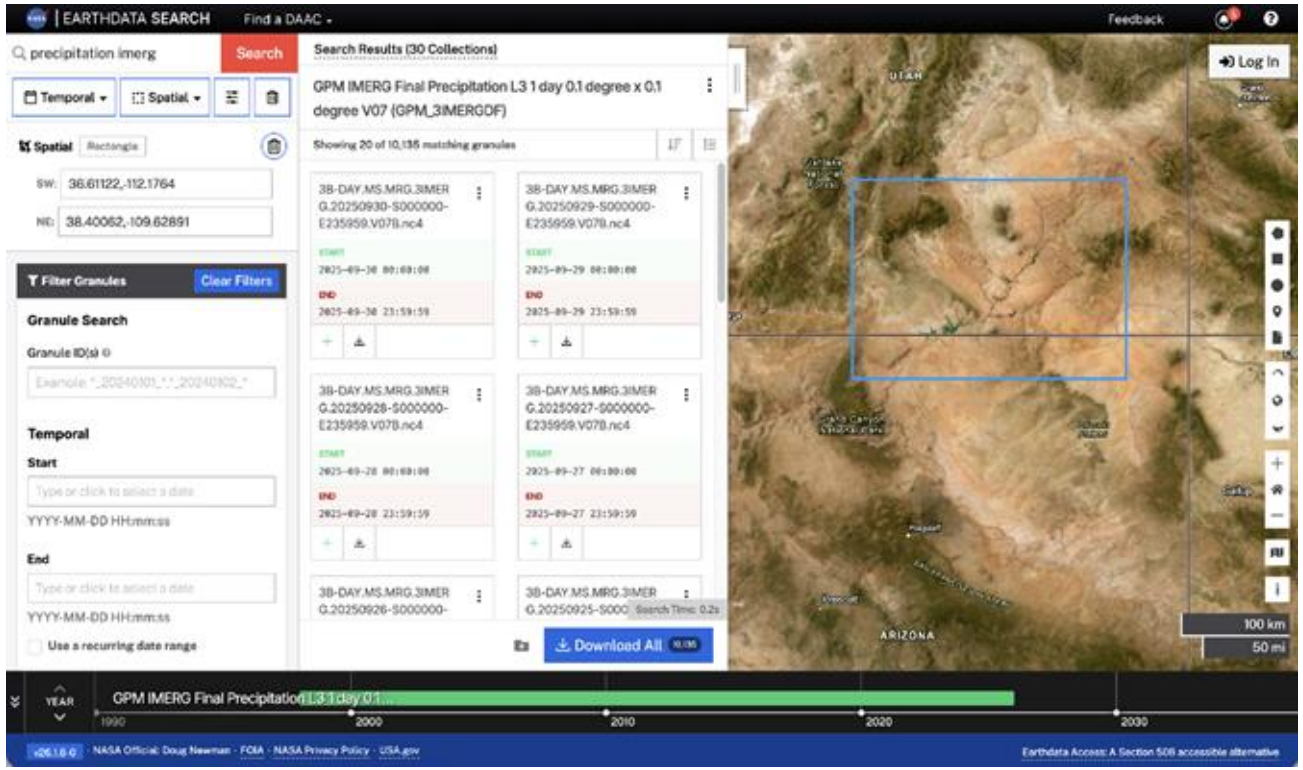
Access NASA Earth Science Data with Earthdata Login

Spatial, Temporal, and Advanced Filtering in NASA Earthdata Search

Earthdata Search – Precipitation, Soil Moisture, Snow Cover

- Earthdata Search is the **starting point to find and download** the specific GPM IMERG, SMAP, or MODIS/VIIRS datasets one needs for their specific river basins.

- IMERG Precipitation
- SMAP Soil Moisture
- MODIS/VIIRS Snow Cover



Demo – NASA Earthdata Search

Lake Powell, Colorado River Basin, USA

Lake Powell

- Formed by the completion of the Glen Canyon Dam on the Colorado River.
- Straddles the Utah-Arizona border within the Glen Canyon National Recreation Area.
- The second-largest U.S. artificial reservoir by maximum capacity (USBR, 2026).
- Serves as a water reservoir to guarantee downstream deliveries to the Lower Basin and Mexico.
- Produces 4–5 billion kilowatt-hours of hydroelectric power annually for the western U.S.
- Remains a major tourism hub famous for boating, fishing, and striking red rock canyons.
- A 20-year megadrought and chronic overuse have pushed water levels to historic lows, threatening infrastructure (USBR, 2026).

True color image of Lake Powell captured by Sentinel-2 MSI on 6 August 2018.
Credit: Copernicus Sentinel-2, ESA

Lake Itaipu, Paraná River Basin, South America

Lake Itaipu

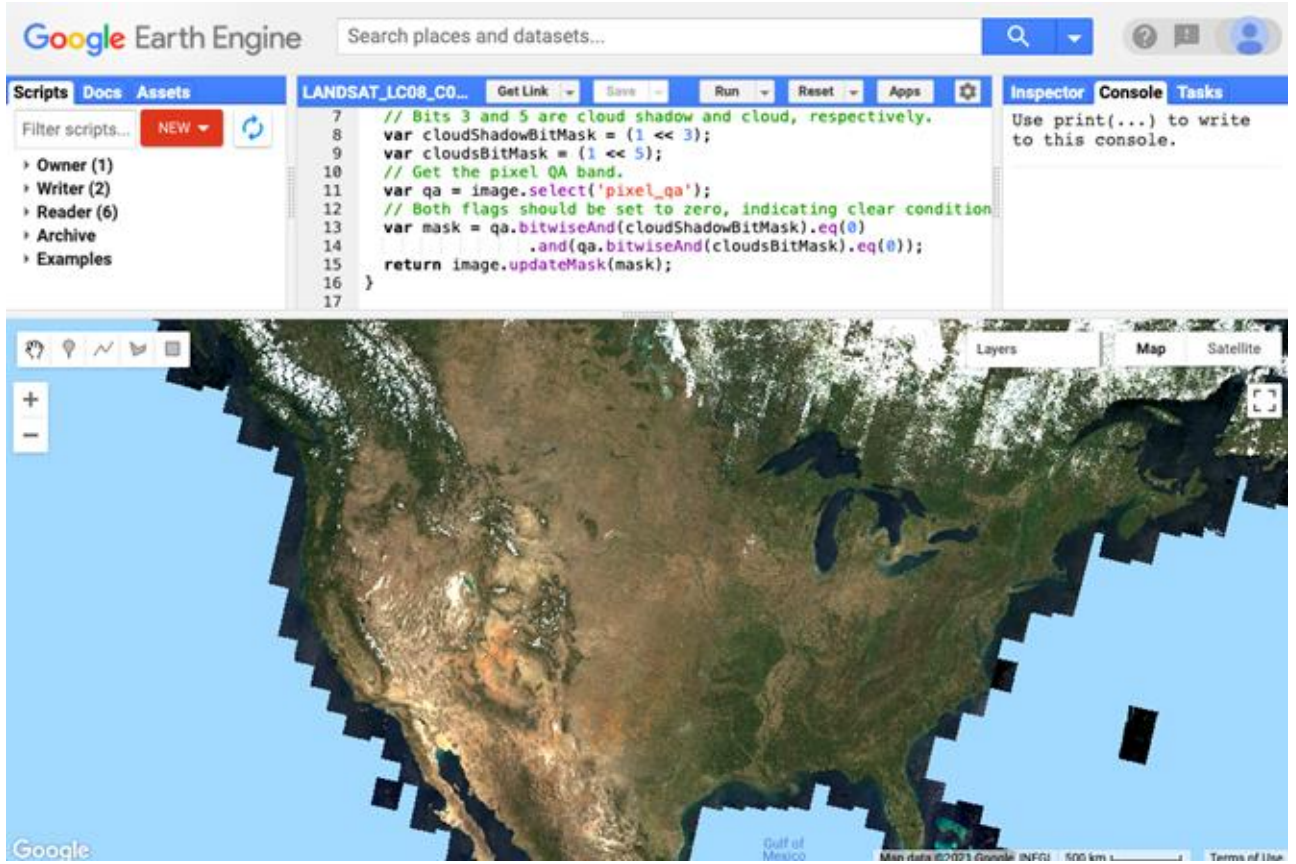
- Located on the Paraná River, built and owned equally by Brazil and Paraguay under the 1973 Treaty of Itaipu.
- Dam's construction took place from 1975 to 1982.
- 14,000 MW across 20 generating units (Itaipu Binacional, 2026).
- The world's third-largest hydroelectric dam by energy production (IE Media, Inc., 2025).
- Supplies ~90% of Paraguay's electricity and 10–15% of Brazil's. Paraguay sells its unused 50% share to Brazil.
- Operates using a 2012 efficiency system designed to maximize the power generated from every drop of water that reaches the reservoir.

Itaipu Dam with Lake Itaipu in the background. Credit: Jonas de Carvalho

Google Earth Engine – Watershed Data Access and Analysis

GEE – Cloud-Based Raster Computing for Remote Sensing Analysis

- Google Earth Engine
- Cloud-based platform hosted by Google that runs on Google's powerful computing network
- It was primarily designed to process satellite information for research, education and other nonprofit use
- **It is free for noncommercial use**
- Earth Engine for Noncommercial and Research Use



Google Earth Engine code editor interface using the JavaScript API, displaying Landsat 8 surface reflectance true color imagery for the U.S.
Credit: Google Earth Engine Developers

GEE – Cloud-Based Raster Computing for Remote Sensing Analysis

- Google Earth Engine (GEE) uses cloud computing to provide a single platform for accessing, analyzing, and visualizing satellite data.
- GEE's application programming interface (API) allows users to easily apply land cover monitoring algorithms and classifications with coded commands.

Image Credit: Google Earth Engine

GEE Demo – Watershed Data Access and Analysis

Lake Powell – https://code.earthengine.google.com/47c1a569b20181c80d78756c8ba2981f

Lake Itaipu – https://code.earthengine.google.com/a7690f2b92e05afd80a09148fdc0d6ad

Demo: Reservoir Data Access and Analysis

Reservoir Elevation Data Access and Analysis using GWM and SWOTviz

Datasets and Webtools:

Global Water Measurements (GWM)

SWOTviz

Refer to the following training for details of these tools:

ARSET: Monitoring Global Terrestrial Surface Water Using Remote Sensing

Streamflow Data Access and Analysis using GEOGLOWS

Datasets and Webtools:

GEOGLOWS Hydroviewer

Refer to the following training for details about GEOGLOWS Hydroviewer:

ARSET: Monitoring and Predicting Floods Using Earth Observations for Planning and Preparedness

Summary

Summary

- Navigate NASA Earthdata Search to filter and download specific satellite datasets from petabytes of archives.
- Utilize Google Earth Engine (GEE) to process and analyze massive Earth observation datasets directly in the cloud for reservoir and water utility management.
- Remote sensing and modeled data (IMERG, SMAP, MODIS/VIIRS, GLDAS) are used to track critical watershed conditions (e.g., soil saturation and snowpack) that dictate runoff into reservoirs.
- Changing surface water elevations in reservoirs can be monitored using Global Water Measurements (GWM) and SWOTviz.
- GEOGLOWS Hydroviewer is used to track the volume of river inflow entering the reservoir and outflow releases.
- These tools help managers address high-stakes challenges, from navigating a 20-year megadrought at Lake Powell to maximizing binational hydropower at Lake Itaipu.

Looking Ahead to Part 3

- Analyze multi-year precipitation and soil moisture anomalies (IMERG & SMAP).
- Monitor long-term Snow Water Equivalent (SWE) and snow cover trends (GLDAS & MODIS).
- Analyze long-term trends in reservoir heights (GWM & SWOT) for Lake Powell and Lake Itaipu.
- Examine streamflow anomalies feeding into both reservoirs.
- Observe short-term (days to month) to long-term (seasonal/inter-annual) variability of these parameters.
- Explore soil moisture and runoff time-series (SMAP, GLDAS) to examine their immediate impact on streamflow anomalies feeding into both reservoirs.

Homework and Certificates

- **Homework:**
  - One homework assignment
  - Opens on 11/08/2026
  - Access from the training webpage
  - Answers must be submitted via Google Forms
  - **Due by 25/08/2026**

- **Certificate of Completion:**
  - Attend all three live webinars (attendance is recorded automatically)
  - Complete the homework assignment by the deadline
  - You will receive a certificate via email approximately two months after completion of the course.

Contact Information

Trainers:

- Amita Mehta
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- Sean McCartney
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- ARSET Website
- ARSET YouTube

For questions, comments, or to share how you have applied our trainings to your work or studies, email nasa.arset@gmail.com.

Join our mailing list to stay up-to-date on our latest trainings. Visit our Contact page to subscribe.

Resources

- Applied Remote Sensing Training Program (ARSET). Introduction to NASA Snow and Ice Data and Applications for Water Resources Management. (2025)
- Applied Remote Sensing Training Program (ARSET). Monitoring Global Terrestrial Surface Water Height using Remote Sensing (2025)
- Applied Remote Sensing Training Program (ARSET). Monitoring and Predicting Floods Using Earth Observations for Planning and Preparedness. (2026)
- Google Earth Engine
- Hall & Riggs. MODIS/Terra Snow Cover Daily L3 Global 500m SIN Grid, Version 61–User Guide. (2021)
- Huffman et al. NASA Global Precipitation Measurement (GPM) Integrated Multi-satellitE Retrievals for GPM (IMERG) Version 07, Algorithm Theoretical Basis Document. (2023)
- NASA's Earthdata Search
- O'Neill et al. SMAP Enhanced L3 Radiometer Global and Polar Grid Daily 9 km EASE-Grid Soil Moisture, Version 6 – User Guide (2021)
- Reichle et al. SMAP L4 Global 9 km EASE-Grid Surface and Root Zone Soil Moisture, Version 8 – User Guide (2025)
- Riggs & Hall. VIIRS/[NPP | JPSS1 | JPSS2] CGF Snow Cover Daily L3 Global 375m SIN Grid, Version 2–User Guide. (2021)
- The National Hydrography Dataset (NHD) – Includes the watershed boundary dataset (WBD)


APPLIED REMOTE SENSING TRAINING PROGRAM
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Thank You!