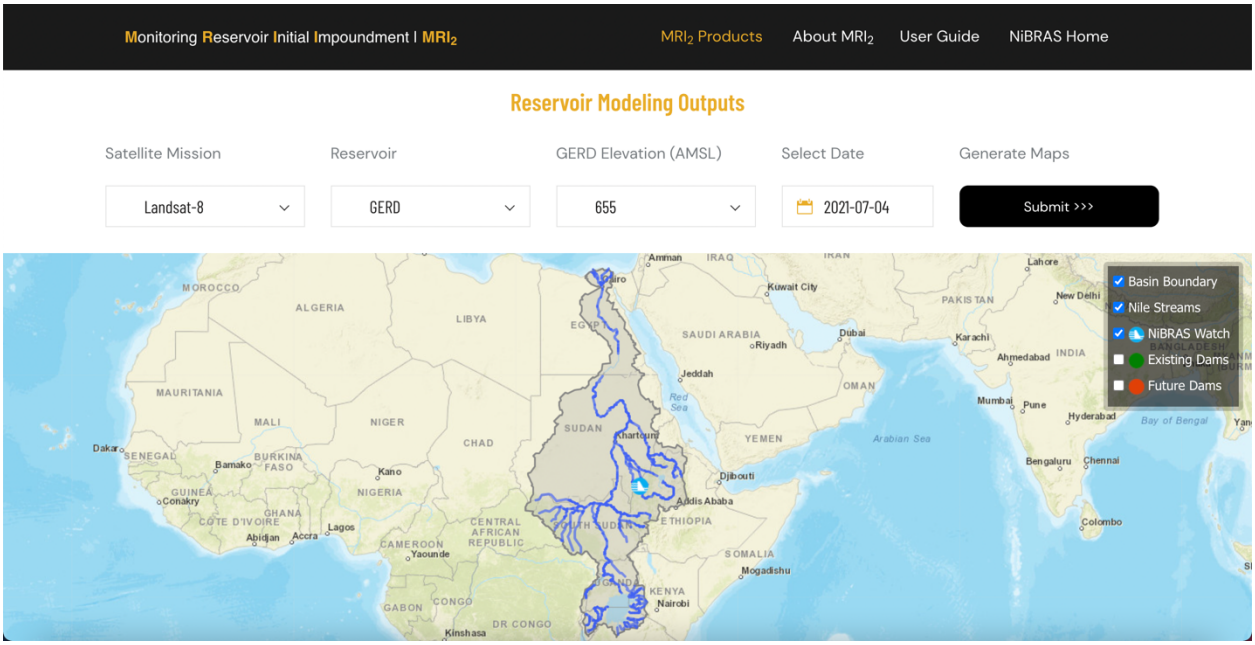
# Monitoring Reservoir Initial Impoundment (MRI$_2$)

*A Satellite-based tool to monitor the initial impoundment of new reservoirs in the Nile River basin*

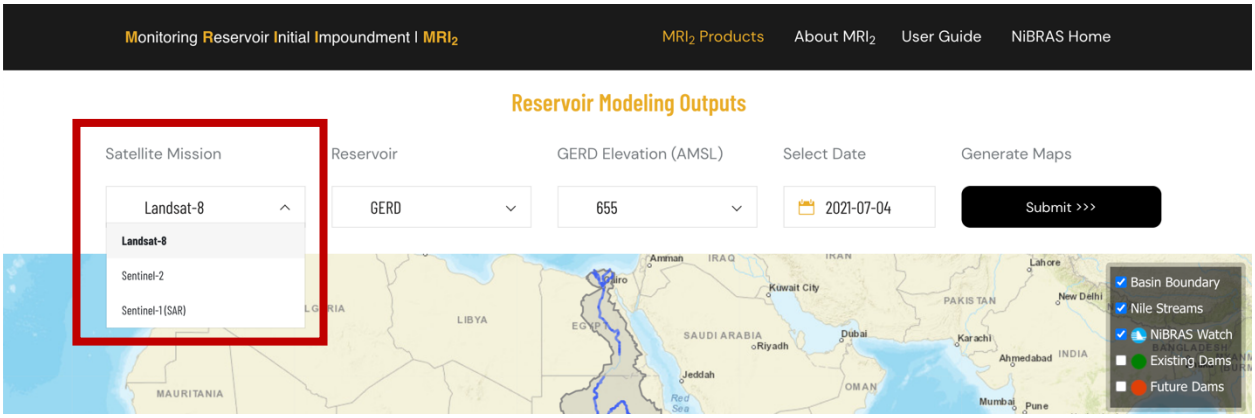
*Developed by Hisham Eldardiry (dardiry@uw.edu)*



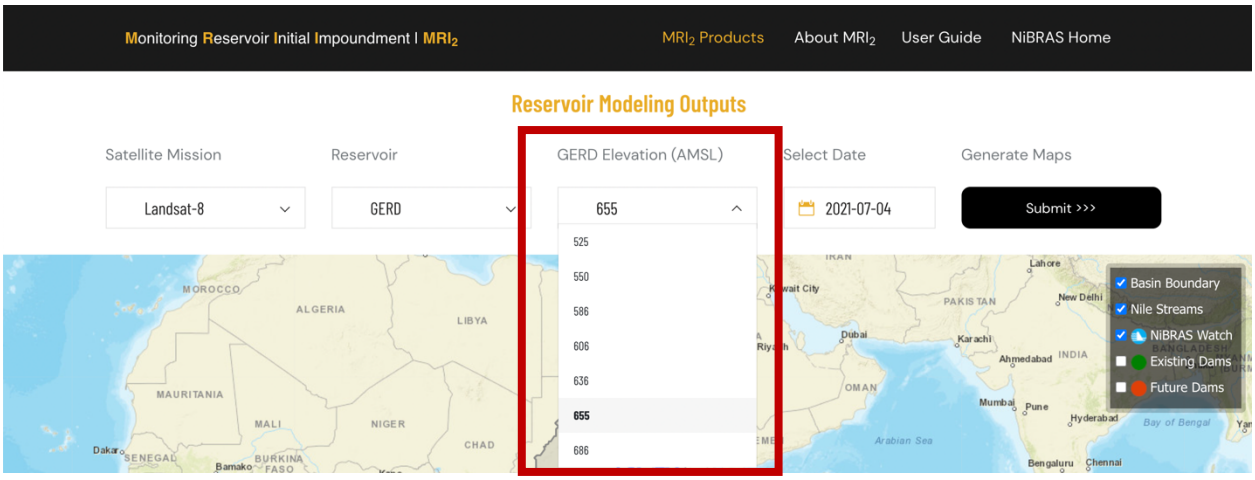

- **MRI$_2$** is one of the NiBRAS tools that is currently implemented for the Grand Ethiopian Renaissance Dam (GERD)
- **MRI$_2$** has two main products: 1) Hydrological Modeling Outputs and 2) Reservoir Modeling Outputs.
- The **hydrological modeling** over the Upper Blue Nile (UBN) is implemented using Variable Infiltration Capacity; VIC model). The VIC model was calibrated and validated at Eldiem station (GERD location and outlet of UBN).
- The **reservoir modeling** is based on deriving the reservoir storage area using a suite of satellite sensors including Landsat-8, Sentinel-1, and Sentinel-2.
- For more details on the reservoir and hydrological modeling framework, the user is referred to Eldardiry and Hossain (2019) *[more references are provided at the end of this guide]*.

## Reservoir Modeling Outputs

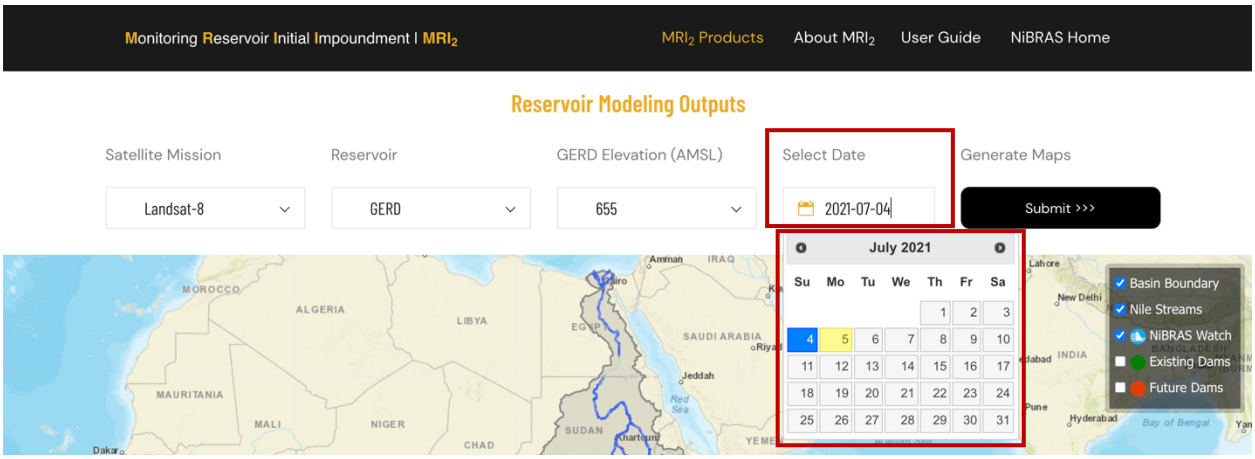
- MRI$_2$ uses three satellite missions (Landsat-8, Sentinel-1, and Sentinel-2) to monitor the initial impoundment of GERD (the only NiBRAS Watch or dam currently implemented in the tool).



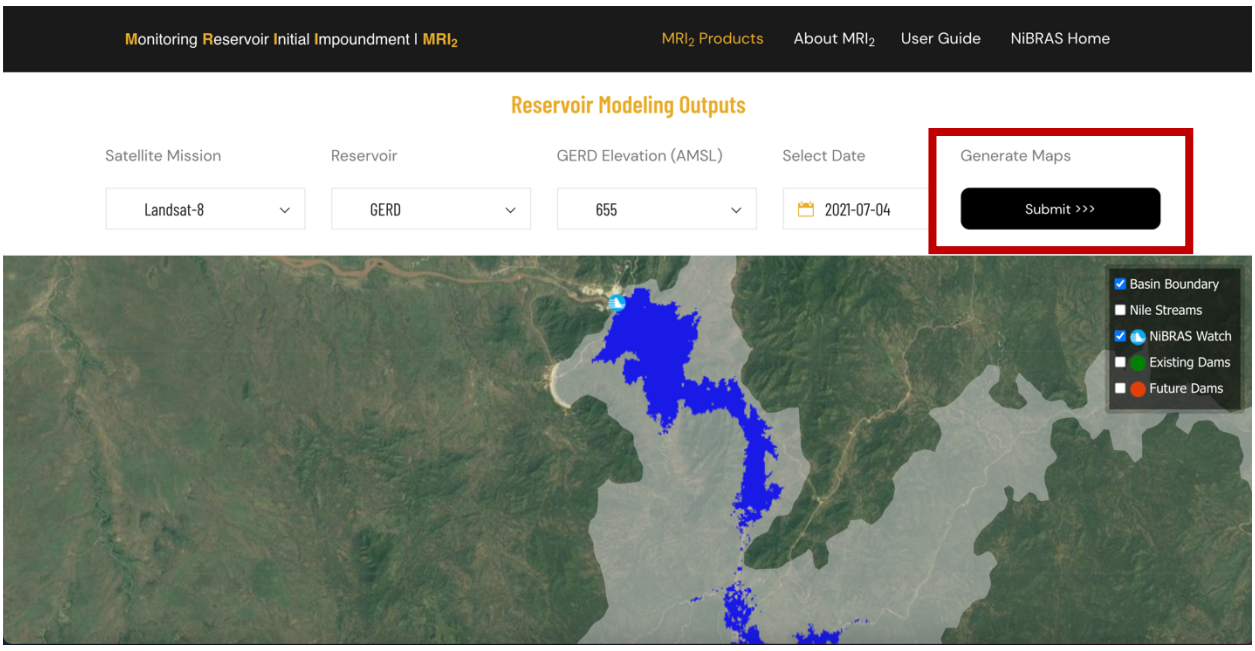

- To check whether the GERD has been filled to one of its key elevations, the user can select a hypothetical GERD elevation and visualize how much of the GERD lake has been filled (as compared to the contour or boundary of the selected elevation). The default value is set to "655 m", which is the crest level of GERD.



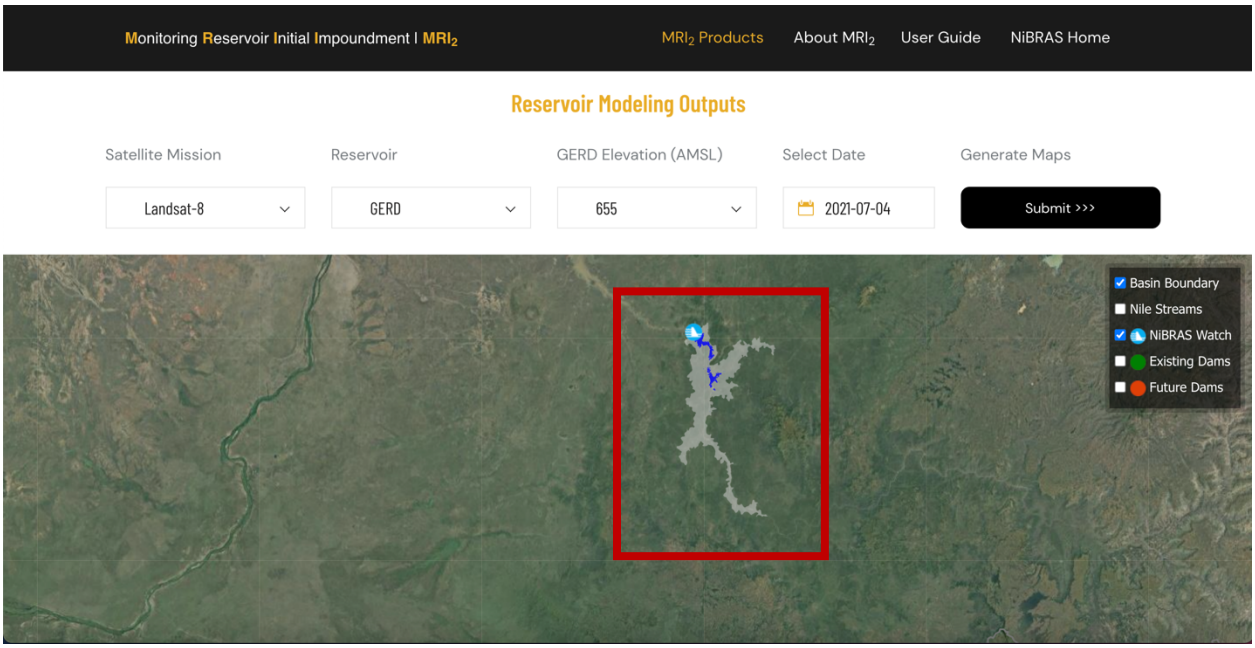

- The default date is set to yesterday date since the models run every day (at the end of the day) after having the forcing data, e.g., precipitation, available for running the hydrological model. The outputs are therefore made available in the next day.



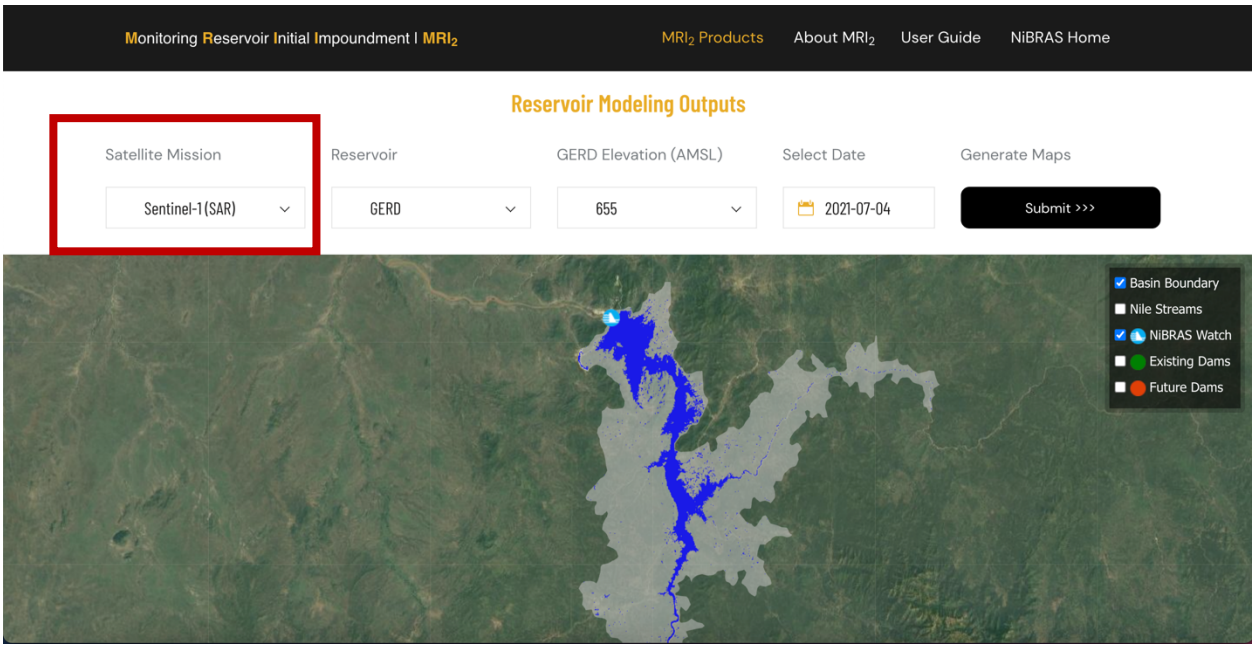

- Once the user submits the request to generate maps, the tool will zoom into the GERD dam showing a spatial map of the GERD lake as derived from the satellite mission and in comparison to the boundary of the selected elevation contour (default is 655 m AMSL).

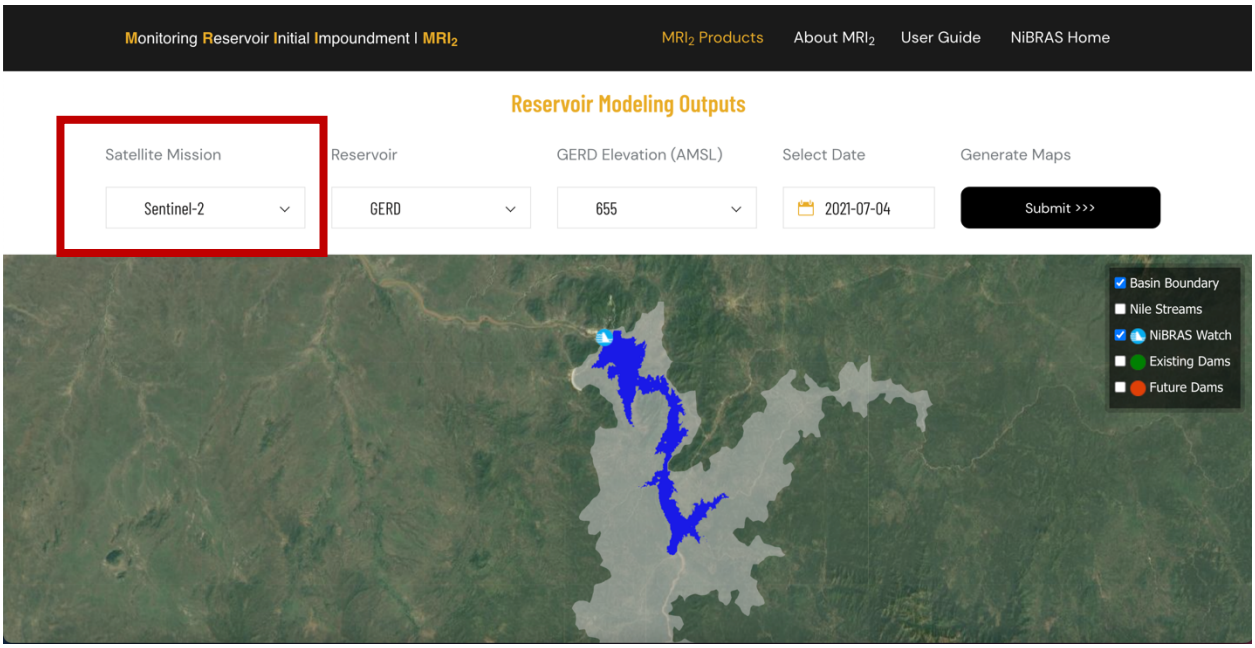



- The user can zoom out to see the entire boundary of the hypothetical GERD lake (i.e., at elevation of 655 m). It is obvious that the GERD has not reached the elevation 655 m AMSL (on July 4$^{th}$, 2021).

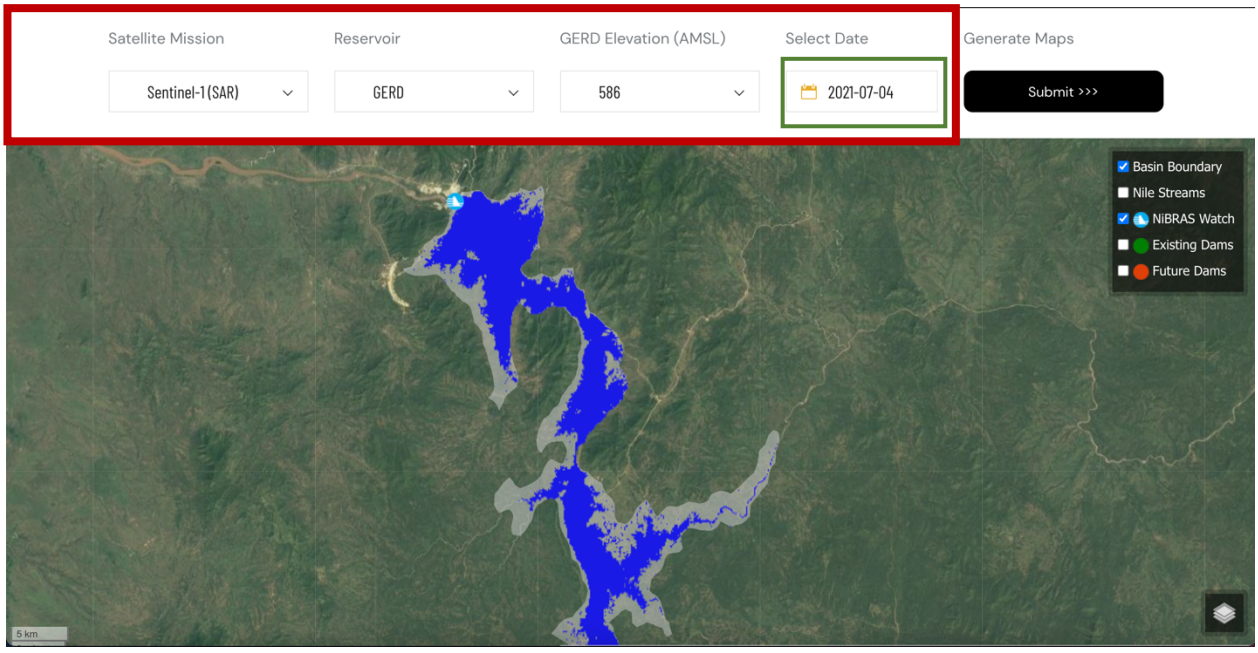


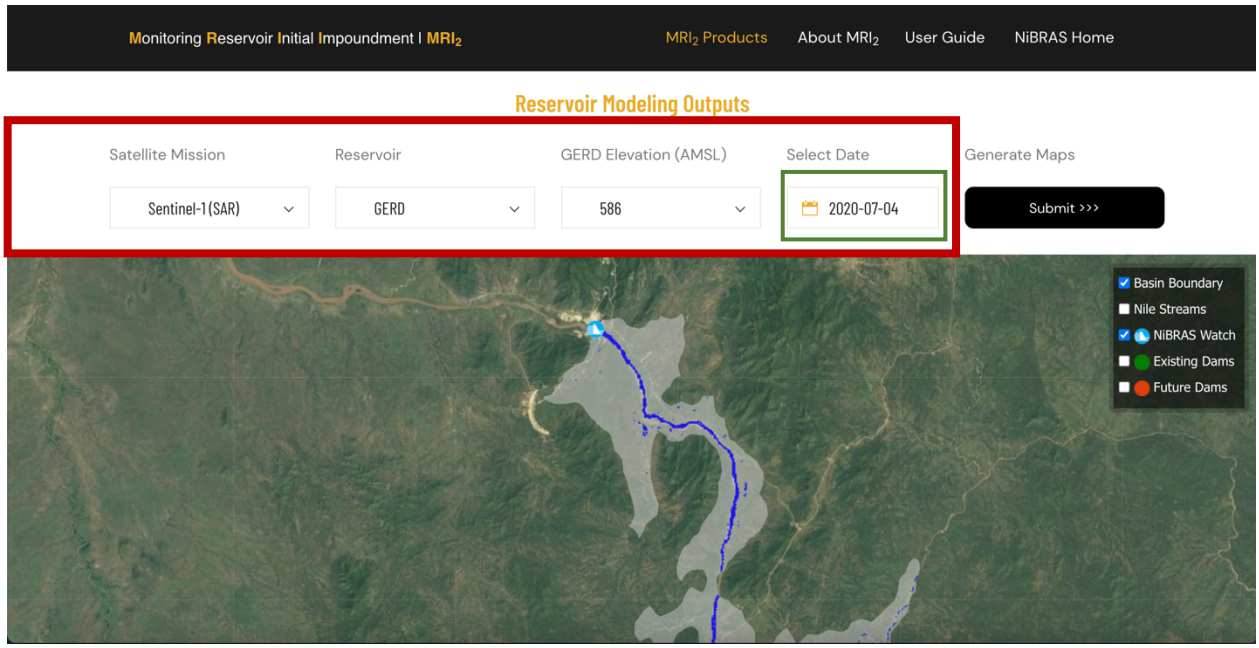

- The user can also explore the GERD lake as derived from other missions such as Sentinel-1 and Sentinel-2.



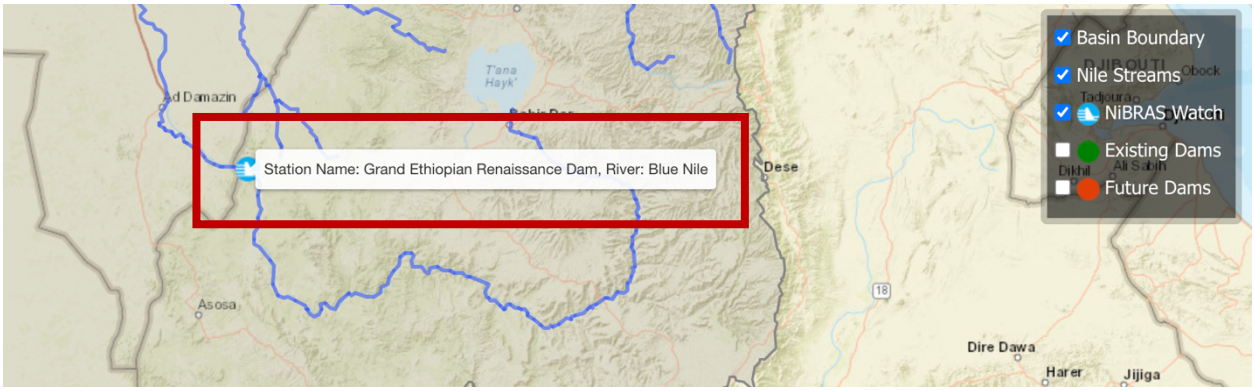



- The images of GERD lake are saved for the last four years and therefore the user can visualize the GERD lake for the same date last year (to compare the filling progress).

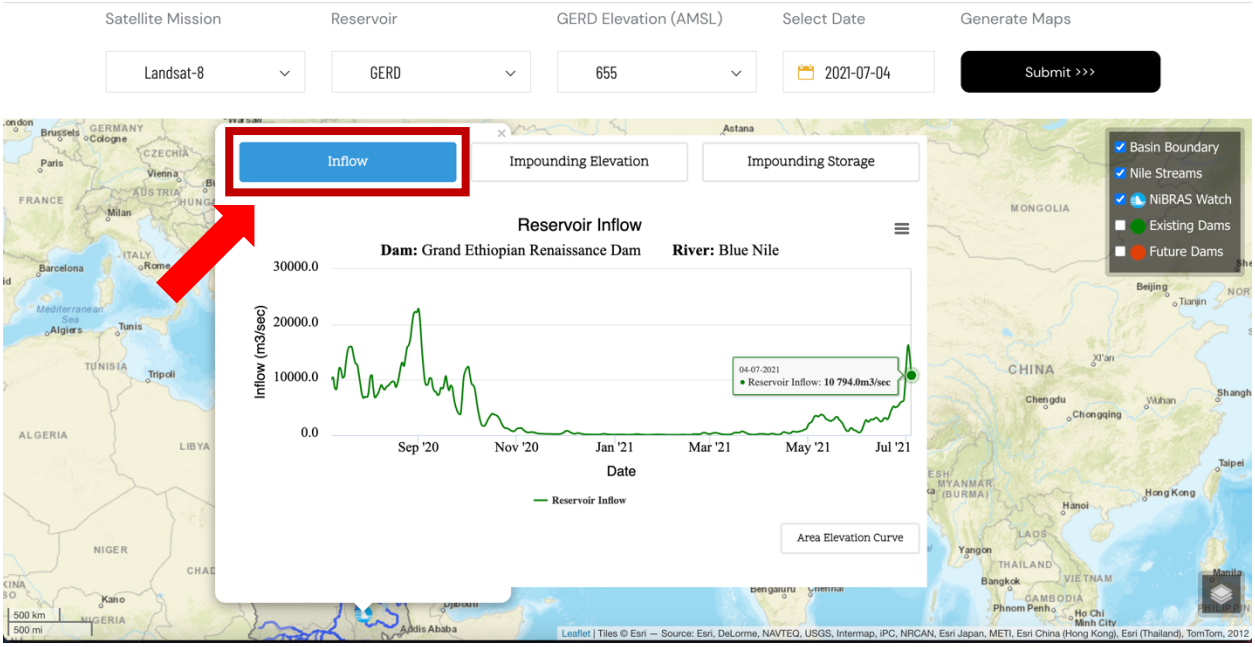




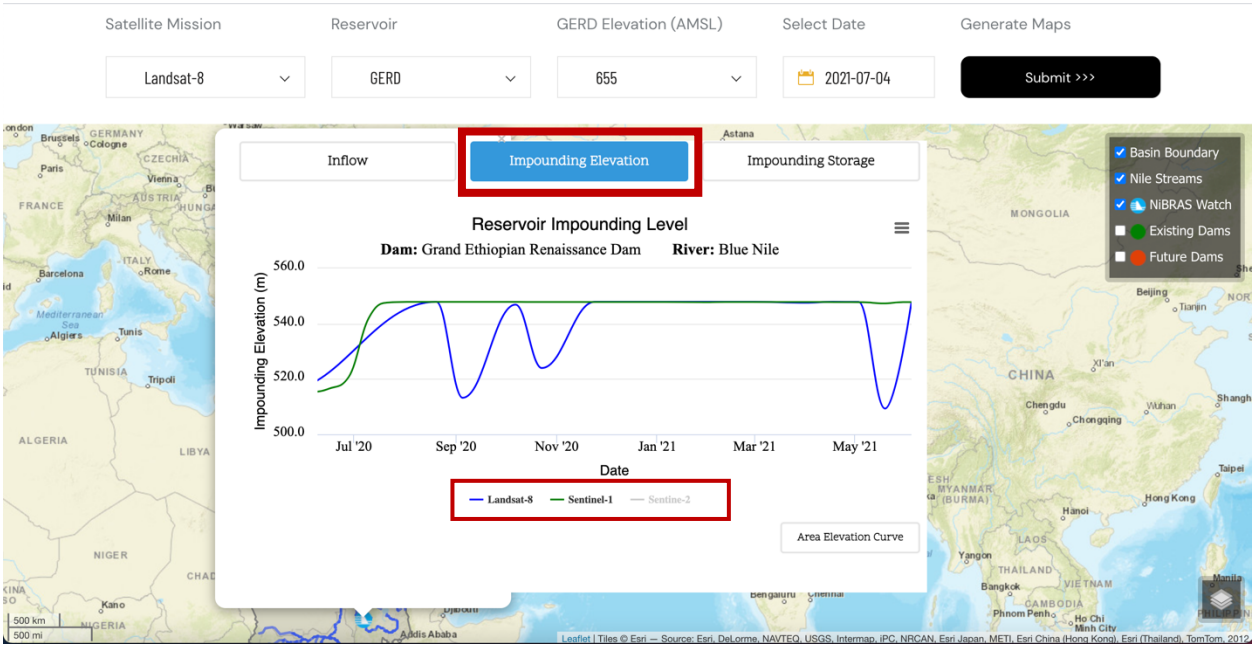

- The NiBRAS Watch icon indicates the dams or stations that are currently monitored by the MRI$_2$ tool. In case of MRI$_2$ tool, only GERD and Eldiem station (same location as GERD) are monitored.



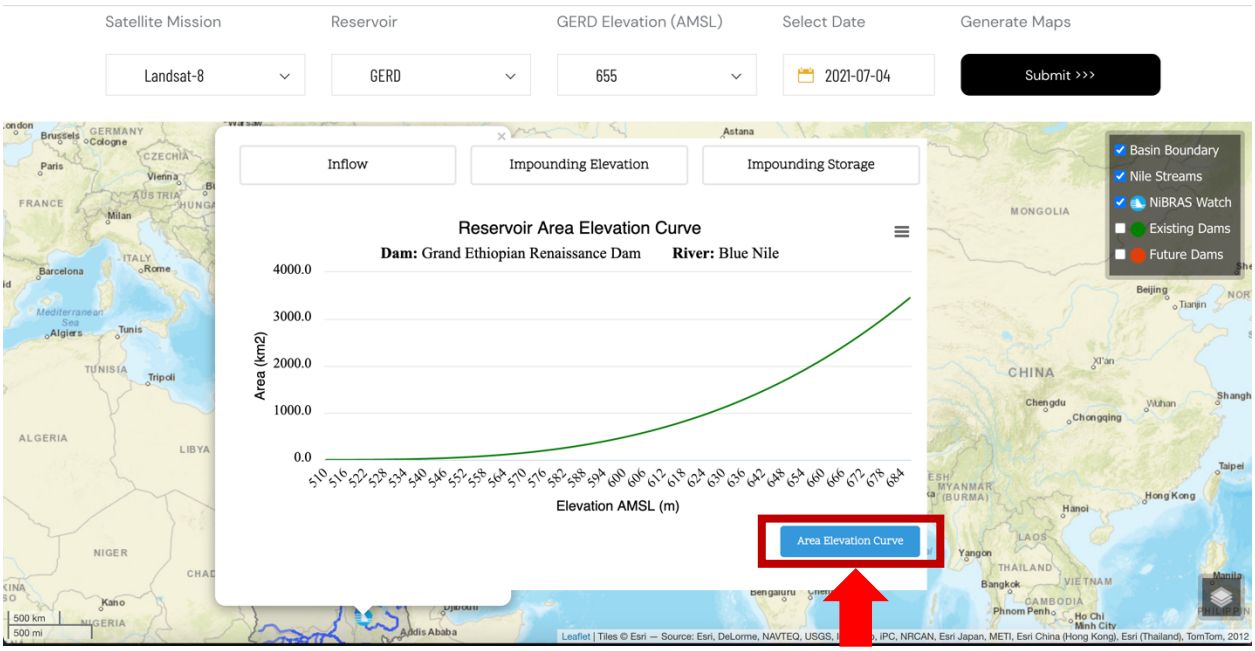

- When clicking on GERD, the user can visualize the daily inflow into the dam based on the hydrological modeling over the UBN (using the VIC model). The VIC model runs every day to simulate the hydrology of UBN and produces the streamflow at Eldiem station (or GERD inflow).




- In the popup window, the user can also explore the impoundment rate (elevation and volume) of GERD as monitored by different satellite missions.

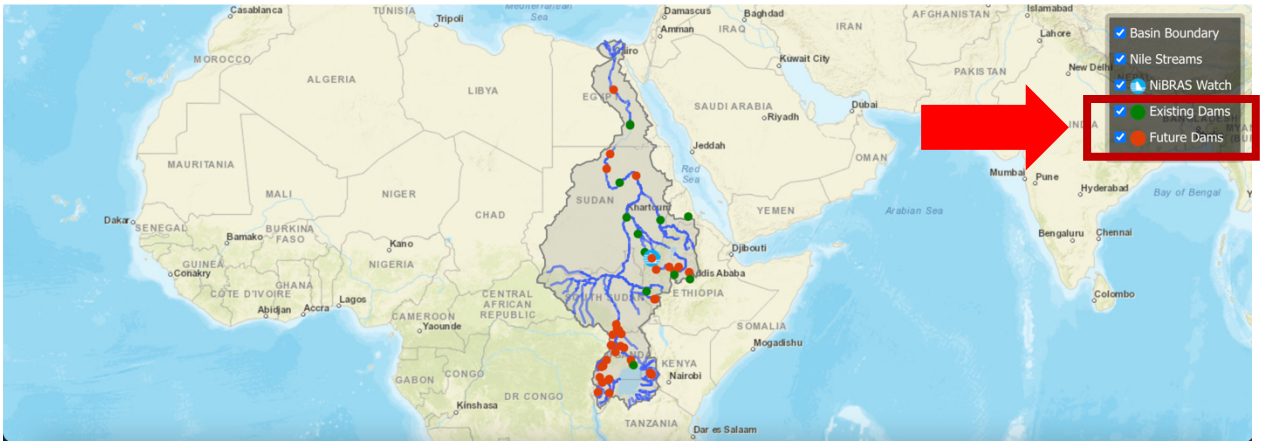



- The elevation and volume of GERD impoundment are calculated based on the Area-Elevation Curve (AEC) relationship for GERD. The AEC for GERD is derived based on SRTM satellite observations and can be displayed in the popup window.



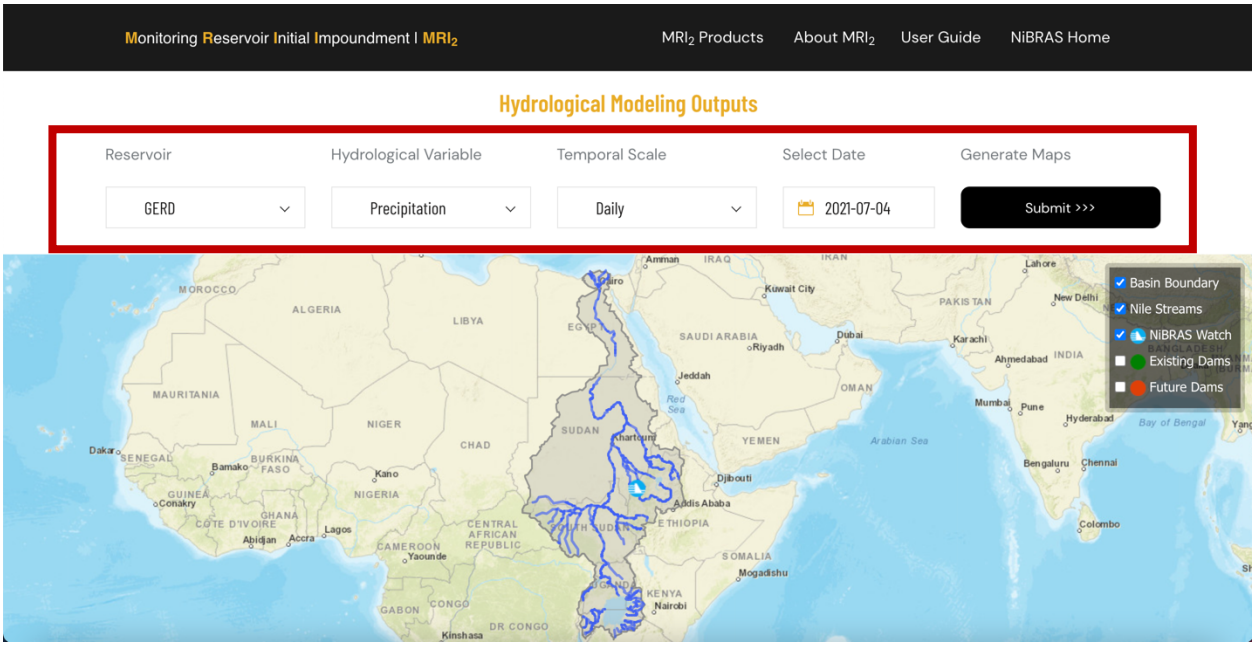

- The MRI$_2$ provides a variety of overlay maps including Google Satellite, Terrain Map, and Street Map.


- The user can display the existing and future dams in the Nile basin based on the databases produced by Lehner et al. (2011) [existing dams or GRaND Database] and Zarfl et al. (2015) [future hydropower dams]. These layers are turned off by default.

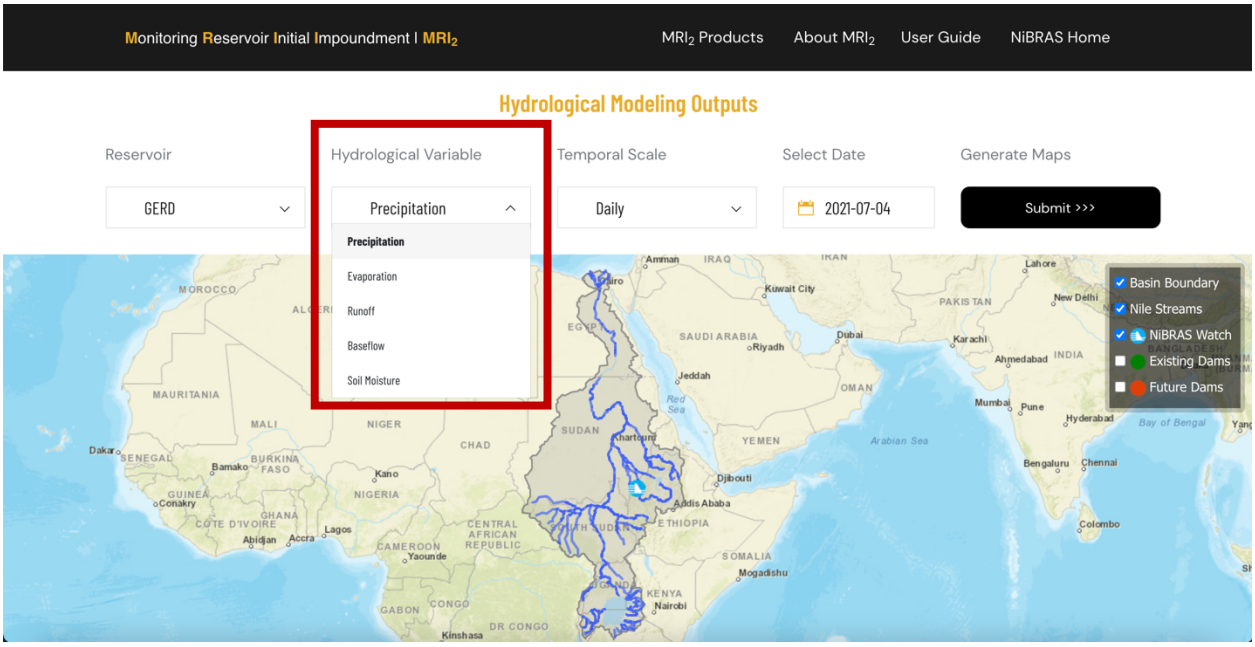


## Hydrological Modeling Outputs

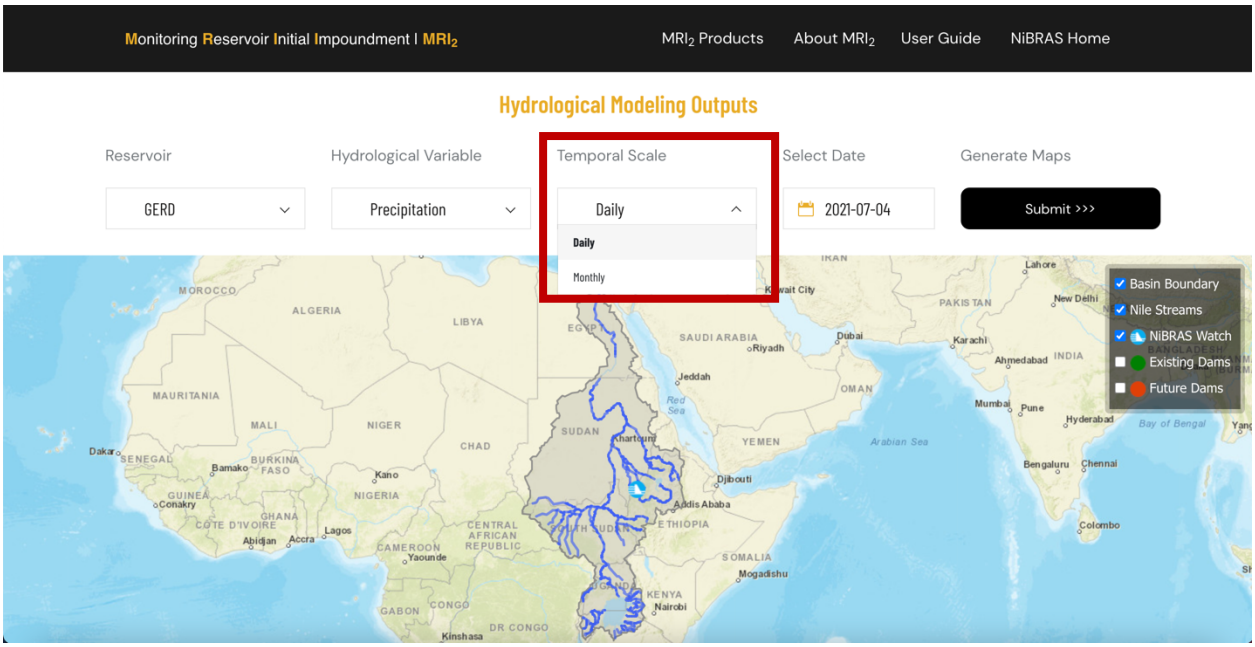
- The second product from the MRI$_2$ tool is the outputs from the hydrological model.



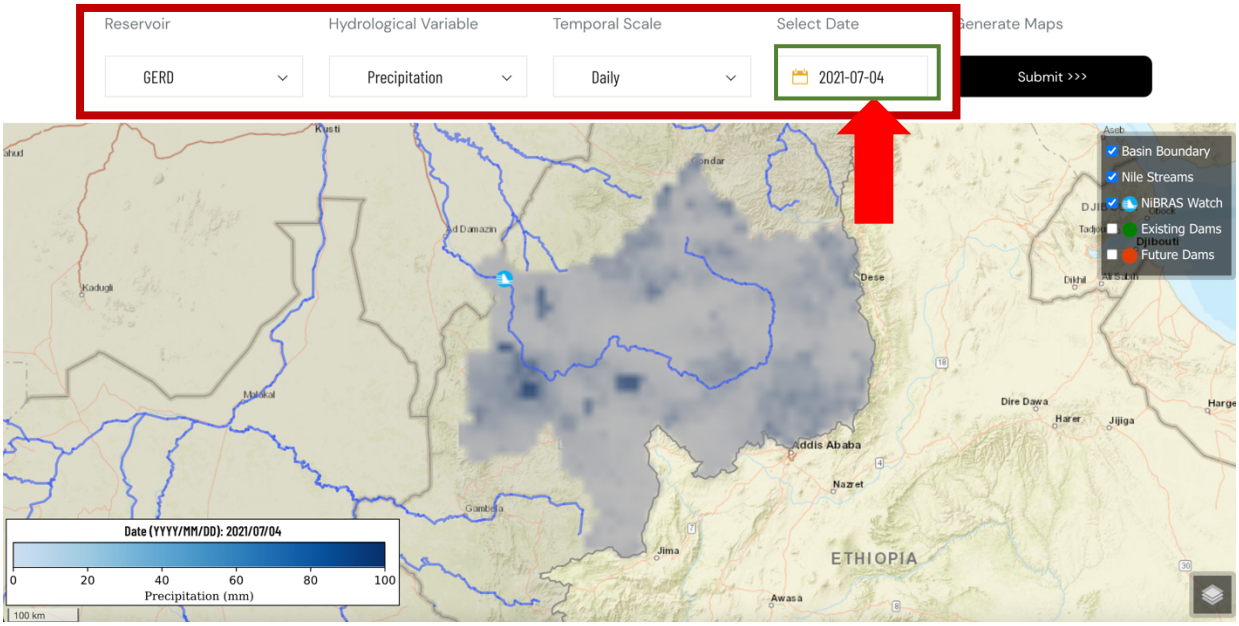

- The user can explore different hydrological variables upstream the reservoir of interest (e.g., GERD) including precipitation, evaporation, runoff, baseflow, and soil moisture.



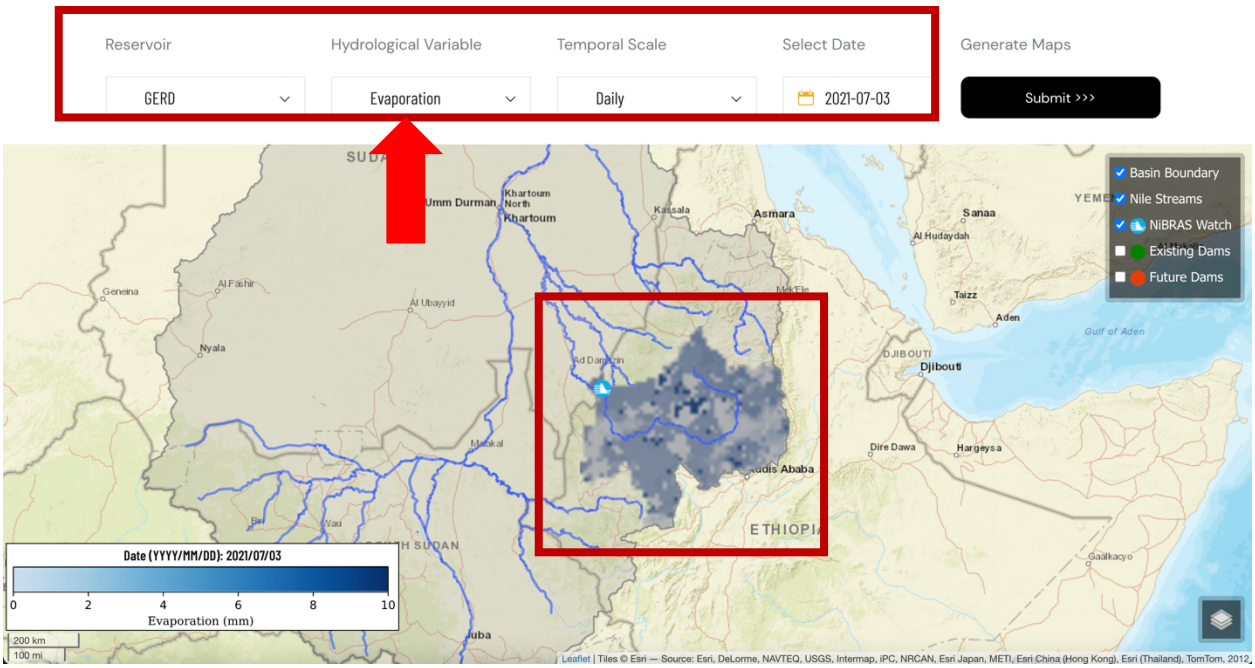

- The hydrological variables are made available at daily and monthly scale.



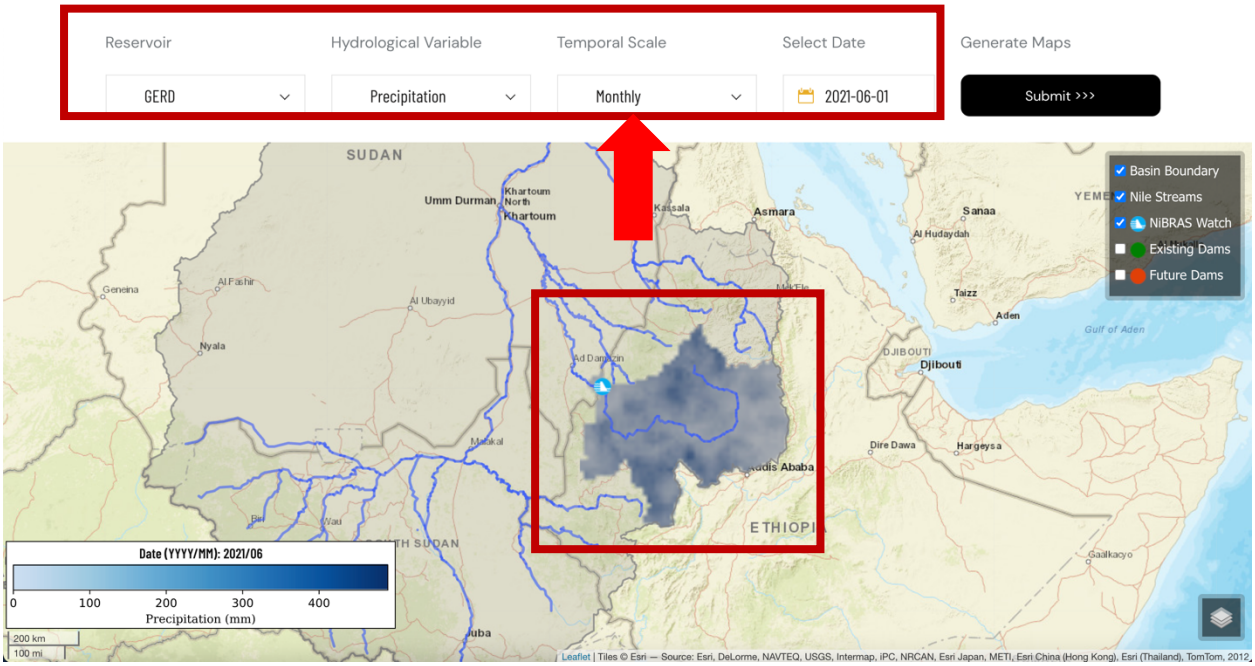

- Producing a spatial map of the total daily precipitation on July 4$^{th}$, 2021 over the UBN (almost zero precipitation).



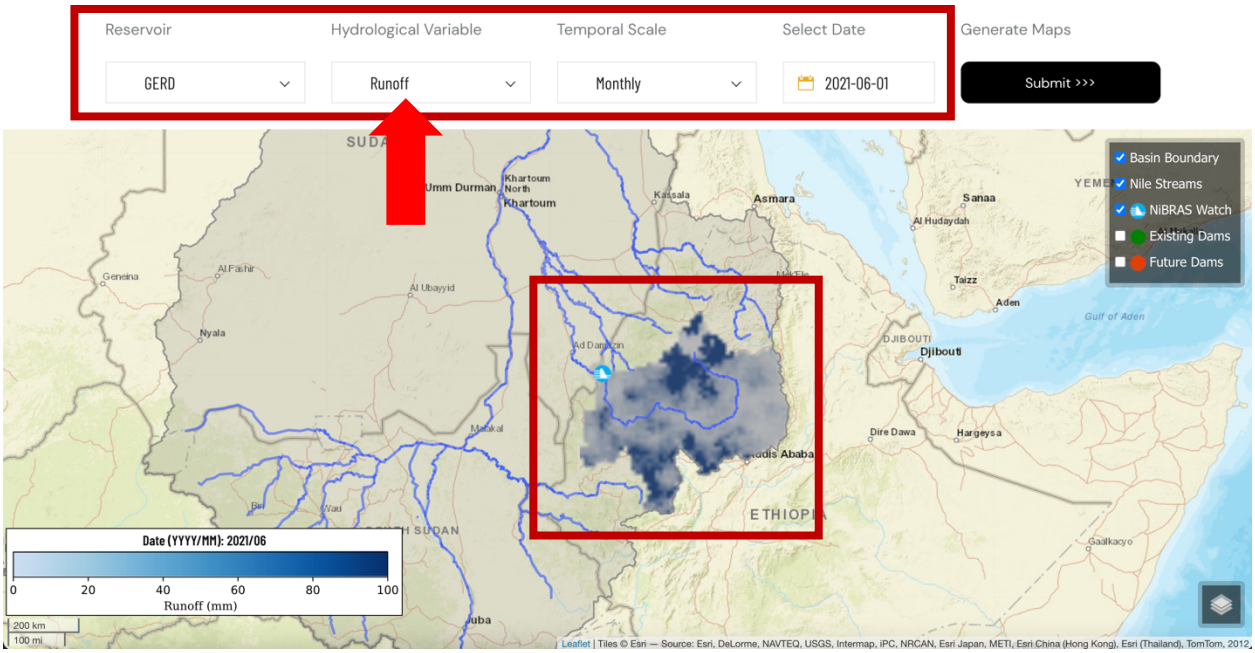
- Producing a spatial map of the total daily evaporation on July 3rd, 2021 over the UBN.




- Producing a spatial map of the total monthly precipitation on June, 2021 over the UBN.




- Producing a spatial map of the total monthly runoff on June, 2021 over the UBN.


Reservoir
Hydrological Variable
Temporal Scale
Select Date
Generate Maps
GERD
Runoff
Monthly
2021-06-01
Submit >>>

## References


- **Eldardiry, H.**, & Hossain, F. (2019). Understanding reservoir operating rules in the transboundary nile river basin using macroscale hydrologic modeling with satellite measurements. *Journal of Hydrometeorology*, *20*(11), 2253-2269.
- **Eldardiry, H.**, & Hossain, F. (2020). A blueprint for adapting high Aswan dam operation in Egypt to challenges of filling and operation of the Grand Ethiopian Renaissance Dam. Journal of Hydrology, 598, 125708.
- **Eldardiry, H.**, & Hossain, F. (2021). The Value of Long-Term Streamflow Forecasts in Adaptive Reservoir Operation: The Case of the High Aswan Dam in the Transboundary Nile River Basin. Journal of Hydrometeorology, 22(5), 1099-1115.
- **Eldardiry, H.**, & Hossain, F. (2021). Evaluating the hydropower potential of the Grand Ethiopian Renaissance Dam. Journal of Renewable and Sustainable Energy, 13(2), 024501.
- Lehner, B., Liermann, C. R., Revenga, C., Vörösmarty, C., Fekete, B., Crouzet, P., ... & Wisser, D. (2011). High-resolution mapping of the world's reservoirs and dams for sustainable river-flow management. Frontiers in Ecology and the Environment, 9(9), 494-502.
- Zarfl, C., Lumsdon, A. E., Berlekamp, J., Tydecks, L., & Tockner, K. (2015). A global boom in hydropower dam construction. Aquatic Sciences, 77(1), 161-170.