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MODIS Optical Global Water Intelligence (MOGWAI) Web Application User Guide

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PURPOSE: Using the sensor from the Moderate Resolution Imaging Spectroradiometer (MODIS), the MODIS Optical Global Water Intelligence (MOGWAI) platform is a system created and maintained jointly by the National Geospatial-Intelligence Agency and US Army Corps of Engineers (USACE) that monitors the surface area of lakes and reservoirs using remote sensing in near real time. MOGWAI provides estimates of surface area based on an implementation of the Dynamic Surface Water Extent algorithm that was adapted to use 8-day composites of surface reflectance data from the MODIS sensor, which belongs to the National Aeronautics and Space Administration (NASA). Surface area is monitored for all large waterbodies (greater than 10 km²)* south of 60°N contained in the HydroLAKES database. This information provides near real-time insights related to the regional buffering capacity against flood and drought.

INTRODUCTION: MOGWAI provides estimates of surface area extents based on an implementation of the Dynamic Surface Water Extent (DSWE) algorithm (Jones 2019; USGS, n.d.) that was adapted to use 8-day composites of surface reflectance data from the (MODIS) sensor, which belongs to NASA (NASA, n.d.). Surface area is monitored for all large waterbodies (greater than 10 km²) south of 60°N contained in the HydroLAKES database. MOGWAI also provides locations of existing dams that have been aggregated from the Global Reservoir and Dam (GRanD) (Lehner 2019) and AQUASTAT (Food and Agriculture Organization of the United Nations, n.d.) databases. A smoothing filter is applied to the time series each time new data are incorporated. This can result in differences between the old and new time series, particularly when surface-area trends reverse (e.g., increasing to decreasing, decreasing to increasing). The best practice is to redownload the entire dataset after each update to get the best representation.

ACCESSING THE MOGWAI TETHYS APP

Common Access Card (CAC). The MOGWAI app is accessible via common access card (CAC) authentication from <https://umip.erdcdren.mil> after consenting to the terms and conditions (Figure 1) and choosing the preferred method of authentication (Figure 2). Logging in with username and password is available to non-CAC holders by request for those with appropriate system access and adequate justification.

Once the login process is complete, the user is redirected to the USACE Model Interface Platform (UMIP) home page, which shows all the web applications that are available (Figure 3). To access the MOGWAI app, select the MODIS Optical Global Water Intelligence (MOGWAI) BETA tile.

¹ For a full list of the spelled-out forms of the units of measure and unit conversions used in this document, please refer to *US Government Publishing Office Style Manual*, 31st ed. (Washington, DC: US Government Publishing Office 2016), 248–52 and 345–7, respectively. <https://www.govinfo.gov/content/pkg/GPO-STYLEMANUAL-2016/pdf/GPO-STYLEMANUAL-2016.pdf>.

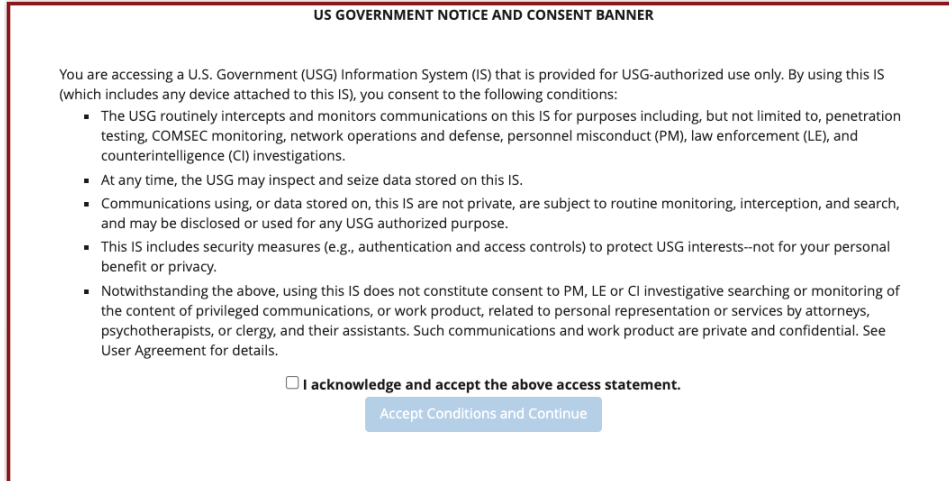


Figure 1. Terms and conditions.

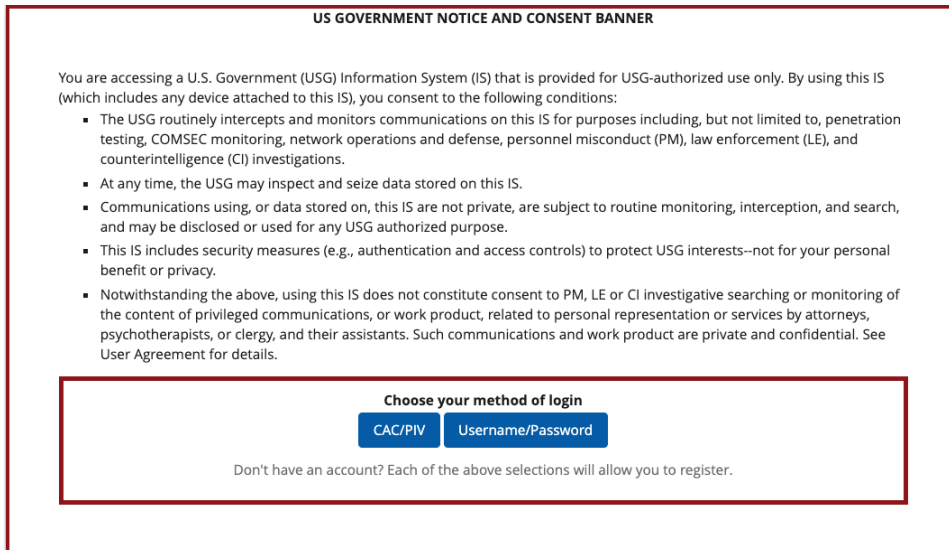


Figure 2. Method of authentication.

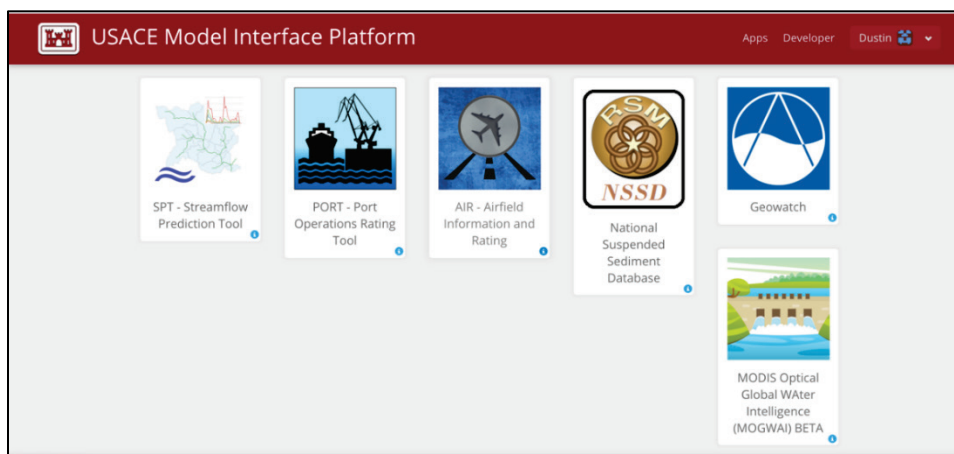


Figure 3. A view of the USACE Model Interface Platform home page showing the available web applications.

Content and Symbology. After selecting the MOGWAI app, the user is redirected to the MOGWAI landing page shown in Figure 4. A map is displayed with a menu in the top banner providing a search function, an option to download data, the About section explaining the origins of the data, a setting button that takes user to that app’s configuration, and an exit button that returns the user to the UMIP home page.

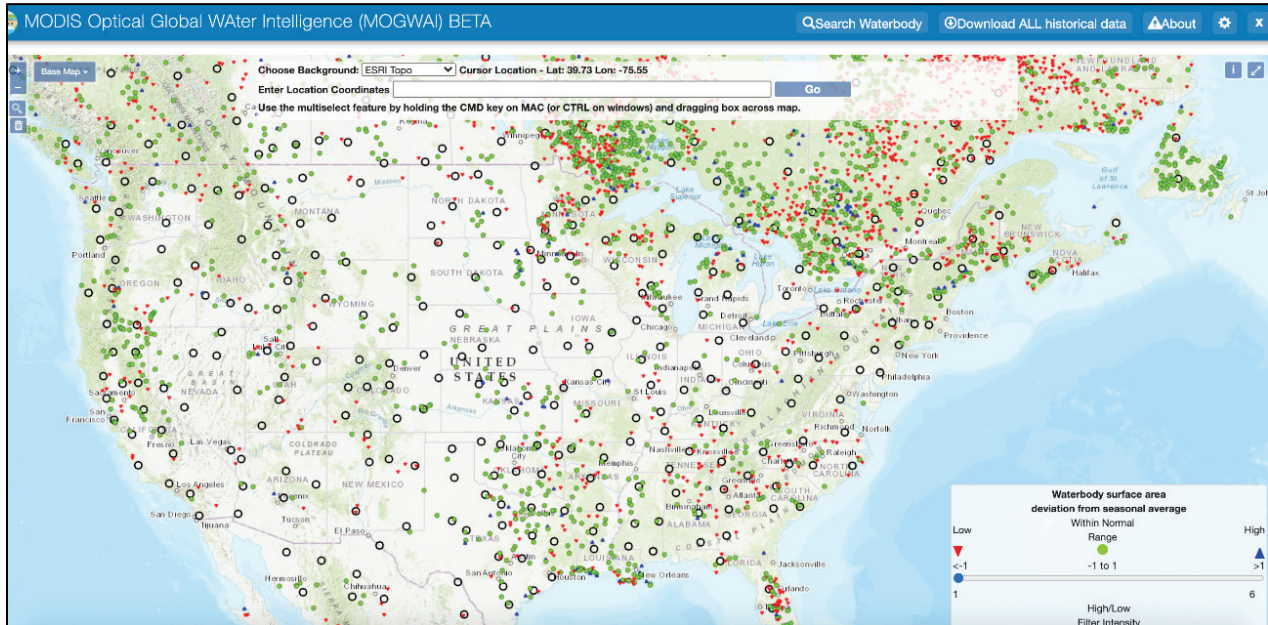


Figure 4. The MOGWAI landing page consists of a map interface depicting dam locations and color classification of the status of lakes and reservoirs.

Specific layers can be toggled on and off through the legend in the bottom right corner of the landing page (Figure 5). Within the app, dams show up as black. Lakes are shown in green unless the latest information indicates areal extents that are above or below normal. Normal is defined as a departure from the historical mean for a given time of year. This departure is expressed in terms of the number of standard deviations. Waterbodies outside the normal are flagged with blue (above normal) or red (below normal) indicators identifying anomalies. These reservoir colors change dynamically according to the latest conditions. Waterbodies within the normal operating range are shown as green. The filter intensity can be increased up to 6 to identify more extreme anomalies. The intensity is the number of standard deviations that the anomaly goes over or under (Figure 5). By default, anything within 1 standard deviation of the mean is displayed as normal.

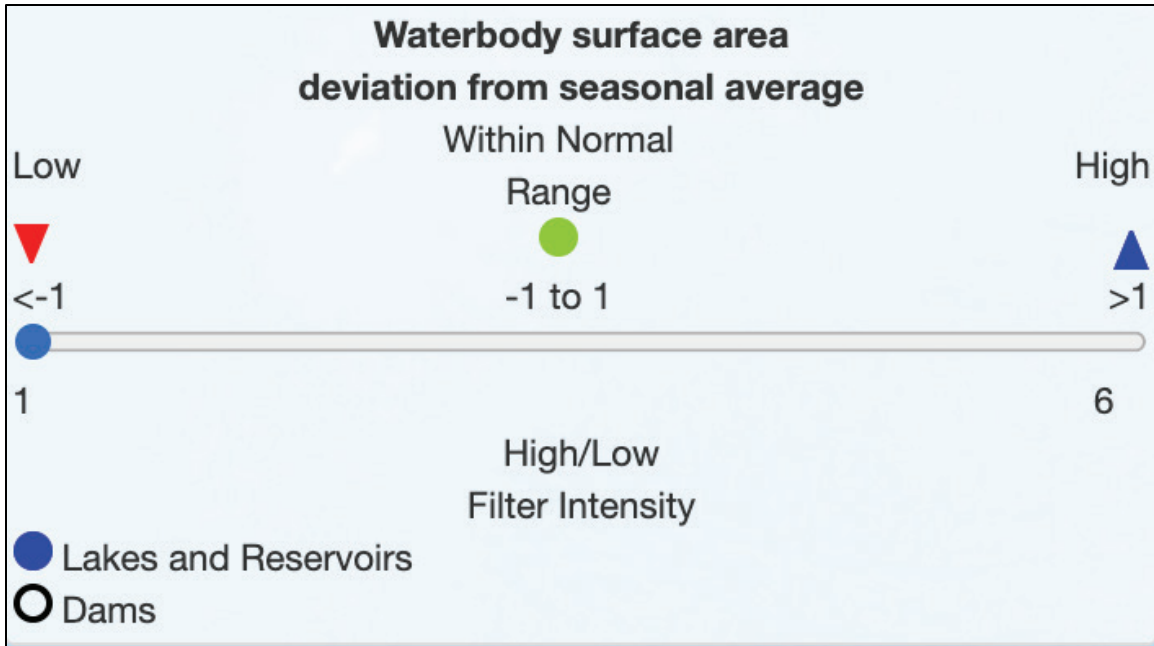


Figure 5. Symbology of the MOGWAI app.

NAVIGATION: The user can interact with the map through pan-and-zoom functionality that works in a similar way to other web-based map interfaces. A control panel centered below the top banner provides some additional display options (Figure 6).

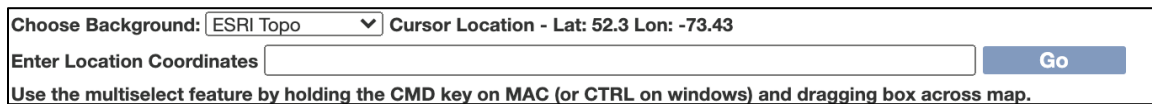


Figure 6. Display options available to the MOGWAI user.

The Choose Background option allows the user to switch between different base maps. An example of the ESRI Imagery background is shown in Figure 7. Other base layer options include Open Street Map, ESRI Topo, and ESRI Terrain. Additionally, the user can center the map on a specific location by entering values for latitude and longitude in various formats, including decimal degrees, DMS (degrees-minutes-seconds), and MGRS (Military Grid Reference System) and then pressing the Go button. There is also a magnifying glass icon on the left side of the map that can be used to search for a specific place name or landmark (Figure 8). Underneath the magnifying glass icon is a garbage icon. Clicking it removes the landmark marker icon that is on the map after the search if the user does not want the marker there anymore.

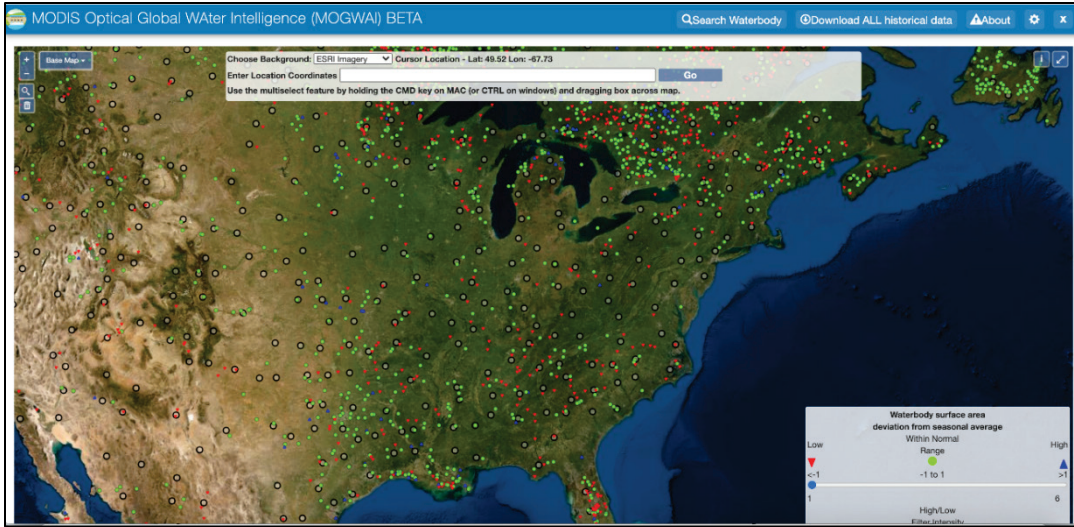


Figure 7. Example of the ESRI imagery background map.



Figure 8. Example of a search by placename.

The two primary map layers are described as follows:

1. Dams: This layer is aggregated from the GRanD (Lehner 2019) databases. Some basic information on these dams is included with the point data shown in Figure 9.
2. Lakes/Reservoirs: This dataset includes all large water bodies (greater than 10 km²) south of 60°N that are contained within the HydroLAKES database (Messenger 2021). This includes spatial locations along with historical surface area extents estimated from the DSWE algorithm. The time series associated with each waterbody is accessed by selecting a given lake or reservoir. New surface area extent values are updated on an 8-day cycle. The entire period of record can be viewed (Figure 10) along with seasonal variation for daily (Figure 12) or monthly (Figure 13) timescales.

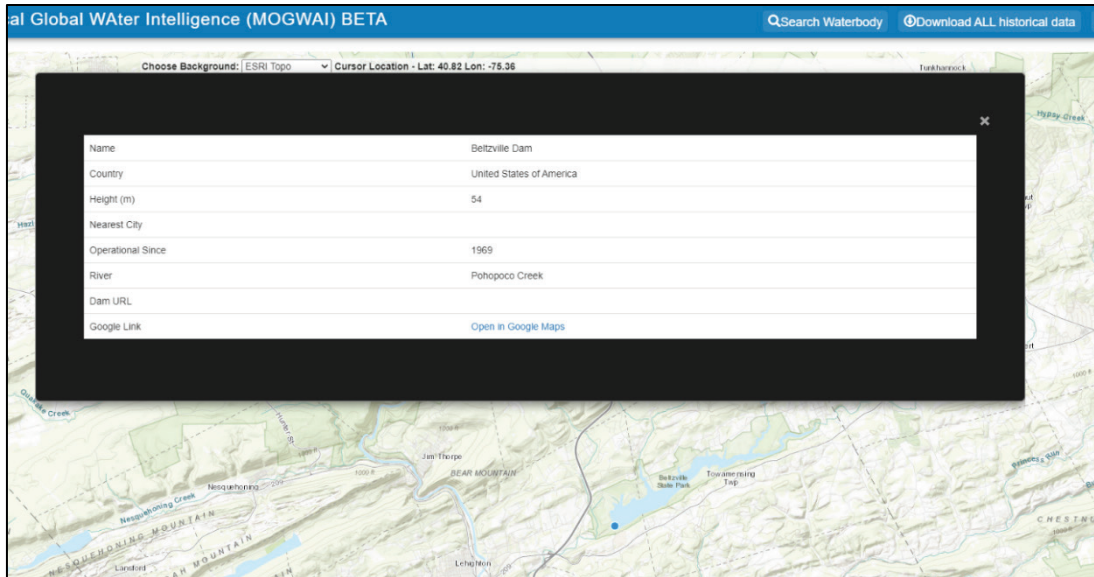


Figure 9. Information about dams in MOGWAI.

Historical Data. A default plot is generated upon selecting a waterbody that shows the historical surface extents for the entire period of record. The observed data are plotted along with the seasonal average for historical context (Figure 10).

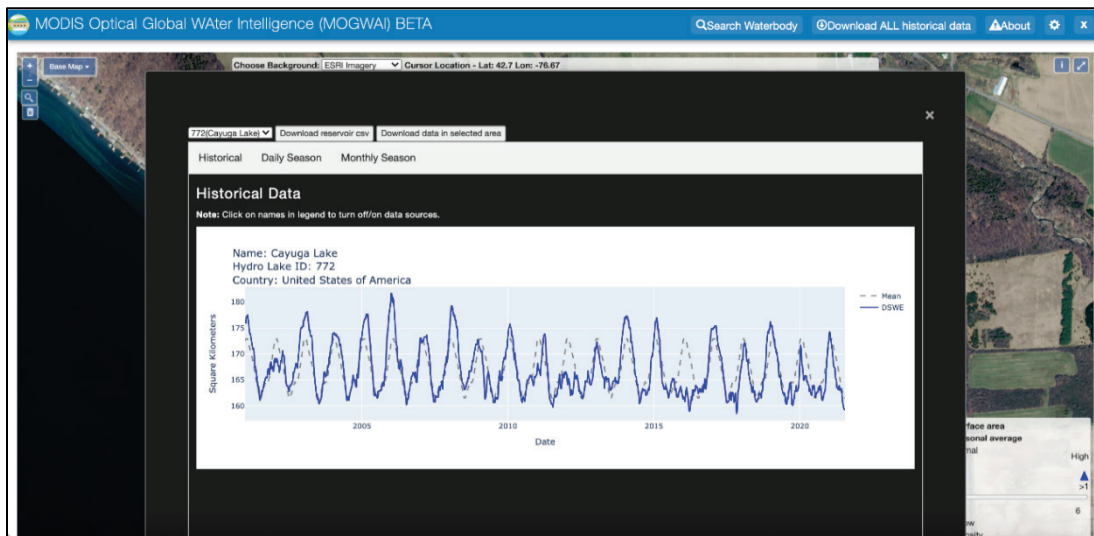


Figure 10. Default plot showing historical lake/reservoir surface area (blue) along with the seasonal average (gray dashed).

If the user hovers on the graph, a menu is displayed on the top right corner where the user can perform actions such as downloading the plot in a portable graphics format (.png) as shown in Figure 11.

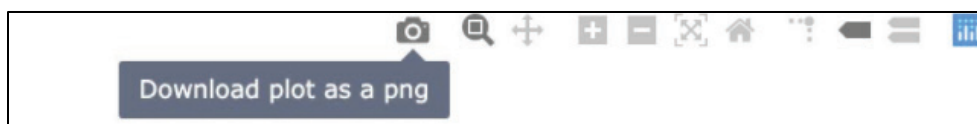


Figure 11. Plot menu provides option to download a static image.

Daily Seasonal. This displays the mean for each calendar day throughout the year along with an envelope 1 standard deviation above and below the mean to characterize the daily variance (Figure 12).

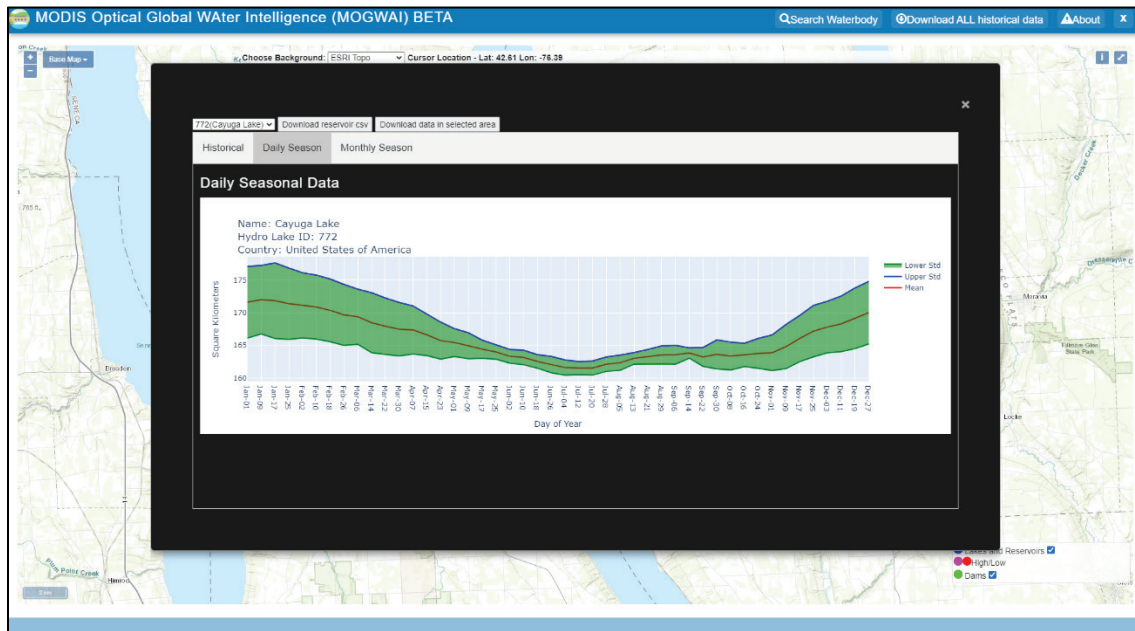


Figure 12. Daily seasonal norms for a given waterbody represented by the daily mean and typical variance.

Monthly Seasonal. This displays the mean monthly values throughout the year along with an envelope 1 standard deviation above and below the mean to characterize the monthly variance (Figure 13).

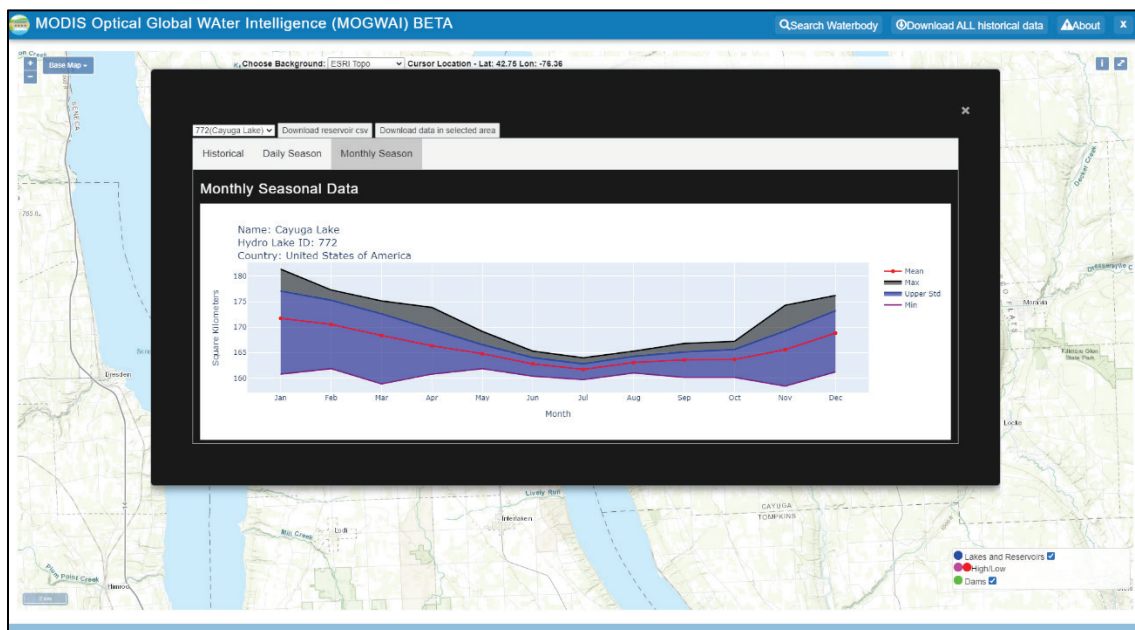


Figure 13. Monthly seasonal norms for a given waterbody represented by the monthly mean and typical variance.

DOWNLOADABLE DATA ON MOGWAI: Downloadable data are available for each waterbody. The time-series data can be downloaded for an individual location or for a group of waterbodies, or alternatively the entire database may be downloaded.

Single Location. A particular waterbody can be selected several different ways. Users can pan and zoom directly to a location of interest, or they may enter coordinates in decimal degrees through the control panel. Alternatively, users utilize the Search Waterbody button (Figure 14) on the top banner to search by common name or by the unique HydroLAKE identifier (i.e., Hylak_id) if this information is known.



Figure 14. Location of button to query by waterbody name or ID.

After selecting the Search Waterbody button, a menu will appear. From here, the user can enter a query in the appropriate selector box as shown in Figure 15.

Figure 15. Search Waterbody button options.

The default chart pops up when a waterbody is selected or when the search feature returns a match. The time series displayed in the chart is downloadable by selecting the Download reservoir csv button shown in Figure 16.

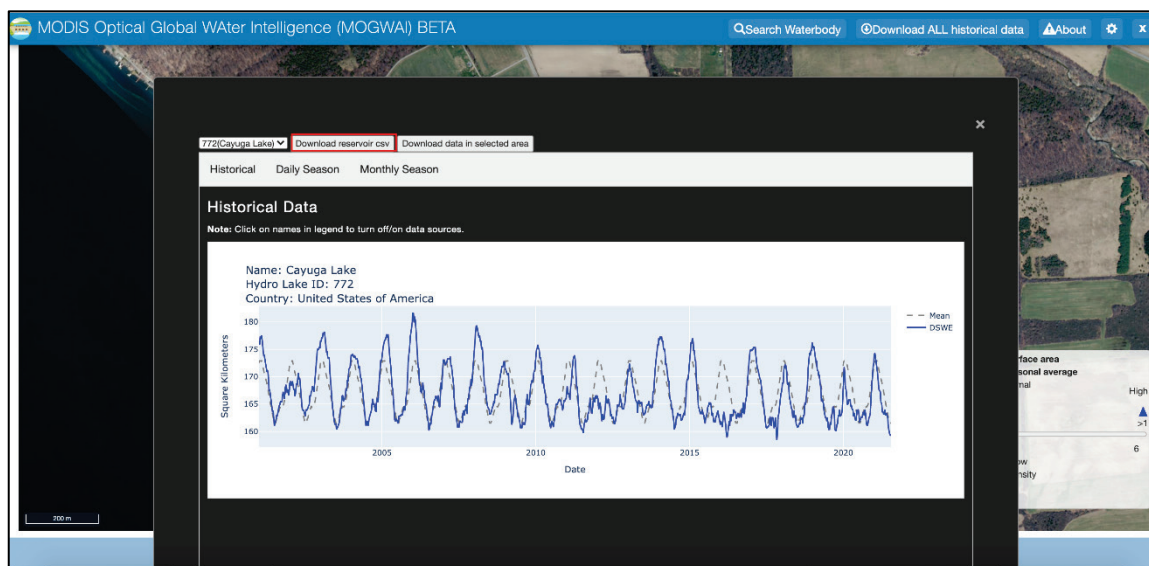


Figure 16. Display showing Download reservoir csv option for a specific location.

Multiple Locations. Multiple locations can be downloaded simultaneously by dragging a box around the region of interest. This is done by holding the Ctrl key (CMD key on Apple OS) and dragging a box across the map that includes the desired waterbodies. This selects all the locations within the box shown in Figure 17.

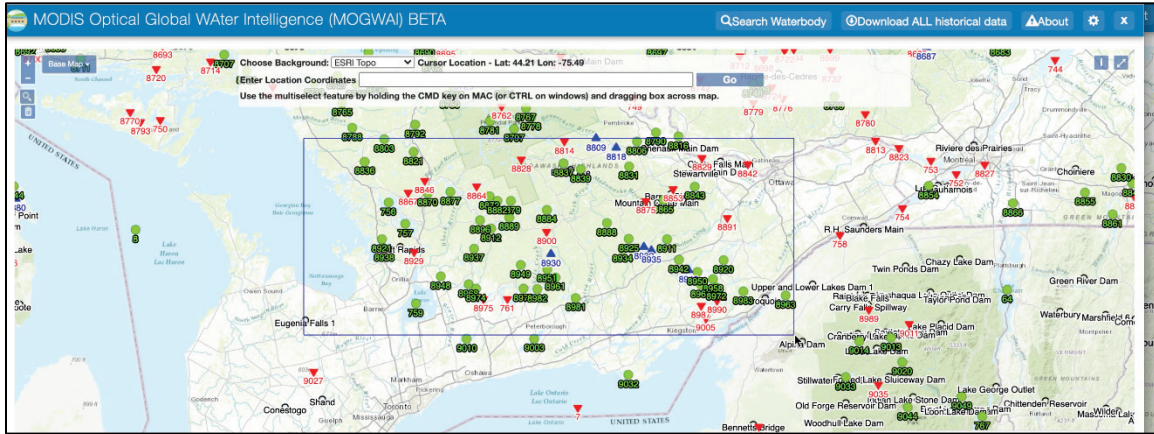


Figure 17. Box highlighting multiple reservoirs/lakes for downloads.

Downloading multiple waterbodies is similar to downloading the data for a single location. The only difference is that, instead of selecting Download reservoir data, the user should select the adjacent Download data in selected area button shown in Figure 18. There is also a dropdown to switch between the different locations to view the specific graphs for those locations as shown in Figure 18.

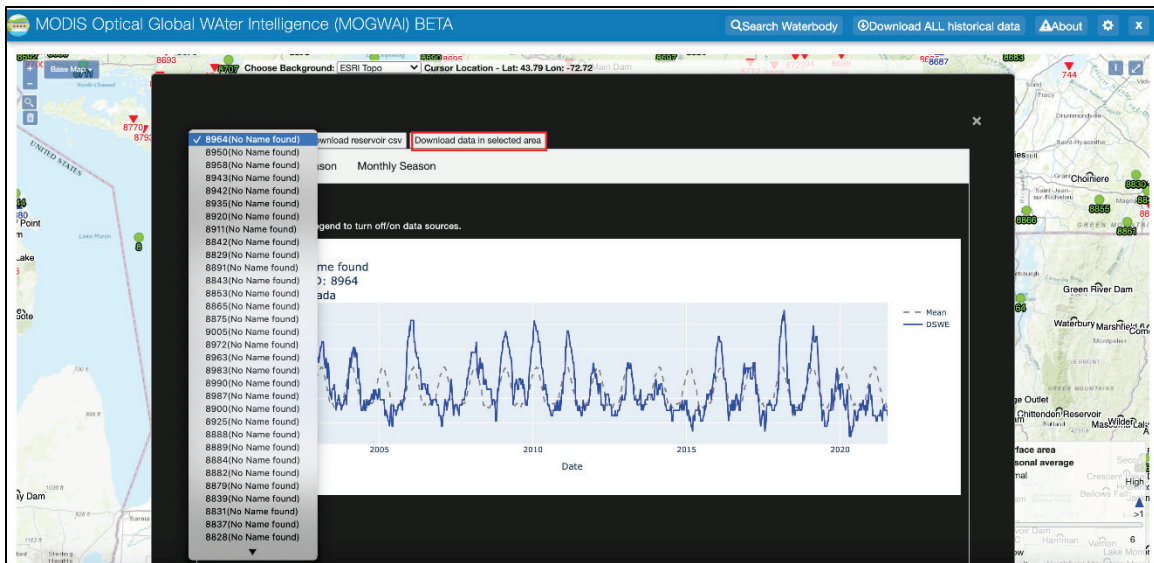


Figure 18. Option showing Download data in selected area.

All Historical Data. To download the entire database, click on the Download ALL historical data button located on the top banner shown in Figure 19 (following page) in a red box. A text file (.csv) is generated containing over 10 yr of data for more than 10,000 waterbodies (~18 MB).



Figure 19. Location of download button for historic reservoir data.

CONCLUSION: The MOGWAI application was developed for the purpose of viewing historical surface areas for the majority of the large bodies of water around the world while also staying reasonably up-to-date with the current date. The UMIP server stores the file that holds the historical surface areas and pulls down the most recent version whenever available while also serving as the map interface that displays the reservoir locations as points. The looks of these points change depending on each reservoir’s current status and can be selected to view more specific details about them. Besides the map backgrounds, all the data that can be viewed can also be downloaded. As of February 2023, the MOGWAI data are still being updated on a regular basis.

ADDITIONAL INFORMATION: For additional information on the DSWE algorithm or to recommend new waterbodies for monitoring, please contact MOGWAI@nga.mil. For additional analysis and modeling support, contact the following: USACE Reachback Operations Center; 601-634-2439/DSN 312-446-2439; uroc@usace.army.mil; uroc@usace.army.smil.mil.

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