



Questions & Answers Session 1

Please type your questions in the Question Box. We will try our best to get to 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).

Question 1: Can Sentinel-2 data also be used to analyze surface water extent?

Answer 1: Yes, surface water extent can be mapped using Sentinel-2 MSI. The Normalized Difference Water Index (NDWI) is commonly used and may refer to one of at least two remote sensing-derived indices related to liquid water.

<https://doi.org/10.3390/rs9060596>

Question 2: Are there similar databases with polygons and bathymetry for large rivers?

Answer 2: Yes, the HydroSHEDS website provides a global database of river polygons derived from the Shuttle Radar Topography Mission (SRTM) mission.

<https://www.hydrosheds.org/>

Question 3: I do not understand what is the meaning of a water mask?

Answer 3: A water mask is a raster file where areas bounded by surface water are assigned a value of 1, and everything else is assigned a value of 0. This helps with visualizing and analyzing surface water.

Question 4: Why is MOD44W only provided every 16 days if MODIS has daily temporal resolution?

Answer 4: MOD44W uses a MODIS-specific compositing method based on product quality assurance metrics to remove low quality pixels. From the remaining good quality pixel values, a constrained view angle approach then selects a pixel to represent the compositing period. The result is a 16-day product with a high level of quality assurance.

User's guide:

https://lpdaac.usgs.gov/documents/109/MOD44W_User_Guide_ATBD_V6.pdf

Question 5: Why do you not talk about the EU Copernicus program and the Sentinel-satellite-family? Of course, it is a NASA Training Program, but is this enough to be



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silent about free data with a high temporal and spatial resolution (e.g., compared to Landsat)?

Answer 5: Yes, you are right. We will be mentioning that in our next week's session where EU satellites are used for producing lake-level height time series. In this session we talked about the satellites from which global water extent/water mask are already derived.

Question 6: Can we download seasonal waterbody extent in shapefile (.shp) format?

Answer 6: I am not aware of a seasonal product that could do that. You could download a seasonal raster file then convert it to a shapefile.

Question 7: What is a burn scar?

Answer 7: A burn scar is the visibly blackened land surface left after fires burn vegetation and leaf litter.

Question 8: In the introduction part you defined natural lakes and reservoirs. By this definition, quarry lakes and pit lakes would be reservoirs - is this correct?

Answer 8: Yes, we use the definition that any lake that is manmade is a reservoir. JRC's Global Surface Water product also includes quarry lakes and pit lakes as well.

Question 9: What happens if you define two roi? Which roi does the code take into account?

Answer 9: You can define as many roi's as you want. When you run the code you will need to specify the variable name of the specific roi you defined to run in Earth Engine.

Question 10: Are you aware of any Python scripts for the same process?

Answer 10: GEE can run on a Python API. We used Java for our examples, but it is possible to use Python with GEE.

Question 11: Does this data have high enough temporal resolution to detect changes in the timing of seasonal water? For example, do the shoulder seasons extend over the spring and fall?

Answer 11: Landsat is available every 16 days (and with two Landsat satellites more frequently) -- so there will be up to 10-12 images per 3 months! But if clouds are present then Landsat will not see water bodies. A product that is currently being developed which will improve temporal resolution is the Harmonized Landsat Sentinel-



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2 product. This is not in GEE but can be acquired through the website provided:

<https://hls.gsfc.nasa.gov/>

Question 12: Can we get these maps in raster format too? How could we export the resultant maps for other uses?

Answer 12: The examples provided today are all provided in raster format. There were two sections of commented code that could be uncommented and changed to be able to be downloaded in a raster format. Below is a link to JRC's website that can allow the data to be downloaded outside of GEE. MODIS water mask is also available and can be downloaded from AppEARS.

<https://global-surface-water.appspot.com/download>

<https://lpdaac.usgs.gov/tools/appears/>

Question 13: How do you take into account "seasonality" in spectral imagery?

Answer 13: There is information such as atmospheric correction and surface temperature that is taken into consideration. There are also technical documents highlighting methods. For using the JRC data, variables such as frozen lakes may not show up.

Question 14: Does HydroLAKES provide a database for all the lakes in Asia? If not, which tool provides the same?

Answer 14: HydroLAKES does provide information for Asia.

<https://www.hydrosheds.org/pages/hydrolakes>

Question 15: In the JRC data, for coastal area water change, have tide effects been considered? E.g., using only high tide or only low tide images to get useful results?

Answer 15: This is unclear from the documentation from JRC. Refer to the links below to learn more about how the products are generated.

<https://www.nature.com/articles/nature20584#Sec15>

https://storage.googleapis.com/global-surface-water/downloads_ancillary/DataUsersGuidev2.pdf

Question 16: Is there a method to identify the full tank level (max water spread) by combining multiple datasets?

Answer 16: We are not aware of specific products.



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Question 17: Which is the level of accuracy of the measurement of reservoir heights?

Answer 17: Lake level height is within the range of a few cm to 30-40 cm. We will cover more on this topic next week.

Question 18: Does the lake dataset include coastal lagoons?

Answer 18: JRC Global Surface Water product includes coastal lagoons.

Question 19: Is it possible to visualize a lake with 2.5km² of water surface?

Answer 19: With JRC, it is possible to 30m² of water surface, but lake level height data are not available at resolution lower than 100 km².

Question 20: How is the water extent calculated during periods of high cloud cover? In some cloudy places (e.g., in South American, India) how can we get the monthly variations of the lake extent if optic sensors do not work? Is JRC Global Surface water dataset derived from cloud free data? If not, what is the cloud cover percent used?

Answer 20: To learn how water extent is calculated during periods of high cloud cover refer to the reference below:

<https://www.nature.com/articles/nature20584#Sec15>

Question 21: What about Sentinel data? Can we use it for water delineation?

Answer 21: Yes, Sentinel-1 and 2 can be used for water delineation. We focused on Landsat since the products demonstrated today are analysis ready and provide a time series going back 36 years.

Question 22: How do you compute the graphs by Pekel et al (2016) which indicate the increase and decrease of the lakes?

Answer 22: That is based on JRC data available for Explorer or GEE.

Question 23: Can we save area changes to an Asset folder on GEE instead of downloading the large files?

Answer 23: Yes, you can. You may have to download the saved area changes to Google Drive or your local machine, but from there they can be uploaded to the Asset folder.

Question 24: Is there any algorithm using remote sensing to automatically differentiate natural and artificial lakes?



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Answer 24: We are not aware of such an algorithm. There is a reservoir and dam database available from HydroLAKES: <https://www.hydrosheds.org/pages/hydrolakes>

Question 25: I would like to ask why you created transition classes with group.by Reducer?

Answer 25: We used the grouped reducer to sum up the area within each transition class and output the results to the Console tab. This provided statistics of how much area in square meters transitioned from '84-'19 within the region of interest.

Question 26: How small a reservoir can be resolved by this tool?

Answer 26: 30 square meters is one pixel.

Question 27: Are JRC data downloads only available in GEE? Is there an application like this, based on SAR data?

Answer 27: ARSET has provided trainings using radar data for deriving surface water. There is a link from JRC where you can download data for your specific region of interest and you may have to do further analysis for your case study.

JRC download: <https://global-surface-water.appspot.com/download>

ARSET training on SAR for flood mapping: <https://appliedsciences.nasa.gov/join-mission/training/english/arset-sar-landcover-applications>

Question 28: What is the sharpest lake surface elevation data in vertical accuracy and temporal return period?

Answer 28: Accuracy based on validation data in selected lakes indicates accuracy of a few cm to tens of cm. It is important to validate lake level height data in the reservoir of your interest by comparing with in situ gauge data if possible. Highest temporal return period is 10 days.

Question 29: Could you explain the quality of water impact to the accuracy of measurement when we use a remote sensing approach?

Answer 29: Heavy sedimentation and turbidity in a lake may affect detection of shoreline of the lake and may have less accurate area estimation.

Question 30: I think you said JRC Global Surface Water was available from 1984 to 2019. Is this being continuously updated or is 2019 the last year that data will be available for?



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Answer 30: Yes, the data will be continuously updated, but so far has not been updated post-2019. Updates should be available in the future.

Question 31: From the 1990s to 2000s, there was a great area change on regional scales (e.g., China) in the annual water history, which is one of the products in Global Surface Water (JRC). Is it suitable to use the dataset before 2000 for the study on regional scales such as China?

Answer 31: JRC data goes back to 1984, making it possible to do so. Specifically 1984-2000 and 2000-2019.

Question 32: Using remote sensing, how is it possible to differentiate between snow/ice and water? Would ice be considered as water?

Answer 32: There is a difference between the reflectance of snow and water when looking at horizontal extent. If a lake is completely covered by ice along with land surrounding the lake, it would be difficult to determine the area of the lake. For water level height purposes, the presence of ice would impact height accuracy.

Question 33: Is it possible to download the information shown in graphs as .xlsx or .csv or is it only available on the website?

Answer 33: GEE gives you the option to download the data in .csv and .png formats.

Question 34: How will Sentinel-6 and future satellites improve these lake datasets?

Answer 34: We will be covering this material next week.

Question 35: Can we measure ocean basins with this technique?

Answer 35: The altimetry missions and technique were designed to measure ocean level height. Basin measures have most likely been done - check JRC.

<https://www.nature.com/articles/nature20584#Sec15>

Question 36: Can I get a reservoir bathymetry information from satellite data in order to calculate the volume of the reservoir?

Answer 36: In the last session of this training, we will cover this more in depth.

Question 37: Can we use remote sensing and GIS techniques in estimating the sedimentation rate in a lake?



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Answer 37: It depends on the amount of sedimentation. Satellites can detect sedimentation so examination of a lake extent over time may be used to get some idea of at what rate the lake extent is changing.

Question 38: I was wondering if there is any validation for the products we have seen? What is the accuracy of the information (water area, level, volume) provided?

Answer 38: All of the products are validated with in situ data in selected reservoirs. It is recommended to validate these products with in situ data for your specific case to get better assessment of accuracy.

Question 39: With respect to ICESat-2, is there a depth limit for the bathymetry?

Answer 39: We will address this in Part 3 of the webinar series. Stay tuned!

Question 40 : What is the resource used to know the variation of water extent along an agricultural season and to be able to compare it with previous years' seasons?

Answer 40: One of the JRC bands, "Seasonality" (number of months water is present), is applicable for agricultural seasons. There is another JRC product, "Monthly Water History", that comprises a monthly time series of water/no water images from 1984-2019. This can be used to align with agricultural seasons as well. A link to the monthly product is found below:

https://developers.google.com/earth-engine/datasets/catalog/JRC_GSW1_2_MonthlyHistory

Question 41: Can we use the panchromatic band in Landsat satellites to study lakes and reservoirs to increase spatial resolution?

Answer 41: Yes, you can use the panchromatic band from Landsat TM, ETM+, and OLI sensors to increase spatial resolution to 15m. Today we are showing operational products (i.e., analysis ready, without further processing) so participants can start their analysis and data exploration without further processing. Sentinel-2 MSI data can be used for a higher spatial resolution as well.

Question 42: If the average depth of a water body is taken and a large number of depth measurements done are either in deep or shallow areas that fall in a narrower part of the water body, would that not impact on the volume calculated adversely?



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Answer 42: Yes, that is one of the limitations. Lake level height is not calculated everywhere it is averaged over available measurements depending on satellite spatial/temporal resolutions.

Question 43: In the various remote sensing datasets, Sentinel (1, 2, 3) are not mentioned. Are these not used for monitoring surface water extent?

Answer 43: The Sentinels are used for monitoring surface water extent--we are demonstrating products that are analysis ready and have a longer time series (36 years) for analyzing decadal-scale change. If you are comfortable with Earth Engine or Desktop software you can calculate surface water on your own using optical and/or radar imagery from the Sentinels.

Question 44: Is it possible to find a direct relation between rainfall and surface changes in the lakes and reservoirs? Or do other factors prevent this direct relationship?

Answer 44: Because of rainfall water level height would change. But there may not be a direct relationship. There are other factors involved such as infiltration and evaporation depending on the geography.

Question 45: Hello, I am having trouble loading the GEE repository: Cannot load repository. This is the error I get when I click on the link in the presentation:

Repository "users/seanemccartney/Reservoir_Lakes" does not exist.

Answer 45: That is strange, we have not had this issue before. I'm pasting the link below and will look into the issue:

https://code.earthengine.google.com/?accept_repo=users/seanemccartney/Reservoir_Lakes

You can also access the script via the link below:

https://code.earthengine.google.com/?scriptPath=users%2Fseanemccartney%2FReservoir_Lakes%3AJRC%20Global%20Surface%20Water%20Mapping

Question 46: What are the possible remote sensing parameters to assess water quality? Are there datasets with such layers?

Answer 46: Yes, MODIS and Landsat have been used to assess water quality. Not part of the datasets we discussed today but there are previous ARSET webinar series specific to this topic. Please see the following links:

<https://appliedsciences.nasa.gov/join-mission/training/english/arset-processing-satellite-imagery-monitoring-water-quality>



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<https://appliedsciences.nasa.gov/join-mission/training/english/aset-integrating-remote-sensing-water-quality-monitoring-program>

Question 47: Is the JRC Global Water dataset still being updated (beyond 2019)?

Answer 47: Yes it is. In less than a year the dataset will be updated and should be continuously going forward.

Question 48: We can apply this second platform to analyze rivers in Brazil?

Answer 48: Yes, you can analyze these rivers via Landsat as long as the river is large enough.

Question 49: Is there any global surface for small lakes and reservoirs (<1 ha)?

Answer 49: One ha is 100m x 100m so you will only get a couple pixels via JRC and Landsat. Sentinel 1 or 2 may be more appropriate for small lakes and reservoirs <1ha.

Question 50: How to quantify the uncertainty associated with the assessment?

Answer 50: Regarding the JRC dataset, we will add a paper to refer to this. If you work with a body that has not been validated in JRC, your own in situ data will be needed.

<https://www.nature.com/articles/nature20584#Sec15>

Question 51: Is there a website where we can find ground-based bathymetry for US or global lakes?

Answer 51: USGS has bathymetry for lakes in the US. Globally, we will look into this.

<https://www.ngdc.noaa.gov/mgg/bathymetry/relief.html>

Question 52: I have a question, as I can see, the only information available starts from 1984. Is there any way to get images from the 1960s? Maybe just aerial imagery? Here in my state, we had a very hard drought issue related to agricultural activity, which resulted in drought isolated water bodies, producing the extinction of 6 endemic species of freshwater fish. Is there any way to obtain information to compare the past with the present?

Answer 52: Landsat was launched in 1971, so there could be imagery available from that date, but may not have been continuous due to images only being captured over certain regions of the planet in the early years of the Landsat mission. Aerial imagery would be the best substitute otherwise.



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Question 53: How can I make a study with higher spatial resolution for rivers of less spatial entity?

Answer 53: Sentinel-1& 2 can provide optical and radar so that can get down to a 10m spatial resolution. The following links provide more information:

<https://www.sciencedirect.com/science/article/pii/S0022169420301499>

<https://link.springer.com/article/10.1007/s41064-020-00111-2>

Question 54: What is the preferable/suitable methodology to estimate surface water extent in a highly wooded area? And a field-scale region like small-scale wetland?

Answer 54: SAR can help in some cases. It can be used to map wetlands and standing water under forest canopies. The following link is to an ARSET webinar on this topic:

<https://appliedsciences.nasa.gov/join-mission/training/english/arset-forest-mapping-and-monitoring-sar-data>

Question 55: Can we detect and measure the water-sediment and silt through Landsat?

Answer 55: Yes, one can detect sediments in water when they change reflectance of water, but in situ data are needed to derive relationships between remote sensing reflectances and sediments for quantitative estimation. Sedimentation models can be used as complementary information for quantitative estimation.

Question 56: Depending on the acquisition time of the image, there can be haze on the water surface. How does this situation affect the result of extent and depth of water?

Answer 56: Extent can be affected by haze, yes. For lake level height, the microwave data may be less sensitive due to atmospheric correction applied to altimeter data.

Question 57: In lakes located in glacial valleys, is it possible to also analyze the variations in volume? What is the methodology?

Answer 57: Optical and microwave data would not give volume in a frozen lake.

Question 58: Does the Google Earth Engine code you provided allow you to generate multiple downloads of water extent in a given ROI for every month in the Landsat record (1984-2019)? Or do you need to download one month at a time?

Answer 58: There is a JRC dataset in GEE that is a monthly surface water product which may be more appropriate for your research. We are providing links below:



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https://developers.google.com/earth-engine/datasets/catalog/JRC_GSW1_2_MonthlyHistory#description

<https://global-surface-water.appspot.com/download>

Question 59: Is there any way to measure recharge/discharge of water fluxes in the lake?

Answer 59: You will have to look at the watershed processes associated with the fluxes in recharge/discharge. Groundwater and streamflow will also contribute to this. Please see the ARSET training on water budgets:

<https://appliedsciences.nasa.gov/join-mission/training/english/arset-using-earth-observations-monitor-water-budgets-river-basin-0>

<https://appliedsciences.nasa.gov/join-mission/training/english/arset-using-earth-observations-monitor-water-budgets-river-basin>

Question 60: With temporal resolution, what is the narrowest time interval being made in these datasets? I want to detect water change in lakes.

Answer 60: 16-day is the Landsat and MODIS revisit time for this product (without cloud cover).

Question 61: What latitudes does SRTM cover?

Answer 61: 60 S to 60 N covering ~80% of global land area.

Question 62: Is there a database with water quality parameters and is this confident? Is it possible to generate water quality parameters from remote sensing for all lakes in the world?

Answer 62: Globally, we are not aware of any remote sensing-based water quality parameters but in the US, there is a CYAN project that provides algal bloom information in inland lakes. <https://www.epa.gov/water-research/cyanobacteria-assessment-network-cyan> . Refer to the links below on two separate ARSET trainings on water quality:

<https://appliedsciences.nasa.gov/join-mission/training/english/arset-using-earth-observations-monitor-water-budgets-river-basin-0>



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<https://appliedsciences.nasa.gov/join-mission/training/english/arset-using-earth-observations-monitor-water-budgets-river-basin>

Question 63: Is there a cutoff used to ignore mapping lakes and reservoirs that are less than a specific area?

Answer 63: All JRC lakes are 10 ha or larger.

Question 64: Are there any plans for adding datasets from new or upcoming missions?

Answer 64: In Part 2 & 3, we will talk about some future datasets: ICESat-2, Sentinel 6, and SWOT.

Question 65: Which software do you use to process Sentinel imagery?

Answer 65: If Sentinel-1, you can use [SNAP](#), an open source software for processing/analyzing radar data. For Sentinel-2 there is a datahub: URL: <https://scihub.copernicus.eu/> with more information.

Question 66: Resolution 30m of Landsat: Is it sufficient to study small reservoir areas, especially in dryland regions?

Answer 66: That is a limitation (30 meter spatial resolution). Sentinel 1 & 2 have higher resolution. Commercial satellite imagery has to be used for smaller reservoirs. In recent years aerial drones are also used to observe reservoirs for research.

Question 67: Could the depth of a lake affect the results of the study (any connections with bathymetry, etc.)? If yes, how/to what extent and how can this be taken into account? (see

Answer 67: For lake level height you are looking at radar echo from the surface and the water height is derived with respect to earth's ellipsoid so it's less sensitive to depth. For water extent, shallow waters may affect accuracy of water extent detection.

Question 68: Can ICESat and Landsat for example be used for monitoring the change of groundwater level in aquifers? There are 2 aquifers below the Giza Plateau and they are threatening that area in terms of stability.

Answer 68: Groundwater will not be able to be detected from the sensors discussed today. We have training on groundwater using the GRACE satellite mission. For more information refer to the link below:



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<https://appliedsciences.nasa.gov/join-mission/training/english/arset-groundwater-monitoring-using-observations-nasas-gravity>

Question 69: Can we find out direct (e.g. deforestation, agricultural/urban expansion) or indirect causes (e.g. climate change in general) behind shrinking water bodies?

Answer 69: Only through detailed analysis along with data about climate change, deforestation, agriculture/urban extent it may be possible to understand causes of shrinking water bodies but it has to be done case by case.

Question 70: Do these tools cover glacial lakes? Can they be used to predict glacial shrinkage?

Answer 70: The JRC Global Surface Water product does detect glacial lakes. You can use the dataset to observe trends in the extent of glacial lakes, which could be used to predict glacial change. It depends on many parameters however.

Question 71: As we know, there are many conflicts related to water especially in Africa like Ethiopian Millennium Dam. The question is how we can control the conflict through this new technique?

Answer 71: It is difficult to control conflicts, but it is possible for monitoring water reservoir extent and volume depending on the size of the reservoir. Water managers can use this data to facilitate decision making.

Question 72: What should we do about lakes that are less than 10 ha? How can we map them? I believe even small lakes can be very helpful in water stressed areas like Africa and the Middle East.

Answer 72: Google Earth has high resolution imagery (although not the most optimal temporally, seasonally) which is one method. High resolution (commercial) imagery would be needed for very small lakes.