

TAT6 Training Workshop

Module #1 (AWS Online User Interface) - Exercise #1 (Cloud-free Mosaics)

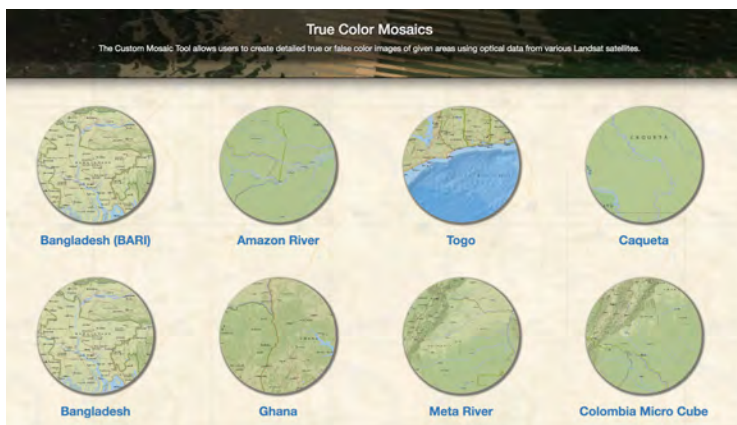
Objective: Create a Landsat cloud-free mosaic in a small region using several methods (median, most recent pixel) and compare the results in the user interface (UI) and in a GIS tool (e.g. QGIS). Users can also explore false-color RGB images, time-series animations and evaluate cloud issues in resulting mosaic products.

Complete the following steps:

- (1) Visit the web-based User Interface (UI) and LOGIN, if required.
- (2) Explore the Data Cube Manager > Data Cube Visualization menu to view the location and size of available data cubes. Click on any region to view the datasets and then click on the datasets to view more details.



- (3) Select Tools > General > Custom Mosaic. This will give you a list of data cubes. Pick a cube of interest.



(4) Pick a region for your mosaic by clicking on the top-left corner and then dragging your mouse to the bottom-right corner of the region. You should see a shaded box on your screen. Check the LAT and LON boundaries of your cube and try to keep the region to less than 1deg x 1deg. This will make the execution faster for everyone. As you move around the map, you can also see the LAT-LON position in the upper-right corner of your screen.

(5) Select a Start and End data for your mosaic. Pick ONE year within the range of dates for your cube. The system will default to the range of dates that are available. You can also pick shorter time periods for seasonal mosaics.

(6) Pick a "Result Type". You might start with a "true color" image first, which is the typical Red-Green-Blue (RGB) output. There are also several other false color outputs that can be interesting to identify certain land features. Try a few of them to see the differences in these RGB combinations.

NIR-SWIR1-SWIR2 or NIR-SWIR1-RED = Land appears in shades of orange and green, ice stands out as a vibrant magenta color, and water appears in blue.

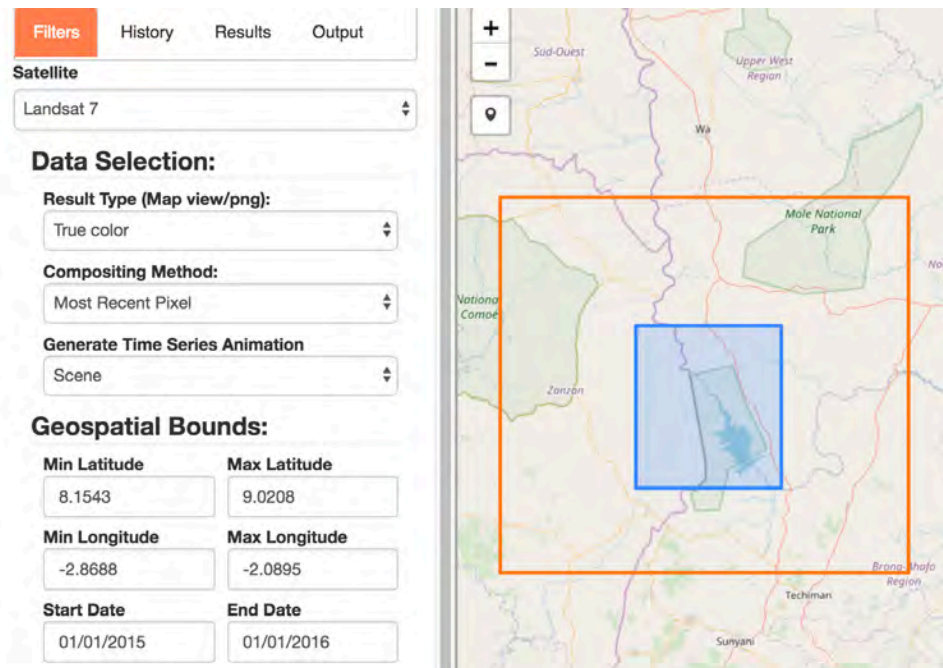
SWIR1-NIR-RED = Good for vegetation analyses

SWIR2-NIR-GREEN = This band combination was used for the global Landsat mosaic created by NASA.

SWIR1-NIR-BLUE = Useful for the monitoring of agricultural crops, which appear as a vibrant green. Bare earth appears as magenta color and non-crop vegetation appears as more subdued shades of green.

NIR-RED-GREEN = Vegetation is red, with healthier vegetation being more vibrant. This is commonly used when looking at vegetation, crops and wetlands.

(7) Pick a "Compositing Method" which is the basis for building the mosaic. You will see Least/Most Recent Pixel, Min/Max NDVI, Median and Geomedian. For your first mosaic, you should try the Most Recent Pixel, as it will select the most recent cloud-free pixel in the time series. For your second case, you should try the "Median Pixel" as it will select the "middle" value of each band in the time series. We suggest you DO NOT run the Geomedian mosaic, as it takes some time to execute and is more complex than the other choices.

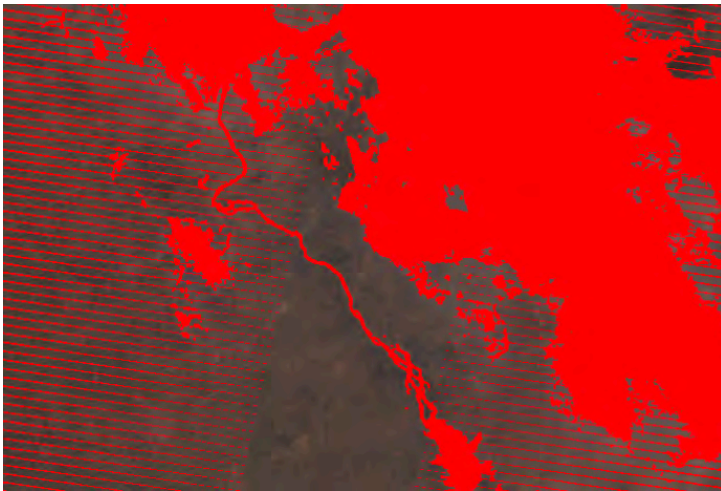


(8) Pick a "Generate Time Series Animation" choice. This will produce an animation file that will allow you to see each of the images in the time series stack which are the basis for the mosaic product. Scene = this will give you a scene by scene look. Cumulative = this will give you a cumulative look at the mosaic as it filters for clouds over the time series. It is suggested to use the SCENE selection as this is a nice way to view the available data for each scene in the time series. NOTE: SCENE is not possible with median mosaics, but should be used for least/most recent pixel mosaics.

(9) Select the "SUBMIT" button when are ready to run your analysis. The "Running Tasks" window will show you the progress of your analysis. It make take a few minutes, so be patient. Once complete, you will see the final mosaic (cloud-filtered) on the main screen.

(10) Select the HISTORY tab on the top-left menu to see a history of your analysis cases. By clicking on any of the listed tasks you can see the details of analysis and load past results into the screen.

(11) Select the RESULTS tab on the top-left menu to see the details of the underlying scenes that were used for the mosaic. You will see an "Acquisition List" that shows details for each of the scenes in the mosaic. For example, you can see the "clean pixel percentage", which is the same as 1-Cloud%. In addition, any one of these individual scenes can be loaded for viewing. Try one! When a scene or mosaic is selected the user can also check the "Highlight No Data" box to color the no-data or clouds as RED in the image. An example is shown below.



(11) Select the OUTPUT tab on the top-left menu to choose a variety of output products. Once a result is selected there will be a drop-down list of possible outputs, such as PNG, animations and GeoTIFF. Try downloading a PNG file (flat image), a GeoTIFF (to view in QGIS or ArcGIS) and a time series animation (GIF file). For each one, you will need to press the "Download Selected" button to download the final result. Be sure to download and view a GIF animation file as it is interesting to see the variations in cloud cover, Landsat-7 banding and scene edges as you go thru the time slices in the data cube.

In addition, when a product is selected you will see a list of details for the mosaic. This includes the run time, the number of scenes in the image, the pixel count and the clean pixel percentage (% cloud free), Lat-Lon range, time range and compositing method. This is valuable information.

(12) Repeat the steps above with variations in the selections. For example, try a different region, time period, false color mosaic output, or compositing method.

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Module #1 (AWS Online User Interface) - Exercise #2 (Water Analyses)

Objective: Create a Landsat water extent product (Australian WOFS algorithm) and evaluate areas of water change due to seasonal flooding or single flood events. Users will then create separate annual water extent products to determine when and where the extreme events occurred and try to correlate those events with known changes in rainfall (droughts or heavy rains using precipitation data). Users will then create a water quality product (Total Suspended Matter - TSM) over an inland water body to determine water quality spatial variability and to assess changes in water quality over time.

Complete the following steps:

Water Extent (part 1)

(1) Visit the web-based ODC User Interface and LOGIN, if required.

(2) Select Tools > Water > Water Detection. This will give you a list of data cubes. Pick a cube of interest.

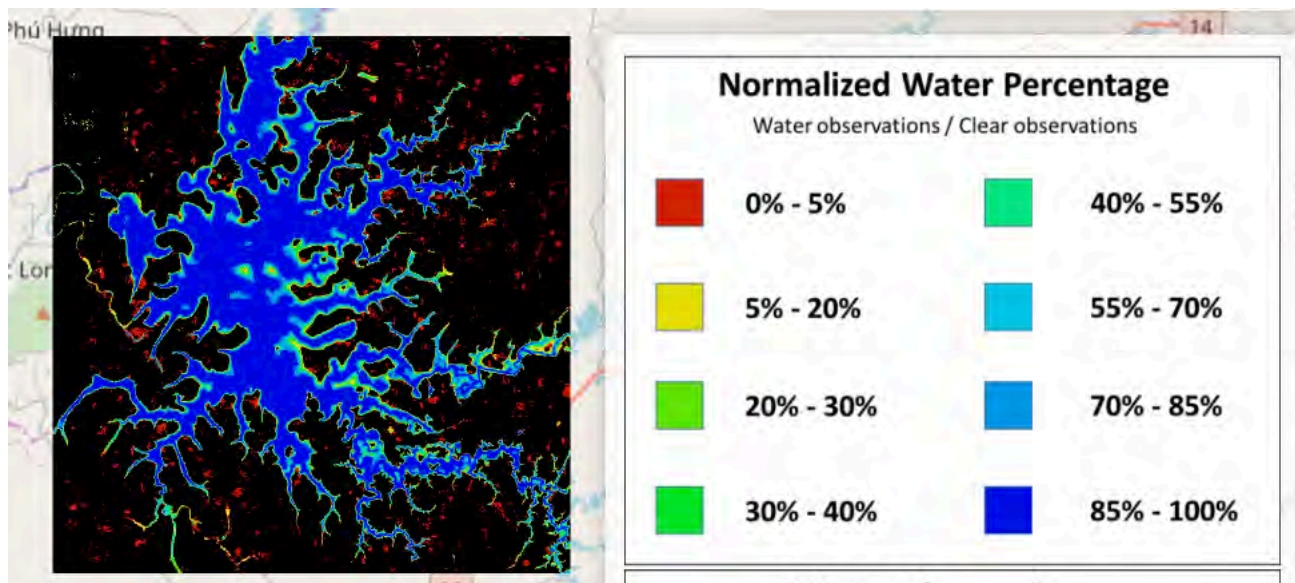
(3) Pick a region over an inland water body by clicking on the top-left corner and then dragging your mouse to the bottom-right corner of the region. You should see a shaded box on your screen. Check the LAT and LON boundaries of your cube and try to keep the region to less than 1deg x 1deg. This will make the execution faster for everyone. As you move around the map, you can also see the LAT-LON position in the upper-right corner of your screen.

(4) Select a Start and End data for your mosaic. Pick 10+ years for your analysis or use the entire time range of the data cube.

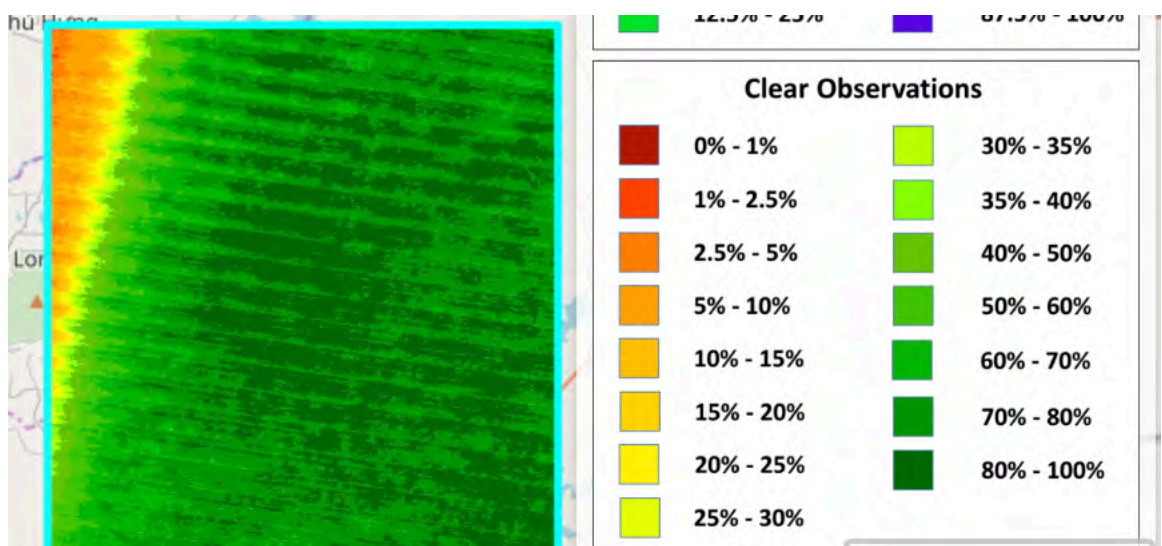
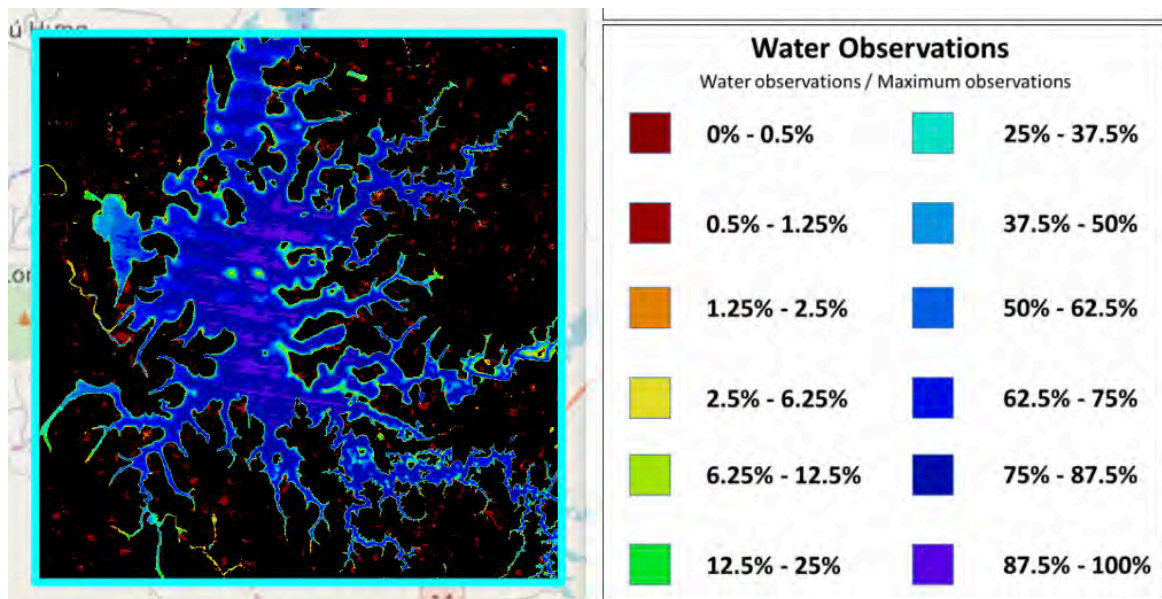
(5) In the "Data Selection" area, select the image background color (BLACK is best for viewing the data). DO NOT select a time series animation at this point. We will do this later in Step #9.

(6) Select the "SUBMIT" button when are ready to run your analysis. The "Running Tasks" window will show you the progress of your analysis. It make take a few minutes, so be patient. Once complete, you will see the final product (normalized water percentage) on the main screen.

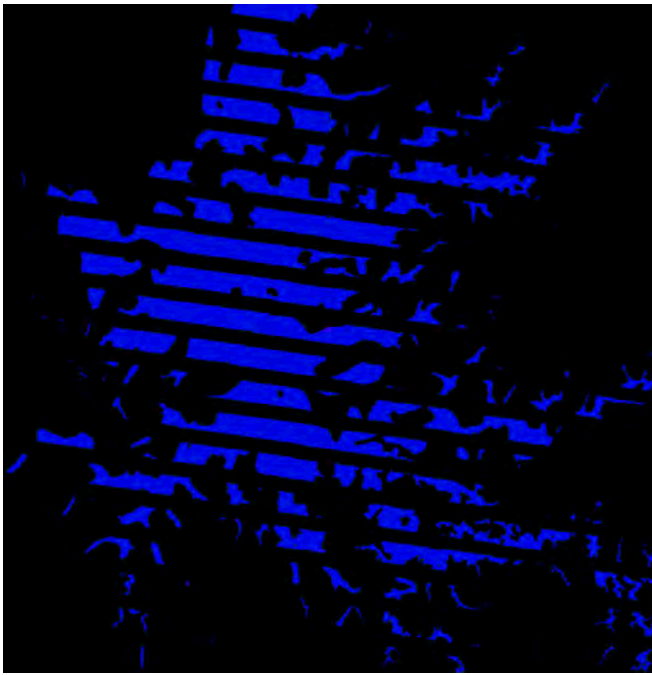
(7) Review the output product and ZOOM in for more details. In the top-right of the screen is a small button that looks like a water droplet. Click this for the legend. The first legend is the one used for the default screen output. An example is below. The product shows the percent water observations versus the number of clear observations for each pixel. RED regions are very infrequent water observations where water may have existed for a very short time in the time series. DARK BLUE regions are water for the majority (85-100%) of the time series. It is interesting to see how water changes along the edges of inland lakes or coastlines, how water exists in low lying areas during rainy seasons or storm events and the variability of water over time.



(8) Select the RESULTS tab and the analysis product to view other types of output. You will be able to select 2 other products ... Water Observations / Maximum Observations and the % Clear Observations. For the example above, here are those products with the legend on the right. You will see that some results are skewed by the number of clear observations due to scene positioning or available data.

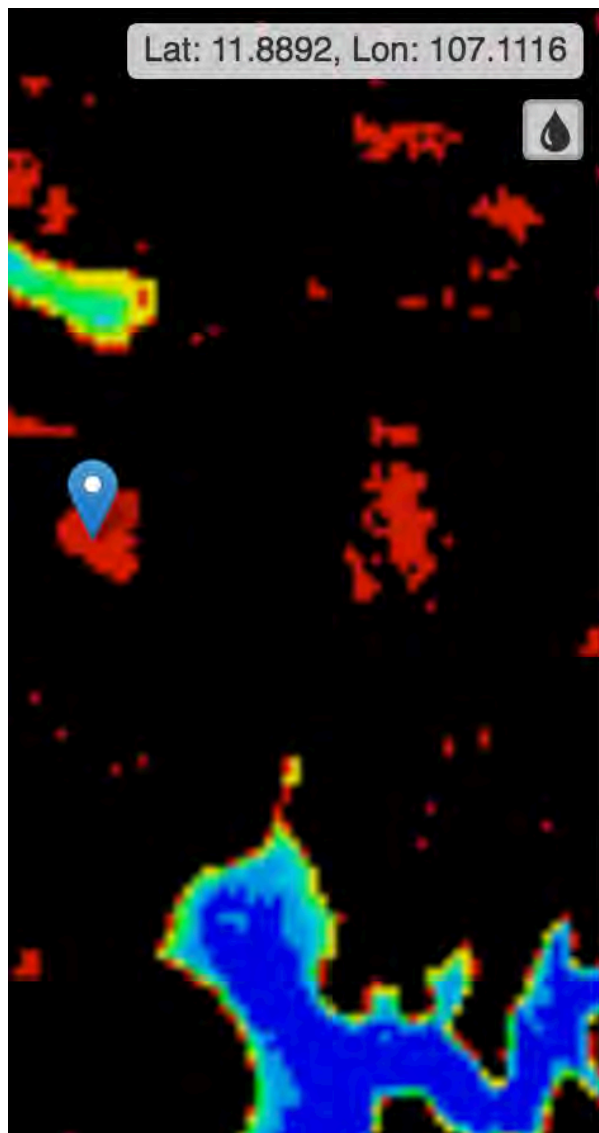


Using the same RESULTS tab, it is also possible to see individual scenes to evaluate the extent of water at any specific time. Be sure to view the clean pixel % as many scenes could be covered by clouds. Below is a 57% clean pixel image from Feb-2015. Water extent is shown in one color ... BLUE. In this example you can also see the Landsat-7 "banding" that causes missing data across the scene.



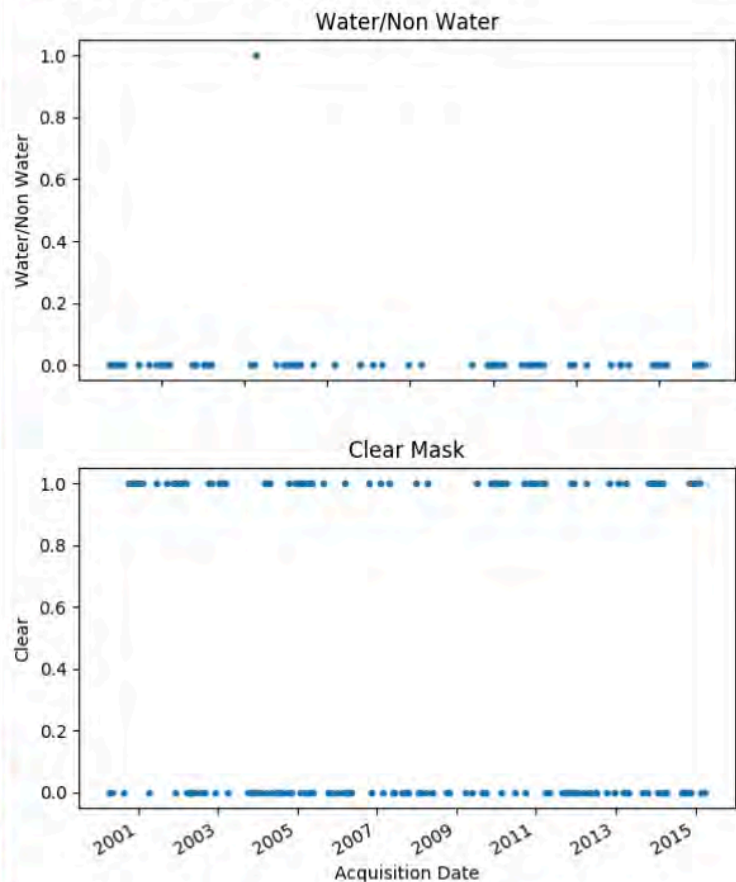
(9) Run another case that produces a time series animation with "Scene" selected. You may want to choose another region, but make it small, since the animation file takes more time to generate than the prior cases. There are several time series animation products. Scene = water extent for each time slice, Cumulative Percentages = cumulative water extent over time, Cumulative Observations = cumulative number of clear observations for a each pixel. The most common selection is the "Scene" animation. The animation product must be downloaded by selecting the OUTPUT tab, selecting the output case, selecting "Water Animation" and then selecting the "Download Selected" button. The product will be an animated GIF file. These animations are quite interesting for viewing water extent, cloud cover variation, and Landsat "banding" issues.

(10) Use the "Marker Tool" to look at any single pixel location. This tool is located in the top-left of the map and looks like a small "marker". After the result has been generated in Step #6, you can click the marker tool and then move the marker to any point in the figure. A 2-D plot will be generated to show the time series water / non-water results for the selected pixel. This will allow you to view the impact of clouds (clear mask graph) and the time series variation of water existence. Try this for a RED area on your output image, as this area would experience times of water and non-water. The 2-D result will allow you to determine the exact times when the water existed. The example below has placed the marker on a RED area in the image. The top plot shows that water existed ONE time in the 15 year time series and it appears to be in 2004. The bottom plot shows the variations cloud vs clear over this same location.



2D Plots

A full listing of the plots generated by your pixel drilling task can be seen below.



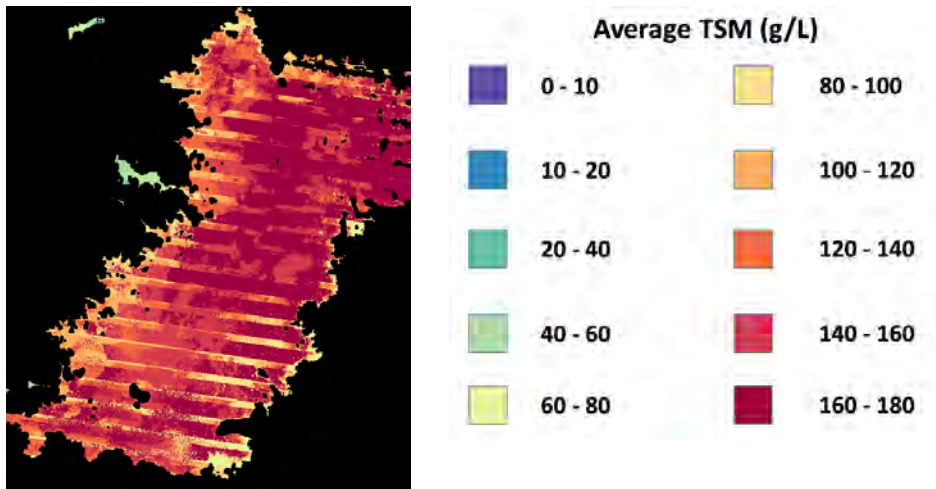
(11) Use these products and analysis tools to review several areas and try to find areas where there has been single flood events, areas that have experienced seasonal flooding due to a rainy season, or water boundaries that have experienced change over time.

Water Quality (part 2)

(12) Select Tools > Water > Water Quality TSM. Select a cube and then select an inland water body where you might think the water is used for drinking water supplies. Similar to above, select a region and time period.

This analysis will use a simple single-band algorithm to predict Total Suspended Matter (TSM) in the water. It is believed that TSM is a proxy for water quality and represents the "cleanliness" or "turbidity" of the water. Though many scientists will agree that Landsat cannot accurately measure TSM, there is value in these results when viewing spatial differences in TSM and time series variations in TSM. In general, Landsat-8 is better than Landsat-7 for water quality, as the signal-to-noise is better for L8.

(13) Select a "Result Type" such as "Maximum TSM" or "TSM Variability" and run an analysis for a long time period. A sample output is shown below (Maximum TSM) for a lake in Vietnam.



(14) Similar to Step #10, one can view a single pixel to see the variability in TSM values over time. Below is an example for a water reservoir in Uruguay using Landsat-8 from 2013 thru 2016 (4 years). The variability can be easily seen with the 2-D pixel level plot. In this case it appears there is seasonal variability in water quality as well as overall changes in water quality (year to year). Try this same analysis for a water body in your region and use this information to determine how you might take water quality samples or monitor the impact of a water management change.

