

Kvarken Space Economy Education Module #2

Module title: Kvarken Space Conversations #2 "Wavelengths Tell Many Stories" Satellite Imagery

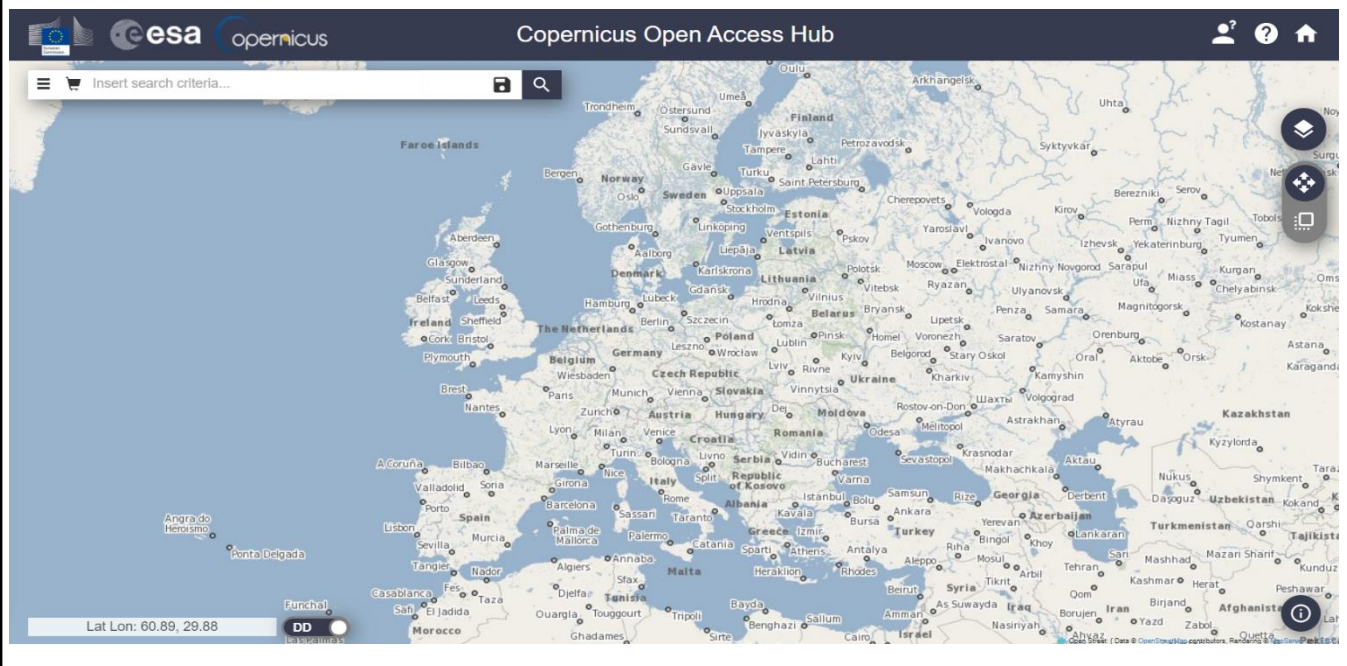
Background: Kvarken Space Economy presents space-based observations to society within the Finnish Bothnia-Atlantic area with monthly articles. For our monthly contribution (May 2020) in science and technology feature magazine, Mega, we introduced the concept of "Wavelengths". Web access to this monthly sequence can be found at the following link location: <http://www.kvarkenspacecenter.org/index.php/kvarken-space-discussions/>. By looking at the section, "#2 Wavelengths Tell Many Stories", you can find discussions about wavelength that tells many stories.

Module purpose: This education module shows you the steps needed to create the same image as in the article on your computer. The magazine image for May is seen here: <http://www.kvarkenspacecenter.org/wp-content/uploads/2020/05/MegaWavelengths.png>. Once these steps are completed, you will understand the mechanics of replicating the space observations from ESA's MSI and be ready to try other locations anywhere in the world. **It takes several steps to complete this module.**

STEP 1 OPEN THE APPLICATION For our work here, we use ESA's Copernicus data hub to download the data. It provides complete, free and open access to Sentinel satellite products. To visualize, process and analyze downloaded Sentinel data products, ESA provides an open source software called Sentinel Application Platform (SNAP). To begin, let us first download the data used in the magazine, open the following link in your browser.

<https://scihub.copernicus.eu/dhus/#/home>

You should be able to see as shown in the image below. We take the approach here to focus on our goal of duplicating the "#2 Wavelengths Tell Many Stories" image found in the magazine. **As you follow the steps, think what each step accomplishes. This should give you ideas to try other possibilities after the education module is completed.**






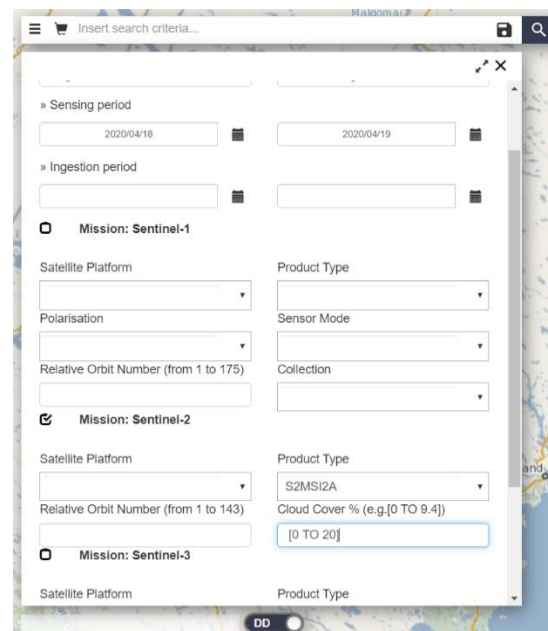
To download the data, one must first sign up for an account in Copernicus Open Access Hub. To do that, follow the instructions as provided in the following link:

<https://scihub.copernicus.eu/userguide/SelfRegistration> Also, to process the data, install SNAP Toolbox on your computer from the following link: <https://step.esa.int/main/download/snap-download/>

	Windows 64-Bit	Windows 32-Bit	Mac OS X	Unix 64-bit
Sentinel Toolboxes	These installers contain the Sentinel-1, Sentinel-2, Sentinel-3 Toolboxes			
	Download	Download	Download	Download
SMOS Toolbox	These installer contains only the SMOS Toolbox. Download also the Format Conversion Tool (Earth Explorer to NetCDF) and the user manual .			
	Download	Download	Download	Download
All Toolboxes	These installers contain the Sentinel-1, Sentinel-2, Sentinel-3 Toolboxes, SMOS and PROBA-V Toolbox			
	Download	Download	Download	Download

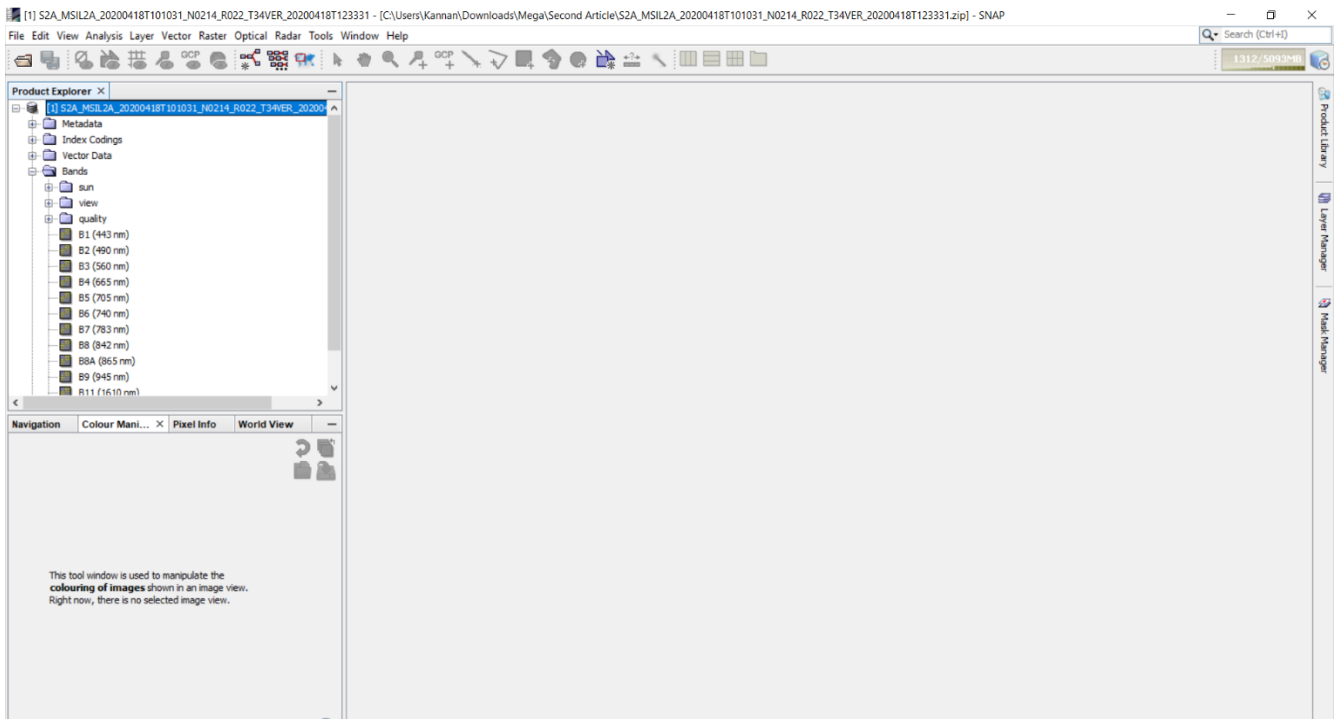
STEP 2 DOWNLOAD THE IMAGERY Our “#2 Wavelengths Tell Many Stories” image is centered over the Vaasa, Ostrobothnia region. The Copernicus Open Access Hub upon login with an account, it is not focusing on this area. As our “Area Of Interest (AOI)” is centered over the Vaasa, let us follow the steps below to select the right region.

1. Click the navigation mode icon  on the right side of the screen and use the mouse scroll to zoom in to the Vaasa region.
2. Click Area mode icon  on the right side of the screen, then left click and drag over the area to form a rectangle shape as shown in the figure.
3. To download the actual data used in the magazine, click on the icon  on the top left of the screen that enables ‘Advanced Search’ window.
4. ‘Sensing Period’ tab enables us to search satellite imagery taken by a satellite on a particular date. In our case, for this magazine we used satellite imagery taken by the satellite on 2020/04/18. Therefore, use sensing period date as “2020/04/18 to 2020/04/19”.
5. Click on the “Mission: Sentinel-2” with product type ‘S2MSI2A’ and cloud cover [0 TO 20] as shown in the figure. Sentinel-2 satellite produce level 1 and level 2 products denoted as ‘S2LIC’ and ‘S2MSI2A’.
6. Click ‘Search’ icon and it displays products that are available from Sentinel-2 mission on that particular date.
7. Select the data from the lists, and click download icon on the bottom edge of that particular product in the list as shown in the figure.
8. Downloaded data will be in Zip format.

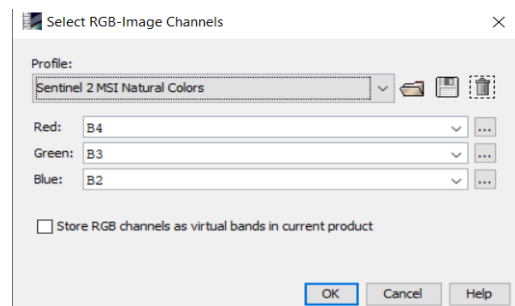


STEP 3 PROCESSING THE IMAGERY IN SNAP From the **KvarkenSpaceEduModule1**, the concept of different band combinations of Sentinel-3 OLCI in EO browser and their results such as false color image, natural color image were known. Similarly, it is possible to obtain Sentinel-2 natural color, false color and vegetation analysis images in EO browser. By using SNAP, it is possible to visualize, process and obtained high quality data than in EO browser application. We will combine the different bands in Sentinel-2 and produce the three images namely natural color image, false color and vegetation analysis image.

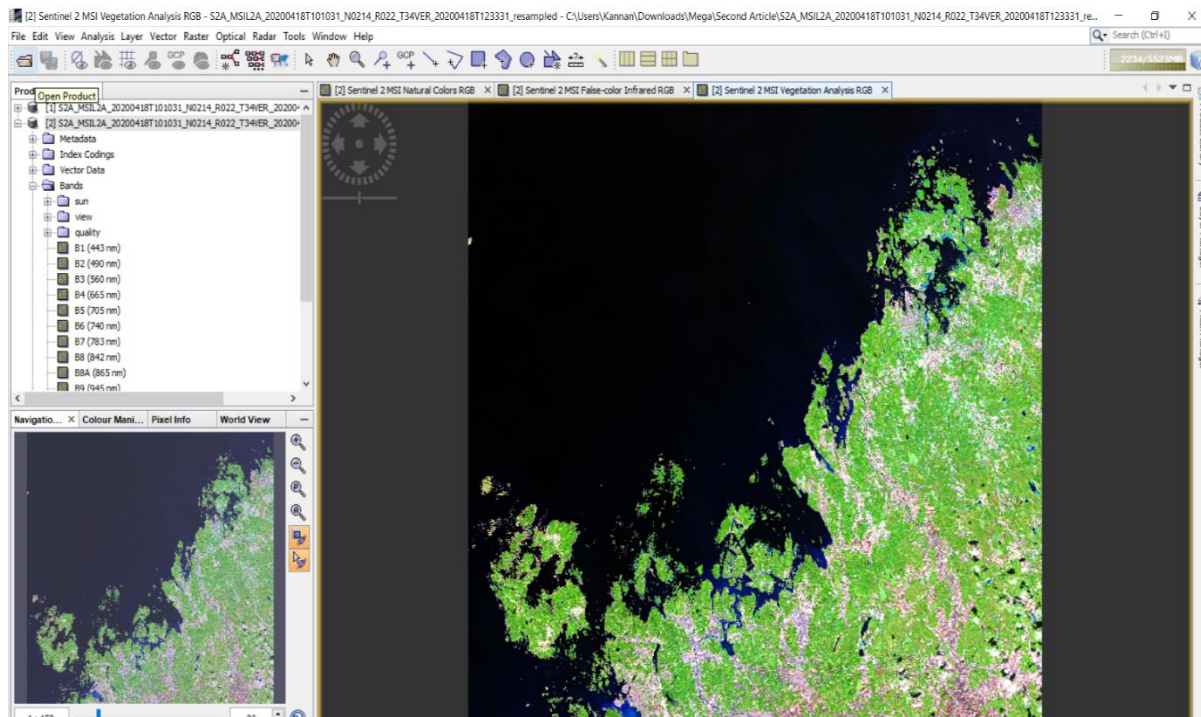
1. Load the SNAP application from your computer, open the downloaded ZIP format product using File → Open product. The product will be displayed in the product explorer as shown in the image. Double click the product to get information on different bands and other details of the data.





2. Sentinel-2 consists of 13 bands and each band has different resolution such as 10 meters, 20 meters and 60 meters. Our goal is to obtain image based on different band combinations. Therefore, it is important to have all the bands in same resolution for creating image based on band combinations. Resampling is the method used to obtain all bands in same resolution.
3. For resampling, select Raster → Geometric Operations → Resampling. In the resampling window, under I/O Parameters, select the product and enable the box near "Save as: BEAM-DIMAP". Also, enable "open in SNAP" option.
4. In "Resampling Parameters" tab, select "By reference band from source product" and from the dropdown list box select "B2". Click 'Run'.
5. Thus, the resampled product will have all the 13 bands with a resolution same as source product band B2, which is 10 meters.
6. Right click the resampled product and click "Open RGB Image Window". A pop-up window appears as shown in figure with bands B4, B3 and B2.



7. Click 'Ok'. The Natural Color RGB image based on the band combinations B4, B3 and B2 will be visualized.
8. Right click the product again, select 'Open RGB Image Window' and the pop-up window appears. From the dropdown list, select 'Sentinel 2 MSI False Color Infrared' to obtain false color image with band combinations B8, B4, B3 or 'Sentinel 2 MSI Vegetation Analysis' to obtain vegetation image with band combinations B11, B8, B4.
9. Once creating all three images, user can see something similar to the following image.



STEP 4 VISUALIZING THE IMAGERY Here, user will do the final process to obtain desired results similar to the magazine.

1. Select the 'Navigation' panel on the bottom left, use the zoom in and out icons to navigate to the desired region. Also, make sure that  and  icons are enabled as shown in the figure above to synchronize view and cursor positions over multiple image windows.
2. Select Window → Tile Horizontally option. This will display natural color, false color and vegetation images together in individual window with same region.
3. Now user can right click on the three images separately and select 'Export view as Image'. In the 'Export Image' pop-up window, select the desired file type such as JPEG, GeoTiff to save the image.

Step 5 SHARING YOUR RESULTS Select your own AOI, Sentinel-2 satellite instrument, your own time range, process and develop in SNAP three different band combination satellite data imagery. Take a screenshot and send it to kvarkenspacecenter@univaasa.fi. We will collect and display on our web pages for the world to observe. Please include the satellite name, products created such as natural color, vegetation and false color, and which product out of those three interested you. Inform us if you want your name included associated with the imagery on our webpage.