# INTRODUCTION TO SNAP TOOLBOX

## EXERCISE 1 (Exploring S2 data)

Data: Sentinel-2A Level 1C:

- **S2A_MSIL1C_20180303T170201_N0206_R069_T14QNG_20180303T221319.SAFE**

1. Open file
   1.1. 'File' / 'Open Product'
   1.2. Browse to: /Ex_1/S2A_MSIL1C_20180303T170201_N0206_R069_T14QNG_20180303T221319.SAFE
   1.3. Select the 'MTD_MSIL1C.xml' and click 'Open'

2. View metadata
   2.1. Select plus icons [MAC = triangle icons] by filenames in "Product Explorer", expand "Metadata / Level-1C_User_Product / General_Info" folder and double click on "Product_Info". Here you can see the basic product information such as acquisition date, processing level and processing baseline (indicates quality of preprocessing)
   2.2. Double click on "Product_Image_Characteristics". Here you can see the solar irradiance per band and correction factors necessary to convert from Top of Atmosphere Reflectance to Top of Atmosphere Radiance.

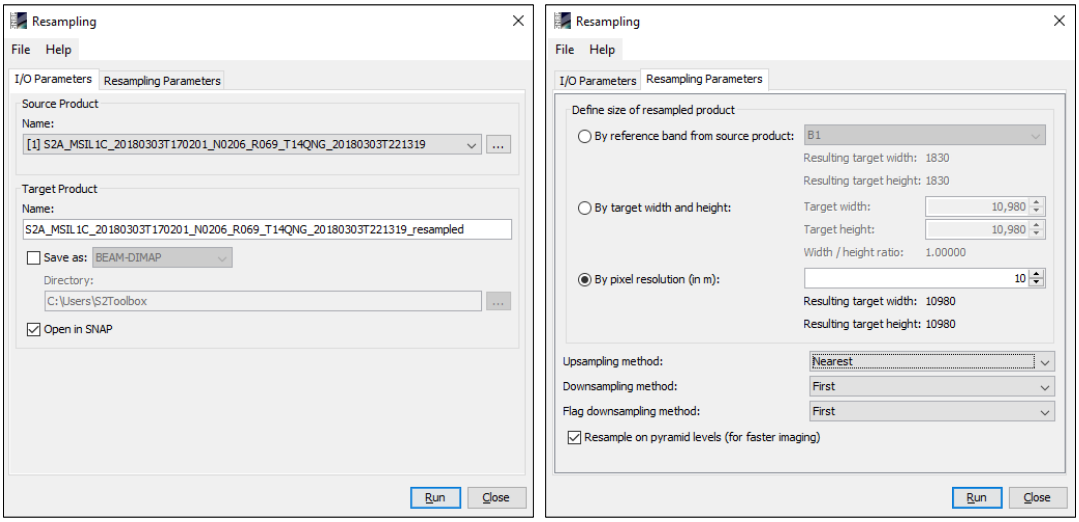
3. View world map
   3.1. Select: 'View' / 'Tool Windows' / 'World Map'
   3.2. Select magnifying glass icon to zoom to image footprint
   3.3. Use mouse wheel and left click to zoom and pan respectively

4. View image single bands
   4.1. Select "Bands" folder in "Product Explorer" window and view each band by double clicking on band name.

5. View multiple viewers
   5.1. Close metadata views, leaving only viewers with bands
   5.2. Synchronise views by selecting the relevant icons in the "Navigation" tab
   5.3. Select: 'Window' / 'Tile Horizontally'

6. View RGB image view
   6.1. Close all viewers
   6.2. Select image name in "Product Explorer" window
   6.3. Select: 'Window' / 'Open RGB Image Window'
   6.4. Leave default natural colour combination and click OK

7. Resampling at 10m
   7.1. Select image name in "Product Explorer" window
   7.2. Select: 'Raster' / 'Geometric Operation' / 'Resampling'
   7.3. In the pop-up window set up the parameters as shown in the Figure below




7.4. Click ‘Run’

8. <u>Open the newly created product</u>

8.1. Repeat step “6” selecting the new image

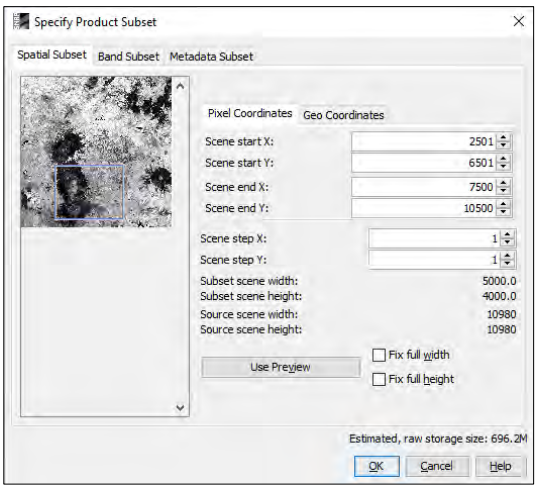
9. <u>Crop</u>

9.1. Zoom into Popocatépetl Volcano

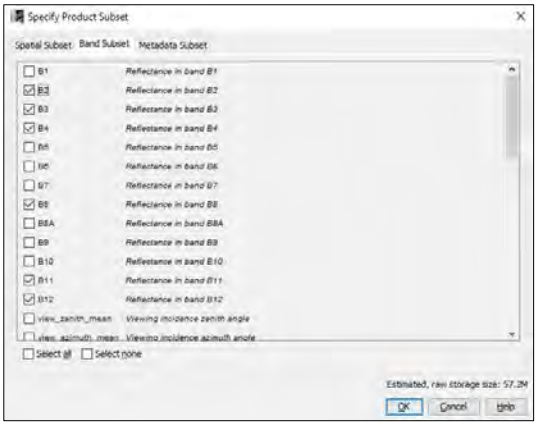
9.2. Select: ‘Raster’ / ‘Subset…’

9.3. Specify: ‘Spatial Subset’ parameters (as shown in Figure below)

- Scene start X: 2500
- Scene start Y: 6501
- Scene end X: 7500
- Scene end Y: 10500




9.4. Specify: ‘Band Subset’ parameters selecting B2, B3, B4, B8, B11 and B12 (as shown in Figure below)

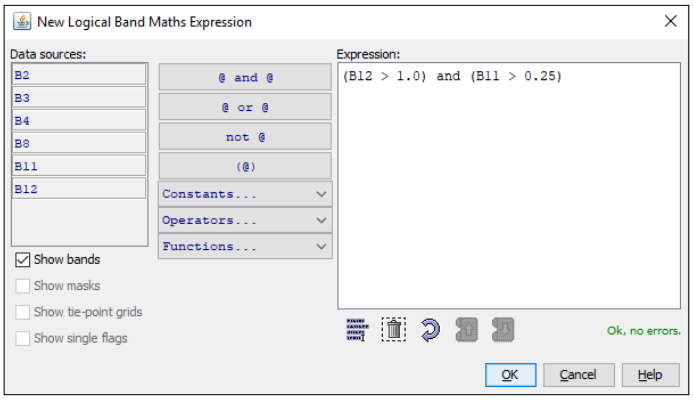



9.5. Click ‘OK’

10. Save the newly created subset image
    10.1. Select product in “Product Explorer”
    10.2. Select: ‘File’ / ‘Save Product As…’
    10.3. Select “Yes” to convert to BEAM DIMAP format (SNAP native file format)
    10.4. Select an output filename and location, and click “Save”
    10.5. In order to view the saved file with the filename you specified, close the cropped image and reopen it

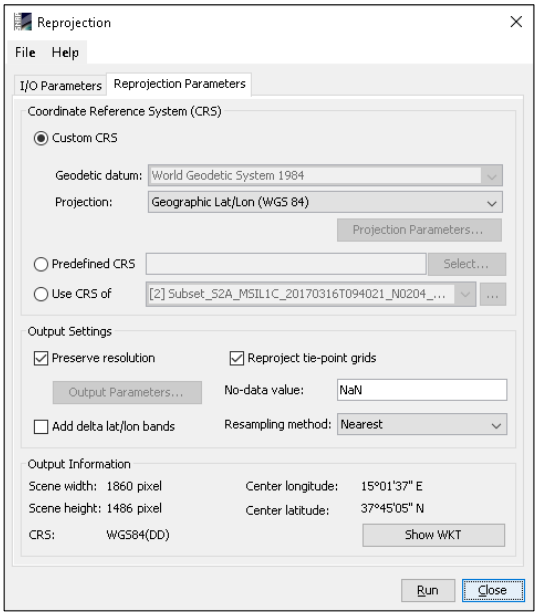
11. Open the newly created product
    11.1. Close all viewers
    11.2. Select image name in “Product Explorer” window
    11.3. Select: ‘Window’ / ‘Open RGB Image Window’
        11.3.1. Leave default natural colour combination and click ‘OK’
        11.3.2. Select B12 for Red, B11 for Green and B4 for Blue and click ‘OK’
    11.4. Synchronise views by selecting the relevant icons in the “Navigation” tab
    11.5. Select: ‘Window’ / ‘Tile Horizontally’ and compare the images

12. Create New Mask (based on a logical band maths expression)
    12.1. Select image name in “Product Explorer” window
    12.2. Select ‘View’ / ‘Tool Windows’ / ‘Mask Manager’
    12.3. Select *‘f(x)’* and edit the expression: *‘(B12 > 1.0) and (B11 > 0.3)’*




    12.4. Click ‘OK’
    12.5. This simple mask highlights the hot surface (e.g. volcano craters, active fires, gas flares, … )

13. Change Projection
    13.1. Select ‘Raster’ / ‘Geometric Operations’ / ‘Reprojection’
    13.2. In “Reprojection Parameters” leave default projection ‘Geographic Lat/Lon (WGS84)’ as shown in Figure




13.3. Click ‘Run’

14. <u>Export to Google Earth</u>
    14.1. Open the reprojected S2 image subset in false colours (B12=Red, B11=Green, B4=Blue)
    14.2. Select ‘File’ / ‘Export’ / ‘Other’ / ‘View as Google Earth KMZ’
    14.3. Double click on the newly created KMZ file to open it in Google Earth

# EXERCISE 2 (Radiometric Indices)

Radiometric indices are quantitative measures of features that are obtained by combining several spectral bands, features that are not otherwise obvious if using only one band.
The indices provided with Sentinel-2 Toolbox, detailed below, are grouped into three categories:

- *Vegetation indices*
- *Soil indices*
- *Water indices*

Data: Sentinel-2A Level-2A pre-processed:
**Subset_S2A_MSIL2A_20170809T100031_N0205_R122_T33TUF_20170809T100028_10m**
The data have been resampled at 10m, cropped spatially and spectrally (B2, B3, B4, B5, B6, B7, B8, B11, B12) and exported in BEAM-DIMAP (SNAP native file format).

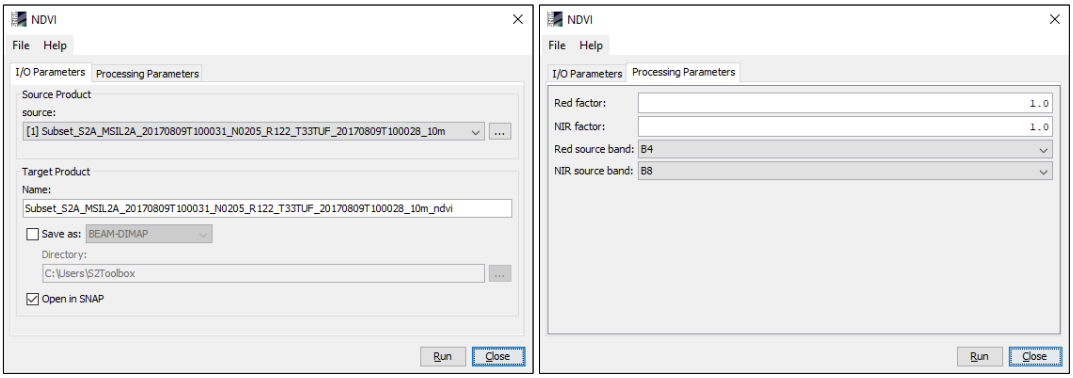
1. Open files
   1.1. 'File' / 'Open Product'
   1.2. Browse to:
   /Ex_2/Subset_S2A_MSIL2A_20170809T100031_N0205_R122_T33TUF_20170809T100028_10m
   1.3. Click 'Open'

2. View RGB image view
   2.1. Select image name in "Product Explorer" window
   2.2. Select: 'Window' / 'Open RGB Image Window'
   2.3. Leave default natural colour combination and click OK

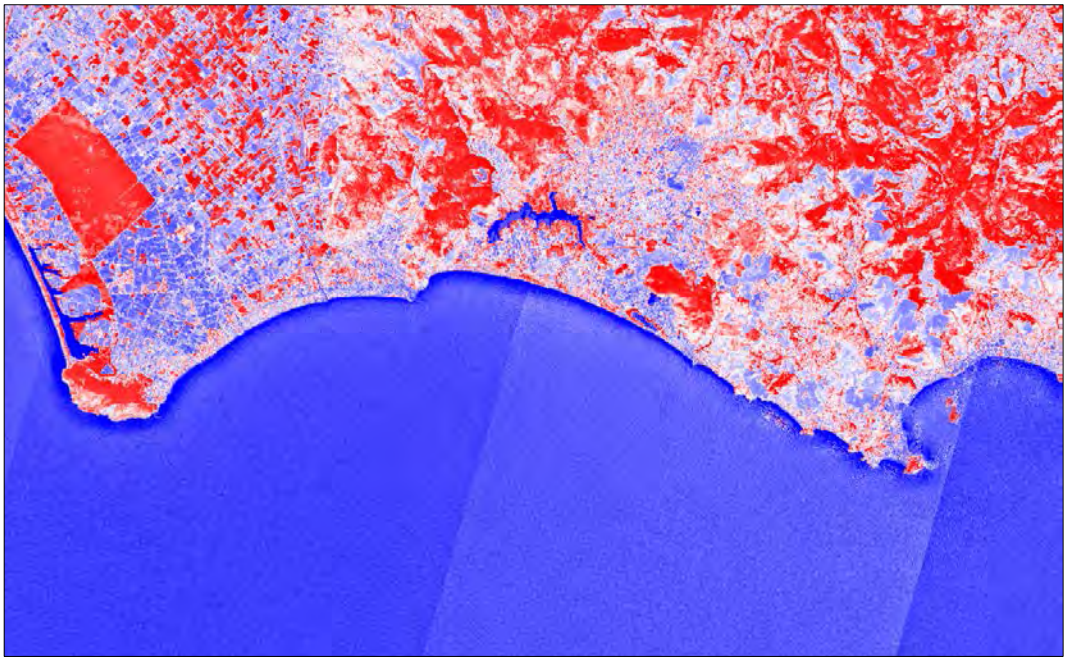
3. Normalized Difference Vegetation Index (NDVI)
   The NDVI composes a measurement for the photosynthetic activity and is strongly in correlation with density and vitality of the vegetation. The normalizing reduces topographic and atmospheric effects and enables the simultaneous examination of a wide area.

$$NDVI = \frac{(NIR_{factor} * NIR_{band}) - (Red_{factor} * Red_{band})}{(NIR_{factor} * NIR_{band}) + (Red_{factor} * Red_{band})}$$

   3.1. Select: 'Optical' / 'Thematic Land Processing' / 'Vegetation Radiometric Indices' / 'NDVI Processor'
   3.2. Set up the I/O and the processing parameters as shown in the Figure below




   3.3. Obtaining the following result.
   3.4. [Min: Blue]; [Mean: White]; [Max: Red]



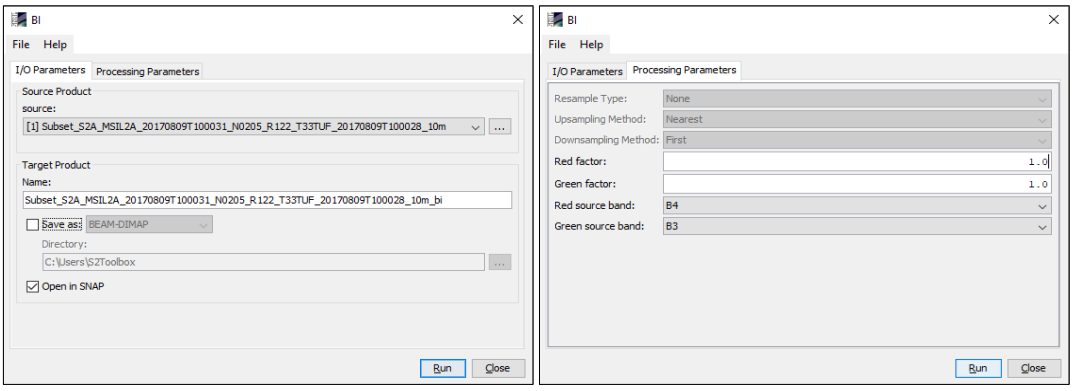
4. Brightness Index (BI)

The Brightness Index algorithm is representing the average of the brightness of a satellite image. This index is sensitive to the brightness of soils which is highly correlated with the humidity and the presence of salts in surface (Escadafal, 1989).

$$BI = \sqrt{\frac{\left(Red_{factor} * Red_{band}\right) + \left(Green_{factor} * Green_{band}\right)}{2}}$$

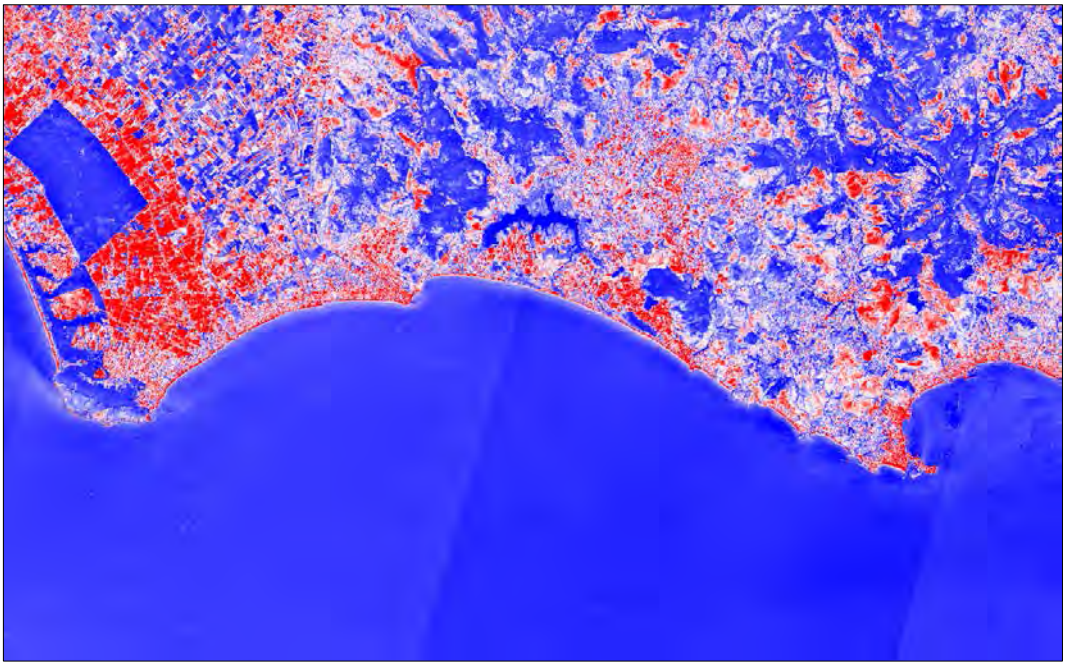
4.1. Select: 'Optical' / 'Thematic Land Processing' / 'Soil Radiometric Indices' / 'BI Processor'

4.2. Set up the I/O and the processing parameters as shown in the Figure below




4.3. Obtaining the following result.

4.4. [Min: Blue]; [Mean: White]; [Max: Red]



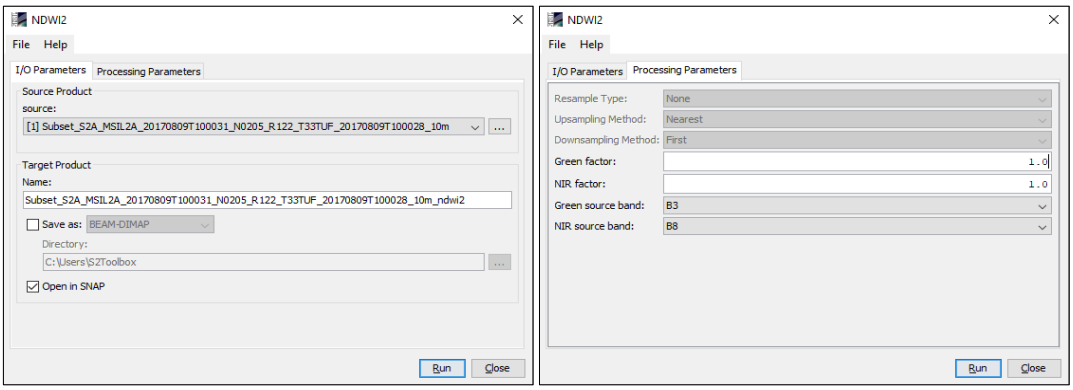
5. Second Normalized Difference Water Index (NDWI2)

The second Normalized Difference Water Index algorithm was developed by McFeeters (1996) to detect surface waters in wetland environments and to allow for the measurement of surface water extent.

$$NDWI2 = \frac{(Green_{factor} * Green_{band}) - (NIR_{factor} * NIR_{band})}{(Green_{factor} * Green_{band}) + (NIR_{factor} * NIR_{band})}$$

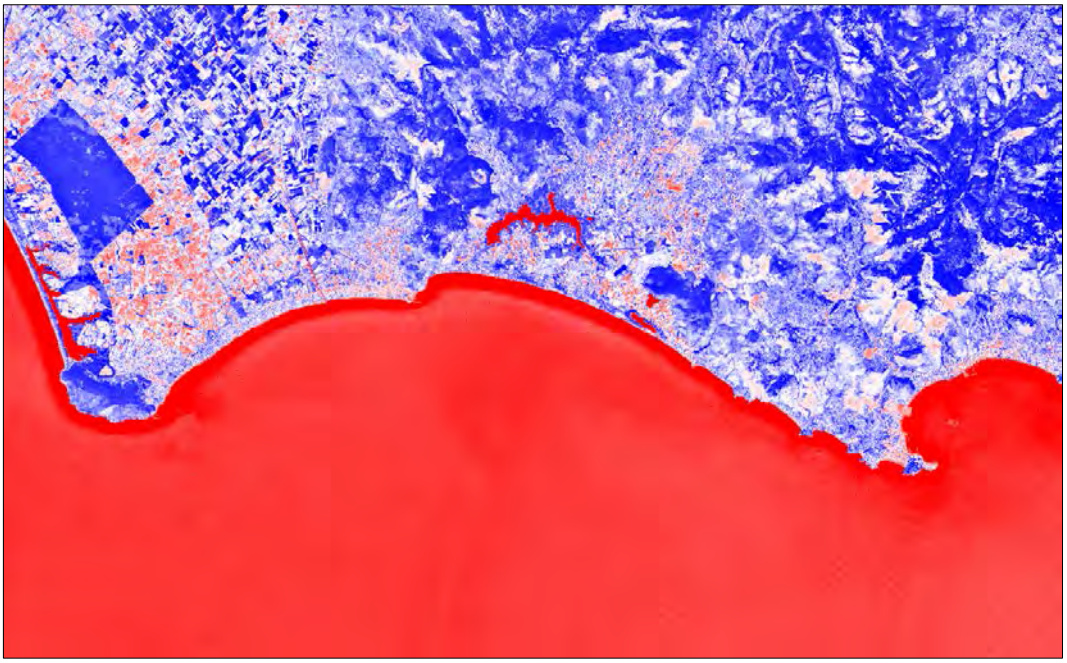
5.1. Select: 'Optical' / 'Thematic Land Processing' / 'Water Radiometric Indices' / 'NDWI2 Processor'

5.2. Set up the I/O and the processing parameters as shown in the Figure below

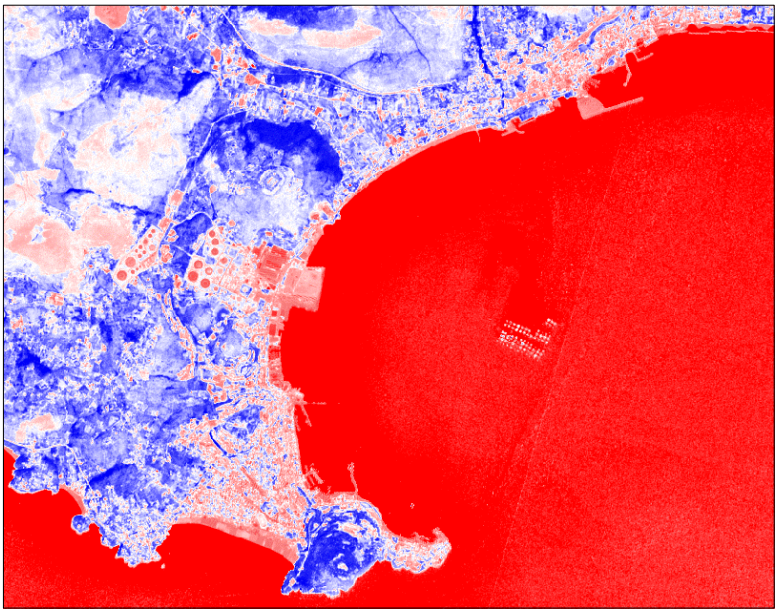



5.3. Obtaining the following result.

5.4. [Min: Blue]; [Mean: White]; [Max: Red]



Zooming in the gulf of Gaeta (right part of the image), thank you to the NDWI2 index, it is visible an aquaculture system as shown below.



6. Graph Builder
   - 6.1. Select the product in “Product Explorer” window
   - 6.2. Select: ‘Tools’ / ‘GraphBuilder’ or the icon
   - 6.3. In the GraphBuilder window we can start to build our graph clicking the right button of the mouse and add all the SNAP modules that we need.
   - 6.4. Brightest Index Operator: ‘Add’ / ‘Optical’ / ‘Thematic Land Processing’ / ‘Soil Radiometric Indices’ / ‘BiOp’
   - 6.5. NDWI2 Operator: ‘Add’ / ‘Optical’ / ‘Thematic Land Processing’ / ‘Soil Radiometric Indices’ / ‘Ndwi2Op’
   - 6.6. NDVI: ‘Add’ / ‘Raster’ / ‘BandMaths’ editing the equation (B8-B4)/(B8+B4)

6.7. Bands Merge Module: ‘Add’ / ‘Raster’ / ‘BandMerge’

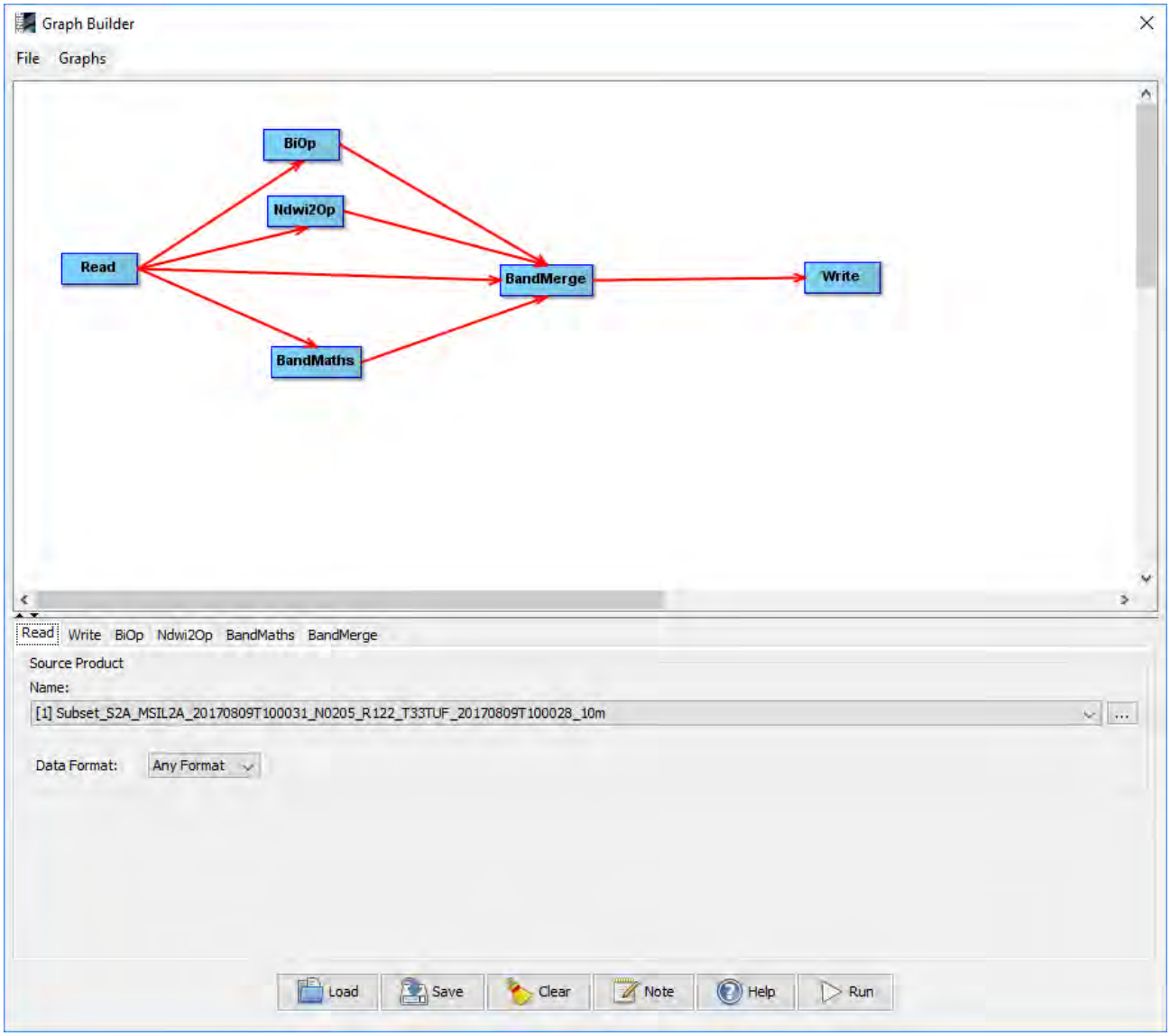


**Figure 1: Natural Colour**

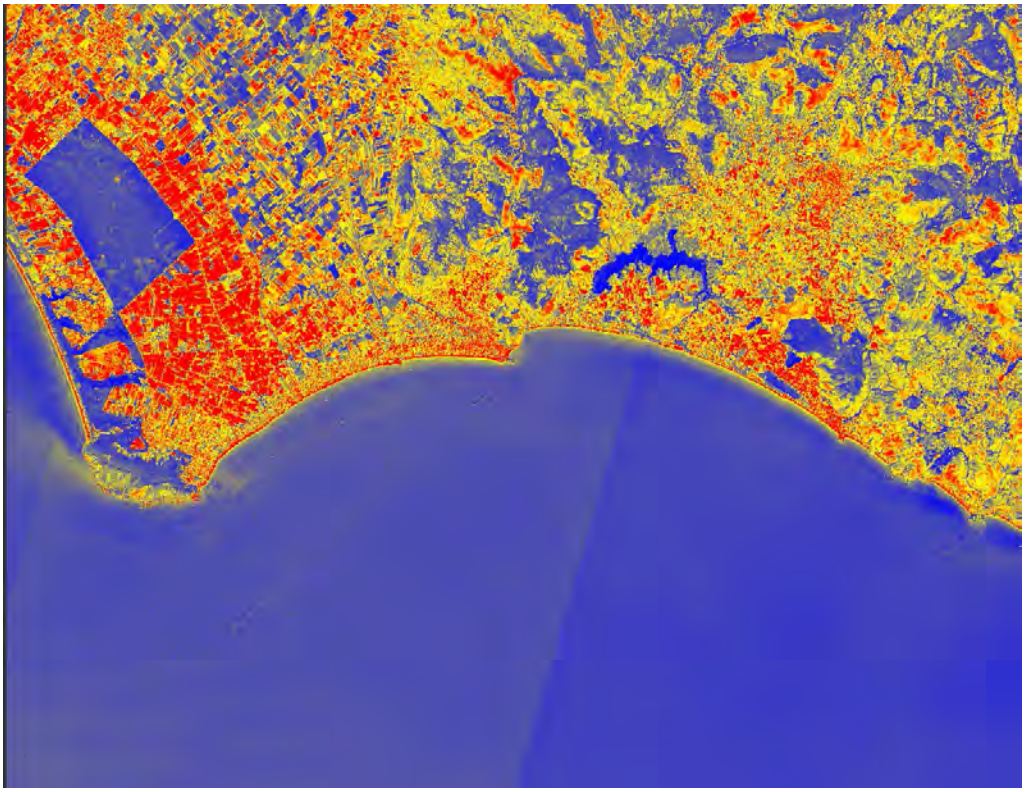


**Figure 2: Brightest Index output**

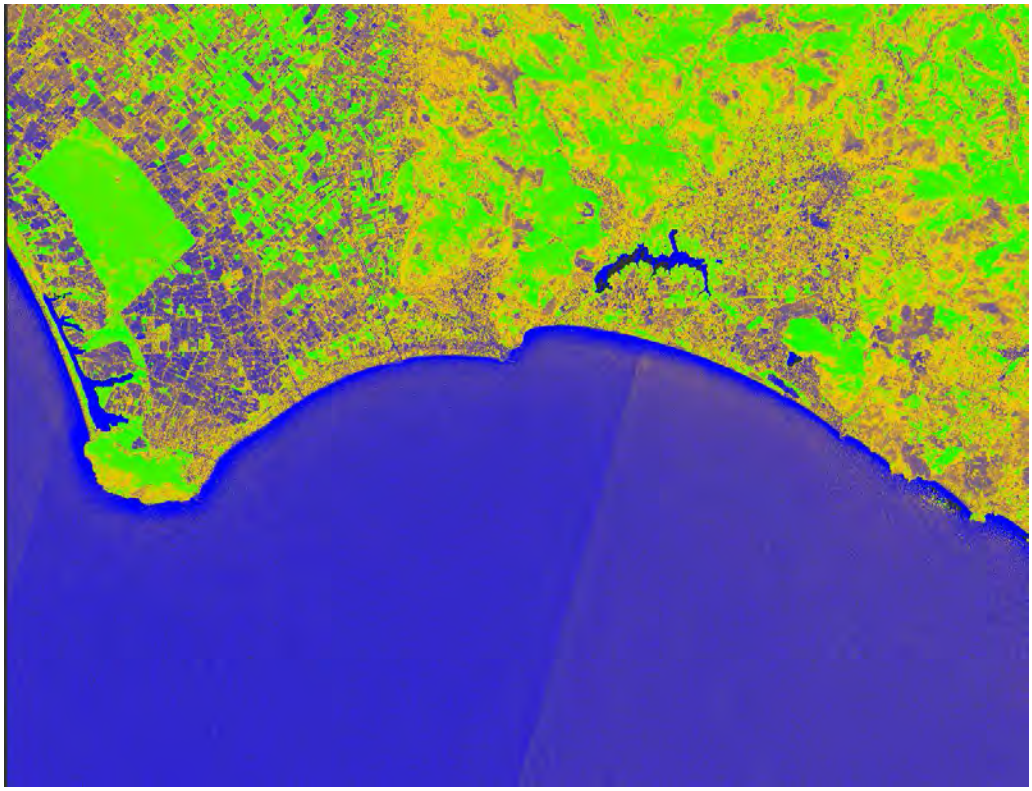


**Figure 3: NDVI output**

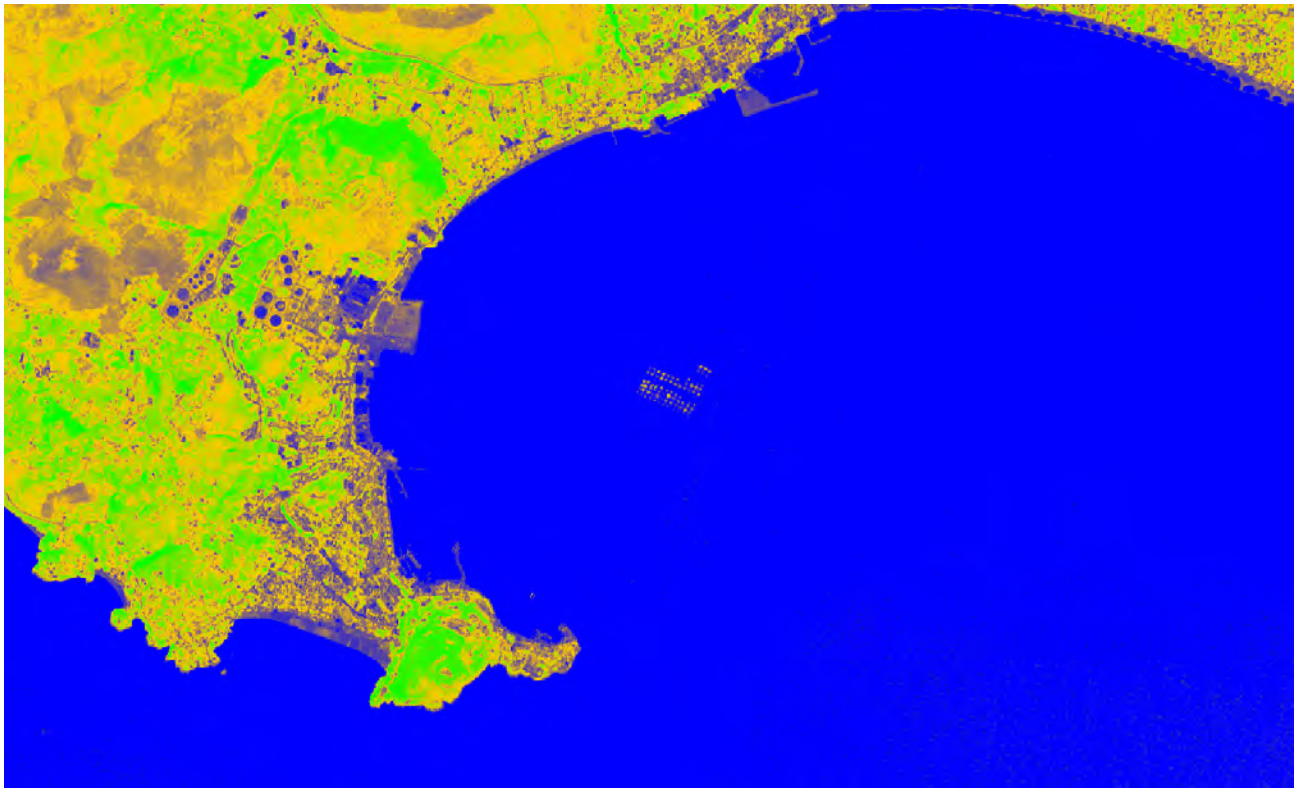


**Figure 4: NDWI-2 output**