Ex. 1: Sentinel-2
Introduction

June 2019 | Martin Sudmanns

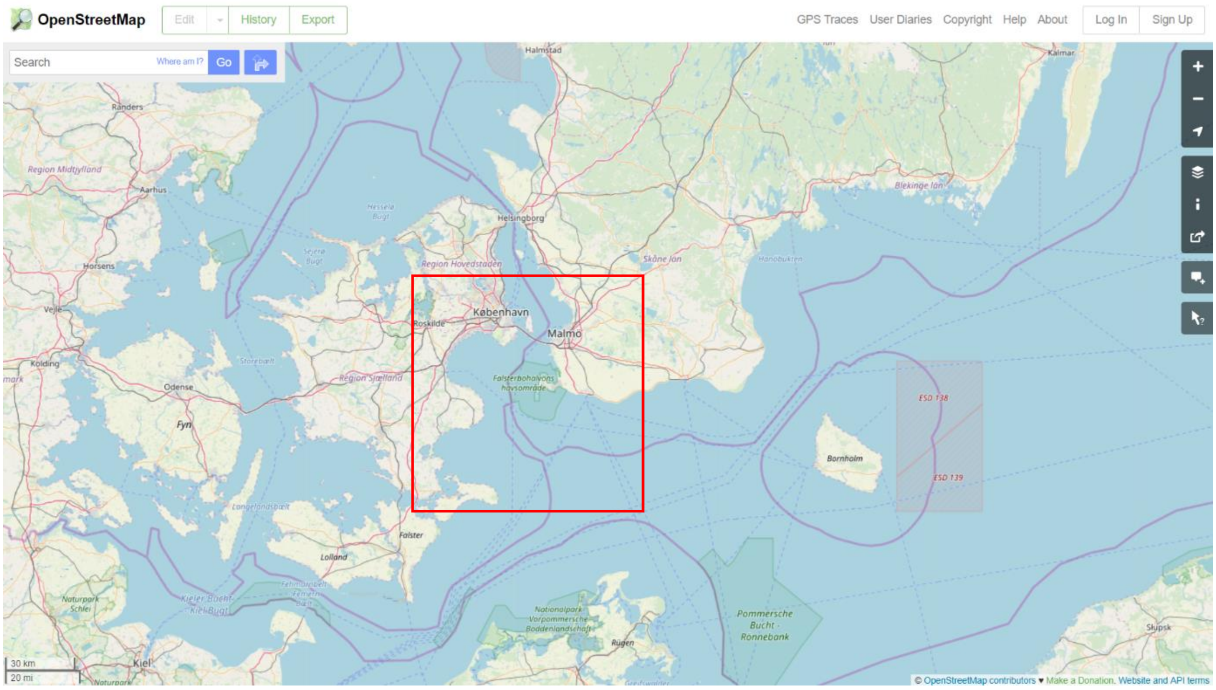
Summary

In this exercise, you will learn how to use Sentinel-2 images in the SNAP toolbox and calculate some basic information layers based on the spectral signatures of the pixels. Indexes, which are calculated from salient features of the spectral signature, are commonly used. Examples are the NDVI (Normalized Difference Vegetation Index) or the NDWI (Normalised Difference Water Index). If you are new to this type of calculations, the exercise gives you an introduction. If you are already familiar with it, you are invited to reflect on the different use cases where the application of indexes might make sense or not.

Content

1.) Introduction

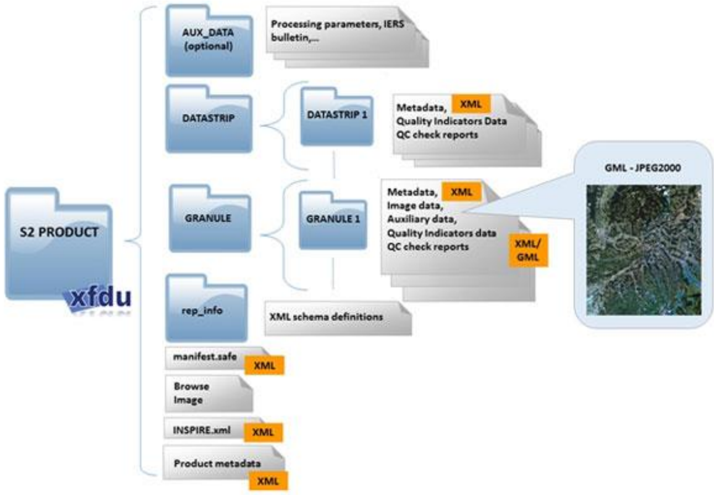
The Sentinel-2 image you will work with is located at the Øresund strait and parts of the Baltic sea. The coverage is approximately the red rectangle in the map below.



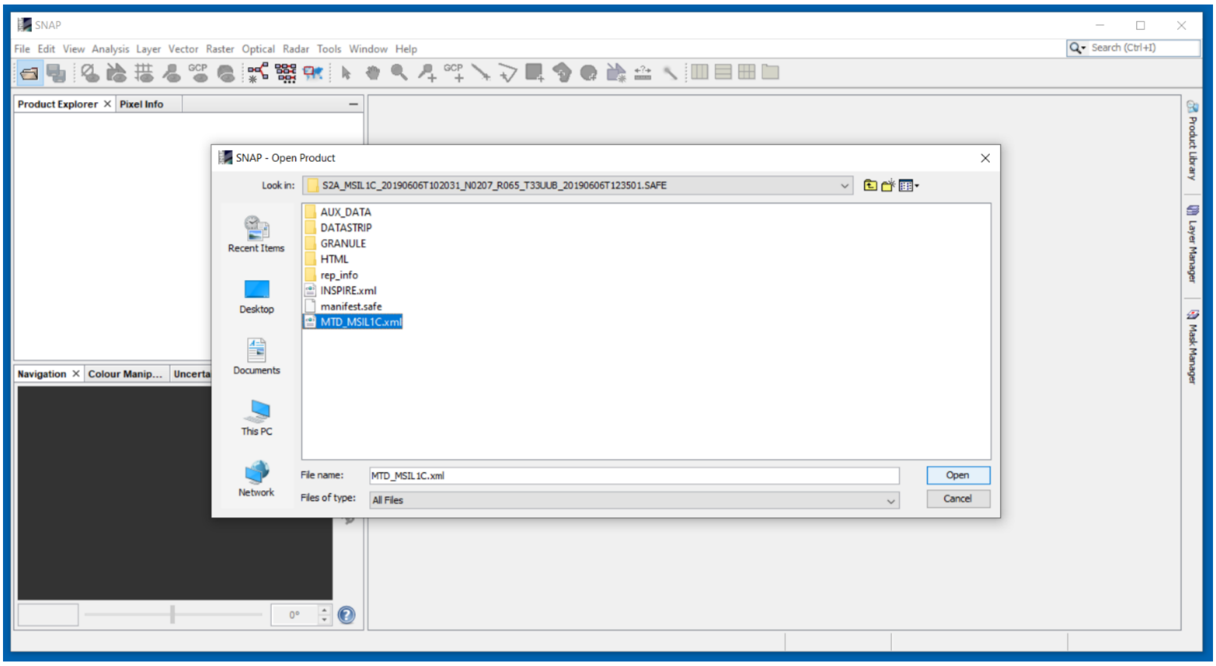
- Locate the Sentinel-2 Level 1C and Level 2A image on your virtual machine and start the SNAP toolbox.

2.) Use and visualise Sentinel-2 images

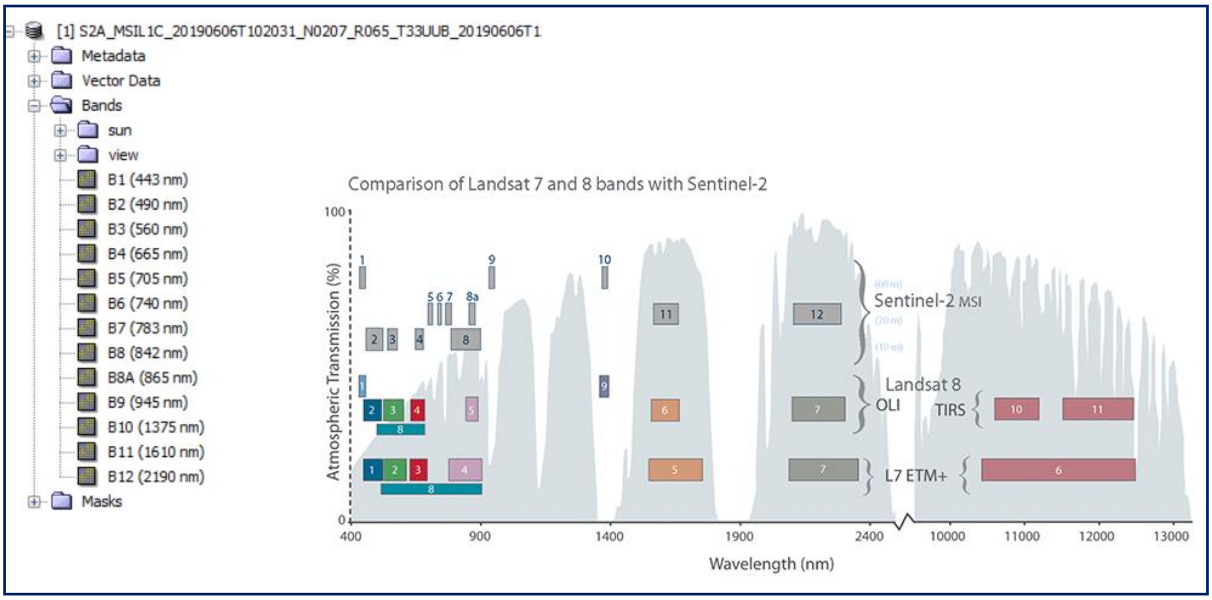
Once you located the image, make yourself familiar with the file structure. The most important one for now is the product metadata file. Have a look at the ESA website for further information: https://sentinel.esa.int/web/sentinel/user-guides/sentinel-2-msi/data-formats



SNAP can handle Sentinel data natively. In case of Sentinel-2 images you select the “MTD_MSIL1C.xml” file within the Sentinel-2 image folder. This file contains the product metadata. If you have not seen it before, open it in a text editor.

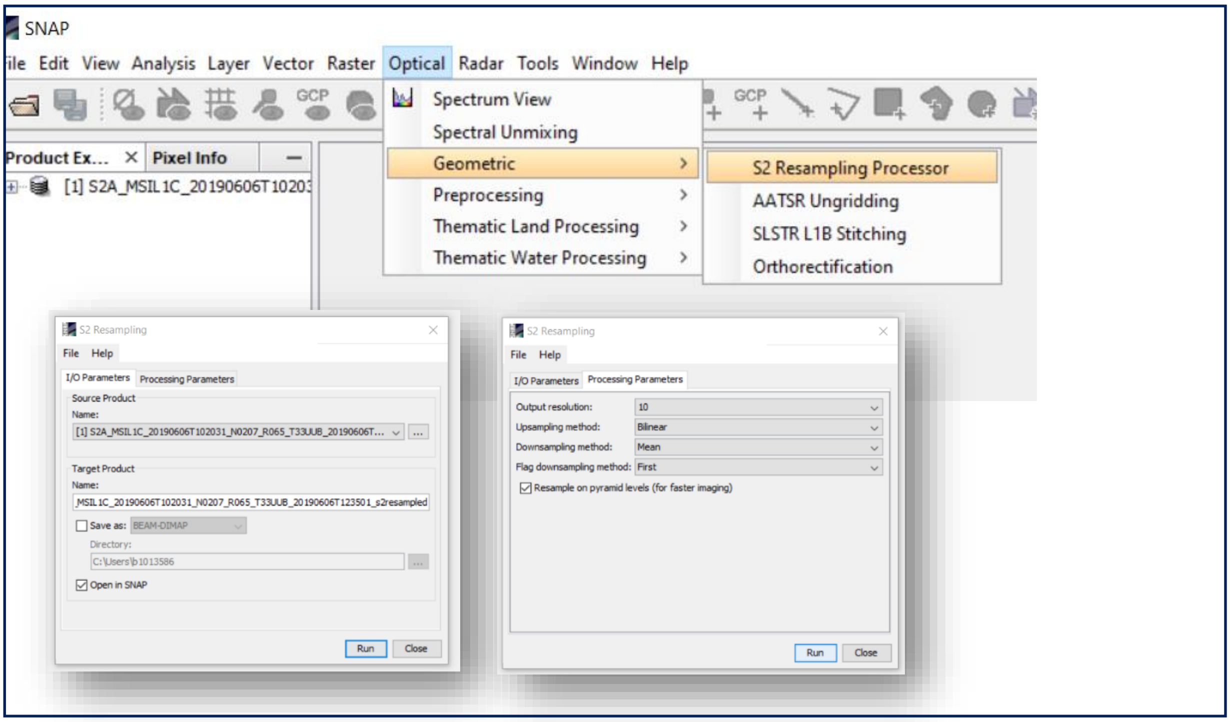


- Open the Sentinel-2 Level 1C image in the SNAP toolbox.
- Compare the different bands in the “Bands” subfolder with the schematic visualization of the Sentinel-2 bands and wavelengths.

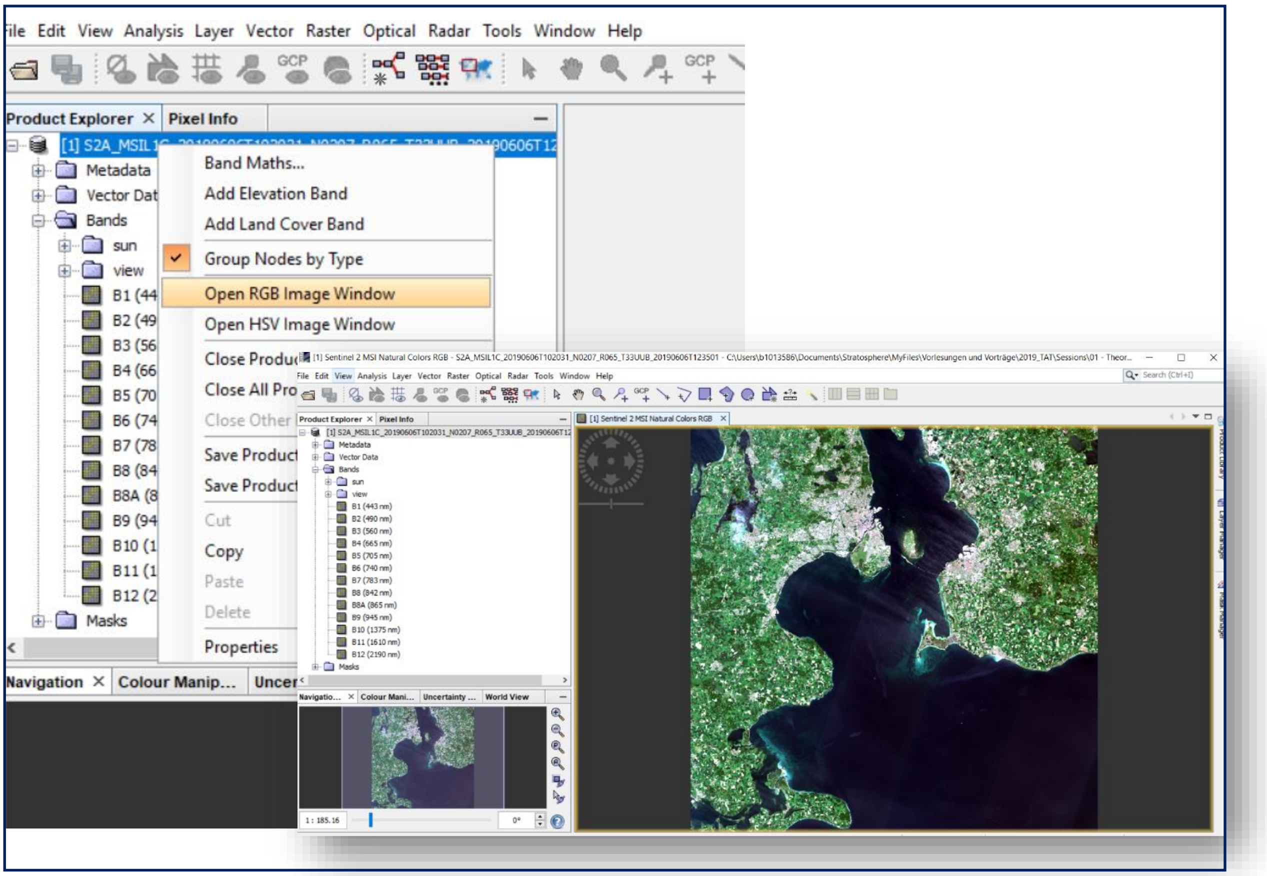


As with every image from a multi-spectral sensor, every band can be mapped to any of the three colours red (R), green (G), blue (B), which are the base colours for visualisation of images on the computer screen. SNAP allows direct visualisation of RGB and HSV band combinations.

Since the Sentinel-2 bands have different spatial resolutions (10, 20 and 60m), for some analysis you have to re-sample the bands to a common resolution. We can use the standard bilinear re-sampling, which is implemented in SNAP for this. This tool is available in SNAP under *"Optical → Geometric → S2 Resampling Processor"*. In the *I/O Parameters* tab, un-tic the *Save as* option. In the *Processing Parameters* tab, select *10* as *Output resolution*. *If you experience some (performance) problems, you may want to change it to 20 or 60.*



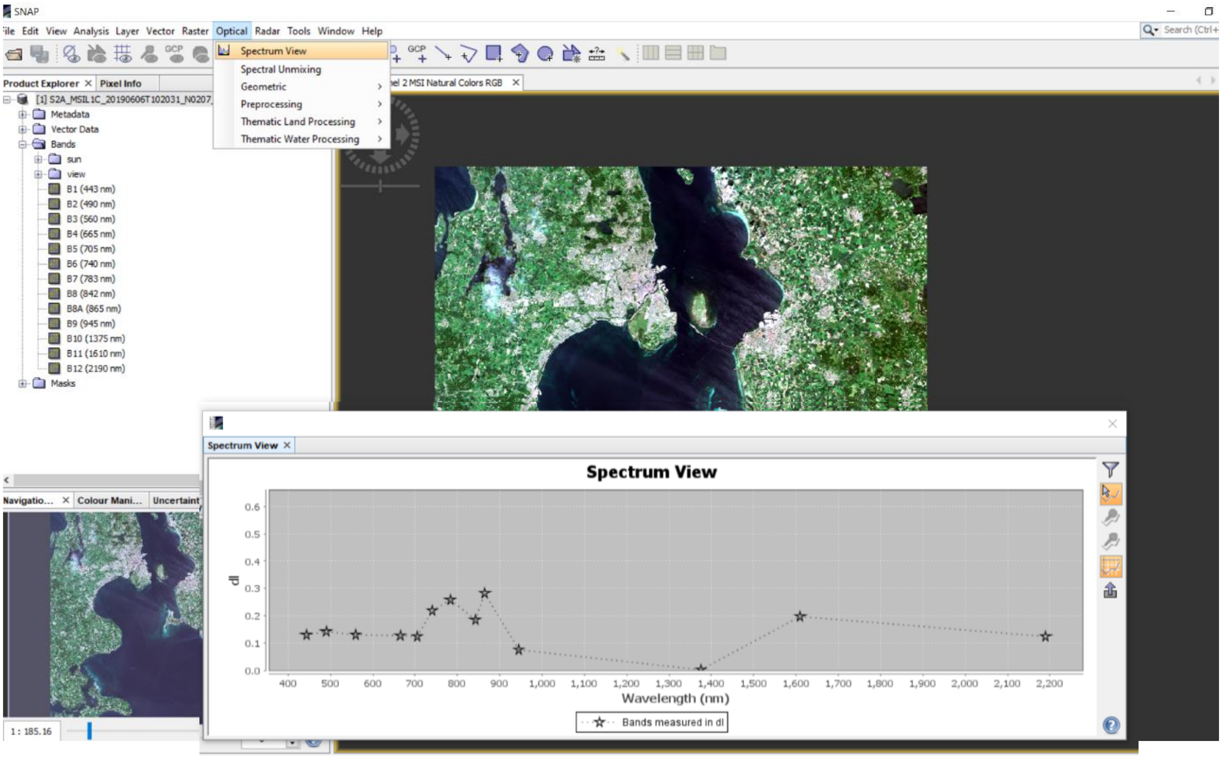
After re-sampling it is possible to visualise any band combination by *right-click* on the product and selecting *Open RGB Image Window* in the Context menu.



- Visualise the content of the image in true colour (RGB) and false colour infrared.
- Open the following bands individually: B1 (aerosol), B9 (water vapour), B 10 (cirrus). How are they important for land cover analyses?

3.) Viewing and interpreting the spectral signature

As we already saw the sensor is sensitive to the Earth's reflectance in different wavelengths, the different bands create the spectral signature of each pixel. This contains important information about the image content. We can use the Spectrum View for that, which is located in the menu under "*Optical → Spectrum View*".



- Open the "Spectrum View" in SNAP and move your mouse over some areas in the image. Make sure you select different land cover types. You may use the RGB band combination or the B11 - B8a - B2 combination for this. Observe the spectral signature show in the "Spectrum View" window.
- Read the first paragraph of the Wikipedia article (below). Can you use the spectral signature for classification? Why?

> *"Most remote sensing applications process digital images to extract spectral signatures at each pixel and use them to divide the image in groups of similar pixels (segmentation) using different approaches. As a last step, they assign a class to each group (classification) by comparing with known spectral signatures. Depending on pixel resolution, a pixel can represent many spectral signature "mixed" together - that is why much remote sensing analysis is done to "unmix mixtures"."* https://en.wikipedia.org/wiki/Spectral_signature

4.) Derive additional indexes using characteristics of the spectral signature

As you have seen the different spectral signatures, which can (might) be associated to specific features such as land, water, … a first approach to derive additional information is to use specific salient characteristics in the spectral signature to calculate indicative numbers for different land cover types:

Water Vegetation

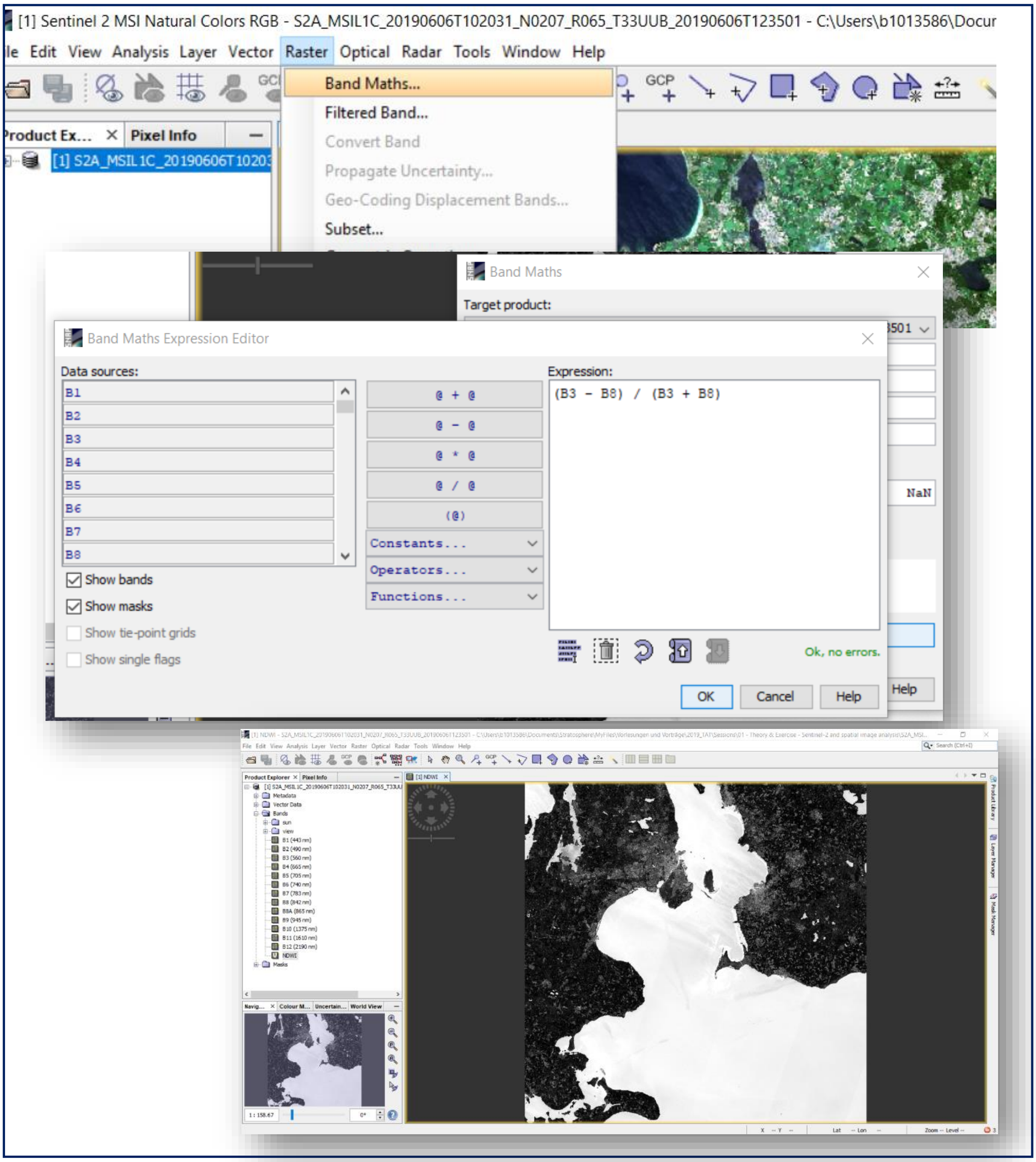
The NDWI can be used to derive additional information about water bodies. One formula to calculate it is

$$\frac{(Green - NIR)}{(Green + NIR)} \tag{1}$$

In the case of Sentinel-2, it refers to the following band numbers

$$\frac{(B03 - B08)}{(B03 + B08)} \tag{2}$$

To calculate this index in SNAP, you can use the *Band Math* tool, which you will find under "*Raster → Band Math*". In this window you can either directly type in the formula or click on the *Edit Expression* button, which will support you with several templates.

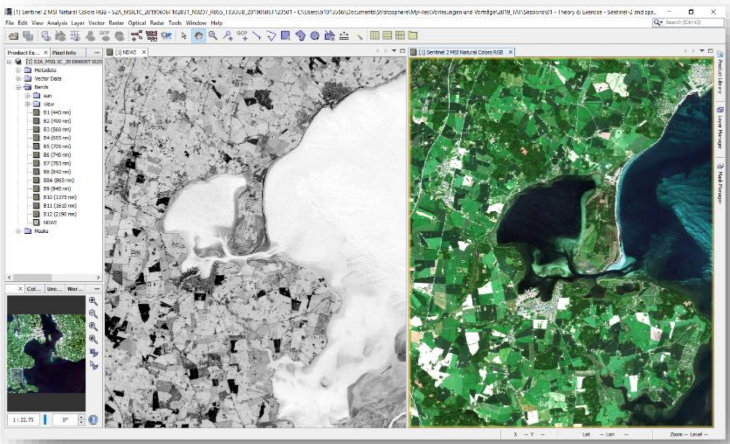


- Calculate the NDWI using the “Band Math” function in SNAP.
- Repeat this with the NDVI (Normalised Difference Vegatation Index)
- Make yourself familiar with the output images to proceed with the next question.

You might know the NDVI formula for the Sentinel-2 bands already:

$$\frac{(B08 - B04)}{(B08 + B04)} \tag{3}$$

5.) Do-it-yourself practice



While you had a look at the two output images of the NDWI and NDVI, what is the benefit of using them and what might be problematic? Consider that:

- Not the whole spectrum is used,
- The information of neighbouring pixels are not used,
- A spectral signature does not necessarily map to a specific land cover type.

Is the algorithm dependent or independent on the pixel's location within the image. Think of a random re-arrangement of the pixel: Does it still yield the same result? What are the benefits and limitations of that?

- Open the Level 2A image (if not already opened) and have a look at the Scene Classification Maps (SCMs). How could you use the available classes to stratify your analysis?

Acknowledgements:

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