

# WORKING ON SATELLITE DATA - BASICS

Tutorial #2



**UNIWERSYTET GDAŃSKI**

FPCUP

Framework Partnership Agreement on Copernicus User  
Uptake

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## INTRODUCTION

This guide will show you how to acquire Copernicus satellite data using websites such as [www.scihub.copernicus.eu](http://www.scihub.copernicus.eu) and [www.sentinel-hub.com](http://www.sentinel-hub.com). The open source software for processing satellite images - QGIS will also be described. Basic operations on images such as creating colour compositions and counting indicators, will be presented. The guide will focus on the use of optical satellite data from Sentinel-2.

## DOWLONADING SATELLITE IMAGES

### [WWW.SCIHUB.COPERNICUS.EU](http://WWW.SCIHUB.COPERNICUS.EU)

Go to website Copernicus Access Hub and choose „Open Hub”

Welcome to the Copernicus Open Access Hub

The Copernicus Open Access Hub (previously known as Sentinels Scientific Data Hub) provides complete, free and open access to Sentinel-1, Sentinel-2, Sentinel-3 and Sentinel-5P user products, starting from the In-Orbit Commissioning Review (IOC).

Sentinel Data are also available via the Copernicus Data and Information Access Services (DIAS) through several platforms.

Please visit our [User Guide](#) for getting started with the Data Hub Interface. Discover how to use the APIs and create scripts for automatic search and download of Sentinels' data.

Latest update: see the section on [Long Term Archive](#) for the upgrade of the interfaces for access to offline data.

For further details or requests of support please send an e-mail to [eosupport@copernicus.esa.int](mailto:eosupport@copernicus.esa.int)

**Reports & Stats**

Data updated hourly

35,327  
prod. published in the last 24h  
(S1 + S2 + S3 + S5P)

224,794  
downloads in the last 24h  
(S5Hub + API Hub +  
S-3 PreOps + S-5P PreOps)

**Resources**

## LOG-IN

Copernicus Open Access Hub

Please login to access our services...

Username \_\_\_\_\_

Password \_\_\_\_\_

**LOGIN**   **Sign up**   **Forgot password?**

Firstly, you should choose „Open Hub”. Then, the above page will be displayed. It is necessary to login to be able to use the website. To do this, click the icon in the upper right corner of the page. Prior registration is required. To register, click "Sign up". After clicking "Sign up", the following registration form will be displayed. Then, enter your login (username) and password (password), and then press "Login".

**Copernicus Open Access Hub**

Sentinel data access is free and open to all.

On completion of the registration form below you will receive an e-mail with a link to validate your e-mail address. Following this you can start to download the data.

Username field accepts only lowercase alphanumeric characters plus "-", "\_" and ".".

Password field accepts only alphanumeric characters plus "!", "@", "#", "\$", "%", "&", "!", "(", ")", "+", "=", ";", "\_", "-", "=".

Password fields minimum length is 8 characters.

Firstname	Lastname
Username	
Password	Confirm Password
E-mail	Confirm E-mail
Select Domain	
Select Usage	
Select your country	

[www.copernicus.eu](#)

By registering in this website you are deemed to have accepted the T&C for Sentinel data use.

## SEARCH AND DOWNLOAD DATA



Click on the icon indicated by the arrow in the image above to define search parameters. The list as shown in the image below will appear.

Sort By - select how to sort the searched images:

- Ingestion date;
- Sensing period;
- Tile id.

Sensing period/Ingestion period – selection of dates within which the user makes a search.

Order by:

- Descending;
- Ascending.

These are general search parameters that are applied to each data source.

Let's use search parameters like:

- Sort by: Sensing Date;
- Start date: 1st of June 2019;
- End date: 31st of June 2019.

To search for Sentinel-2 Satellite products, check the box next to Mission: Sentinel-2.

After scrolling down the search page, it is possible to set parameters related to searching for Sentinel-2 imagery.

Satellite Platform – selection of the Satellite performing the imaging. These are satellites with the same parameters. To increase the search range, leave the field blank to search for images from both satellites:

- S2A;
- S2B.

Product Type – product type, image processing level selection:

- S2MSI1C – not subjected to atmospheric correction;

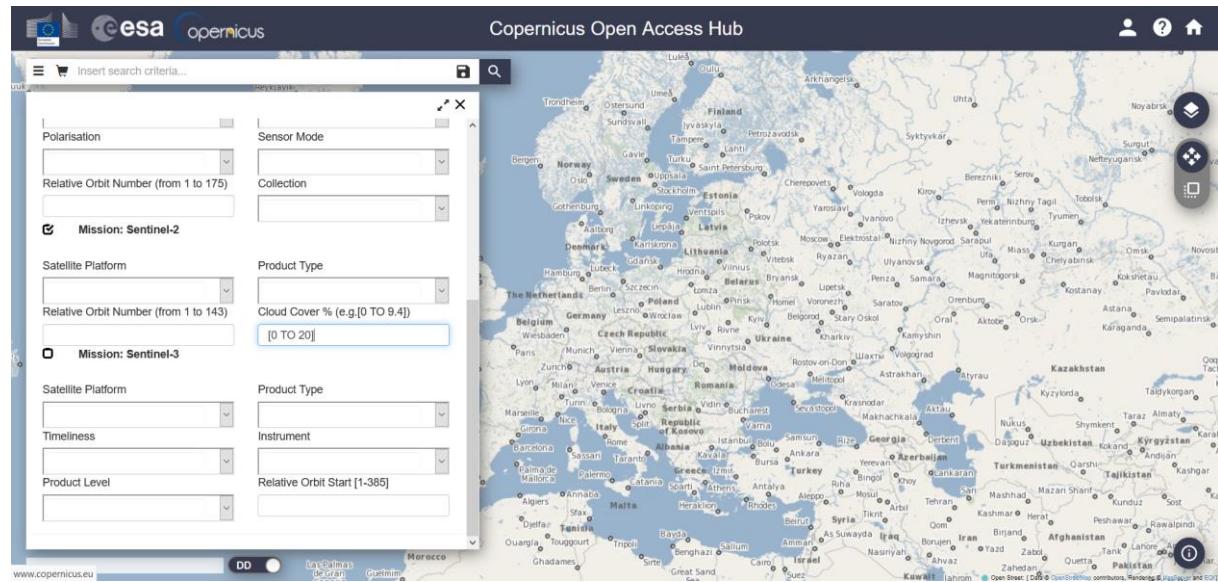
- S2MSI2A – atmospheric corrected data.

For the purposes of the exercise, let S2MSI2A be selected.

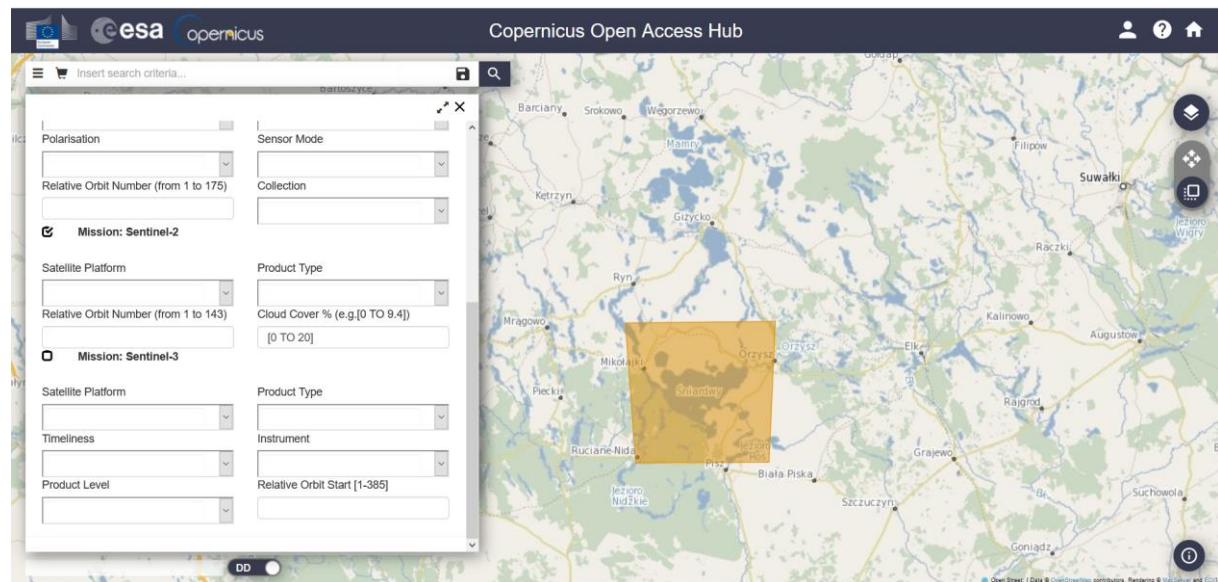
Relative orbit number - number of the so-called track, i.e. the imaging belt assigned to a given place on Earth.  
To increase the range of the search, leave the field blank.

Cloud cover % – cloud cover of the image. It is worth setting a parameter that will limit the search to cloudless or partially cloudless images. Usually, the cloud cover is set at 20%.

Enter the value [0 TO 20]

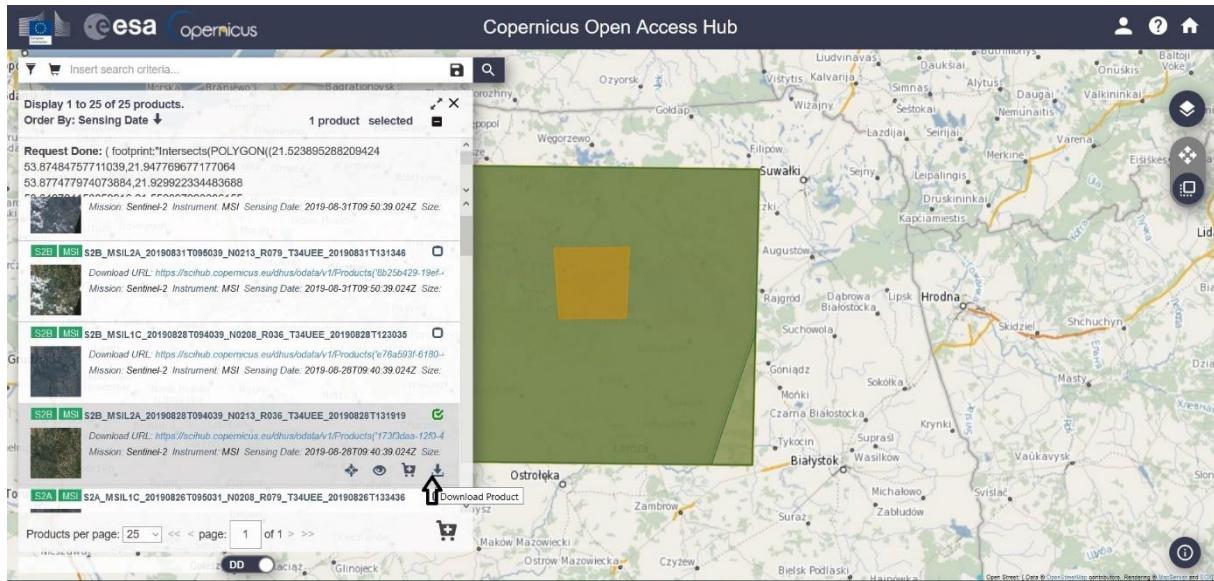


Further, select a search area. To do this, select the "Switch to Area Mode" icon on the right side of the screen.

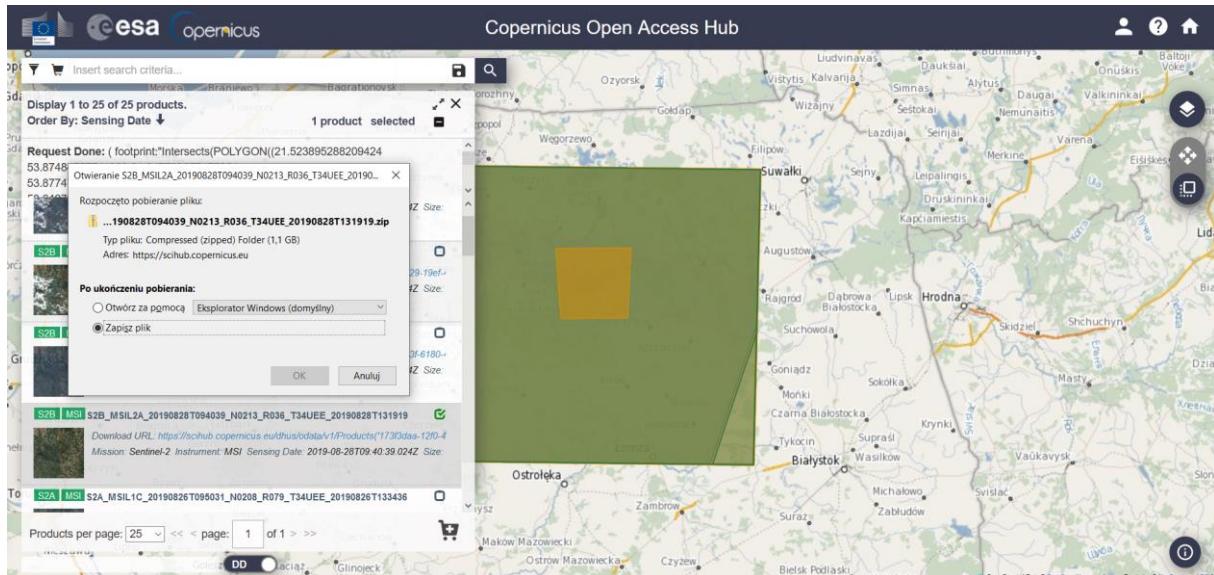


Move closer to the Śniardwy Lake area and draw a polygon. Right-click twice to close the polygon.

Click on the magnifier. It will search for all images where the search parameters are true within the selected polygon. A list of found images will appear. Select the fourth image from the list: August 28, 2019 (images are ordered from newest to oldest) and click "Download Product".



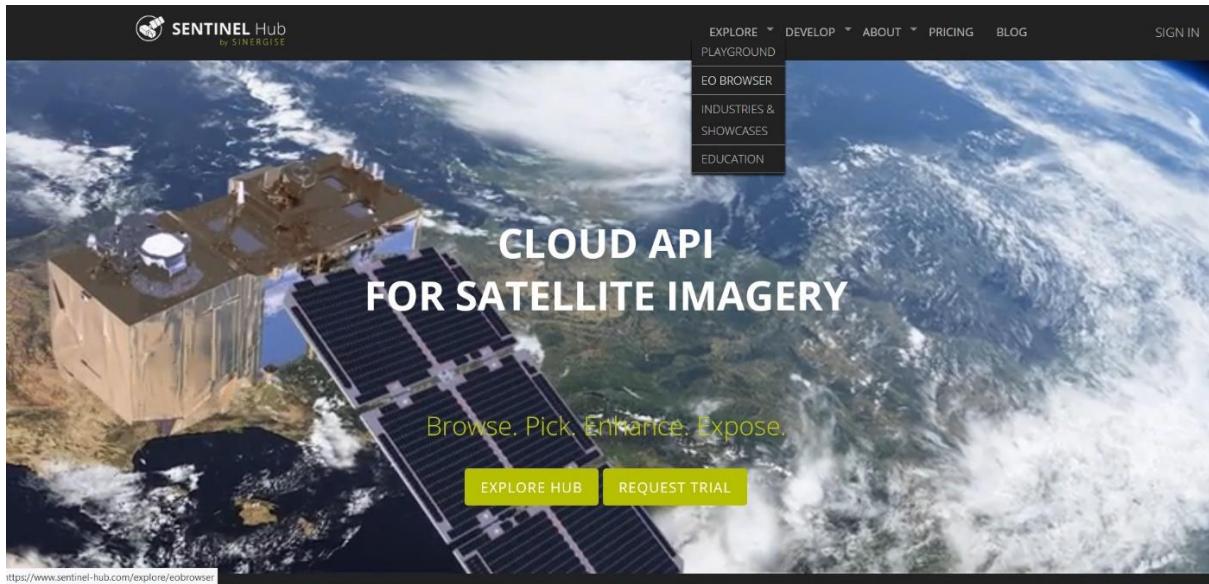
The window will appear. Select path for download data. This may take several minutes due to the large file size.



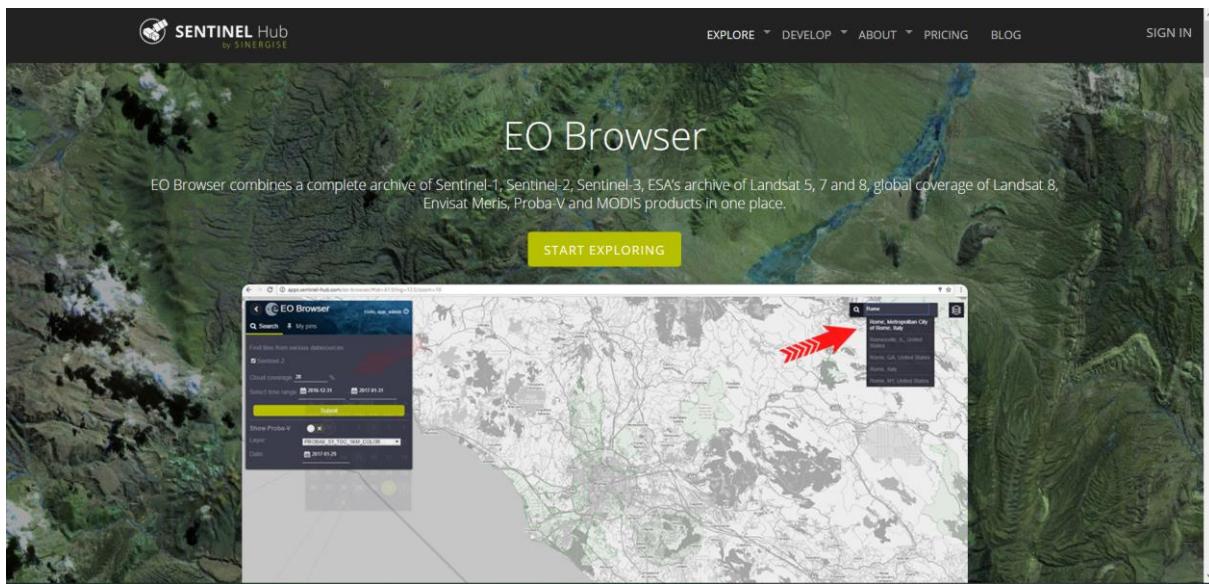
[WWW.SENTINEL-HUB.COM](http://WWW.SENTINEL-HUB.COM) – EO BROWSER

#### ACCESS TO EO BROWSER

Go to website [www.sentinel-hub.com](http://www.sentinel-hub.com) and choose EXPLORE, then EO BROWSER.

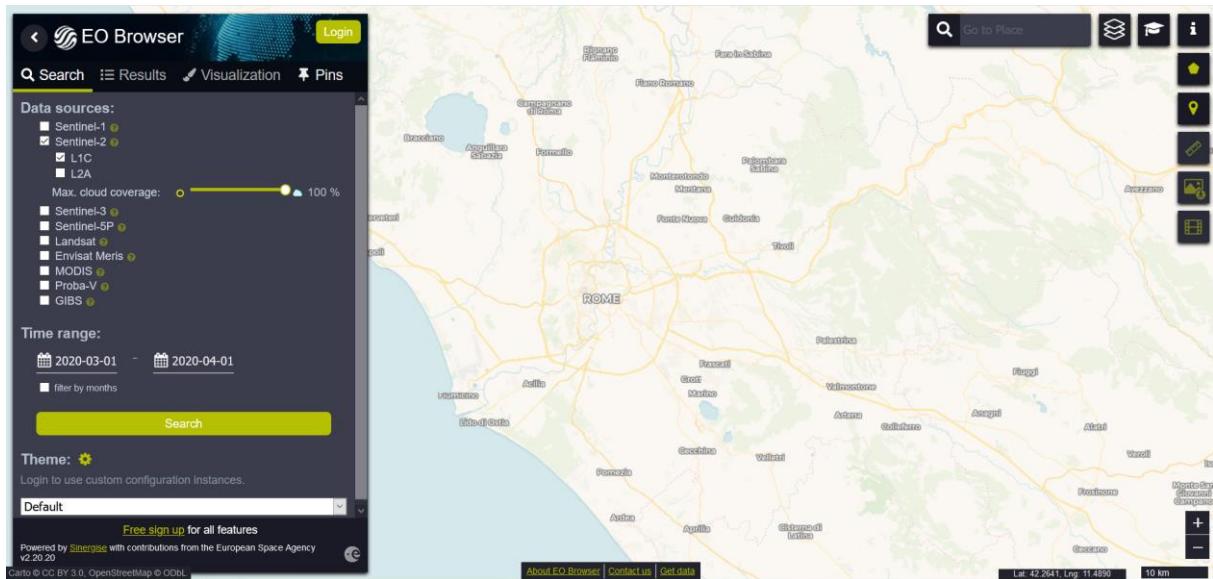


Then click START EXPLORING.

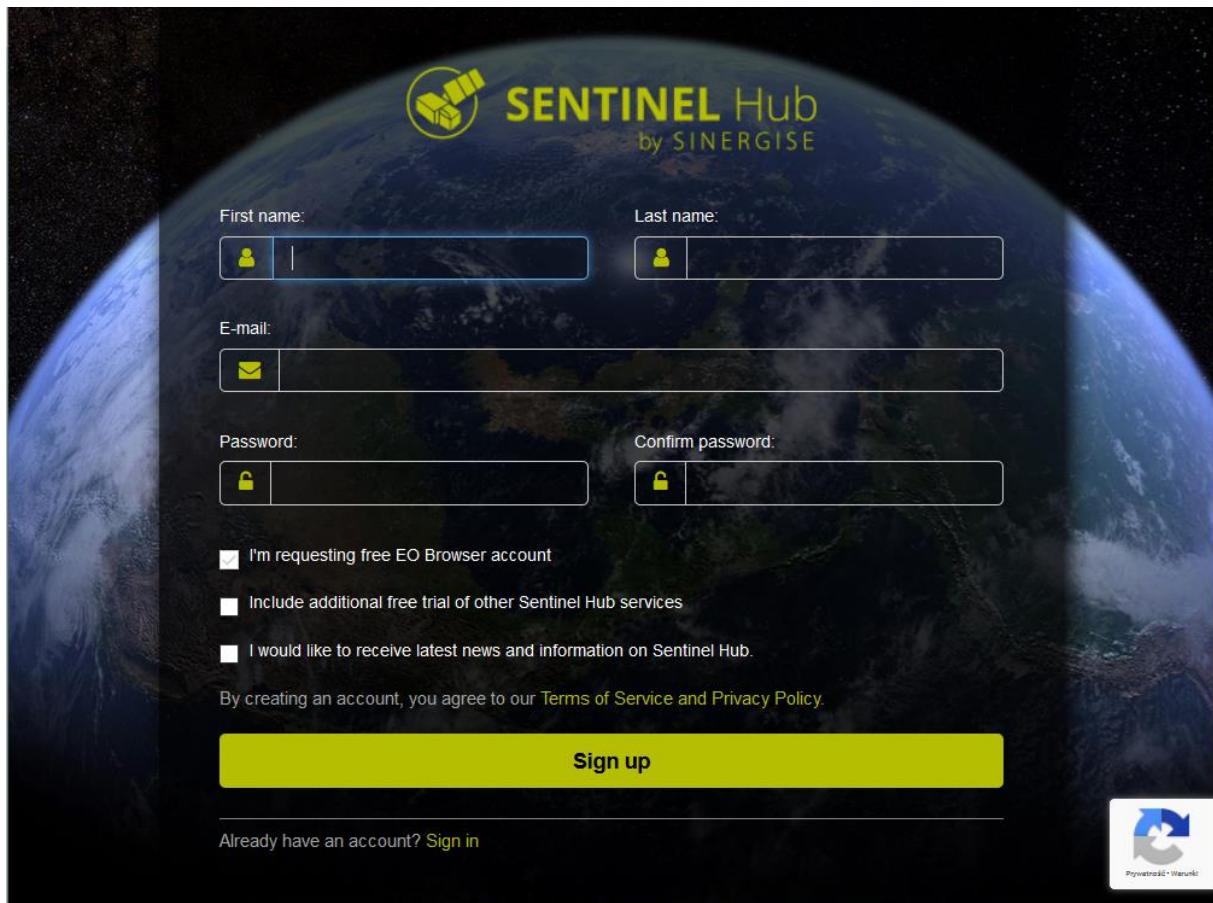


#### LOG-IN

A new screen will appear with the "Login" button on the left side of it.



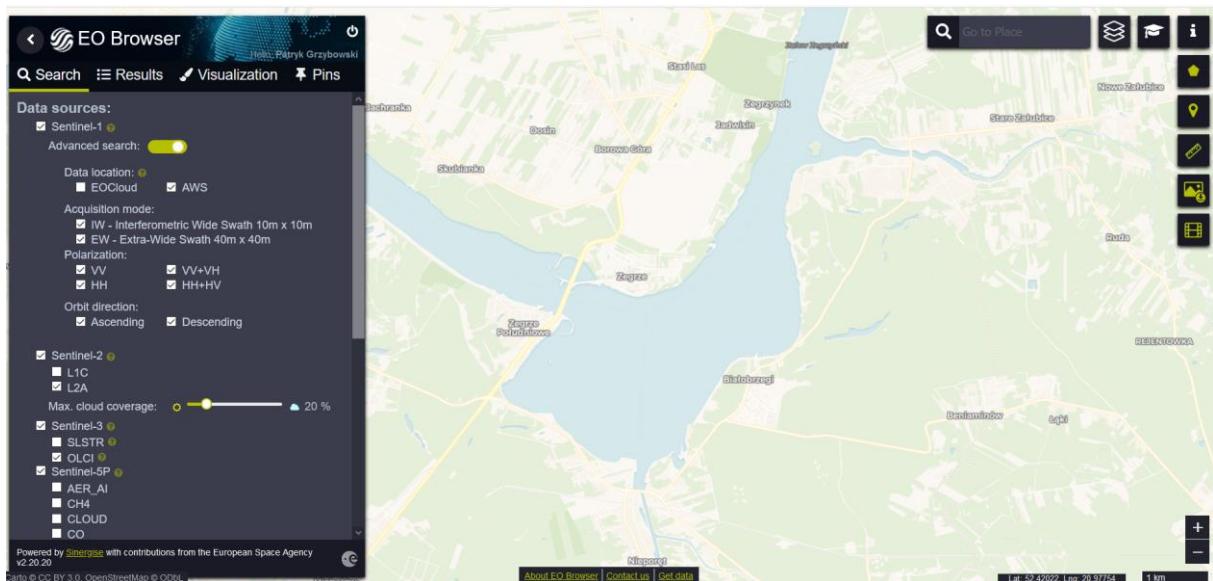
In the absence of an account, create one by clicking "Login" and then "Sign Up"



## SEARCH

To search for an image, move over the area of interest. In this case, move over to the area of the Zegrze Reservoir, where the Bug river joins the Narew river. It is not necessary to define the search area. It will be limited to the area that is displayed on the monitor. Any imagery that covers even part of the viewable area will appear in search results.

On the left side, there is a menu where you can define the your search. Additional search attributes will be displayed by checking the boxes next to the names of the satellites.

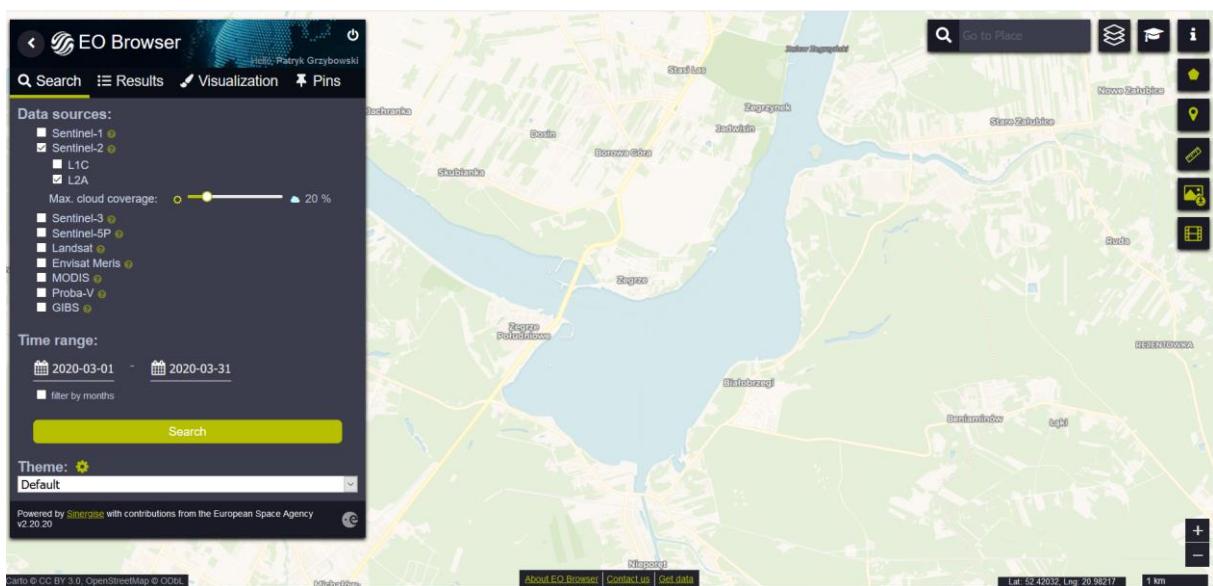


W sekcji Seninel-2 można wybrać pola:

- L1C - not subjected to atmospheric correction;
- L2A – atmospheric corrected data;
- Max cloud coverage – maximum cloudiness of the image, defined by setting the appropriate value on the slider.

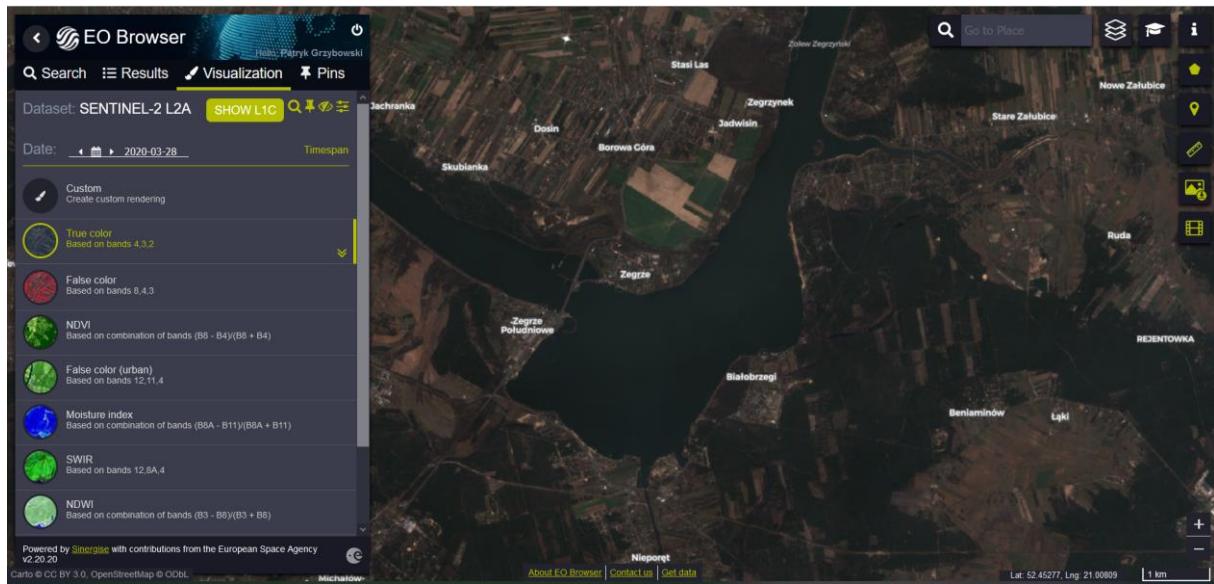
As the task is to concern optical data from Sentinel-2, select Sentinel-2, L2A, and set the cloud cover to 20%.

Time range – the period of time for which the data will be searched. Set from March 1, 2020 to March 31, 2020. Click "Search".



## VIEVING OF THE RESULTS

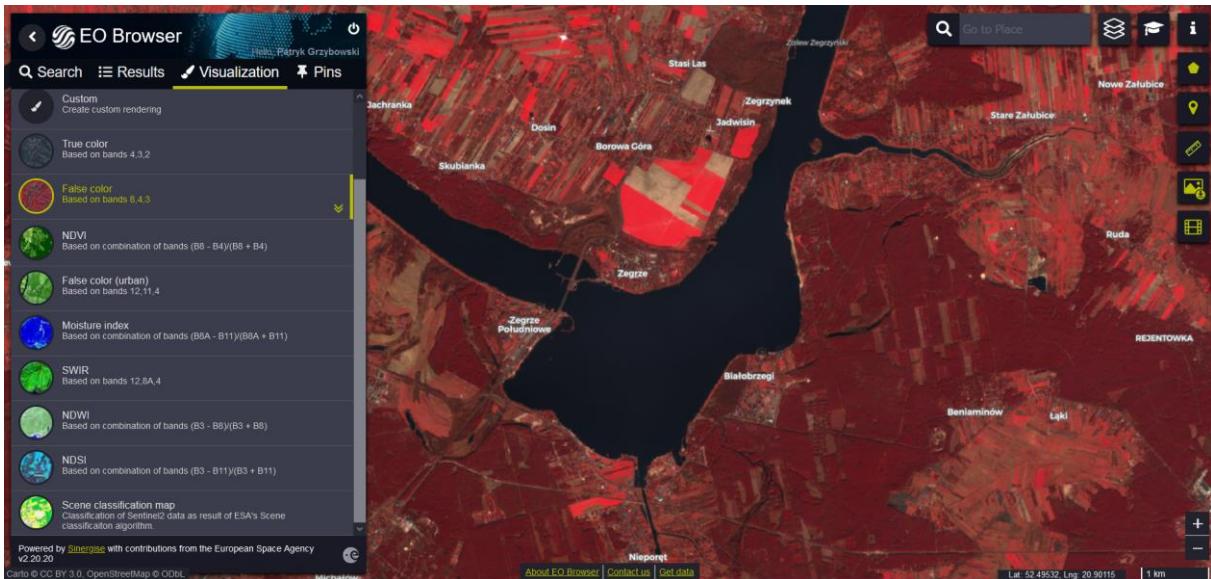
To see a list of found images, go to the "Results" tab. Select the first image and click "Visualize". You will automatically be moved to the "Visualization", where the selected image will be displayed in real colours (RGB).



On the left side of the screen, a list will appear. You can now choose how to display the image (colour composition or index). You can also choose the option of displaying classified image according to ESA algorithm.

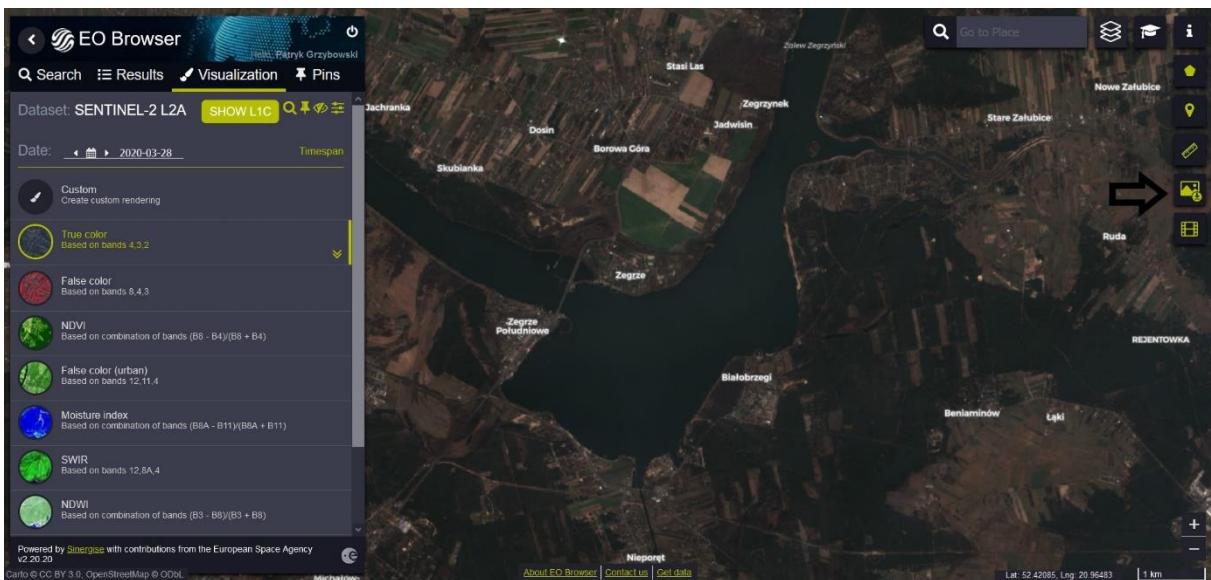
- True color – true colours;
- False color – near infrared composition. Useful for analyzing vegetated areas;
- NDVI – a commonly used index of the condition of vegetation;
- False color (urban) – composition using two mid-infrared bands. Useful in classifying built-up areas;
- Moisture Index – an index providing information on moisture;
- SWIR – combination used for soil moisture monitoring, vegetation studies and various stages of crop growth;
- NDWI - an index that provides information on the water content of vegetation;
- NDSI – an index useful for classifying snow cover and water
- Scene classification map – image subjected to classification, due to the coverage of the area, according to ESA algorithm.

Below is an image displayed by the composition "False color".

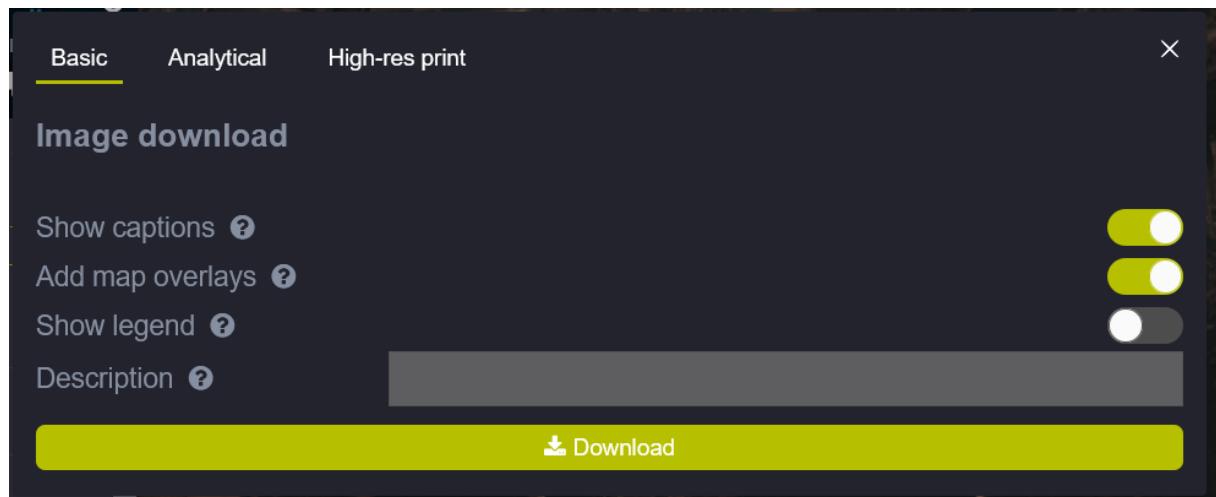


## DOWNLOAD

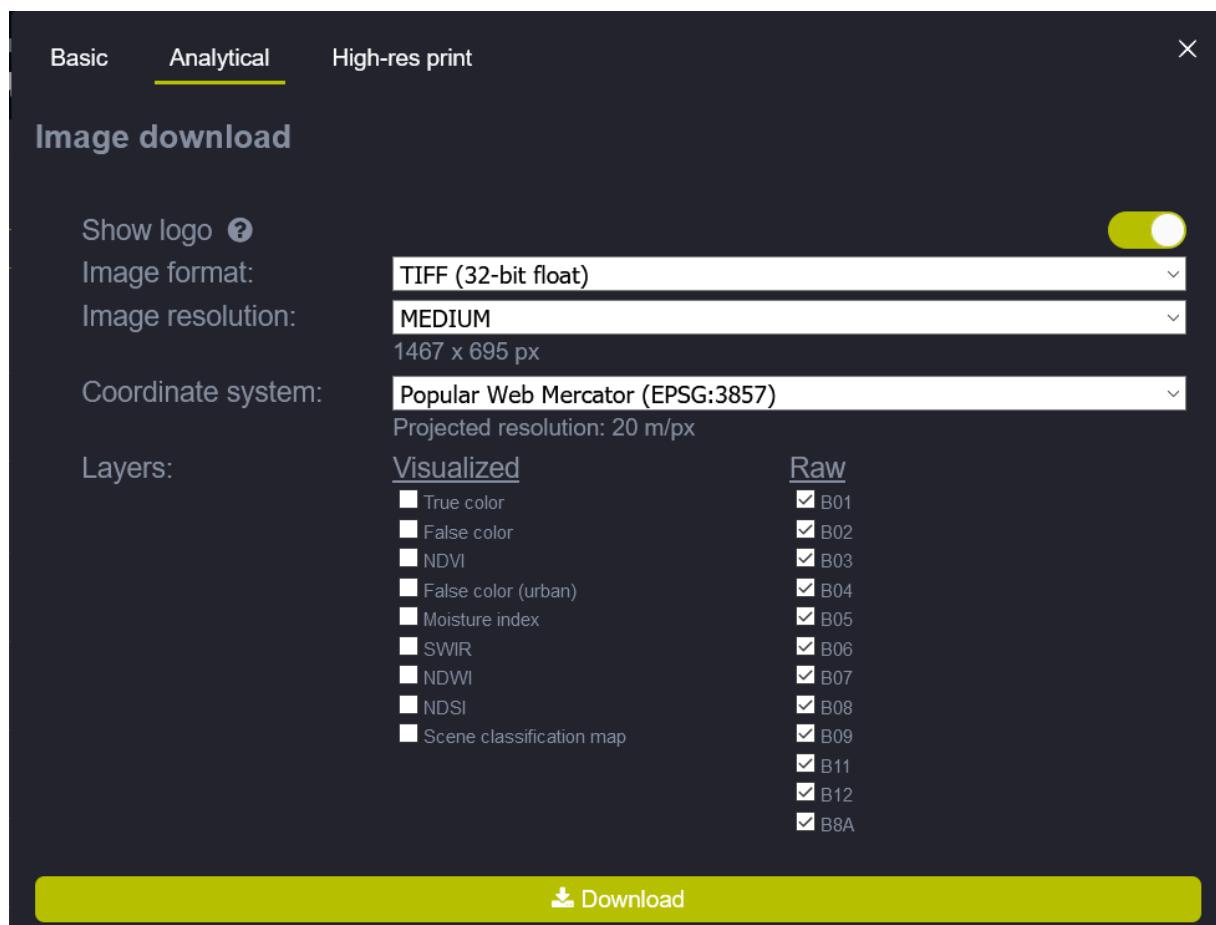
To download an image, click the "Download image" icon on the right side of the screen.



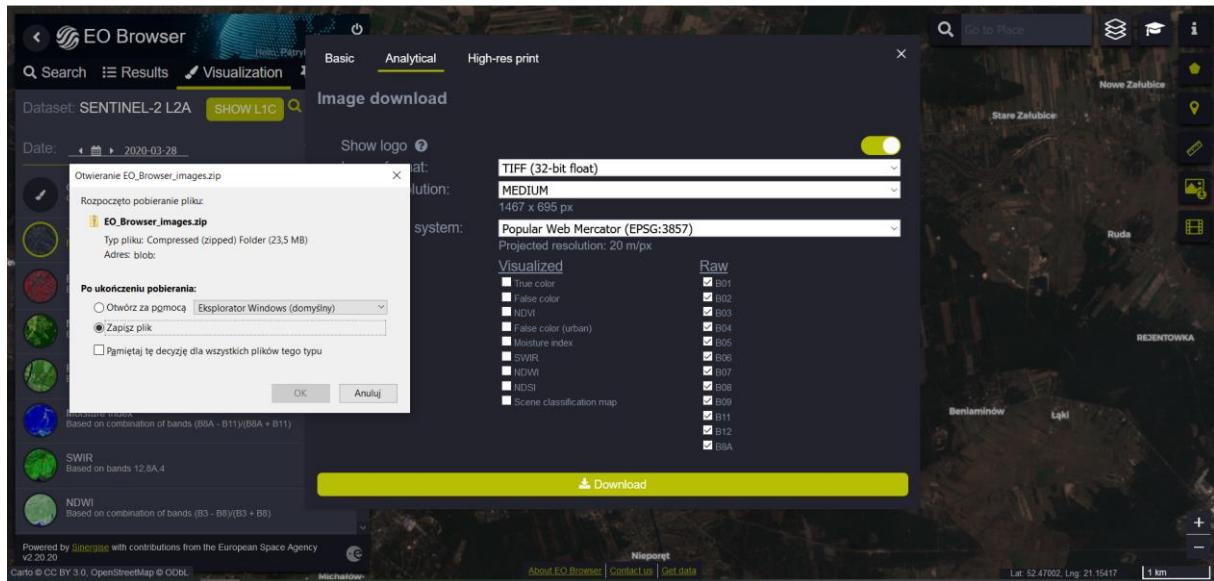
A new window will appear. The "Basic" section will be displayed. By selecting "Download" in this section, a .jpg image will be downloaded in real colors.



Going to the "Analytical" section, it is possible to select a georeferenced image - tiff. By clicking all the boxes in the "Raw" column, data from all bands will be retrieved.



Click on "Download". Remember that only the data for the limited area (which is displayed in the window) will be downloaded, not the whole scene (it is a reason of the small file size).



## FILE'S STRUCTURE OF SENTINEL-2 DATA

### DATA OBTAINED FROM [WWW.SCIHUB.COPERNICUS.EU](http://WWW.SCIHUB.COPERNICUS.EU)

After downloading the data from the sci-hub.copernicus.eu website, open the folder where the downloaded file is located. It will be a compressed into .SAFE file. Extract and open it.

Przeglądarka plików				
Przeszukaj: S2B_MSIL2A_201...				
	Nazwa	Data modyfikacji	Typ	Rozmiar
materialy_szkoleniowe	S2B_MSIL2A_20190828T094039_N0213_R036_T34UEE_20190828T131919.SAFE	28.08.2019 18:20	Folder plików	
S2B_MSIL2A_20190828T094039_N0213_R036_T34UEE_20190828T131919.SAFE	AUX_DATA	28.08.2019 18:20	Folder plików	
S2B_MSIL2A_20190828T094039_N0213_R036_T34UEE_20190828T131919.SAFE	DATASTRIP	28.08.2019 18:20	Folder plików	
S2B_MSIL2A_20190828T094039_N0213_R036_T34UEE_20190828T131919.SAFE	GRANULE	28.08.2019 18:20	Folder plików	
S2B_MSIL2A_20190828T094039_N0213_R036_T34UEE_20190828T131919.SAFE	HTML	28.08.2019 18:20	Folder plików	
S2B_MSIL2A_20190828T094039_N0213_R036_T34UEE_20190828T131919.SAFE	rep_info	28.08.2019 18:20	Folder plików	
S2B_MSIL2A_20190828T094039_N0213_R036_T34UEE_20190828T131919.SAFE	INSPIRE	28.08.2019 18:20	Dokument XML	19 KB
S2B_MSIL2A_20190828T094039_N0213_R036_T34UEE_20190828T131919.SAFE	manifest.safe	28.08.2019 18:20	Plik SAFE	90 KB
S2B_MSIL2A_20190828T094039_N0213_R036_T34UEE_20190828T131919.SAFE	MTD_MSIL2A	28.08.2019 18:20	Dokument XML	52 KB

The name of the file provides the user with a lot of information. Analyzing the above case::

- S2B – The satellite that provided the data - in this case Senitnel-2B;
- MSIL2A – Sensor – MSI and Processing Level - L2A;
- 20190828T094039 – time of capturing image - August 28, 2019, 9:40:39 UTC;
- N0213 – Processing numer;
- R036 – orbit number; number defining the so-called "Track";
- T34UEE – ID of the area that has been visualized - the so-called "granule".

From the point of view of data analysis and processing the most important folder is the "GRANULE" folder. This is where the images are located, in order to see them follow the path:

GRANULE -> L2A\_T34UEE\_A012932\_20190828T094520 (this folder will have a different name for different data)  
-> IMG\_DATA

GRANULE > L2A_T34UEE_A012932_20190828T094520 > IMG_DATA			
	Nazwa	Data modyfikacji	Typ
ep	R10m	28.08.2019 18:20	Folder plików
ty	R20m	28.08.2019 18:19	Folder plików
szkole	R60m	28.08.2019 18:19	Folder plików
o2			
katowi			
ter			
hv			

R10 – spatial resolution of images – 10 m

- AOT – Aerosol Optical Thickness;
- B02 – Band 02 – „blue”;
- B03 – Band 03 – „green”;
- B04 – Band 04 – „red”;
- B08 – Band 08 – „NIR”;
- TCI - True Colour Image;
- WVP – Water Vapour Pressure Image.

R20 - spatial resolution of images - 20 m:

- AOT - Aerosol Optical Thickness;
- B02 – Band 02 – „blue”;
- B03 – Band 03 – „green”;
- B04 – Band 04 – „red”;
- B05 – Band 05 – „red edge 1”;
- B06 – Band 06 – „red edge 2”;
- B07 – Band 07 – „red edge 3”;
- B8A – Band 8A – „NIR narrow”;
- B11 – Band 11 – „SWIR 1”;
- B12 – Band 12 – „SWIR 2”;
- SCL - Scene Classification Image;
- TCI - True Colour Image;
- WVP - Water Vapour Pressure Image.

R60 - spatial resolution of images - 60 m:

- AOT - Aerosol Optical Thickness;
- B01 – Band 01 – „coastal aerosol”;
- B02 – Band 02 – „blue”;

- B03 – Band 03 – „green”;
- B04 – Band 04 – „red”;
- B05 – Band 05 – „red edge 1”;
- B06 – Band 06 – „red edge 2”;
- B07 – Band 07 – „red edge 3”;
- B8A – Band 8A – „NIR narrow”;
- B09 – Band 09 – „water vapour”;
- B11 – Band 11 – „SWIR 1”;
- B12 – Band 12 – „SWIR 2”;
- SCL - Scene Classification Image;
- TCI - True Colour Image;
- WVP - Water Vapour Pressure Image.

#### DATA OBTAINED FROM [WWW.SENTINEL-HUB.COM](http://WWW.SENTINEL-HUB.COM) – EO BROWSER

After downloading the data from sentinel-hub.com, open the folder where the downloaded file is located. It will be a compressed into .ZIP file. Extract and open it.

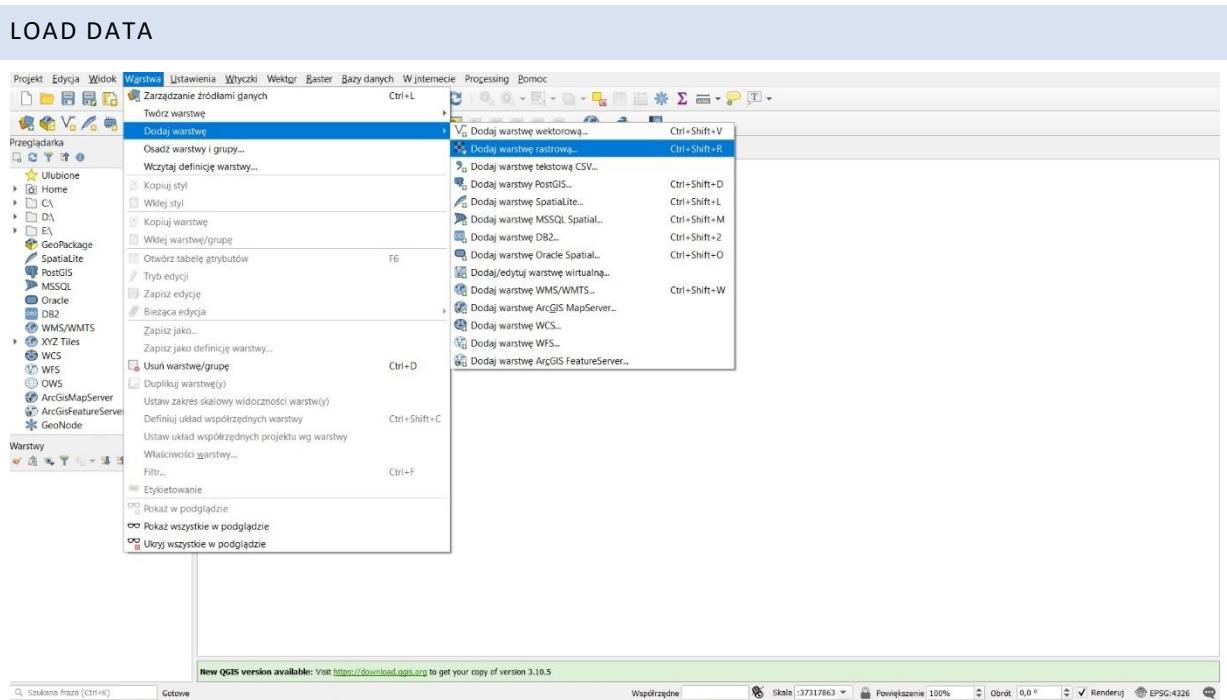
igik > fpcup > materiały_szkoleniowe > EO_Browser_images		▼	↻	🔍 Przeszukaj: EO_Browser_im...
Nazwa	Typ	Rozmiar po skompresji	Chronione	Rozmiar
2020-03-28, Sentinel-2B L2A, B01	Plik TIFF	1 532 KB	Nie	1
2020-03-28, Sentinel-2B L2A, B02	Plik TIFF	1 863 KB	Nie	1
2020-03-28, Sentinel-2B L2A, B03	Plik TIFF	1 888 KB	Nie	1
2020-03-28, Sentinel-2B L2A, B04	Plik TIFF	1 948 KB	Nie	1
2020-03-28, Sentinel-2B L2A, B05	Plik TIFF	1 995 KB	Nie	1
2020-03-28, Sentinel-2B L2A, B06	Plik TIFF	2 105 KB	Nie	2
2020-03-28, Sentinel-2B L2A, B07	Plik TIFF	2 143 KB	Nie	2
2020-03-28, Sentinel-2B L2A, B08	Plik TIFF	2 027 KB	Nie	2
2020-03-28, Sentinel-2B L2A, B8A	Plik TIFF	2 164 KB	Nie	2
2020-03-28, Sentinel-2B L2A, B09	Plik TIFF	2 044 KB	Nie	2
2020-03-28, Sentinel-2B L2A, B11	Plik TIFF	2 214 KB	Nie	2
2020-03-28, Sentinel-2B L2A, B12	Plik TIFF	2 188 KB	Nie	2

The structure of the folder containing the data downloaded by the EO-Browser service has a simple structure. Folder contains 12 images, no extra files.

- B01 – „coastal aerosol”;
- B02 - „blue”;
- B03 – „green”;
- B04 – „red”;
- B05 – „red edge 1”;
- B06 – „red edge 2”;
- B07 – „red edge 3”;
- B08 – „NIR”
- B8A – „NIR narrow”;
- B09 – „water vapour”;
- B11 – „SWIR 1”;
- B12 – „SWIR 2”.

#### WORK WITH SATELLITE DATA IN QGIS

For further exercises, the free QGIS software version 3.4 "Madeira" will be used. Download the software at <https://qgis.org/en/site/forusers/download.html>.



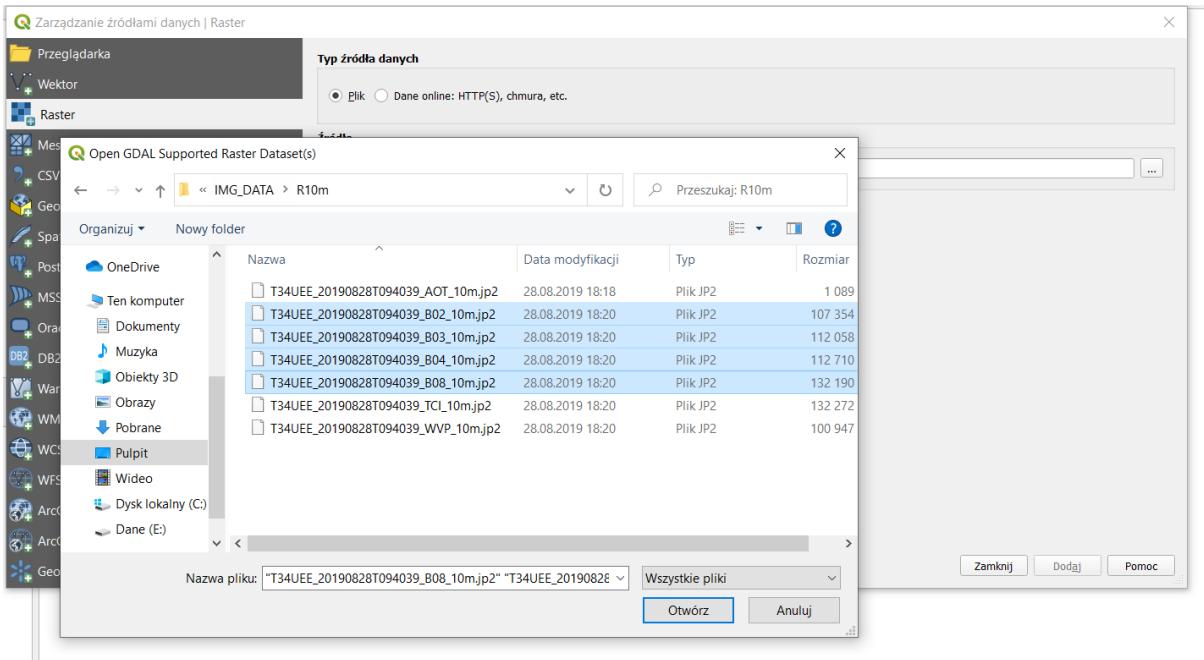
To add satellite images for analysis in QGIS, select:

Layer -> Add Layer -> Add Raster Layer...

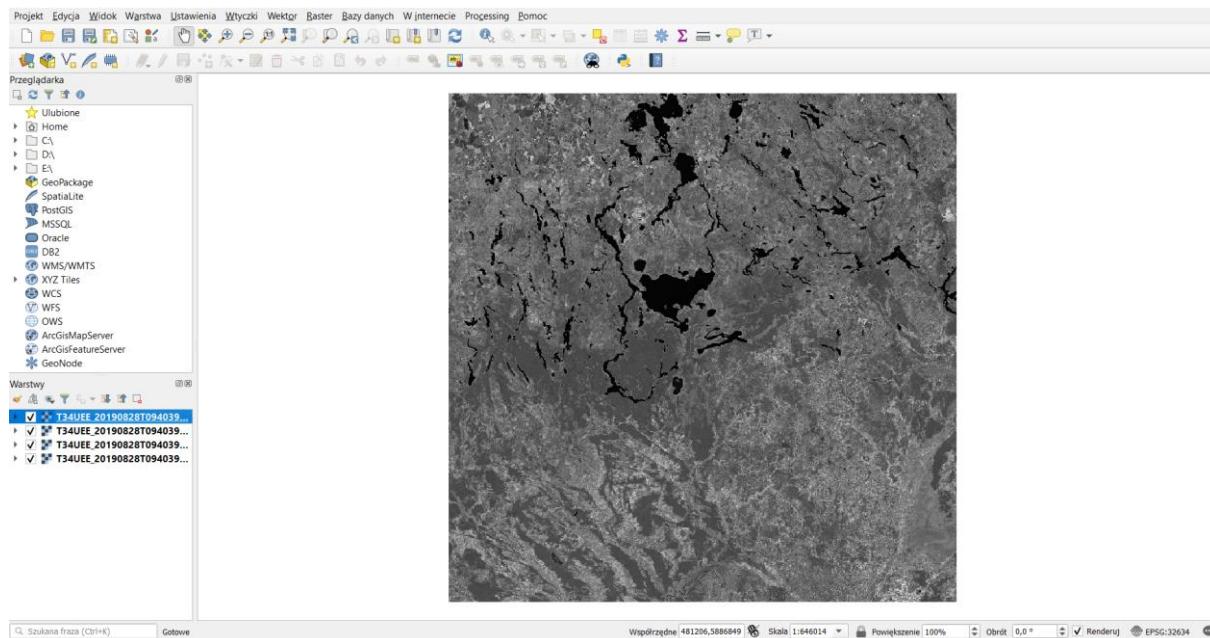
Then, click on the ellipses on the right side of the window. During this exercise you will use data from WWW.SCIHUB.COPERNICUS.EU. You need to get to the folder containing this data. Data of 10 m spatial resolution will be analyzed. Path reminder:

GRANULE -> L2A\_T34UEE\_A012932\_20190828T094520 -> IMG\_DATA -> R10

Bands necessary to create the RGB composition (B02, B03, B04) and calculate the NDVI index (B02, B03, B04, B08) will be used. Select them and click "Open", confirm "Add" and close the window.



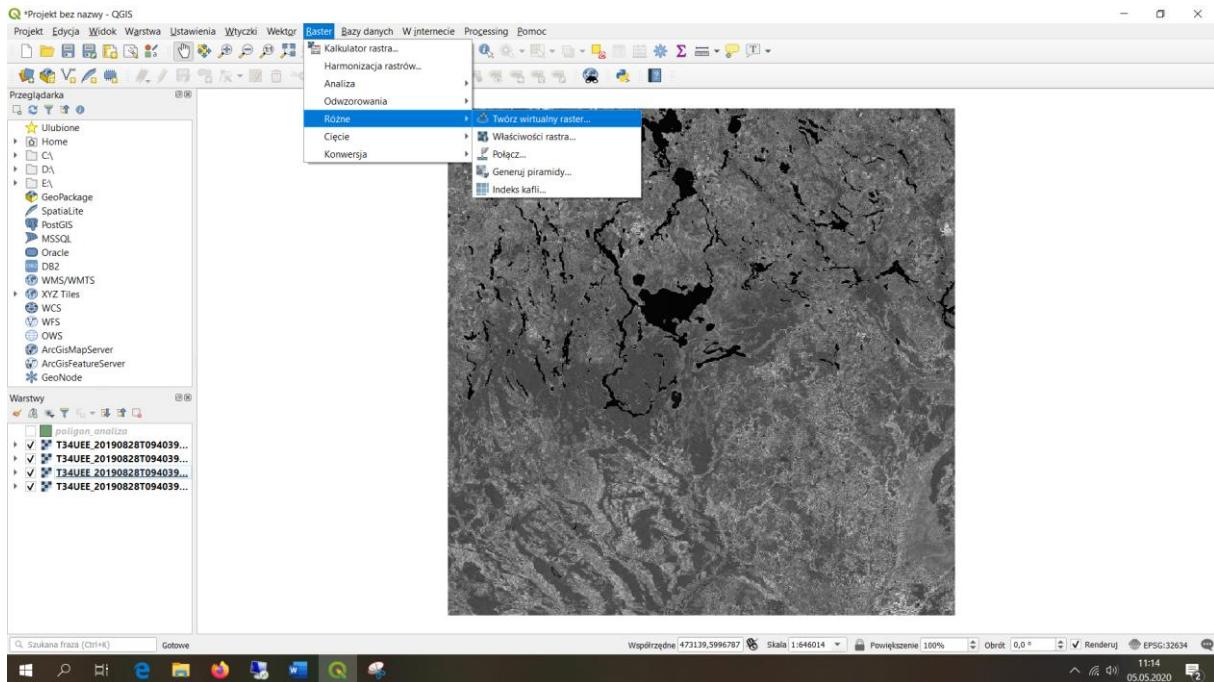
The loaded data should look like this:



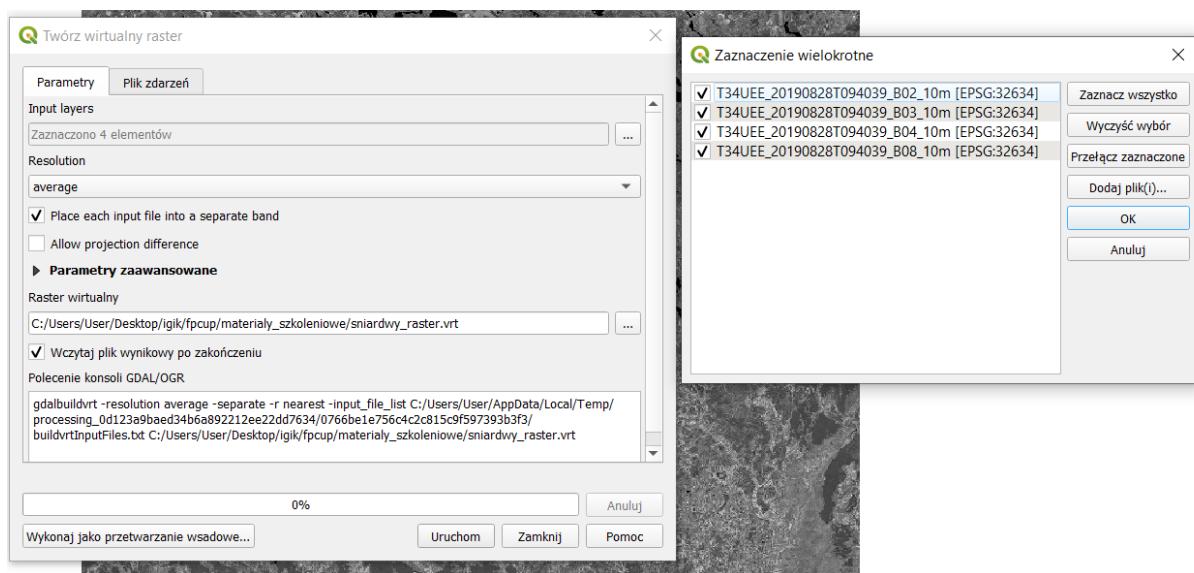
## CREATING OF THE MULTIBAND IMAGE

At this point, 4 images are loaded. It is necessary to create a multiband image - the so-called virtual raster to be able to perform operations such as creating color compositions. This operation involves "combining", in this case 4 images, into one image.

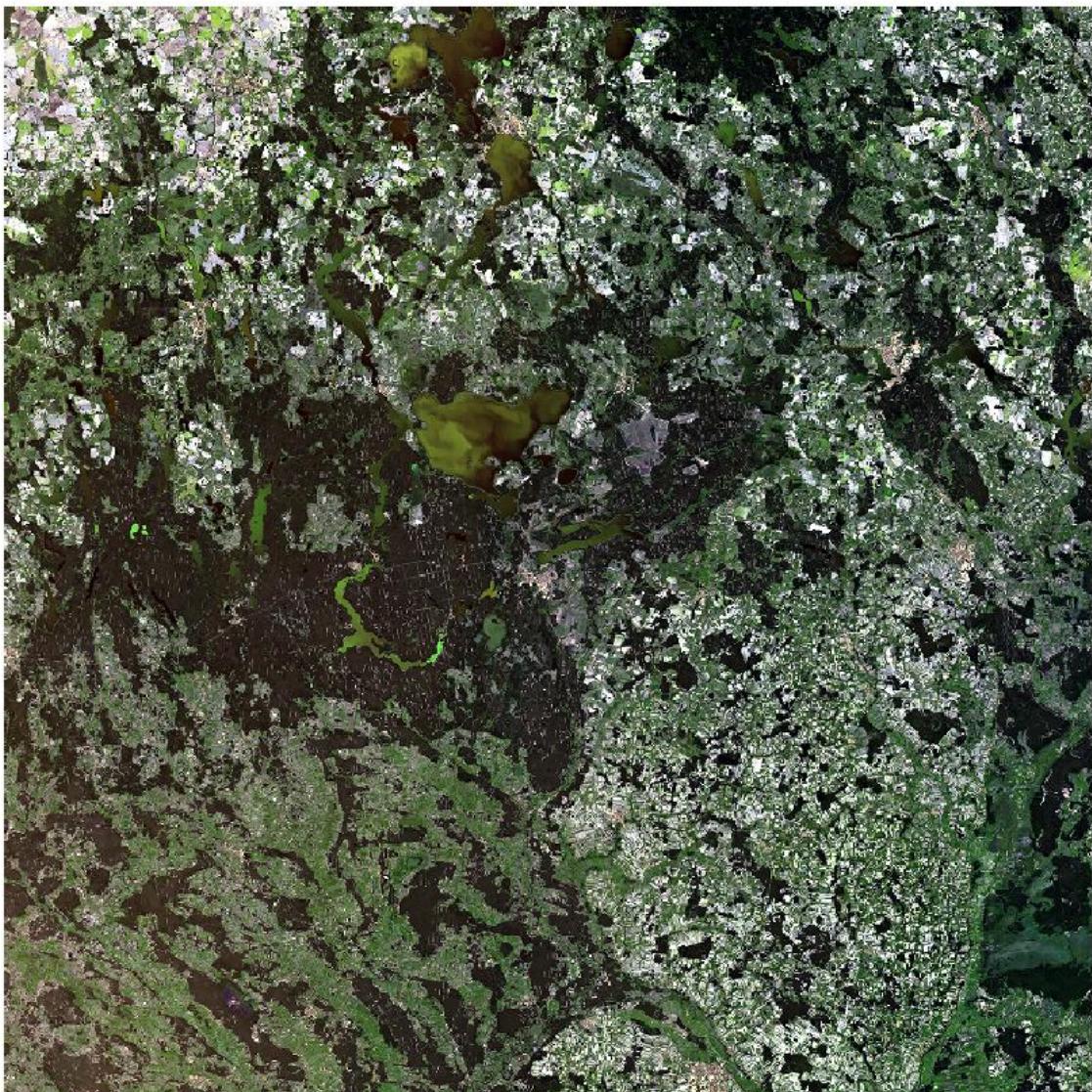
Baster -> Miscellaneous-> Build Virtual Baster...



As a "Input layers", specify 4 images that will be combined into one. It is extremely important to mark the point "Place each input file into a separate band". Thanks to that each image becomes a separate band. In the window under "Virtual raster", specify the saving path of the created file.



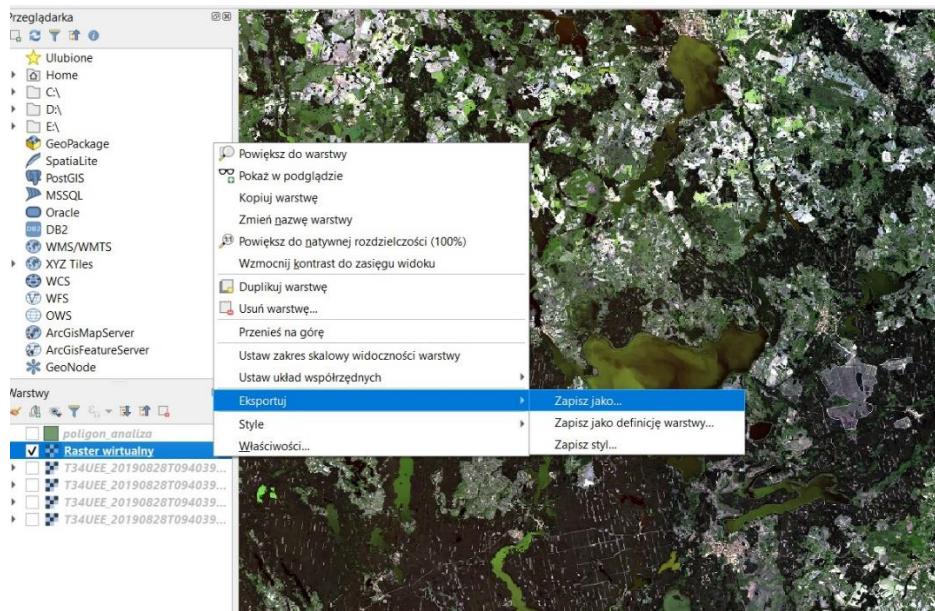
The operation must be confirmed by clicking "Run". The result should look like this later.



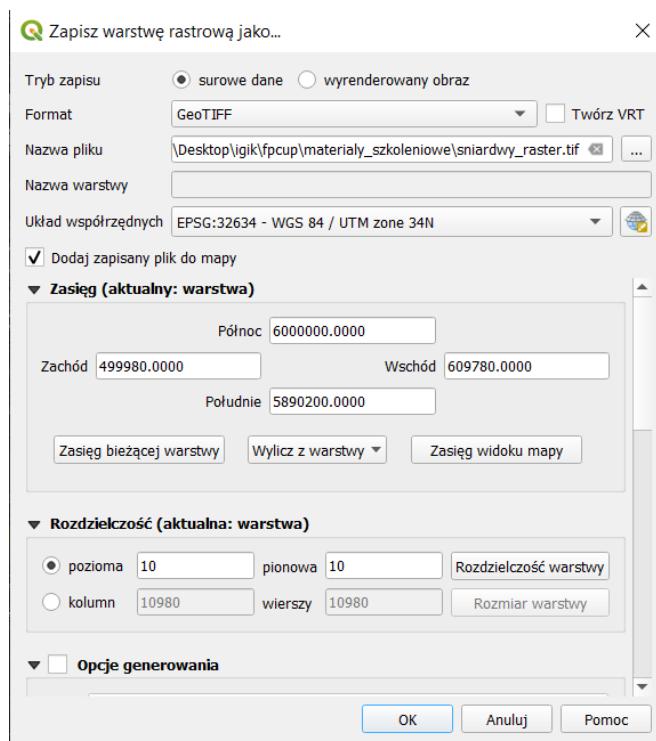
#### CONVERSION TO .TIF

The result of the operation is an image-file with the .vrt extension. It is worth converting to .tif file due to its greater versatility.

Virtual raster (created at the previous point) -> Right mouse button (RMB) -> Export -> Save as...



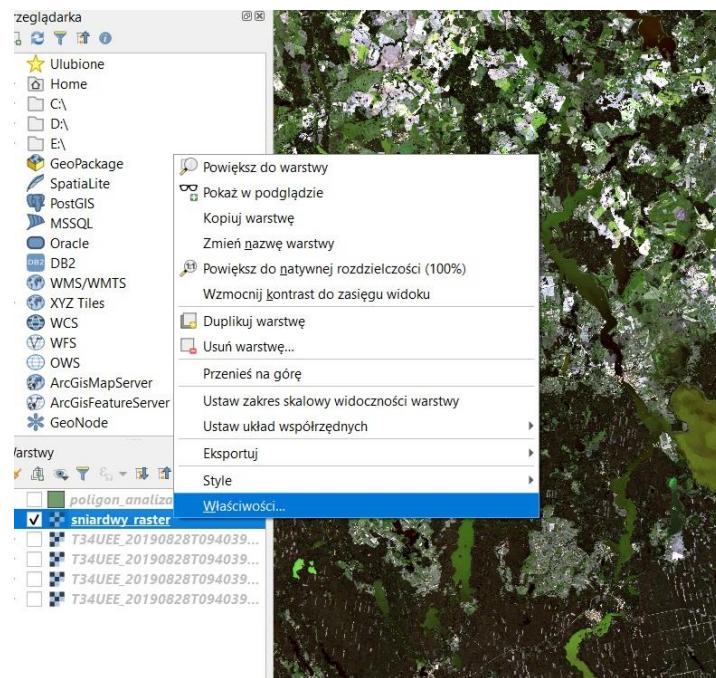
In the format section, select "GeoTIFF". In file name section specify the name of the new raster with the .tif extension. Define the saving path.



The new image will be automatically loaded into the program.

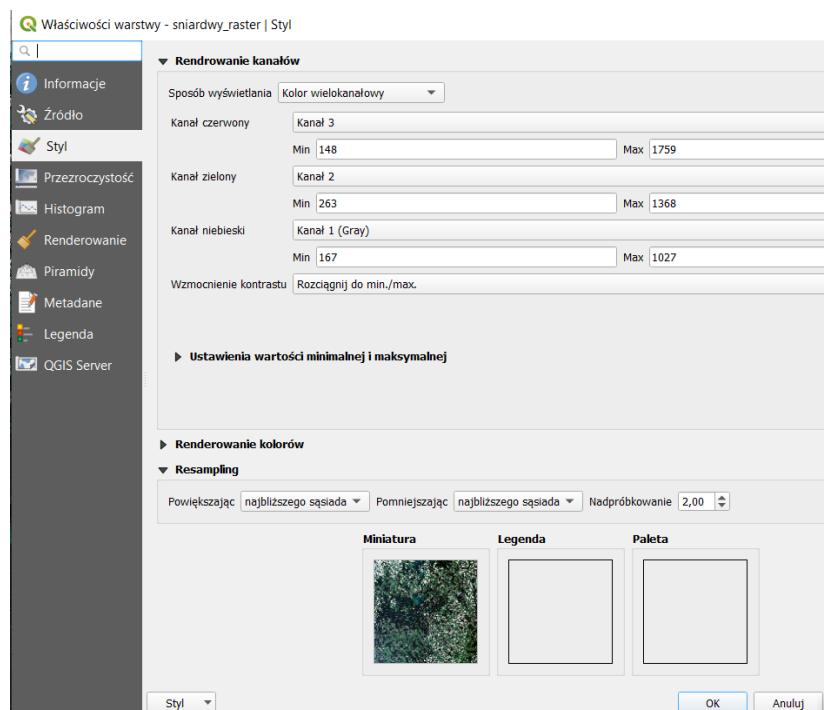
## COLOUR COMPOSITION

The resulting image assumed unnatural colors by default. To display it in natural colors, i.e. RGB composition, it should be set in display properties.

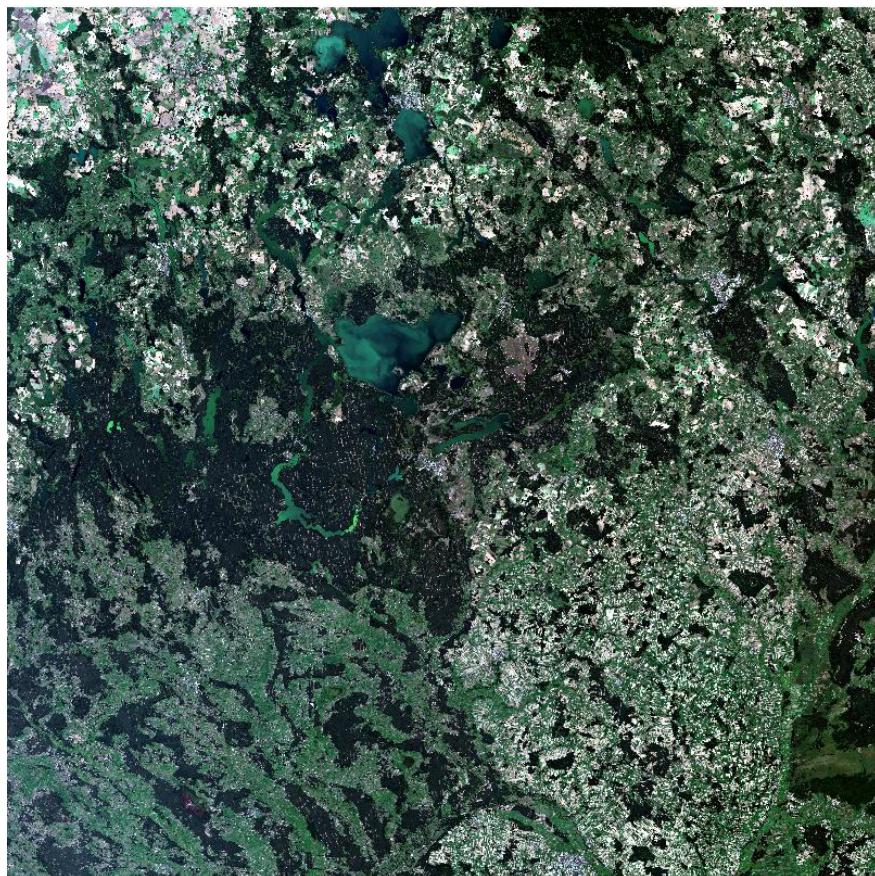


RMB (image) -> Properties -> Symbology

It is necessary to enter the "Symbology" tab in "Properties". In the window, select the red band! – band 03, green band - band 2, blue band - channel 1. Confirm with "OK".



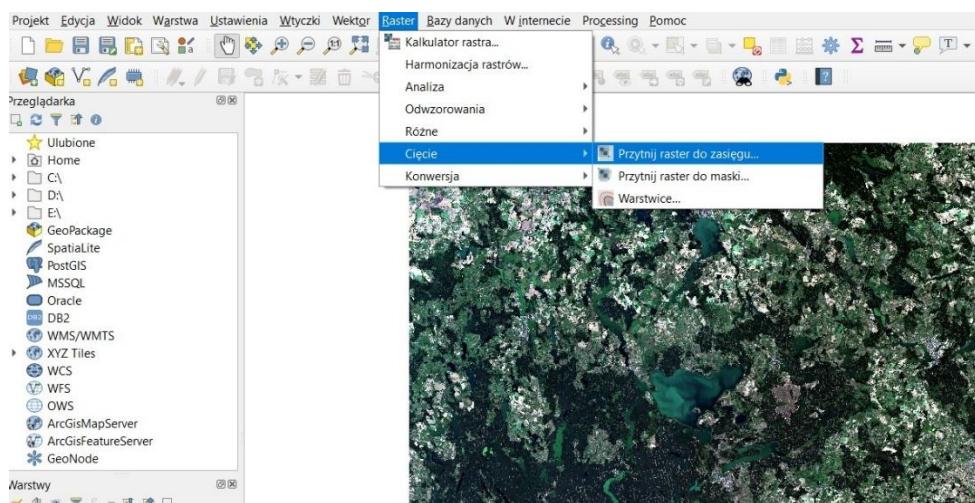
Result:



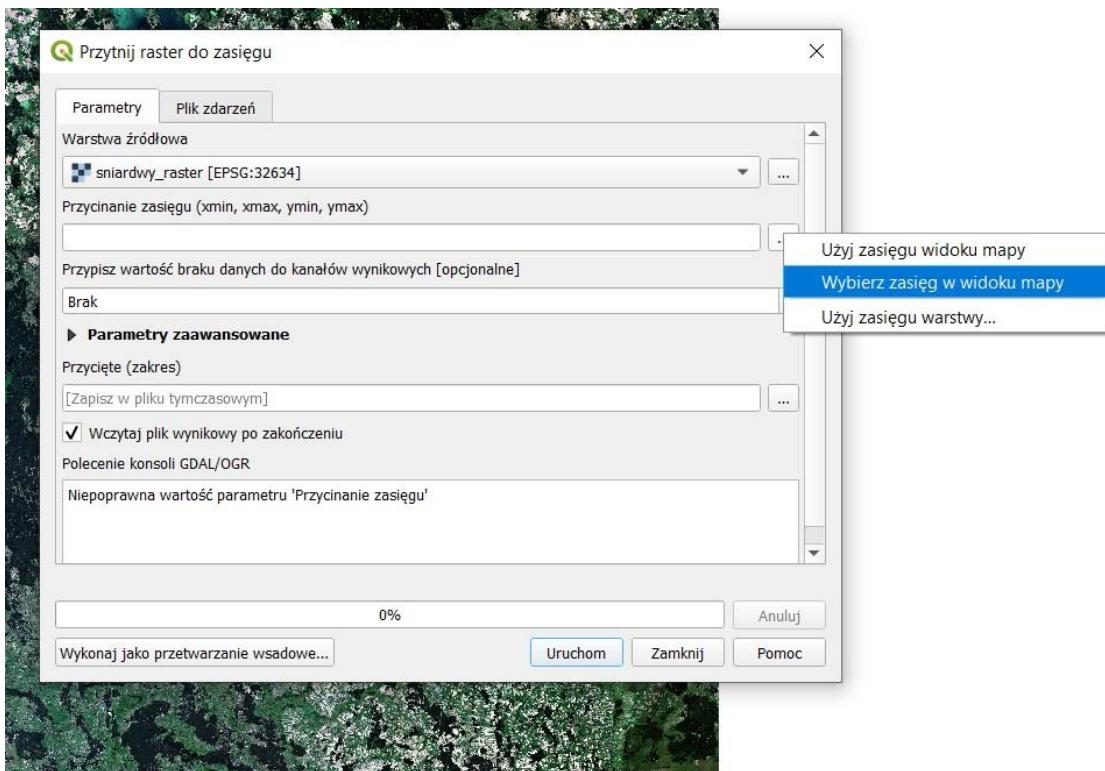
## EXTRACTION OF IMAGE

The area nearby of Śniardwy Lake will be analyzed. You should crop the image to the area of interest in order to not to overload the computer with processing unnecessary data and to reduce the time spent working on the data.

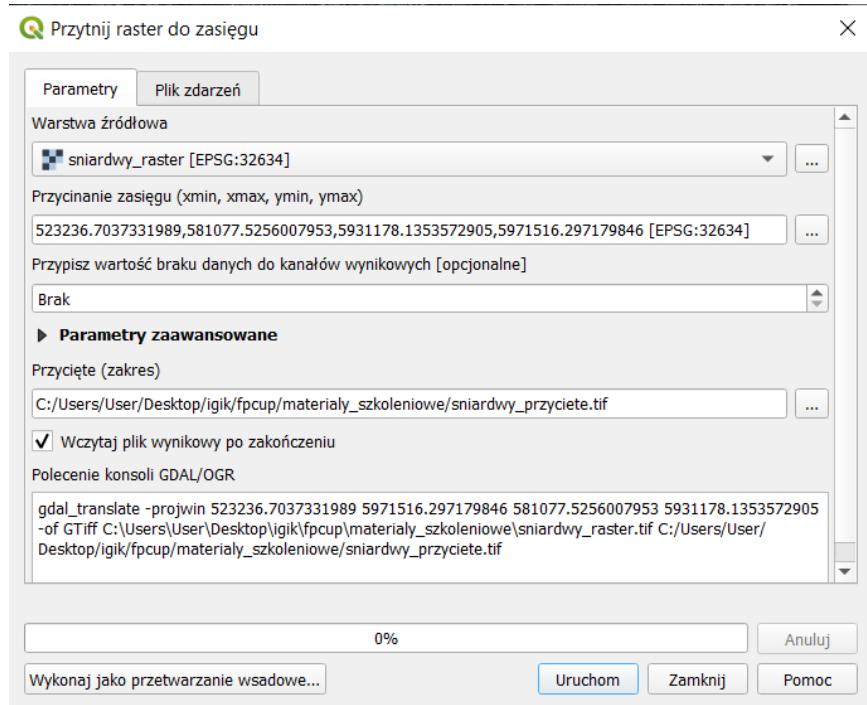
Raster -> Extraction-> Clip Raster by Extent...



To crop the image to the extent that you want to define by yourself, click the ellipses under the "Clipping extent" window and then select "Select extent on canvas".



The "Menu" window will automatically disappear and the user will be able to draw the rectangle to the border of which the image will be cropped. In the "Clipped (extent)" window, specify the saving path, file name and extension (default .vrt, select .tif). Confirm by clicking "Run".

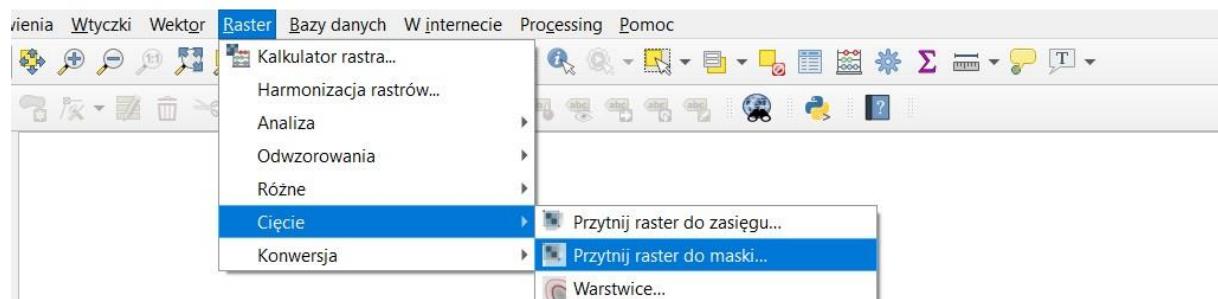


After loading a new image, it will be displayed in an unnatural color by default. To change it to RGB, follow the steps in the previous exercise. Below is the effect of the operation.

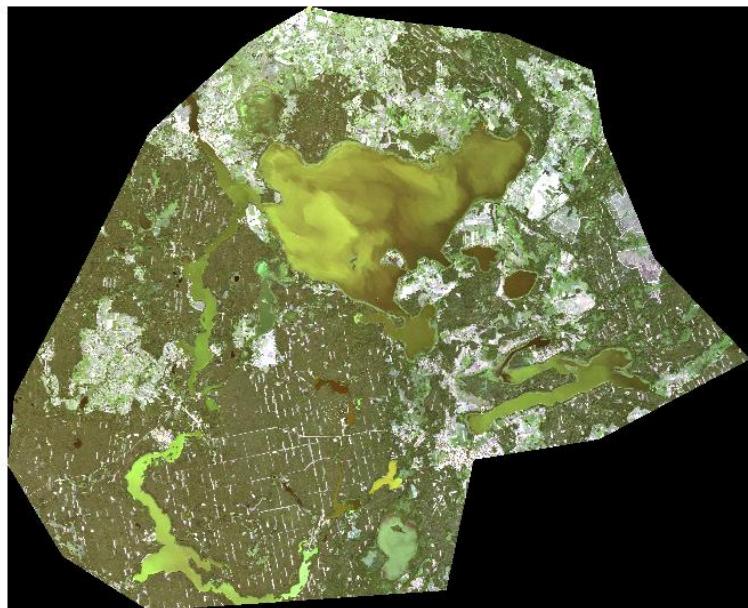


Another way to crop an image is to crop it to a vector layer, such as a reserve border, parcel or user-specified area. For the purposes of the exercise, the vector file "poligon\_analiza" was created, which is an irregular polygon covering the area around Śniardwy Lake.

Raster -> Extraction -> Clip Raster by Mask Layer...



Input layer: the image to be clipped (in this case, a virtual raster in .tif format). Mask layer: a polygon in .shp format that defines the range of extraction. Clipped (Mask): save path, name and format (.tif). Confirm "Run". The effect of the operation below.



#### HOW TO COMPUTE NDVI

In this exercise, you will use a .tif image that was cropped to a rectangle (first method, in the previous exercise - sniardwy\_przyciete.tif). The values of the NDVI index - Normalized Difference Vegetation Index - will be calculated. An index determines the condition of vegetation. It takes values from -1 to 1, where values closer to 1 mean the vegetation is in better condition. It can also be used to identify areas vegetation-non-vegetation, because the areas not covered with plants should have values lower than 0.4.

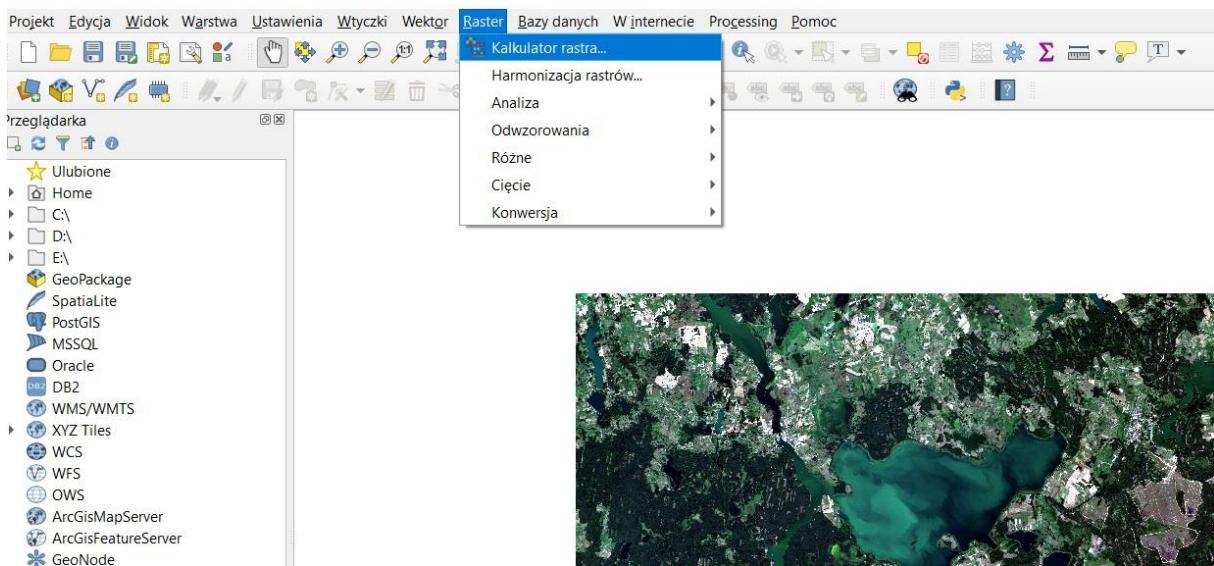
NDVI equation:

$$NDVI = \frac{NIR - RED}{NIR + RED}$$

RED – red light recording band(so-called "red channel")

NIR – near-infrared light recording band (so-called "NIR channel")

Raster -> Raster calculator...



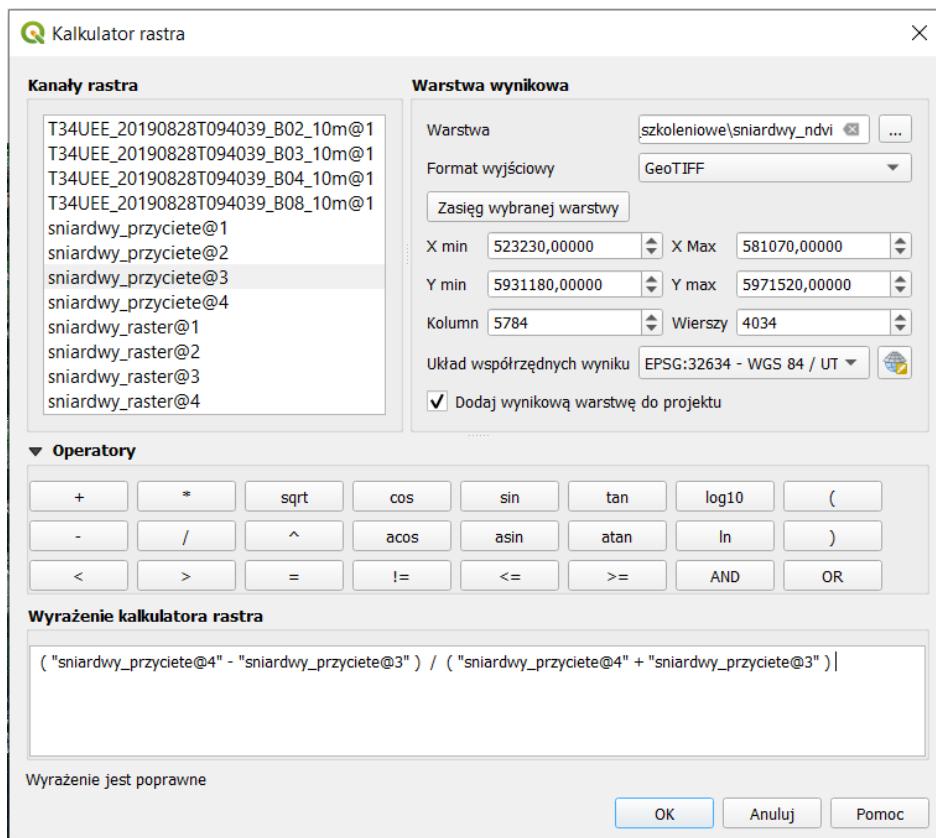
Remember which channels corresponded to the given ranges (in the image that is analyzed):

- Band 3 – kanał RED;
- Band 4 – kanał NIR.

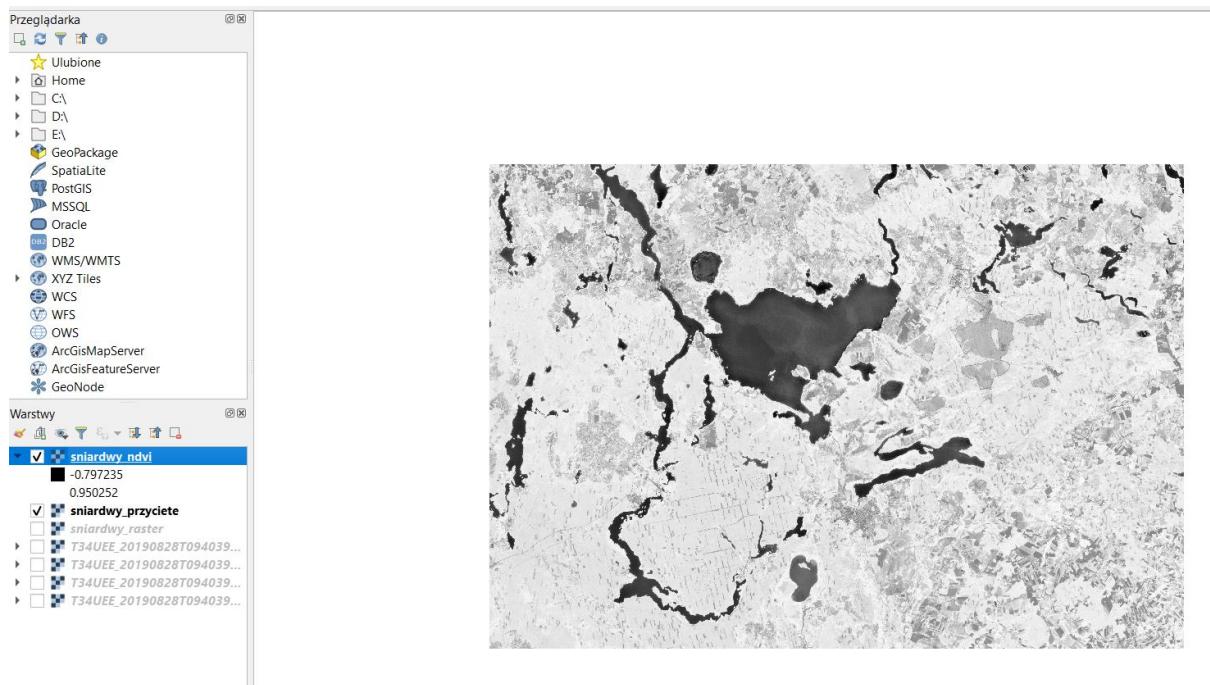
In the "Raster Calculator Expression" section, therefore, enter the following:

`(„sniardwy_przyciete@4” - „sniardwy_przyciete@3”) / („sniardwy_przyciete@4” + „sniardwy_przyciete@3”)`

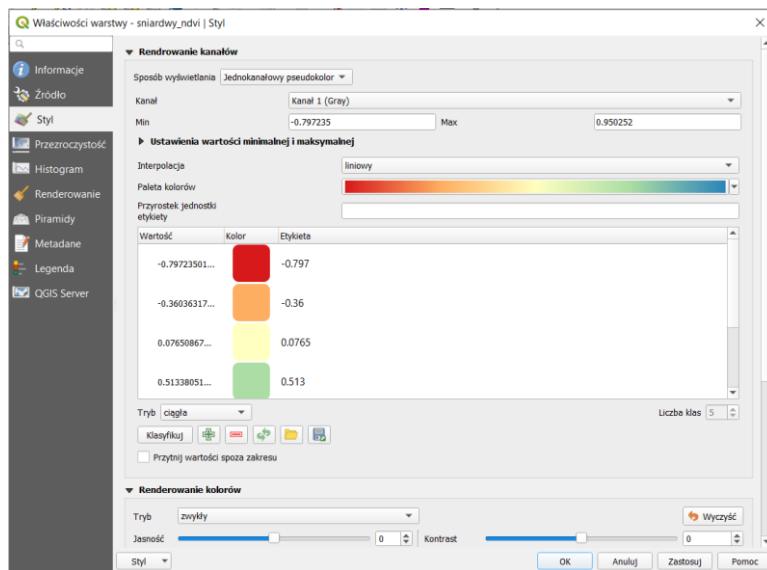
In "Output layer", specify the save path, file name. Then, select "GeoTIFF" as "Output format". Confirm with "OK".



Result:

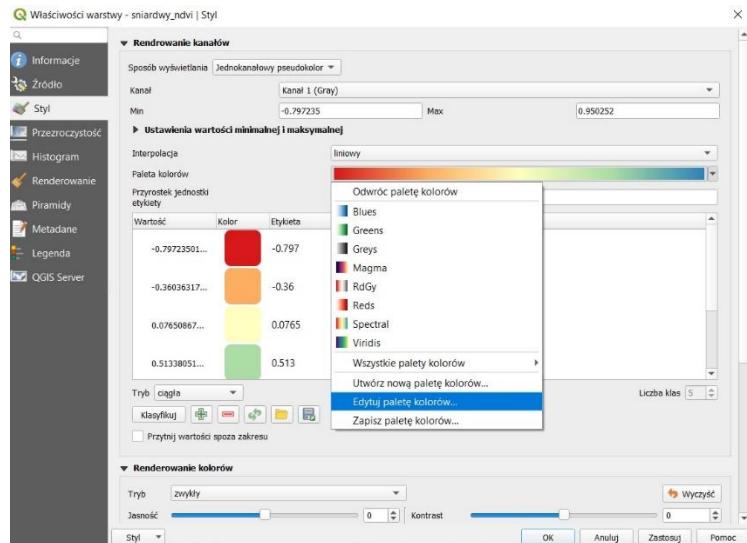


Identification of water areas is very easy due to low NDVI values. In the image above, water areas are defined as black pixels. Considering that it is mainly about vegetation such image is not intuitive. Therefore, the color palette should be changed. It is necessary to enter the "Properties" of the file and the "Symbology" tab. In the "Render type" section, select "Singleband pseudocolor".

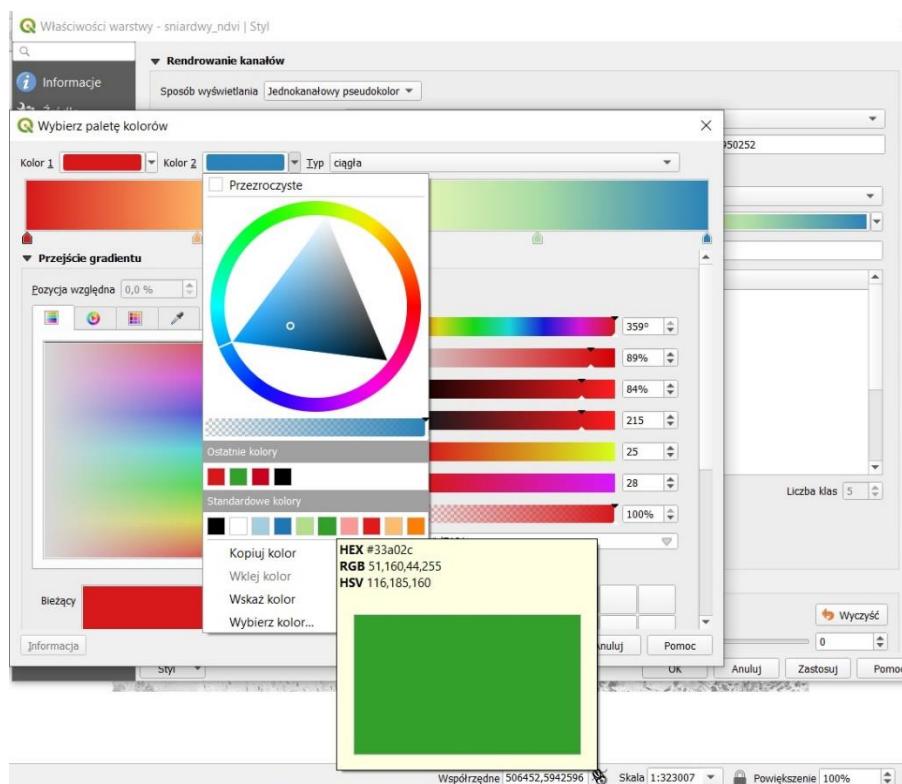


By default, the pixels with the highest values will be coloured to blue, so you should change it that these pixels become close to green.

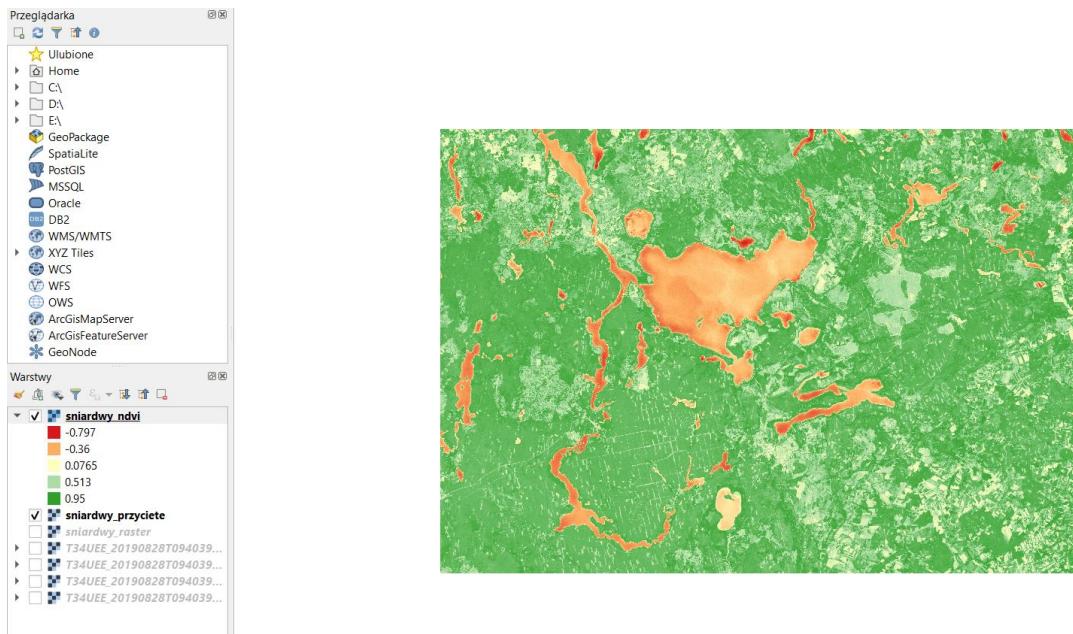
RMB on Color Ramp -> Edit Color Ramp...



In the window next to "Color 2", select green.



Confirm by clicking "OK". Below is the result.

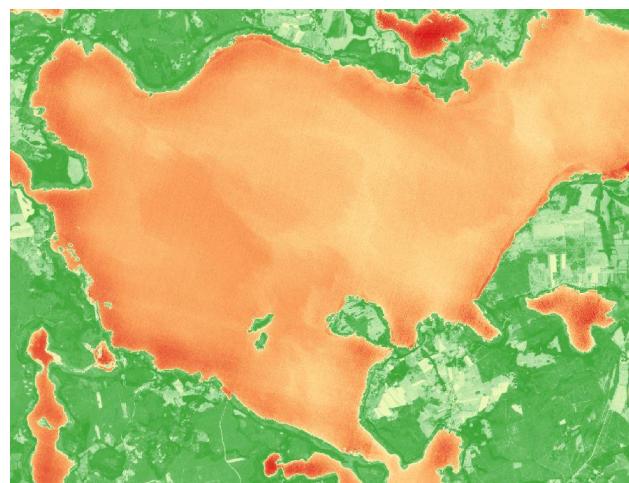


Zoom it and you will notice clear differences in the presentation of areas with specific land cover.

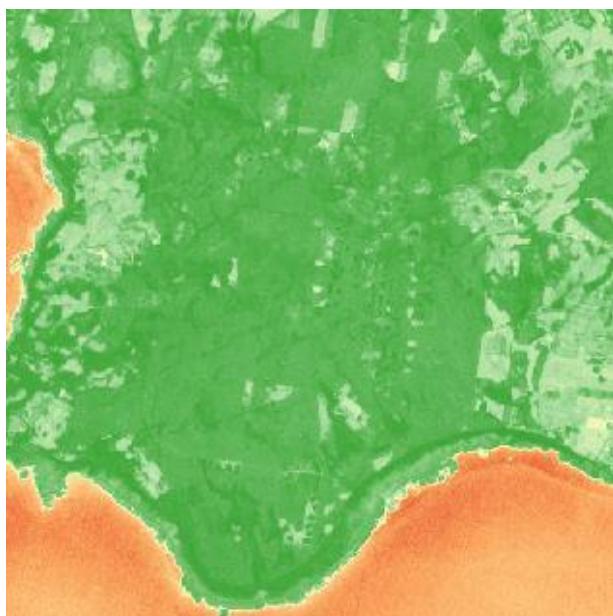
Built-up areas - city



Water areas



## Forests



Farmland - fields in the central part of the drawing (yellow), not covered with vegetation - bare soil.



## SUMMARY

This guide provided information on downloading satellite images from two different services, described the structure of the downloaded satellite data files and described the basic possibilities of working with satellite images from the Sentinel-2 in the QGIS software.

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