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PONTOS VIRTUAL TRAINING MODULES

December 2022

PONTOS-EU.AUA.AM

AUA ACOPIAN CENTER for the ENVIRONMENT

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DEMOCRITUS UNIVERSITY OF THRACE

GREEN ALTERNATIVE

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Module 4

The Application of Earth Observation: Wetland & Floating Vegetation Changes with the example of Assessments via PONTOS platform

Please contact imanakos@iti.gr / lefkats@iti.gr for more information

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Responsible Partner: Center for Research and Technology Hellas (CERTH)
Supporting Partner: Odessa National I.I. Mechnikov University (ONU)
Slides and Scripts prepared by: MSc Eleftherios Katsikis, Dr. Ioannis Manakos
Contact Information: lefkats@iti.gr , imanakos@iti.gr

This module is developed in the framework of the BSB 889 PONTOS Project

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LEARNING OBJECTIVES OF MODULE 1

Familiarize with the QGIS software

Download and preprocess Sentinel-2 images

Understanding the Watermaks and Hydroperiod workflow

Familiriaze with the PONTOS Web Application for the Watermask and Hydroperiod generation

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MODULE STRUCTURE

Background knowledge:

1. Introduction
2. Images download via Copernicus access hub
3. Add layers to QGIS and preprocessing
4. Watermask map generation
5. Hydroperiod map generation from series of Watermasks

Watermask and Hydroperiod generation via PONTOS Web Application:

1. Register and login
2. Dataset Viewer
3. Watermask map generation, visualization and output download
4. Hydroperiod map generation, visualization and output download

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Background knowledge (QGIS implementation)

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Introduction

The Watermask module generates a classified map that seperates the area in four different classes:

- Land
- Open water
- Emergent vegetation
- Floating vegetation

The Hydroperiod module generates a hydroperiod map from series of water masks, falling within the time period between the starting and the ending date of hydroperiod, by applying the following interpolation approach. For two dates separated by n days, the occurrence of water is compared. If a pixel is inundated on both dates, then it is assumed inundated for n-days. If a pixel is not inundated on both dates, then it is assumed inundated for n/2 days. The total number of days of inundation per pixel in the Hydroperiod map is determined by accumulating the water masks throughout the desired time period.

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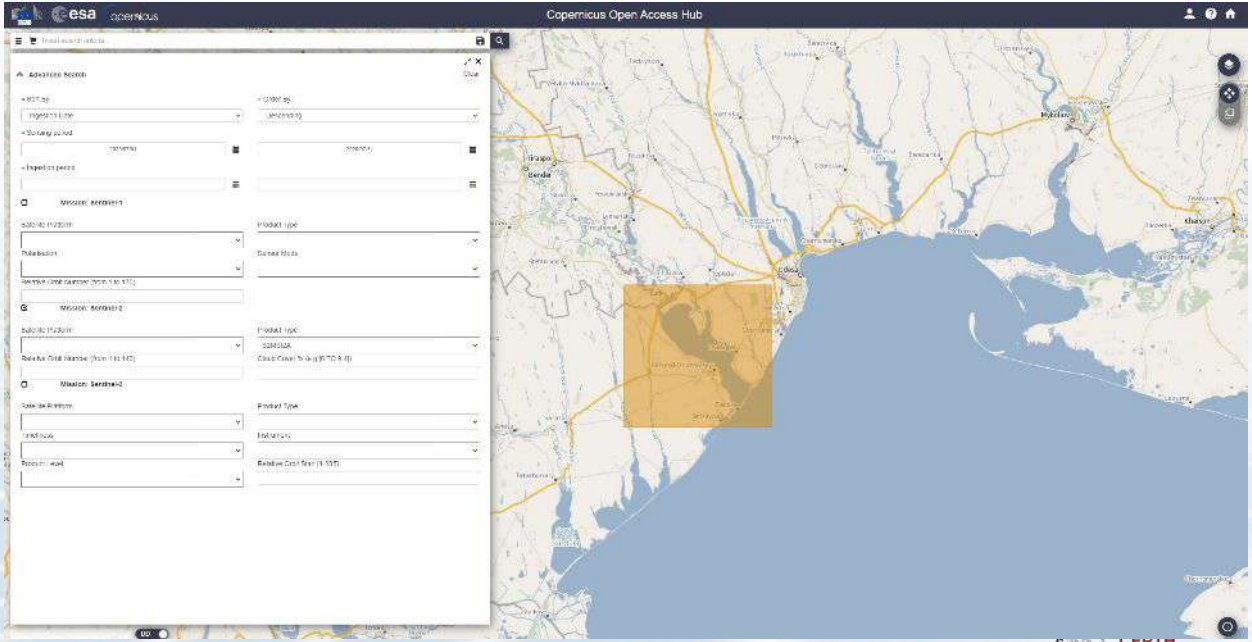
Sentinel-2 images download

Steps:

1. Sentinel-2 images can be downloaded from the link: https://scihub.copernicus.eu/dhus/#/home
2. Denoting the area of interest
3. Define the criteria for downloading data (Sensing Period, Cloud Coverage, etc.)



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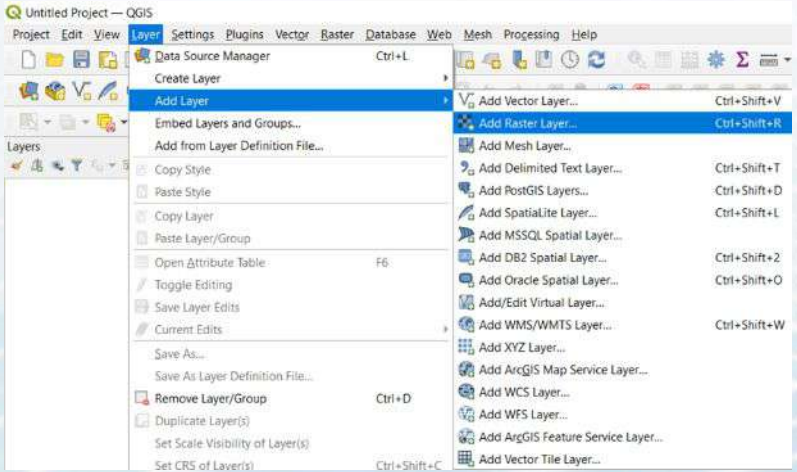
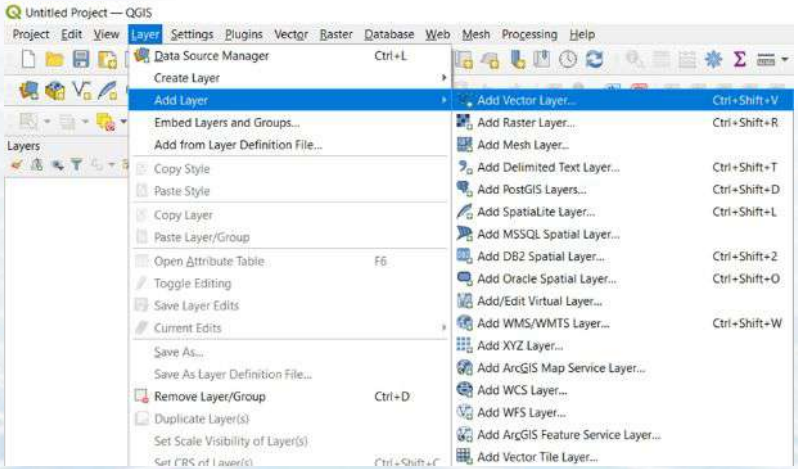
Add layers

Add raster layer:
Layer -> Add Layer -> Add Raster Layer



Add shape file:
Layer -> Add Layer -> Add Vector Layer



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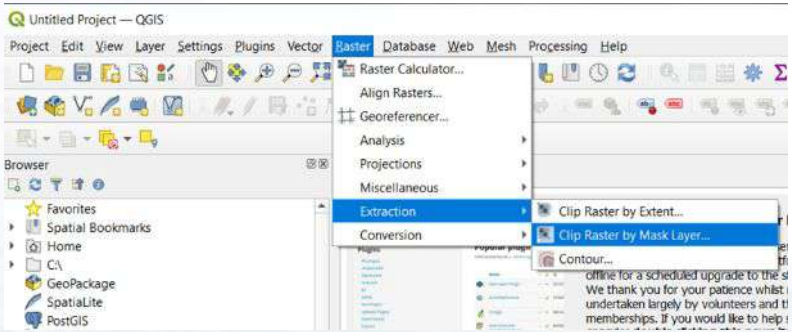
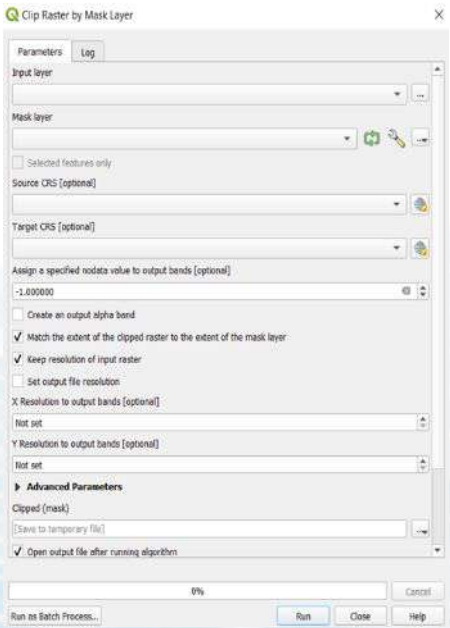
Crop a raster to the boundaries of the shapefile (1)





Steps:

1. Layer panel -> Raster -> Extraction -> Clip Raster by Mask Layer
2. Fill the form as below:

- insert path to input layer (pick one of the ".jp2")
- insert path of the mask layer (select the .shp file)
- check box "No data value" and set value to -1
- check "Match the extent of the clipped raster to the extent of the mask layer" and "keep resolution of input layer"
- insert path to Clipped (mask) to save the output

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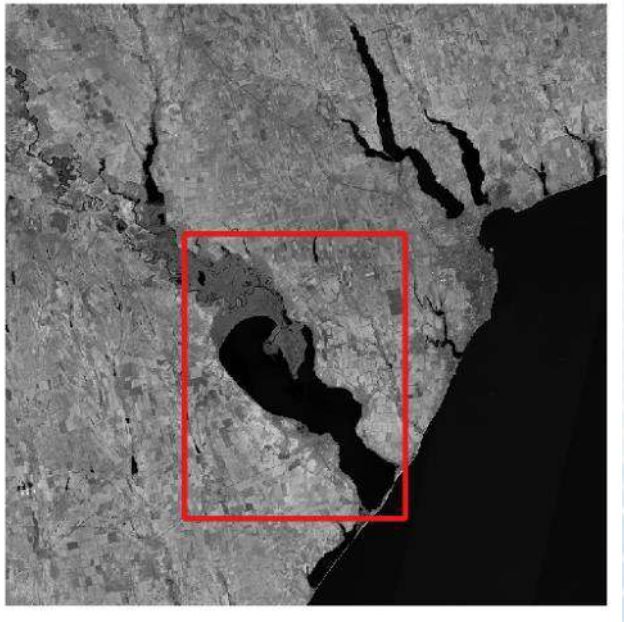
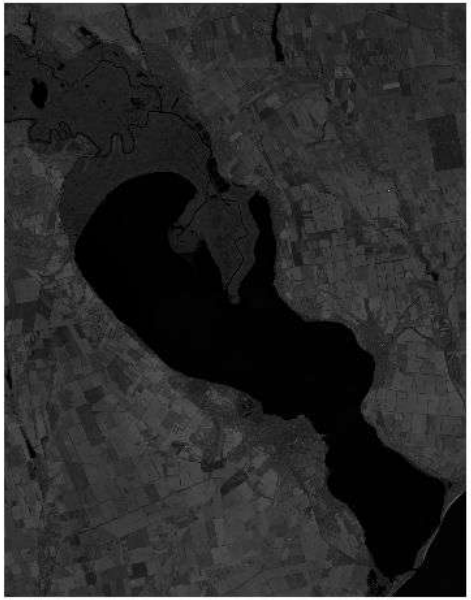
Crop a raster to the boundaries of the shapefile (2)





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Sentinel-2 bands

Sentinel-2 Bands	Central Wavelength (μm)	Resolution (m)	Bandwidth (nm)
Band 1 – Coastal aerosol	0.443	60	20
Band 2 – Blue	0.490	10	65
Band 3 – Green	0.560	10	35
Band 4 – Red	0.665	10	30
Band 5 – Vegetation Red Edge	0.705	20	15
Band 6 – Vegetation Red Edge	0.740	20	15
Band 7 – Vegetation Red Edge	0.783	20	20
Band 8 – NIR	0.842	10	115
Band 8A – Narrow NIR	0.865	20	20
Band 9 – Water vapour	0.945	60	20
Band 10 – SWIR – Cirrus	1.375	60	20
Band 11 – SWIR	1.610	20	90
Band 12 – SWIR	2.190	20	180

Required bands for the Watermask and Hydroperiod generation

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NDVI index generation

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

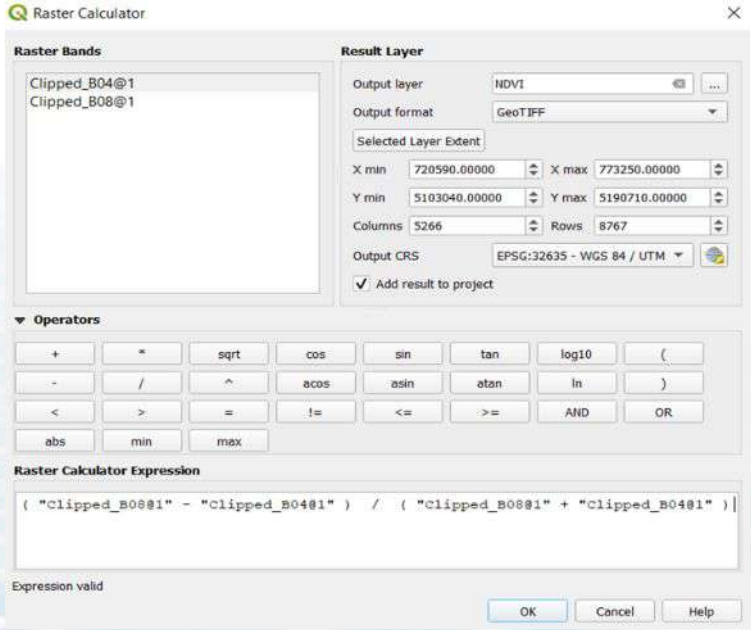
Steps:

- Layer panel -> Raster -> Raster Calculator

- Raster Calculator Expression:

("Clipped_B08@1"-"Clipped_B04@1")/("Clipped_B08@1" +"Clipped_B04@1")

- Output Layer: “NDVI”



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NDVI index

NDVI (Normalized Difference Vegetation Index): The Normalized Difference Vegetation Index (NDVI) measures the greenness and the density of the vegetation captured in a satellite image. Healthy vegetation has a very characteristic spectral reflectance curve which we can benefit from by calculating the difference between two bands – visible red and near-infrared. NDVI is that difference expressed as a number – ranging from -1 to 1.

*https://eos.com/make-an-analysis/ndvi/

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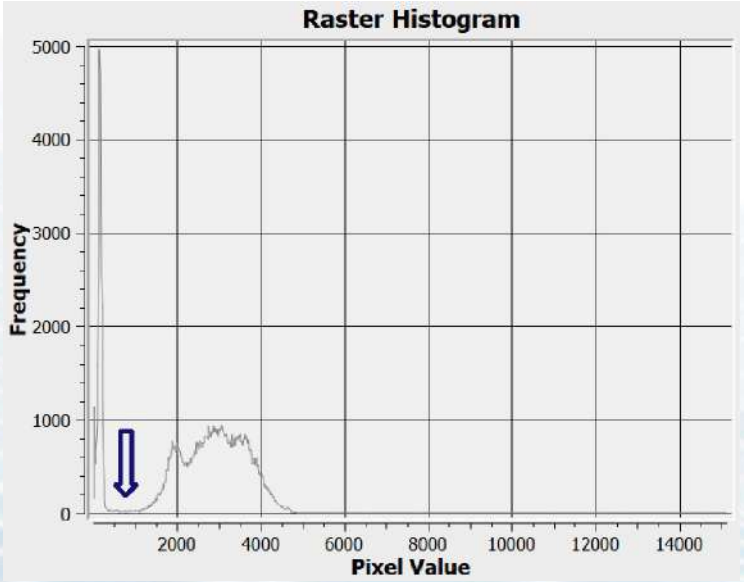
Open Water Detection

SWIR histogram visualization

Steps: Layers -> Panel -> Right click to the B11 band -> Properties -> Histogram -> Compute Histogram

The first threshold that identifies the open water is detected to the first deep valley of the SWIR band's histogram. In this case the threshold is 800.

SWIR histogram



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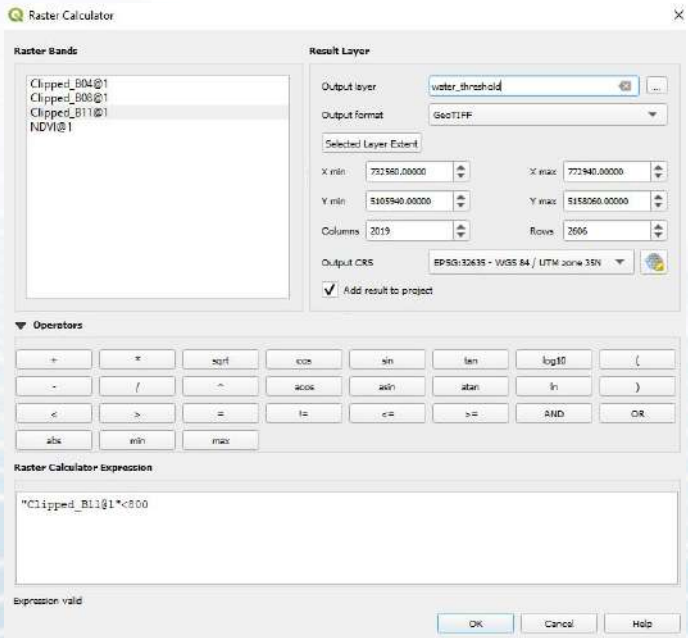
Open Water mask generation

Steps:

- Layer panel -> Raster -> Raster Calculator
- Raster Calculator Expression: *"Clipped_B11@1“ < 800*
- Output Layer: “water_threshold”



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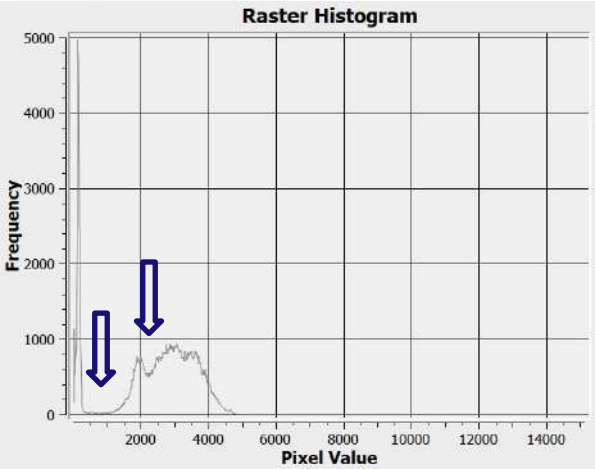
Emergent Vegetation Detection

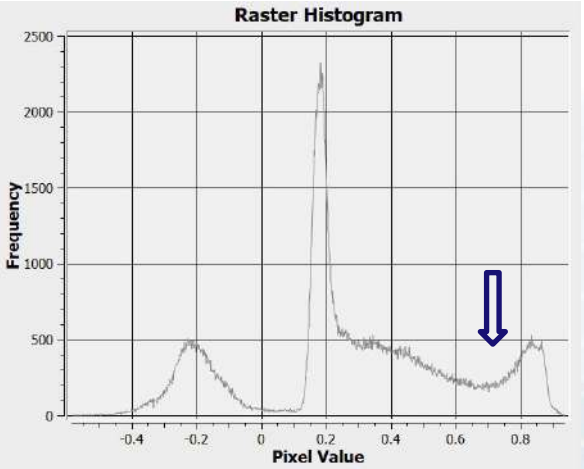
The SWIR value of the pixels is higher in areas where water is covered by emergent vegetation compared to the SWIR values of the pixels having water or water with sparse vegetation.

The emergent vegetation is detected to the pixels which are between the first and the second deep valley in the SWIR histogram and after the first deep valley after the value 0.3 in the NDVI histogram.

SWIR histogram



NDVI histogram



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Emergent Vegetation mask generation

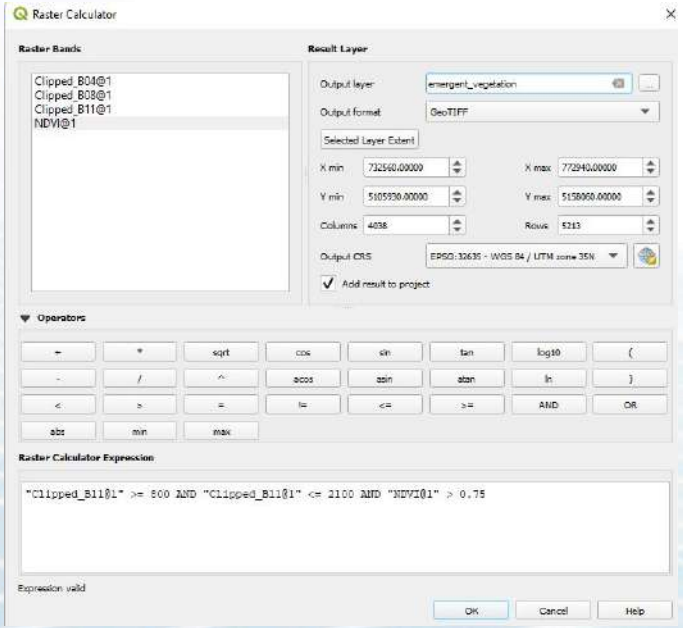
Steps:

- Layer panel -> Raster -> Raster Calculator

- Raster Calculator Expression:

“Clipped_B11@1” >= 800 AND
“Clipped_B11@1” <= 2100 AND
“NDVI@1” > 0.75

- Output Layer: “emergent_vegetation”



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Floating vegetation detection

The floating vegetation is detected to the pixels, which are not detected as open water or emergent vegetation and are meeting specific criteria, which are to be announced soon after the methodology is accepted and approved by peer reviewed online publishing process

Note 1: The methodology is currently experimental and has not been announced yet

Note 2: The workflow (including floating vegetation determination) has been tested on the Dniester River Delta area (an Ukrainian pilot site within the PONTOS project). The generated results presented below have been derived for the Dniester River Delta area (Ukraine).

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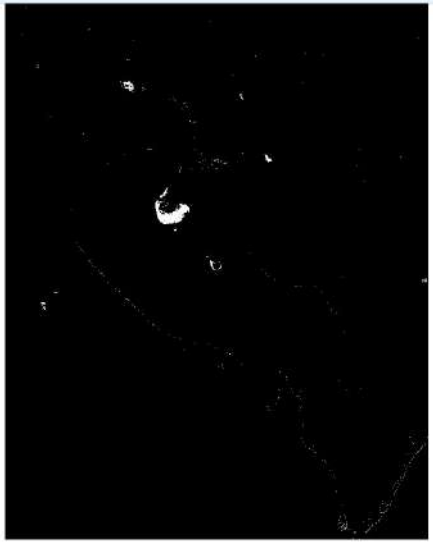
Classified images

Open water

Emergent vegetation

Floating vegetation (if existing)



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Final Watermask map generation

The final Watermask comprising the 3 categories (open water, emergent vegetation, floating vegetation). To generate the final Watermask, add the 3 classified images via the Raster Calculator.

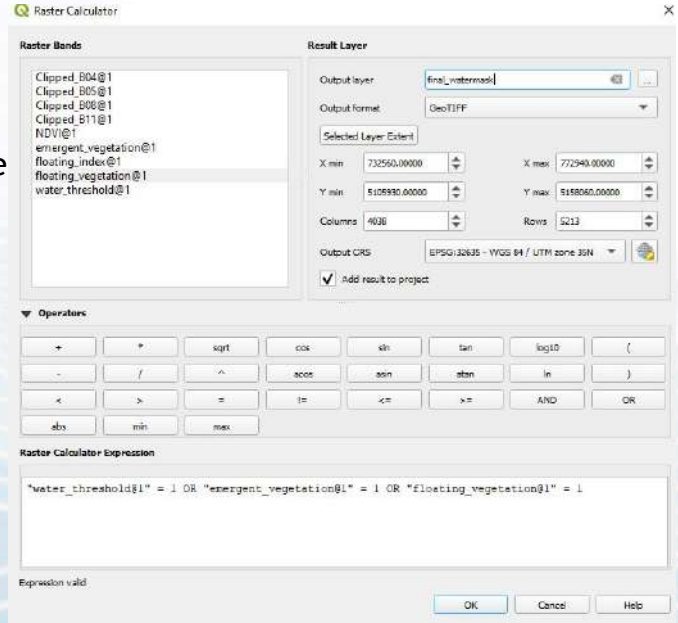
Steps:

- Layer panel -> Raster -> Raster Calculator

- Raster Calculator Expression:

"water_threshold@1" = 1 OR
"emergent_vegetation" = 1 OR
"floating_vegetation" = 1

- Output Layer: "final_watermask"



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Watermask series

01-07-2020

10 days

11-07-2020

25 days

05-08-2020

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First Hydroperiod map

For the Watermasks between 01/07/2020 and 11/07/2020 the difference is 10 days. If a pixel is inundated on both dates, then it is assumed that it is inundated for 10 days. If a pixel is inundated on one date, then it is assumed that it is inundated for 10/2 days. If a pixel is not inundated on any dates, then it is assumed that it is inundated for 0 days.

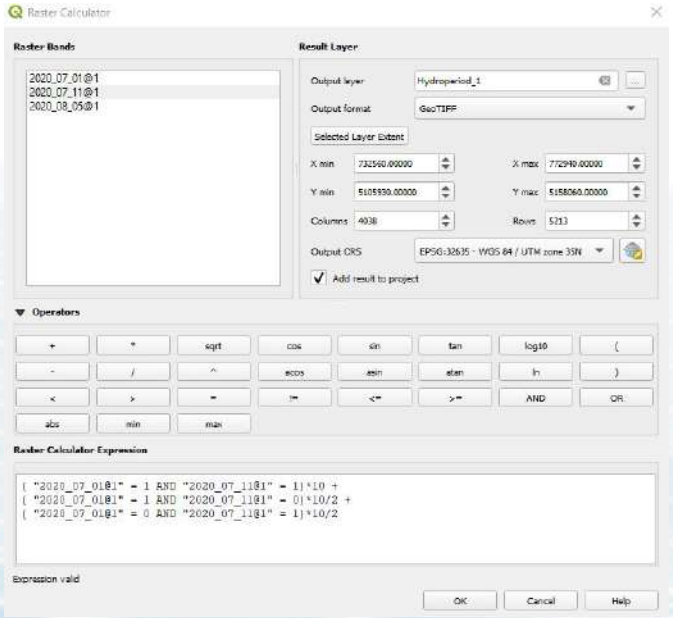
Steps:

- Layer panel -> Raster -> Raster Calculator

- Raster Calculator Expression:

*(“2020_07_01@1” = 1 AND “2020_07_01@1” = 1)*10 +*
*(“2020_07_01@1” = 1 AND “2020_07_01@1” = 0)*10/2 +*
*(“2020_07_01@1” = 0 AND “2020_07_01@1” = 1)*10/2*

- Output Layer: “Hydroperiod_1”



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Second Hydroperiod map

For the Watermasks between 11/07/2020 and 05/08/2020 the difference is 25 days. If a pixel is inundated on both dates, then it is assumed that it is inundated for 25 days. If a pixel is inundated on one date, then it is assumed that it is inundated for 25/2 days. If a pixel is not inundated on any dates, then it is assumed that it is inundated for 0 days.

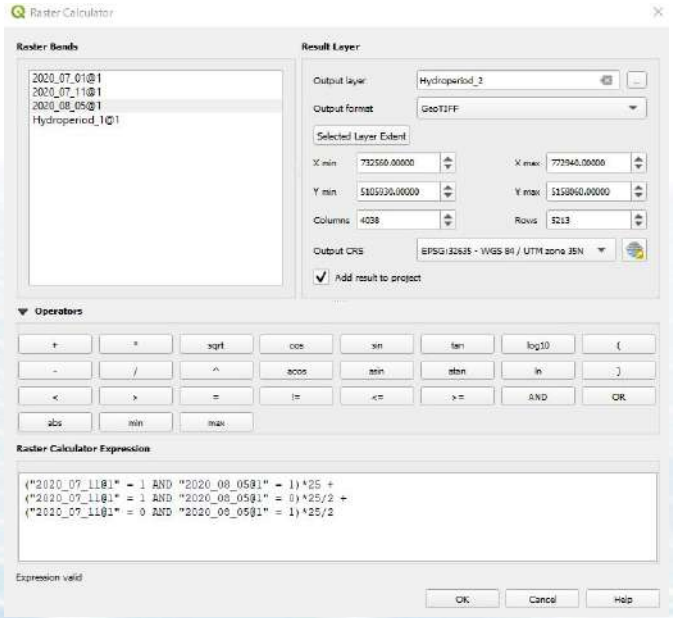
Steps:

- Layer panel -> Raster -> Raster Calculator

- Raster Calculator Expression:

*(“2020_07_11@1” = 1 AND “2020_08_05@1” = 1)*25 +*
*(“2020_07_11@1” = 1 AND “2020_08_05@1” = 0)*25/2 +*
*(“2020_07_11@1” = 0 AND “2020_08_05@1” = 1)*25/2*

- Output Layer: “Hydroperiod_2”



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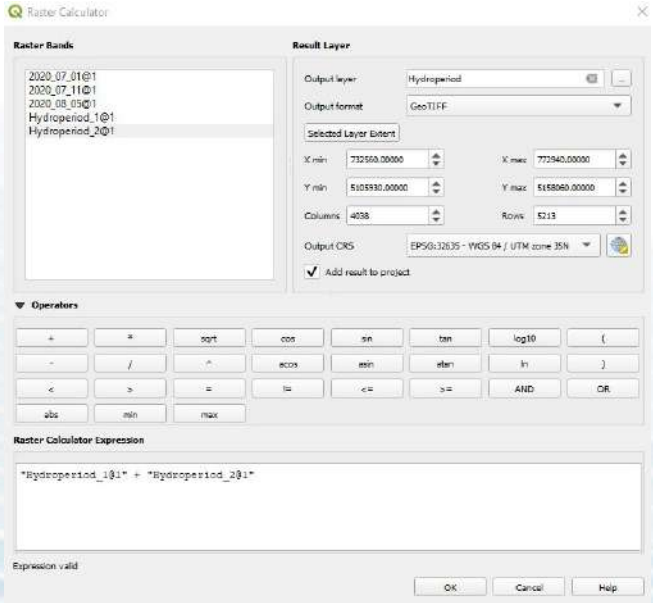
Final Hydroperiod map generation

The final Hydroperiod comprising the Hydroperiod_1 and the Hydroperiod_2. To generate the final Hydroperiod, add the 2 generated Hydroperiods via the Raster Calculator.

Steps:

- Layer panel -> Raster -> Raster Calculator
- Raster Calculator Expression:
  "Hydroperiod_1" + *"Hydroperiod_2@1"*
- Output Layer: "Hydroperiod"



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Final Hydroperiod map

Hydroperiod 1

Hydroperiod 2

Final Hydroperiod

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Watermask and Hydroperiod generation via PONTOS Web Application

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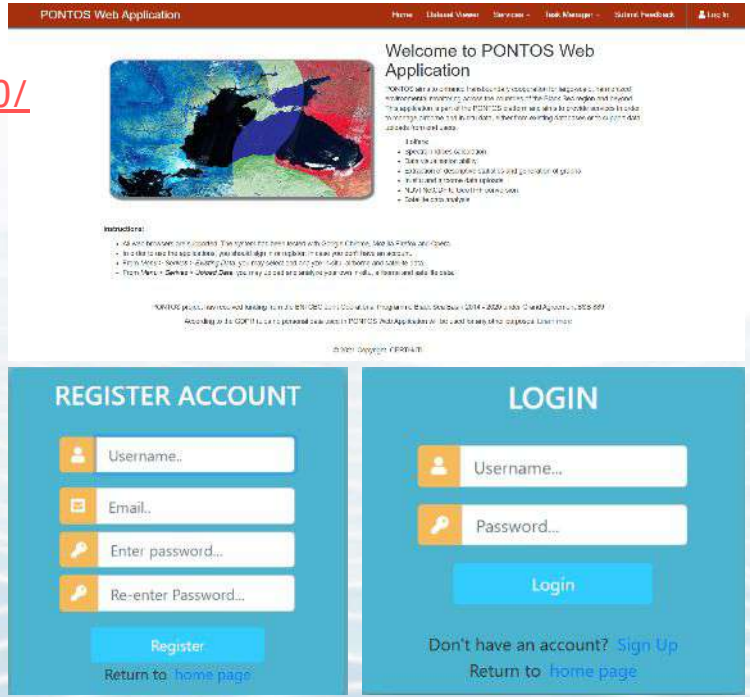
Create account and login

PONTOS Web Application: http://195.250.69.26:7000/

Steps:

- Navigation bar -> Log In
- Log In form -> Sign Up
- Fill the register form with username, email and password. Press Register.
- Fill the login form with username and password. Press Login.



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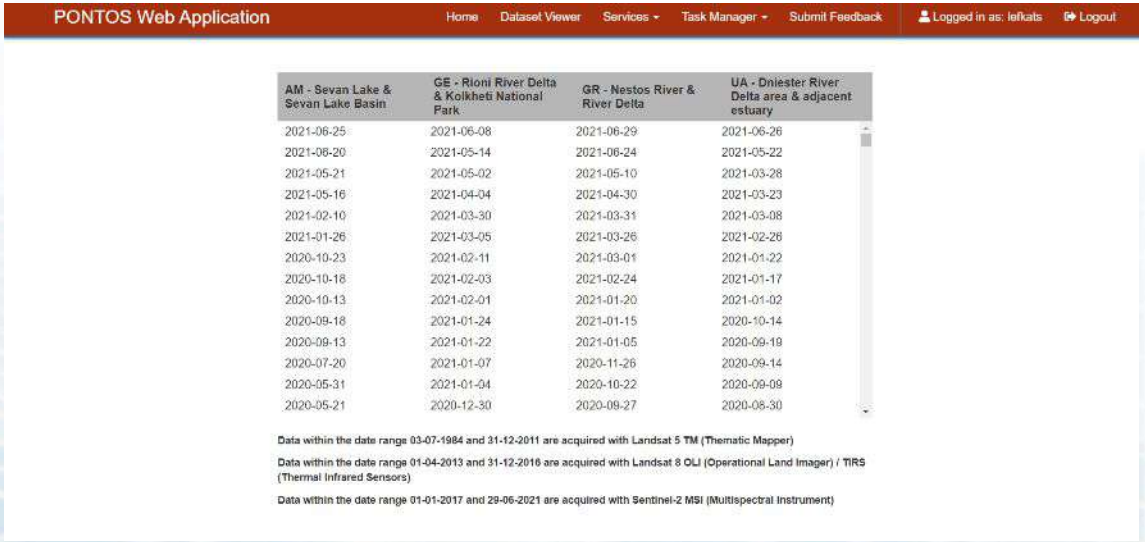
Dataset Viewer

The menu item ‘Dataset Viewer’ informs the users about the dates with available satellite data in the Web Application’s database. The Web Application’s database includes all available Level-2 data from the satellites Landsat 5, Landsat 8 and Sentinel-2 for the period 1984 to 2021, which are cloud and ice free in order to avoid noisy outputs by the application of the ‘Tools’. The available data are already clipped in the extent of the PONTOS pilots (Armenia – Sevan Lake and Sevan Lake Basin, Georgia – Kolkheti Lowlands and Black Sea coastline, Greece – Nestos River and River Delta, Ukraine – Dniester River Delta area and adjacent estuary).



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Watermask generation (1)

Navbar -> Existing data -> Watermasks

Select pilot area

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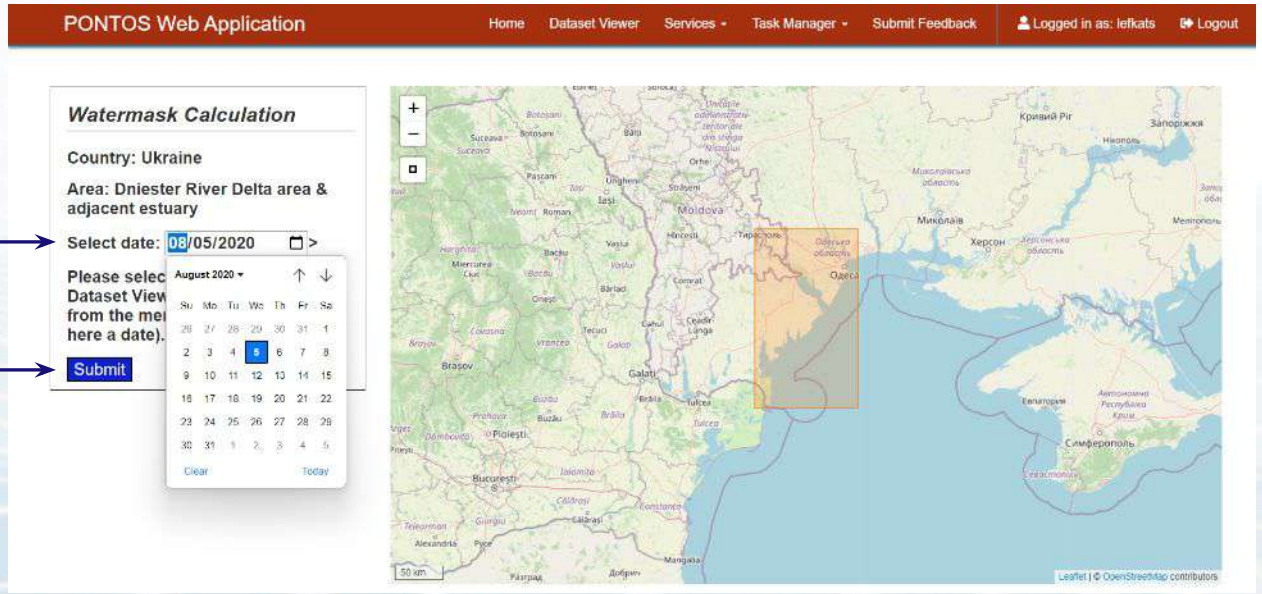
Watermask generation (2)

Select date. The selected date should be included in the Dataset Viewer.

Click the “Submit” button to start the task running. The task may needs some hours to be completed



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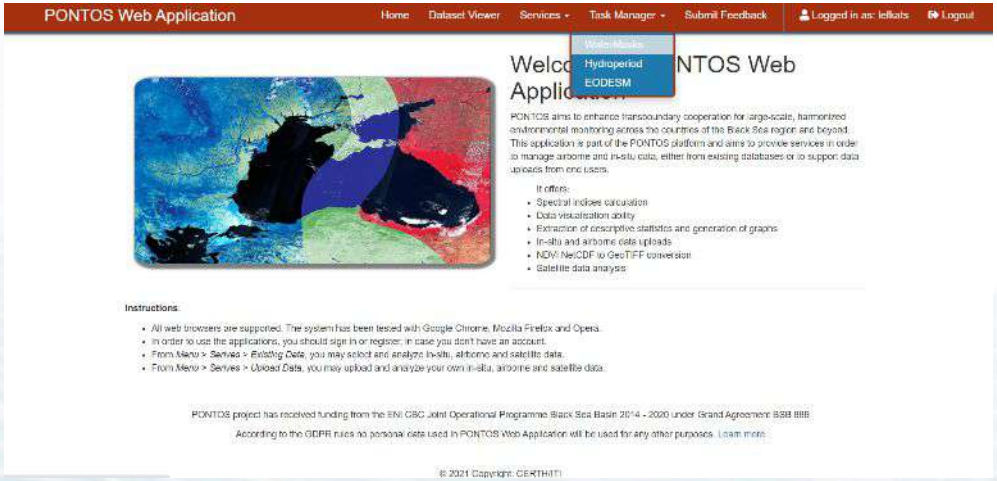
Watermask Task Manager

The Task Manager contains the outputs of all the previous user's submitted tasks.

Steps:

- Navigation bar -> Task Manager -> Watermaks
- Select "Details" on the submitted task



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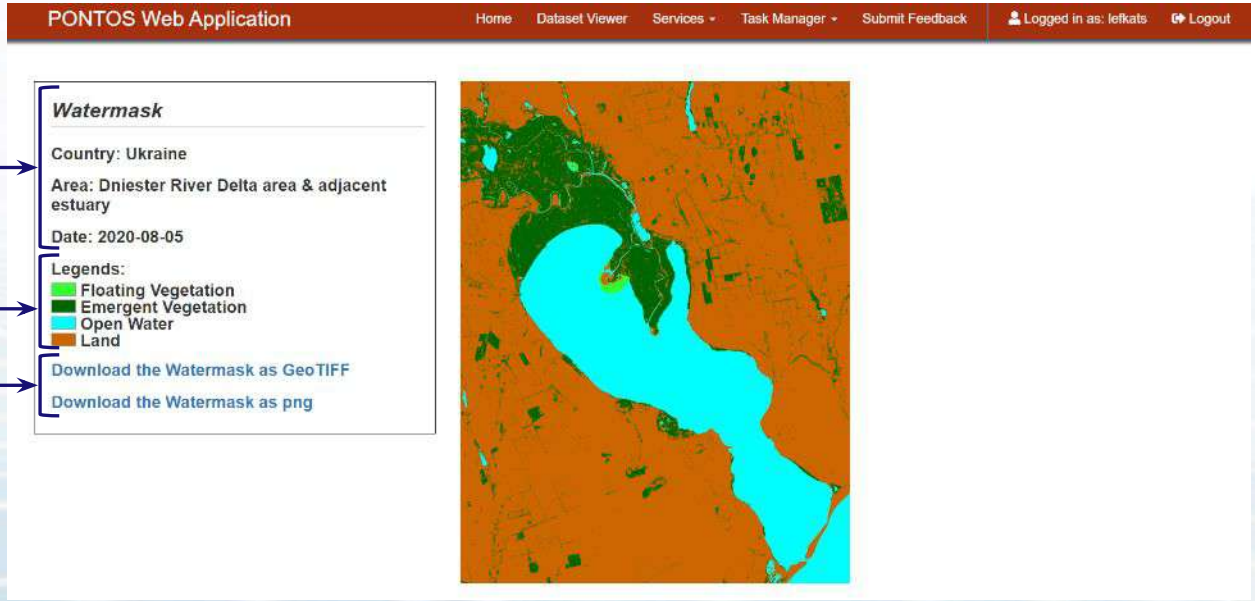
Common borders. Common solutions.

Watermask task details

Task Metadata

Visualization legends

Download Watermask as GeoTIFF or the visualization as png



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Hydroperiod generation (1)

Navbar -> Existing data -> Hydroperiod

Select pilot area

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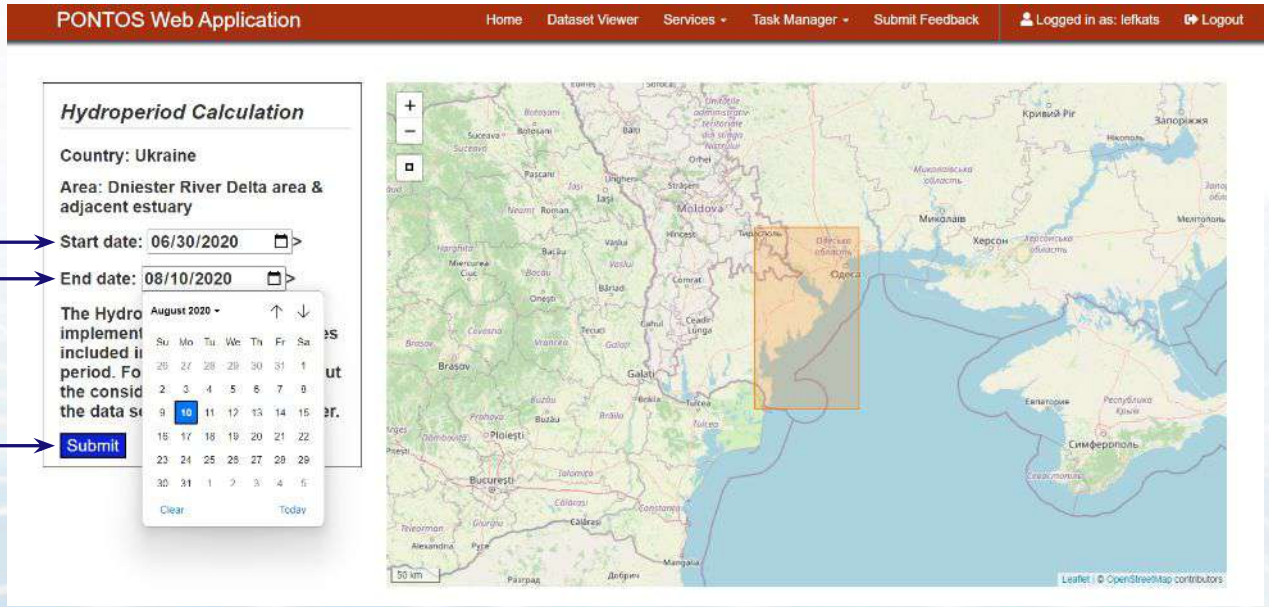
Hydroperiod generation (2)

Select start and end date. The PONTOS Web Application will generate the Hydroperiod for all the available dates (see Dataset Viewer) between the selected dates

Click the “Submit” button to start the task running. The task may needs some hours to be completed



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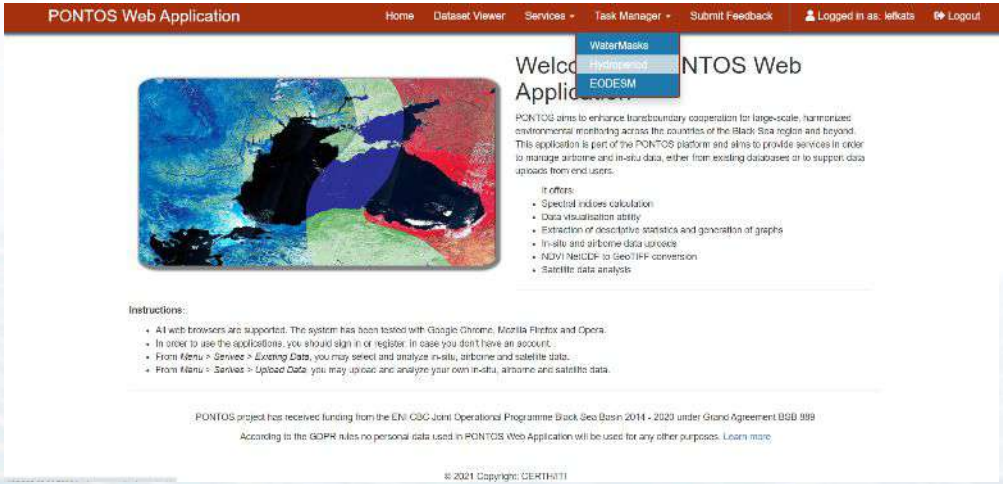
Hydroperiod Task Manager

The Task Manager contains the outputs of all the previous user's submitted tasks.

Steps:

- Navigation bar -> Task Manager -> Hydroperiod
- Select "Details" on the submitted task



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Hydroperiod task details

Task Metadata

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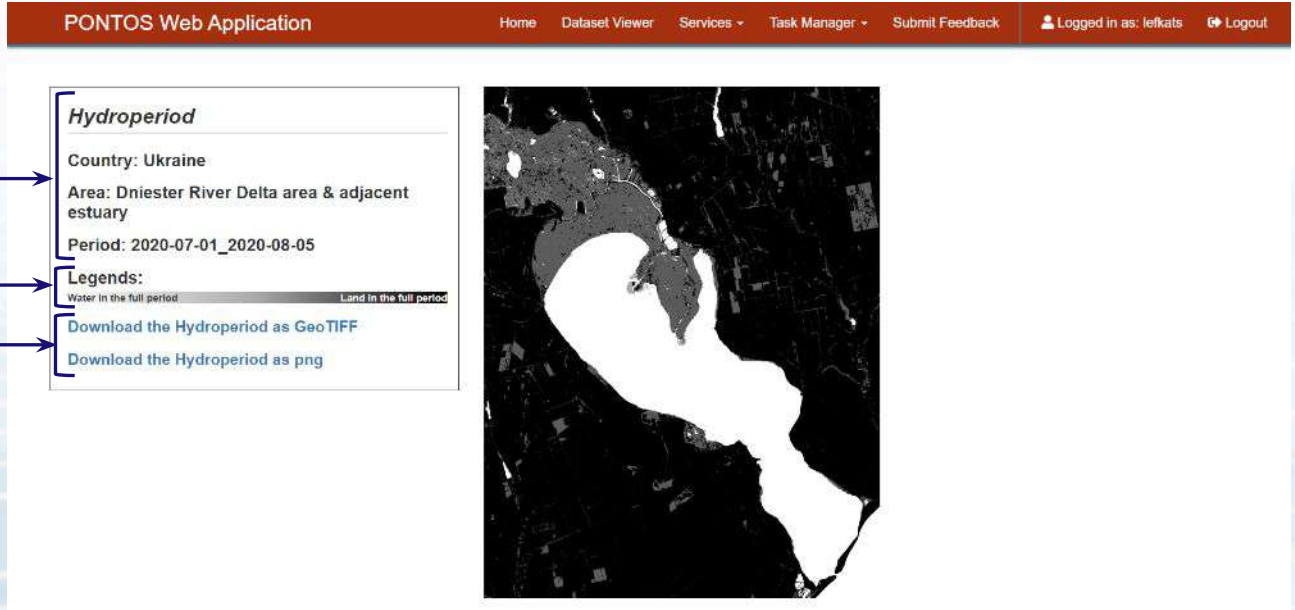

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Joint Operational Programme Black Sea Basin 2014-2020
Copernicus Assisted Environmental Monitoring across the Black Sea Basin – PONTOS
December 2022

Joint Operational Programme Black Sea Basin 2014-2020 is co-financed by the European Union through the European Neighbourhood Instrument and by the participating countries: Armenia, Bulgaria, Georgia, Greece, Republic of Moldova, Romania, Turkey, and Ukraine.

This publication has been produced with the financial assistance of the European Union. The contents of this publication are the sole responsibility of Copernicus assisted environmental monitoring across the Black Sea Basin – PONTOS and can in no way be taken to reflect the views of the European Union.

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