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# PONTOS VIRTUAL TRAINING MODULES

December 2022

[PONTOS-EU.AUA.AM](https://pontos-eu.aua.am)

**AUA** ACOPIAN CENTER  
for the ENVIRONMENT



**CERTH**  
CENTRE FOR  
RESEARCH & TECHNOLOGY  
HELLAS



ΔΗΜΟΚΡΙΤΕΙΟ  
ΠΑΝΕΠΙΣΤΗΜΙΟ  
ΘΡΑΚΗΣ | 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](mailto:imanakos@iti.gr) / [lefkats@iti.gr](mailto: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](mailto:lefkats@iti.gr) , [imanakos@iti.gr](mailto: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**

**Familiarize with the PONTOS Web Application for the Watermask and Hydroperiod generation**

Please contact [imanakos@iti.gr](mailto:imanakos@iti.gr) / [lefkats@iti.gr](mailto:lefkats@iti.gr) for more information



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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 separates the area in four different classes:

- Land
- Open water
- Emergent vegetation
- Floating vegetation

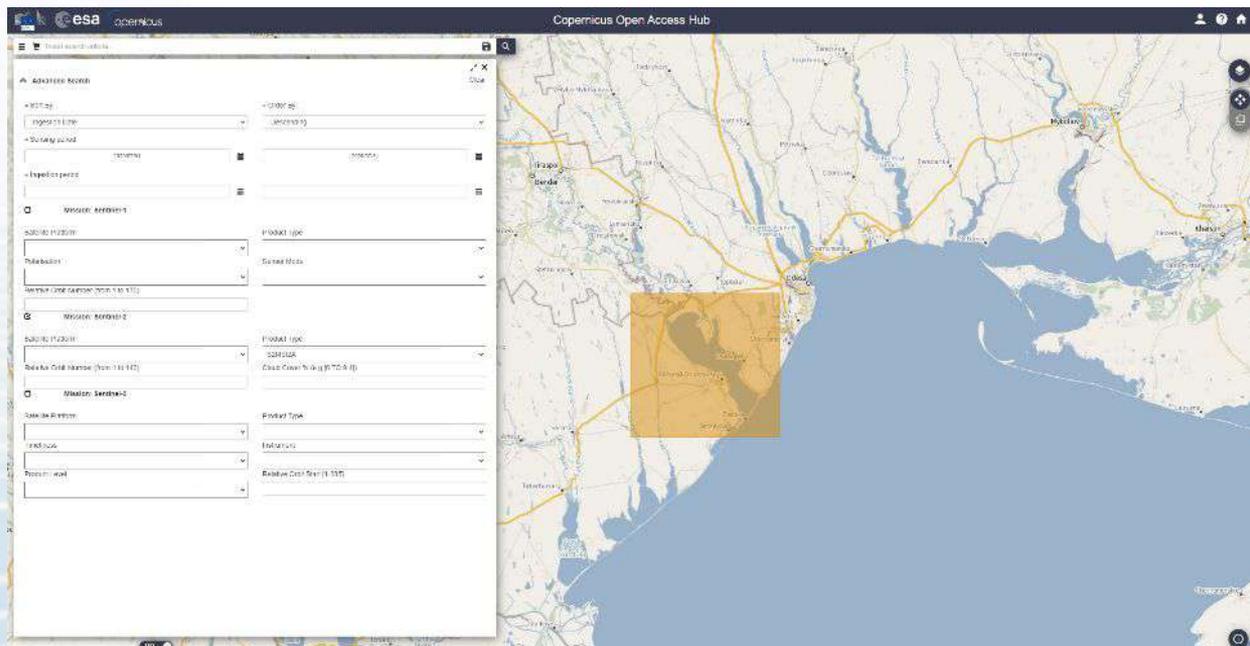
The Hydroperiod module generates a hydroperiod map from series of water masks, falling within the time period between the starting and the ending date of hydroperiod, by applying the following interpolation approach. For two dates separated by  $n$  days, the occurrence of water is compared. If a pixel 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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## Common borders. Common solutions. 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.)



## Common borders. Common solutions.

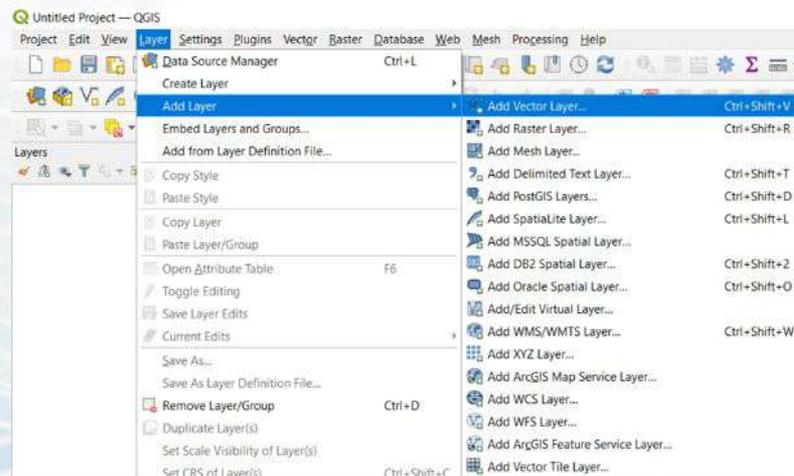
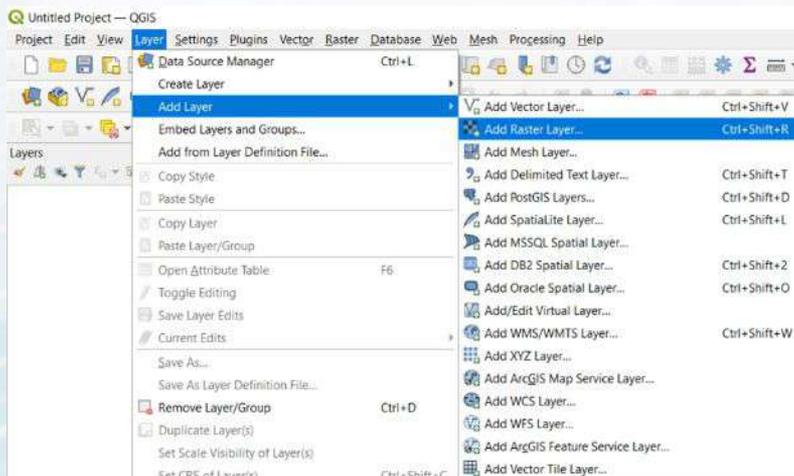
### Add layers

Add raster layer:

Layer -> Add Layer -> Add Raster Layer

Add shape file:

Layer -> Add Layer -> Add Vector Layer





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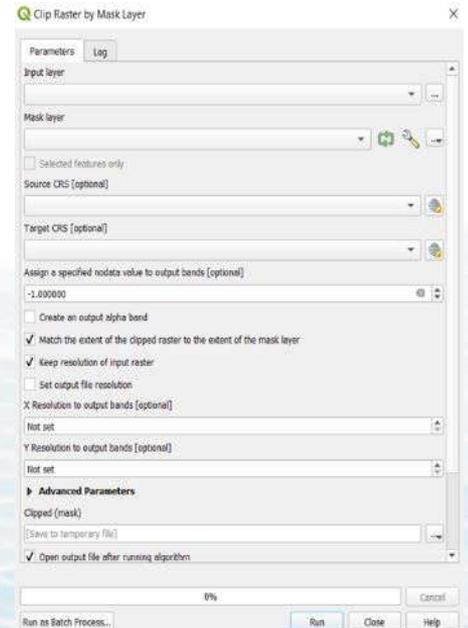
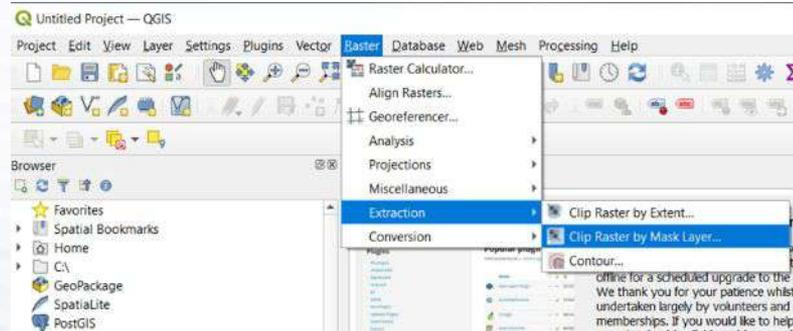


## Common borders. Common solutions.

### 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

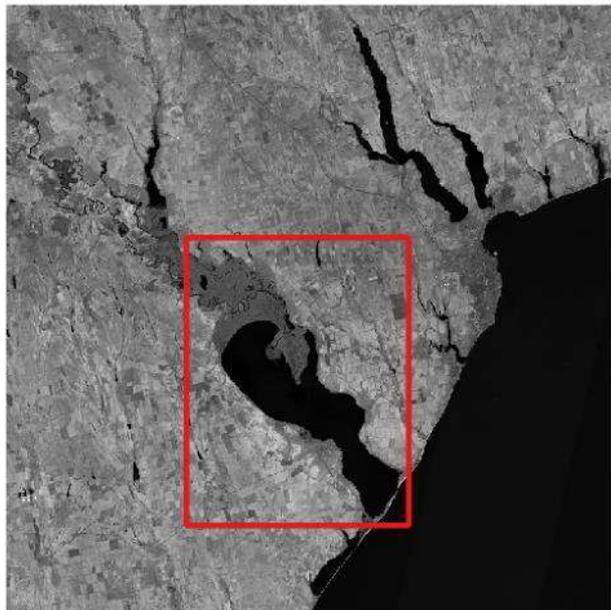




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## Common borders. Common solutions. Crop a raster to the boundaries of the shapefile (2)



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## Sentinel-2 bands

Sentinel-2 Bands	Central Wavelength ( $\mu\text{m}$ )	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
<b>Band 4 – Red</b>	<b>0.665</b>	<b>10</b>	<b>30</b>
<b>Band 5 – Vegetation Red Edge</b>	<b>0.705</b>	<b>20</b>	<b>15</b>
Band 6 – Vegetation Red Edge	0.740	20	15
Band 7 – Vegetation Red Edge	0.783	20	20
<b>Band 8 – NIR</b>	<b>0.842</b>	<b>10</b>	<b>115</b>
Band 8A – Narrow NIR	0.865	20	20
Band 9 – Water vapour	0.945	60	20
Band 10 – SWIR – Cirrus	1.375	60	20
<b>Band 11 – SWIR</b>	<b>1.610</b>	<b>20</b>	<b>90</b>
Band 12 – SWIR	2.190	20	180

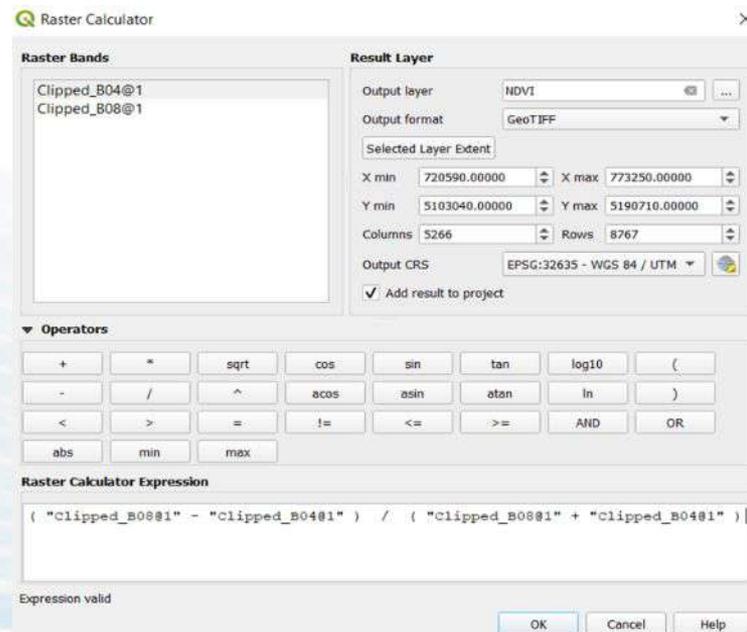
Required bands for the  
Watermask and Hydroperiod  
generation

## Common borders. Common solutions. 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/](https://eos.com/make-an-analysis/ndvi/)



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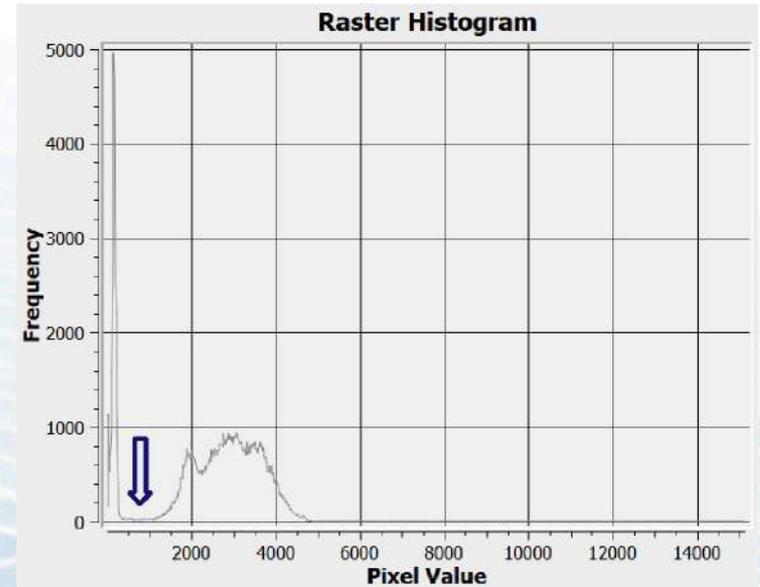
## Common borders. Common solutions. Open Water Detection

### 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.

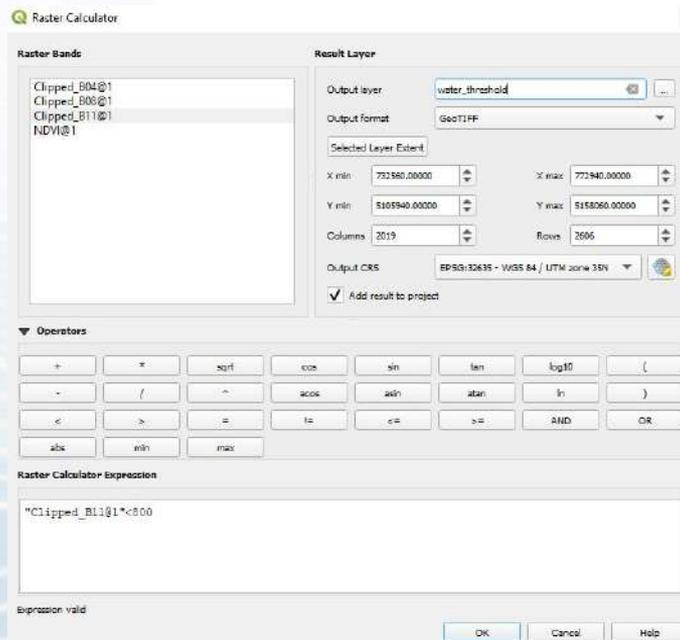
### SWIR histogram



## Common borders. Common solutions. Open Water mask generation

### Steps:

- Layer panel -> Raster -> Raster Calculator
- Raster Calculator Expression:  
"Clipped\_B11@1" < 800
- Output Layer: "water\_threshold"

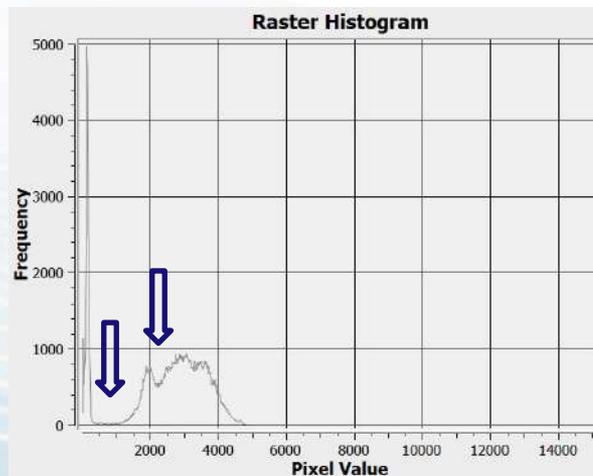


## Common borders. Common solutions. Emergent Vegetation Detection

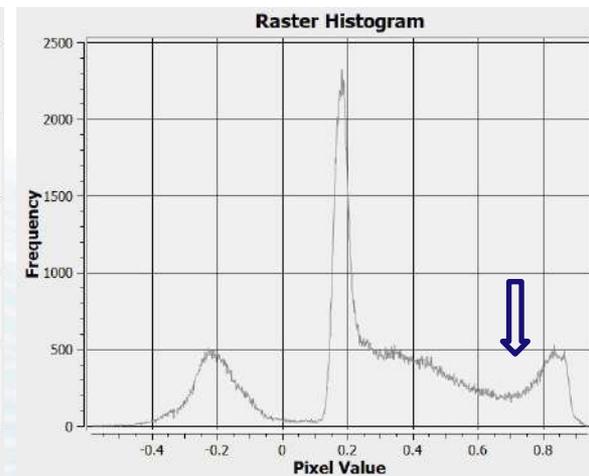
The SWIR value of the pixels is higher in areas where water is covered by emergent vegetation compared to the SWIR values of the pixels having water or water with sparse vegetation.

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





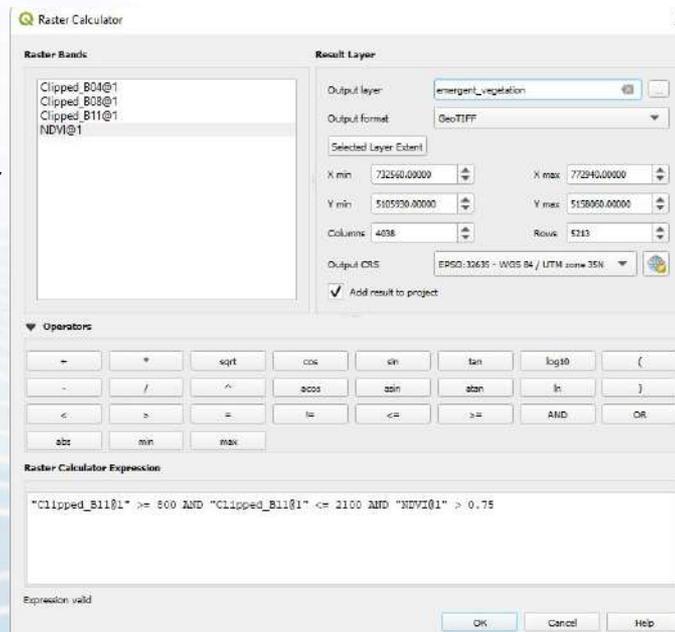
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## Common borders. Common solutions. Emergent Vegetation mask generation

### 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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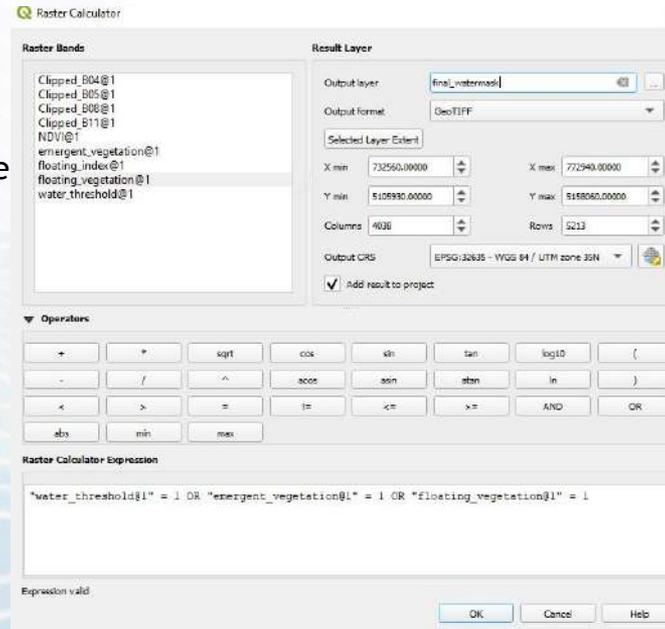
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HELLAS

## Common borders. Common solutions. 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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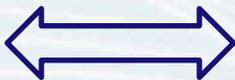


## Common borders. Common solutions. Watermask series

01-07-2020



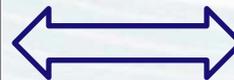
10 days



11-07-2020



25 days



05-08-2020



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## Common borders. Common solutions.

### 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.

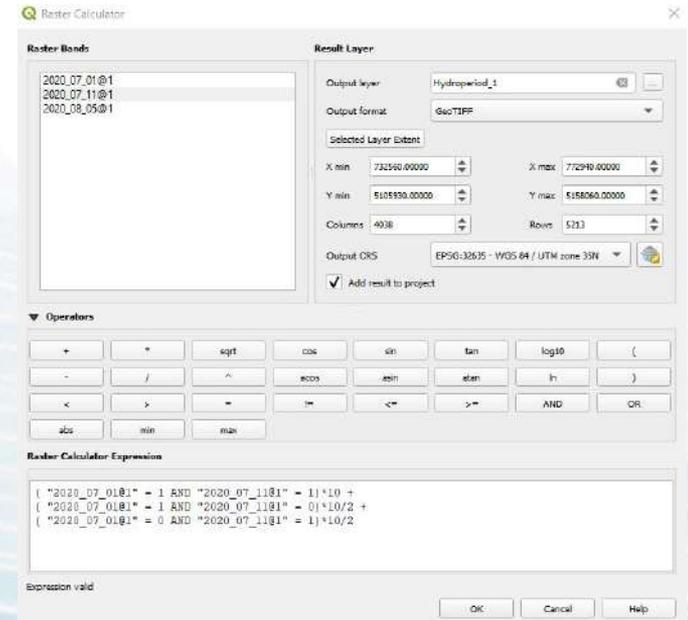
#### Steps:

- Layer panel -> Raster -> Raster Calculator

- Raster Calculator Expression:

$(\text{"2020\_07\_01@1"} = 1 \text{ AND } \text{"2020\_07\_11@1"} = 1) * 10 +$   
 $(\text{"2020\_07\_01@1"} = 1 \text{ AND } \text{"2020\_07\_11@1"} = 0) * 10/2 +$   
 $(\text{"2020\_07\_01@1"} = 0 \text{ AND } \text{"2020\_07\_11@1"} = 1) * 10/2$

- Output Layer: "Hydroperiod\_1"





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## Common borders. Common solutions. Second Hydroperiod map

For the Watermarks 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.

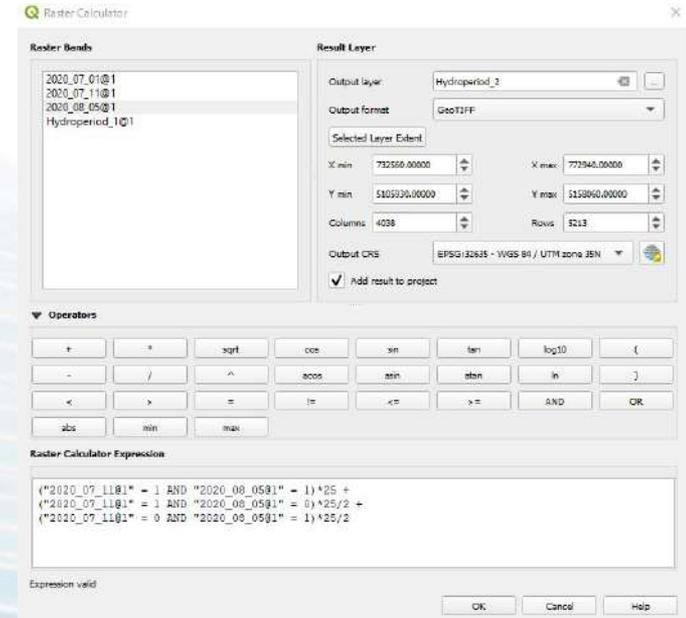
Steps:

- Layer panel -> Raster -> Raster Calculator

- Raster Calculator Expression:

$(\text{"2020\_07\_11@1"} = 1 \text{ AND } \text{"2020\_08\_05@1"} = 1) * 25 +$   
 $(\text{"2020\_07\_11@1"} = 1 \text{ AND } \text{"2020\_08\_05@1"} = 0) * 25 / 2 +$   
 $(\text{"2020\_07\_11@1"} = 0 \text{ AND } \text{"2020\_08\_05@1"} = 1) * 25 / 2$

- Output Layer: "Hydroperiod\_2"





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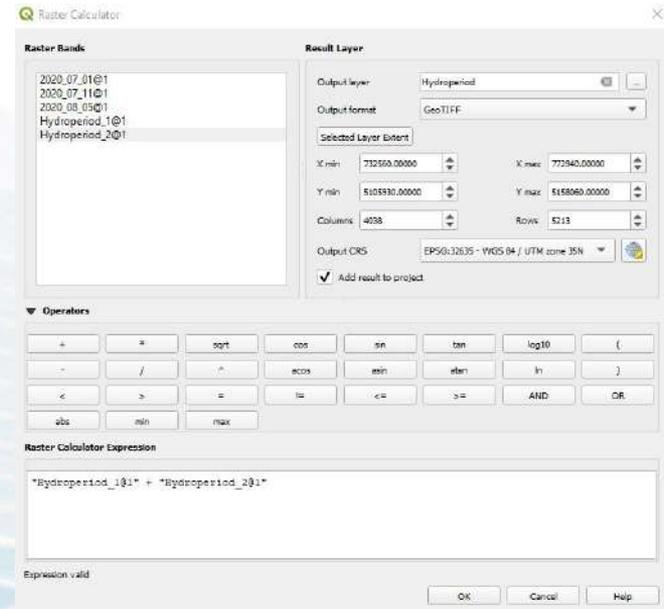


## Common borders. Common solutions. Final Hydroperiod map generation

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

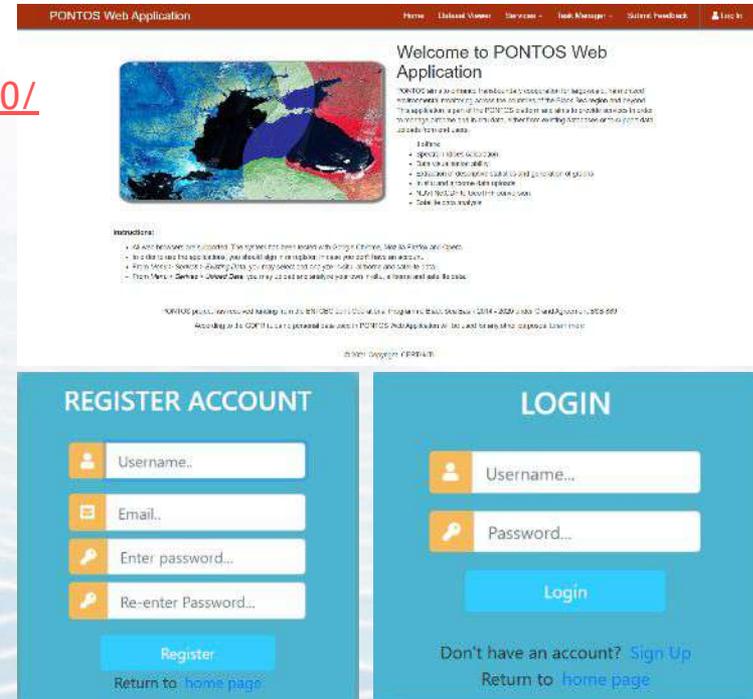
Please contact [imanakos@iti.gr](mailto:imanakos@iti.gr) / [lefkats@iti.gr](mailto:lefkats@iti.gr) for more information

## Common borders. Common solutions. 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.



The screenshot displays the PONTOS Web Application interface. At the top, there is a navigation bar with links for Home, Liked Views, Services, Task Manager, Contact Feedback, and Log In. The main content area features a welcome message and a list of services: Agency for the Black Sea Region, Black Sea Region Agency, Black Sea Region Agency, Black Sea Region Agency, and Black Sea Region Agency. Below this, there are two forms: 'REGISTER ACCOUNT' and 'LOGIN'. The 'REGISTER ACCOUNT' form includes fields for Username, Email, Enter password, and Re-enter Password, with a Register button and a link to Return to home page. The 'LOGIN' form includes fields for Username and Password, with a Login button and a link to Return to home page.

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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).

PONTOS Web Application Home Dataset Viewer Services Task Manager Submit Feedback Logged in as: lefkats Logout

AM - Sevan Lake & Sevan Lake Basin	GE - Rioni River Delta & Kolkheti National Park	GR - Nestos River & River Delta	UA - Dniester River Delta area & adjacent estuary
2021-06-25	2021-06-08	2021-06-29	2021-06-26
2021-06-20	2021-05-14	2021-06-24	2021-05-22
2021-05-21	2021-05-02	2021-05-10	2021-03-28
2021-05-16	2021-04-04	2021-04-30	2021-03-23
2021-02-10	2021-03-30	2021-03-31	2021-03-08
2021-01-26	2021-03-05	2021-03-26	2021-02-26
2020-10-23	2021-02-11	2021-03-01	2021-01-22
2020-10-18	2021-02-03	2021-02-24	2021-01-17
2020-10-13	2021-02-01	2021-01-20	2021-01-02
2020-09-18	2021-01-24	2021-01-15	2020-10-14
2020-09-13	2021-01-22	2021-01-05	2020-09-19
2020-07-20	2021-01-07	2020-11-26	2020-09-14
2020-05-31	2021-01-04	2020-10-22	2020-09-09
2020-05-21	2020-12-30	2020-09-27	2020-08-30

Data within the date range 03-07-1984 and 31-12-2011 are acquired with Landsat 5 TM (Thematic Mapper)  
 Data within the date range 01-04-2013 and 31-12-2016 are acquired with Landsat 8 OLI (Operational Land Imager) / TIRS (Thermal Infrared Sensors)  
 Data within the date range 01-01-2017 and 28-06-2021 are acquired with Sentinel-2 MSI (Multispectral Instrument)



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## Common borders. Common solutions. Watermask generation (1)

PONTOS Web Application

Home | Dataset Viewer | Services | Task Manager | Submit Feedback | logged in as leftkats | Logout

Existing Data | Upload Data | Existing Data Analysis | Visualize Airborne Data | Airborne Data NDVI | Airborne Data NDWI | Physiology Metrics | Water Masks | Hydroperiod | ECODESM

**Water Masks**

PONTOS allows environmental data to be processed into water masks. This application is designed to manage and process data from various sources, including:

- Spectral indices calculation
- Data visualization on maps
- Selection of geographic area and generation of masks
- Multi and binary data upload
- NDVI and NDWI calculation
- Search data analysis

**Instructions:**

- All web browsers are supported. The system has been tested with Google Chrome, Mozilla Firefox and Opera.
- In order to use the applications, you should sign in or register if you are new user. We recommend:
- From Menu > Services > Existing Data, you may select and analyze files, upload and create data.
- From Menu > Services > Upload Data, you may upload your data. You can upload multiple files at once.

FON-ECO project has received funding from the H2020 under the Marie Skłodowska Curie Grant Agreement 101019750. According to the GDPR rules no personal data used in PONTOS Web Application will be used for any other purposes. Learn more.

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← Navbar -> Existing data -> Watermasks

Select pilot area →

PONTOS Web Application

Home | Dataset Viewer | Services | Task Manager | Submit Feedback | logged in as leftkats | Logout

GR - Nestos River & River Delta

AM - Sevan Lake & Sevan Lake Basin

GE - Rioni River Delta & Kolikhiti National Park

UA - Dniester River Delta area & adjacent estuary



## Common borders. Common solutions. Watermask generation (2)

PONTOS Web Application

Home Dataset Viewer Services Task Manager Submit Feedback

Logged in as: lefkats Logout

### Watermask Calculation

Country: Ukraine

Area: Dniester River Delta area & adjacent estuary

Select date: 08/05/2020

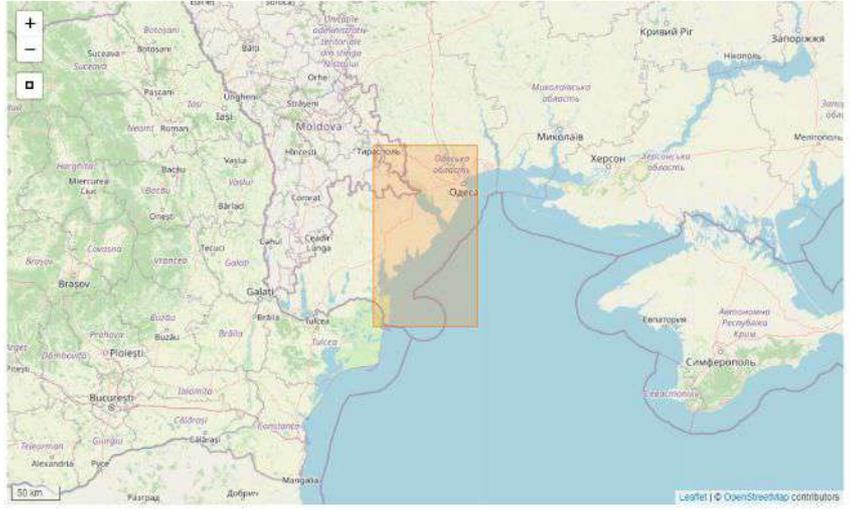
Please select Dataset View from the menu here a date).

Submit

August 2020

Su	Mo	Tu	We	Th	Fr	Sa
28	27	26	25	30	31	1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31	1	2	3	4	5

Clear Today



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

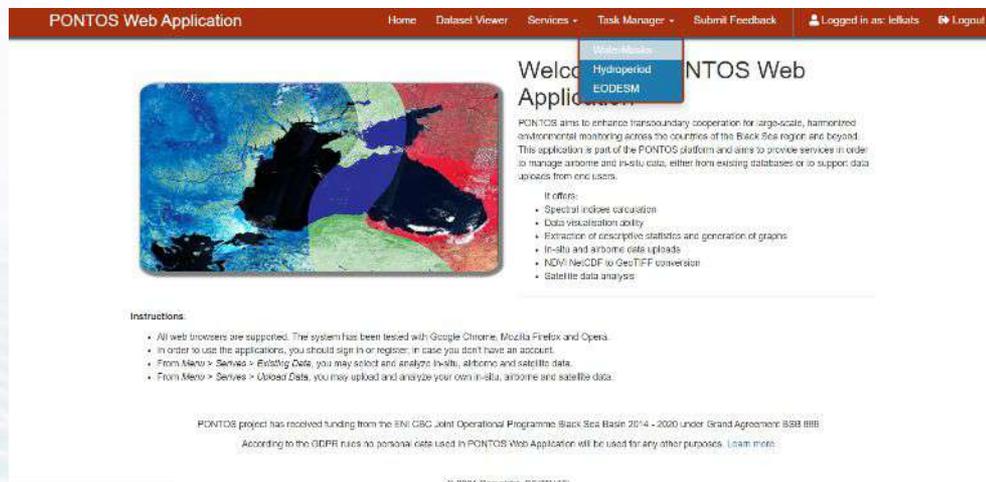
## Common borders. Common solutions.

### 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



PONTOS Web Application

Home Dataset Viewer Services - Task Manager - Submit Feedback

Logged in as: lefkats Logout

### Welcome to PONTOS Web Application

PONTOS aims to enhance transboundary cooperation for large-scale, harmonized environmental monitoring across the countries of the Black Sea region and beyond. This application is part of the PONTOS platform and aims to provide services in order to manage airborne and in-situ data, either from existing databases or to support data uploads from end users.

- In offers:
  - Special indices calculation
  - Data visualization ability
  - Extraction of descriptive statistics and generation of graphs
  - In-situ and airborne data uploads
  - NDVI/NDVI2 to GeoTIFF conversion
  - Satellite data analysis

Instructions:

- All web browsers are supported. The system has been tested with Google Chrome, Mozilla Firefox and Opera.
- In order to use the applications, you should sign in or register, in case you don't have an account.
- From Menu > Services > Existing Data, you may select and analyze in-situ, airborne and satellite data.
- From Menu > Services > Upload Data, you may upload and analyze your own in-situ, airborne and satellite data.

PONTOS project has received funding from the ENI CBC Joint Operational Programme Black Sea Basin 2014 - 2020 under Grand Agreement BSB BBB

According to the GDPR rules no personal data used in PONTOS Web Application will be used for any other purposes. Learn more

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PONTOS Web Application

Home Dataset Viewer Services - Task Manager - Submit Feedback

Logged in as: lefkats Logout

Pilot Area	Date	
Ukraine	2020-07-21	<a href="#">Details</a>



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## Common borders. Common solutions. Watermask task details

Task Metadata

Visualization legends

Download Watermask as GeoTIFF or  
the visualization as png

PONTOS Web Application

Home Dataset Viewer Services Task Manager Submit Feedback

Logged in as: lefkats Logout

### Watermask

Country: Ukraine  
Area: Dniester River Delta area & adjacent estuary  
Date: 2020-08-05

Legends:

- Floating Vegetation
- Emergent Vegetation
- Open Water
- Land

Download the Watermask as GeoTIFF  
Download the Watermask as png

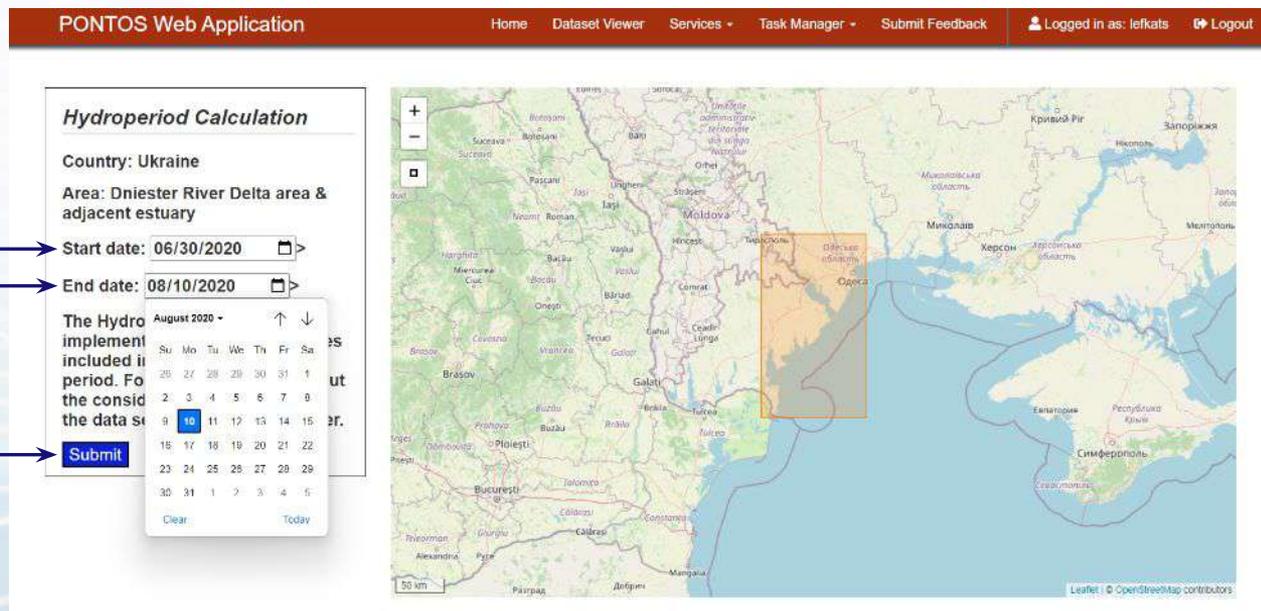
Please contact [imanakos@iti.gr](mailto:imanakos@iti.gr) / [lefkats@iti.gr](mailto:lefkats@iti.gr) for more information



## Common borders. Common solutions. 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 need some hours to be completed



The screenshot displays the PONTOS Web Application interface. At the top, a navigation bar includes links for Home, Dataset Viewer, Services, Task Manager, and Submit Feedback, along with a user login status (Logged in as: lefkats) and a Logout button. The main content area is divided into two sections. On the left, the 'Hydroperiod Calculation' form is visible, with the following details: Country: Ukraine; Area: Dniester River Delta area & adjacent estuary; Start date: 06/30/2020; End date: 08/10/2020. A calendar widget for August 2020 is open, showing the date 10th selected. A 'Submit' button is located below the calendar. On the right, a map shows the geographical area of the Dniester River Delta, with an orange rectangle highlighting the specific area of interest. The map includes various geographical features, labels for cities, and a scale bar.



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## Common borders. Common solutions.

### 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

PONTOS Web Application		Home	Dataset Viewer	Services	Task Manager	Submit Feedback	Logged in as: lefkats	Logout	
Pilot Area	Time Period								
Ukraine	2020-07-01_2020-08-05							Details	

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



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## Common borders. Common solutions. Hydroperiod task details

PONTOS Web Application

Home Dataset Viewer Services Task Manager Submit Feedback

Logged in as: lefkats Logout

**Hydroperiod**

Country: Ukraine

Area: Dniester River Delta area & adjacent estuary

Period: 2020-07-01\_2020-08-05

Legends:

Water in the full period	Land in the full period
--------------------------	-------------------------

[Download the Hydroperiod as GeoTIFF](#)

[Download the Hydroperiod as png](#)



Task Metadata

Visualization legends

Download Watermask as GeoTIFF or the visualization as png



## Common borders. Common solutions.

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

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Please contact [imanakos@iti.gr](mailto:imanakos@iti.gr) / [lefkats@iti.gr](mailto:lefkats@iti.gr) for more information