





# PONTOS VIRTUAL TRAINING MODULES

## December 2022

#### AUA ACOPIAN CENTER for the ENVIRONMENT



CERTH CENTRE FOR RESEARCH & TECHNOLOGY HELLAS





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# Module 4

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









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: <u>lefkats@iti.gr</u>, <u>imanakos@iti.gr</u>

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









## 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









#### **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









# Background knowledge (QGIS implementation)









## 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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## **Common borders. Common solutions.** Sentinel-2 images download

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#### Steps:

- Sentinel-2 images can be downloaded 1. 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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## Common borders. Common solutions. Add layers

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## 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)

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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)











## 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	1	
Band 7 – Vegetation Red Edge	0.783	20	20		Required bands for
Band 8 – NIR	0.842	10	115		Watermask and Hydro
Band 8A – Narrow NIR	0.865	20	20		generation
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		









## 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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## Common borders. Common solutions. 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/











## Common borders. Common solutions. Open Water Detection

## SWIR histogram

#### 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.









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

#### Steps:

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

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## **Emergent Vegetation Detection**

SWIR histogram

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.

#### **Raster Histogram Raster Histogram** 5000 4000 2000 Langer 2000 Liston Li 1000 500 2000 4000 6000 10000 -0.4 -0.2 0.2 0.4 0.6 0.8 8000 12000 14000 Pixel Value **Pixel Value**

### NDVI histogram









## **Emergent Vegetation mask generation**

Steps:

- Layer panel -> Raster -> Raster Calculator
- Raster Calculator Expression:
   "Clipped\_B11@1" >= 800 AND
   "Clipped\_B11@1" <= 2100 AND</li>
   "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).









**Classified images** 

#### Open water



Emergent vegetation



Floating vegetation (if existing)











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

Q Raster Calculator

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

11-07-2020

10 days 25 days









## 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 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 +
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- 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"

			Re	scult Laye	r				
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## Final Hydroperiod map

#### Hydroperiod 1



Hydroperiod 2



Final Hydroperiod











# Watermask and Hydroperiod generation via PONTOS Web Application









## Create account and login

PONTOS Web Application

#### Hume Elaborat Viewer Mersons - Jack Menager - Miland PrestReak

PONTOS Web Application: <u>http://195.250.69.26:7000/</u>

#### Steps:

- Navigation bar -> Log In
- Log In form -> Sign Up •
- Fill the register form with username, email and ٠ password. Press Register.
- Fill the login form with username and password. ٠ Press Login.



#### Welcome to PONTOS Web Application

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PONTOS V

## 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).

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	
2021-08-20	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 29-06-2021 are acquired with Sentinei-2 MSI (Multispectral Instrument)









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









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

**PONTOS Web Application** Submit Feedback Logged in as: lefkats 🛛 🔂 Logout Dataset Viewer Services -Task Manager · Home Watermask Calculation Кринний Ріг **Sanopix**iki Sotosan Country: Ukraine Area: Dniester River Delta area & adjacent estuary Roman Миколаїв Select date: 08/05/2020 □> Херсон Please selec August 2020 个小 Barlad **Dataset View** Mo Tu We Th Fr St from the me here a date). Submit Braso<sub>4</sub> 26 22 Kouse 26 27 28 28 Buzzk. 30 31 4 5 Симферополь 22 3 Clear Today Alexand



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

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







CERTH CENTRE FOR RESEARCH & TECHNOLOGY HELLAS

## Common borders. Common solutions.

## Watermask Task Manager

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## Common borders. Common solutions. Watermask task details











HELLAS.

#### Common borders. Common solutions.

## Hydroperiod generation (1)









Logged in as: lefkats ID Logout

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

Home

Dataset Viewer

Services ·

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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**PONTOS Web Application** 



Task Manager -

Submit Feedback









CERTH CENTRE FOR RESEARCH & TECHNOLOGY HELLAS

## **Common borders. Common solutions.**

PONTOS MAL

## Hydroperiod Task Manager

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## Common borders. Common solutions. Hydroperiod task details









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.















