





PONTOS VIRTUAL TRAINING MODULES

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AUA ACOPIAN CENTER for the ENVIRONMENT



CERTH CENTRE FOR RESEARCH & TECHNOLOGY HELLAS









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Module 6

The Application of Earth Observation: Agricultural Water Balance, Water Productivity & Water Stress Indices with the Example of Assessments via PONTOS Platform







Responsible Partner - Democritus University of Thrace Supporting Partner - Centre for Research and Technology, Hellas Slides and scripts prepared by - PhD Ioannis D. Tsakmakis, Dr Nikolaos T. Kokkos, Prof Georgios K. Sylaios Contact Information - itsakmak@env.duth.gr

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







LEARNING OBJECTIVES OF MODULE 6

Familiarize with satellite images characteristics

Introduction to vegetation indices - Normalized Difference Vegetation Index (NDVI)

Brief to NDVI calculation tools based on Sentinel 2 imagery

NDVI utilization as a crop model calibration/validation index







MODULE STRUCTURE



Part 1: Introduction to satellite images characteristics and vegetation indices





Part 2: NDVI calculation via QGIS geographic information system application



Part 3: NDVI as a crop model calibration/validation index

















Common borders. Common solutions. Introduction to satellite images characteristics

Spatial Resolution

The spatial resolution specifies a satellite's image pixel size on the ground.

Temporal Resolution

The amount of time needed by a satellite to revisit and acquire data for the exact same location.

Spectral Bands

The number of spectral bands that the satellite mounted sensor(s) can capture.











Common borders. Common solutions. Introduction to Vegetation Indices

- o Healthy plants absorb strongly red and blue wavelengths during photosynthesis to create chlorophyll.
- o A healthy plant reflects the largest portion of the incident near infrared radiation.
- Vegetation Index (VI) is a single value derived by the transformation of two or more spectral bands.
- VIs are designed to allow the remote assessment of plants photosynthetic activity and canopy structural variations.









Common borders. Common solutions. Introduction to Normalized Difference Vegetation Index (NDVI)

- Normalized Difference Vegetation Index (NDVI) is a single graphical indicator that can be used to assess the plants health status and the development of their canopy cover.
- o It is defined as the ratio between the difference of the reflectance in near infrared and red against the sum of the reflectance in near infrared and red.

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

















Installing QGIS geographical information software

o Open the following url in a browser:

https://www.qgis.org/en/site/forusers/downl oad.html

- Choose the installation file that corresponds to your operating system (it is highly recommended to choose the long term release).
- Once the download is completed install the QGIS in your system by double clicking on the downloaded executable file.



Note that the MSI installets are much bigger than the previous installars. This is because they include significant larger packages (eg PROJ 8). The main reason for the switch to MSI were the size limits previously used NSIs has, which was blocking updates of dependencies.







Getting started ...

- o Open QGIS by:
 - pressing the windows key, typing qgis and press the Enter button
 - or double clicking on QGIS desktop shortcut.
- The QGIS user interface is initialized with zero layers loaded by default.

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Installation of Semi-Automatic Classification Plugin (SCP)

o From Plugins dropdown menu select Manage and Install Plugins...









Installation of Semi-Automatic Classification Plugin (SCP)

- From the pop up window select *All* and successively type Semi- *Automatic Classification Plugin* in the search bar and hit Enter button.
- In the results menu appears the plugin latest release. By clicking on it, the latest version number and general info about the plugin appear.
- o Click on the Install Plugin button

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- On a successful installation of the Semi-Automatic Classification
 Plugin a new menu named SCP
 will appear in the main menu bar.
- o Click on SCP and from the dropdown menu select Download products

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- From the Semi-Automatic Classification Plugin pop up window select the *Login data* tab and successively, in the *Login Sentinels* category:
 - fill in the Service box with the following url <u>https://scihub.copernicus.eu/dhus/</u>
 - in User and Password boxes insert your Copernicus Open Access Hub username and password, respectively.

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- Switch to Download options tab. By default, the plugin has selected all the available satellite missions and their corresponding bands.
- Deselect all the bands by clicking on the select all buttons located on the right side of the box

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Using SCP to acquire Sentinel 2 imagery for NDVI calculation

• Then in the Sentinel-2-bands category select bands 4 and 8, which correspond to the wavelengths of Red and Near Infrared respectively.

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- Click on *Search* tab and define the co-ordinates of the study area by:
 - (a) inserting the maximum and minimum longitude and latitude (bbox coordinates) in the corresponding boxes using your keyboard

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Using SCP to acquire Sentinel 2 imagery for NDVI calculation

or (b) clicking the (+) button in the window upper right corner and then switching to the area map (main QGIS interface) and click initially to define the first point that approximately corresponds to the minimum longitude and maximum latitude of the study area and then click to define the second point that corresponds to the maximum longitude and minimum latitude of the study area. A rectangle with red fill should cover your study area, while the min/max longitude and latitude boxes were filled in automatically.

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- Once the study area is selected, check if the Sentinel 2 product is selected in the Products dropdown menu and
 - > (a) define the time window that plugin will check for available products
 - > (b) define the acceptable products cloud cover (as percentage of the total image area).

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Using SCP to acquire Sentinel 2 imagery for NDVI calculation

• When the search is completed the available products for the selected area and time period will appear in the *Product list* table.

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- Select a product by clicking on it and press the *RUN* button.
- o Alternatively, hold SHIFT key to select multiple products in row
- o or hold CTRL key to select multiple products scattered within product list.

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Calculating NDVI from Sentinel 2 products

• From the main toolbar click on the Layer dropdown menu and then select Add Layer \rightarrow Add Raster Layer









Calculating NDVI from Sentinel 2 products

• In the pop up window click on *Raster Dataset(s)*, find the path that the downloaded raster (.tif) files are saved, select them and successively press open, add and close.









Calculating NDVI from Sentinel 2 products

• The images are loaded in the *Layers* panel and appear on the main map view









Calculating NDVI from Sentinel 2 products

• From the main toolbar click on the *Raster* dropdown menu and then select the *Raster Calculator*









Calculating NDVI from Sentinel 2 products

• In the pop up window define the path that the derived NDVI map file will be saved and the desired format.

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Calculating NDVI from Sentinel 2 products

• Successively, insert the NDVI formula to the Raster Calculator Expression box using the band 4 and 8 raster images from Raster Bands panel and the available symbols from Operators panel and

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Calculating NDVI from Sentinel 2 products

• If the *Add results to project* option is selected, the derived image is automatically loaded into the Layers panel and displayed in the main map view.









Crop initial NDVI map to field boundaries

*Untitled Project — QGIS

- The NDVI map calculated in the previous step corresponds to the boundaries of the downloaded products.
- In the case that the NDVI for a selected field is needed, the previous map is not that useful, so it has to be clipped to the field boundaries.
- In order to do that, from the main toolbar click on the Layer dropdown menu and then select Add Layer → Add Vector Layer...

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Crop initial NDVI map to field boundaries

- In the pop up window click on Vector Dataset(s) and define the path where the field vector file is saved.
- Press successively the *Open*, *Add* and *Close* buttons.

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Calculating NDVI from Sentinel 2 products

• The selected field polygon is loaded automatically into the Layers panel and displayed on the main map view.









Calculating NDVI from Sentinel 2 products

Subsequently, click on the Raster dropdown menu then select Extraction → Clip Raster by Mask Layer...

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Calculating NDVI from Sentinel 2 products

• In the pop up window we initially set the NDVI map that we created in the previous steps as the Input Layer and the field layer as a Mask layer.

Parameters Log	
Input layer Google Satellite [EPSG:3857] Indvi [EPSG:32634] Radia [EPSG:4326]	
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Calculating NDVI from Sentinel 2 products

- In the Advanced Parameters section set the path and the format of the derived masked NDVI file with field boundaries and press Save button.
- To initiate the mask process press *Run* button.
- Check the Open output file after running algorithm.

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Calculating NDVI from Sentinel 2 products

 To derived masked NDVI map is loaded automatically into *Layer* panel and displayed on the main map view.

















Plant canopy as crop model validation index

- One of the main parameters that is used as an evaluation criterion of crop model performance is the plants canopy.
- The traditional indices used as means to assess plants canopy are Leaf Area Index (LAI) or Green Canopy Cover (CC).
- Both require field measurements, scientific instruments and postprocess of the measured data.









NDVI as an alternative plant canopy index

- A number of studies have shown a fair correlation between the NDVI and the CC and LAI.
- Figures show correlation results between measured CC and NDVI in the case of Corn (Figure a) and Wheat (Figure b) and LAI and NDVI in the case of Wheat (Figure c)











NDVI as an alternative plant canopy index

- These empirical equations can be used to convert the NDVI map values derived from satellite images to CC or LAI.
- Successively, the derived CC or LAI timeseries can be used to validate crop models performance.
- Figure shows an example of AquaCrop crop model capability to simulate corn canopy cover development using in-situ CC measurements and NDVI derived CC.



• Field Measured CC • CC derived from NDVI







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