

GOSTEAM Summer School – Workshop II

Title: Ride like the wind:
selecting an Offshore Wind Farm
sites

Wednesday 07/07/2021



Loukas Katikas – Ellinogermaniki Agogi (EA)

Cross-cutting geospatial & environmental
STEAM instruments for the new generation

Project Number - 2020-1-SE01-KA201-077972



Metadata



Age and language of the students: 15 – 18, Greek

Number of Lessons – Duration (per lesson): 2 Lessons (45 minutes each)

Subjects: Spatial Modelling, Multi-Criteria Analysis, Overlay, Renewable Energy, Offshore Wind Farms

Curriculum and country:

Country: Greece

Class: High School

Grade: 2nd grade

Topic: Environment, Mathematics, Geography

Objectives (Max 100 words): Understand multi-objectivity in spatial analysis, Identify spatial patterns, Solve spatial problem for location-allocation procedures

Materials and Tools (Max 100 words): Spatial data acquisition, GIS application (QGIS – Open Source)



Metadata

Spatial concepts, skills and abilities:

Which spatial concepts and skills are covered by the activity?

Overlay, Buffer, Map, Surface, Map Projection

Spatial skills:

- Select an ideal location based on the given spatial features,
- Visualization,
- Delineation of spatial regions/ zones based on given features/properties

Geospatial concepts and spatial abilities documentation (see Section 3.2):

http://www.gosteam.eu/wp-content/uploads/2021/05/GOSTEAM_IO1_A1_final.pdf

Description of the activity in detail



Short Description (Max 500 words):

Spatial Multi-Criteria Decision-Making (MCDM) is used for decisions with a geographical element, most often in site-prospecting and risk assessment processes where multiple factors need to be considered. Some examples incorporate:

- Location-allocation problems
- Land use management
- Proximity to human infrastructures
- Environmentally sensitive areas and Ecological Risk Assessment
- Disaster Risk Management

What to do?

During this activity, students will get familiar with some of the procedures described in order to identify suitable areas for Offshore Wind Farms using different criteria, reclassification rules and overlay operations.

Keywords (Up to 5):

Multi-criteria analysis, Spatial Modelling, Renewable Energy Resources, Offshore Wind Farms

1. Questions eliciting activities

Provoke curiosity

Usually, the most effective way to provoke students' curiosity is by presenting an exciting video or a series of photos

<https://www.youtube.com/watch?v=HqCVgRbPQcg>

(Offshore Wind Farms characteristics)

Propose preliminary explanations or hypotheses

It is best to ask these questions in the context of a relative discussion.

Have you ever seen wind turbines at the sea?

Why we select the marine environment instead of onshore sites?

How many criteria are needed to be converged in order to allocate suitable areas for RES deployment?

What spatial data are needed and how can spatial modelling improve site-selection procedures at the preliminary assessment steps?



2. Active investigation



Plan and conduct simple investigation

This is the phase in which students are being prepared for the subsequent phase of evidence gathering during observation.



During this step, students may collect evidence regarding multi-criteria decision making and Offshore Wind Farms site-prospecting.

What criteria are considered as the most important?

What type of data are needed? How can we analyze these data?

What tools are used during spatial analysis procedures?

Which are the expected outcomes?

2. Active investigation



Provide students with relevant information and resources and the first cycle of discussion begins:

Available data:

[Wind, Elevation and Bathymetry](#)

[Land-use, Water, Population](#)

[Global spatial data \(multiple topics\)](#)

[National and Global data providers \(multiple topics\)](#)



Available tools for MCDM:

[QGIS](#)

[ArcGIS \(Schools License\)](#)

Need to Learn:

[Offshore Wind Farms Multi-Criteria Decision-Making Criteria and Steps](#) (see Figs.1 and 7)

[Offshore Wind Farm siting criteria](#) (see Table 1)

[Offshore Wind Farm siting criteria](#) (see Section 3 and Tables 1 - 2)

[Offshore and Onshore Wind Farm siting criteria review](#) (see Tables 2-3)

2. Active investigation (Examples)



1. Wind Farm Deployment Model

Decision Variables

1. Number of Turbines
2. Wind Turbine Size
3. Wind Turbine Layout (3 layout cases) Round 3
4. Offshore Wind Farm Locations

Round 3 Offshore Locations

- Annual Mean Wind Speed
- Distance from ports
- Water Depth



LCC Model

$LCC = CP\&C + CP\&A + CI\&C + CO\&M + CD\&D$
 $CAPEX = CP\&C + CP\&A + CI\&C$
 $OPEX = CO\&M$

- Production and Acquisition cost (CP&A)
- Predevelopment and Consenting cost (CP&C)
- Installation and Commissioning cost (CI&C)
- Operation and Maintenance cost (CO&M)
- Decommissioning and Disposal Cost (CD&D)

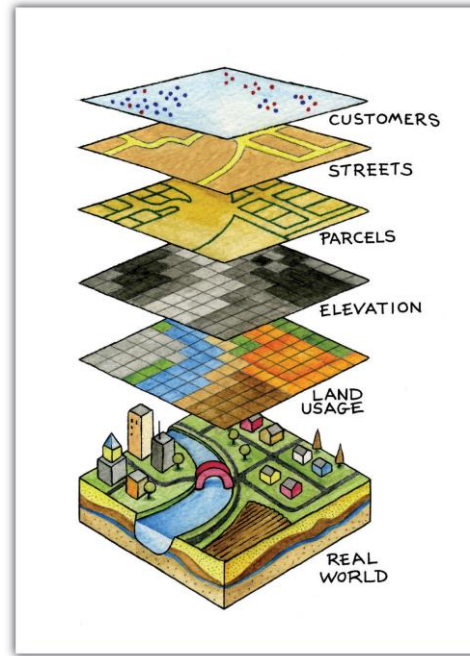
3. Criteria Selection Framework

Criteria Selection Framework

1. Brainstorm and Mindmap
2. Literature Review
3. Discussion with Experts
4. Preliminary Assessment
5. Values Assignment
6. Decision on an appropriate MCDM Method

5. Optimum Location

Offshore Wind Farm Locations Ranking



1. Wind Farm Deployment Model

2. Multi-Objective Optimisation

3. Criteria Selection

4. Multi-Criteria Decision Making

5. Optimum Location

2. Multi-Objective Optimisation

LCC Objective Functions

CAPEX


1. Production and Acquisition cost (CP&A)
2. Predevelopment and Consenting cost (CP&C)
3. Installation and Commissioning cost (CI&C)

OPEX

4. Operation and Maintenance cost (CO&M)
5. Decommissioning and Disposal Cost (CD&D)

Other Objective Functions

6. Number of Turbines (NWT)
7. Total Installed Capacity (TIC)
8. Power Extracted (P)

NSGA II 


Outcome: A non-dominated Set of Optimum Offshore Locations

4. Multi-Criteria Decision Making

Deterministic TOPSIS and Stochastic expansion

Criteria Selection

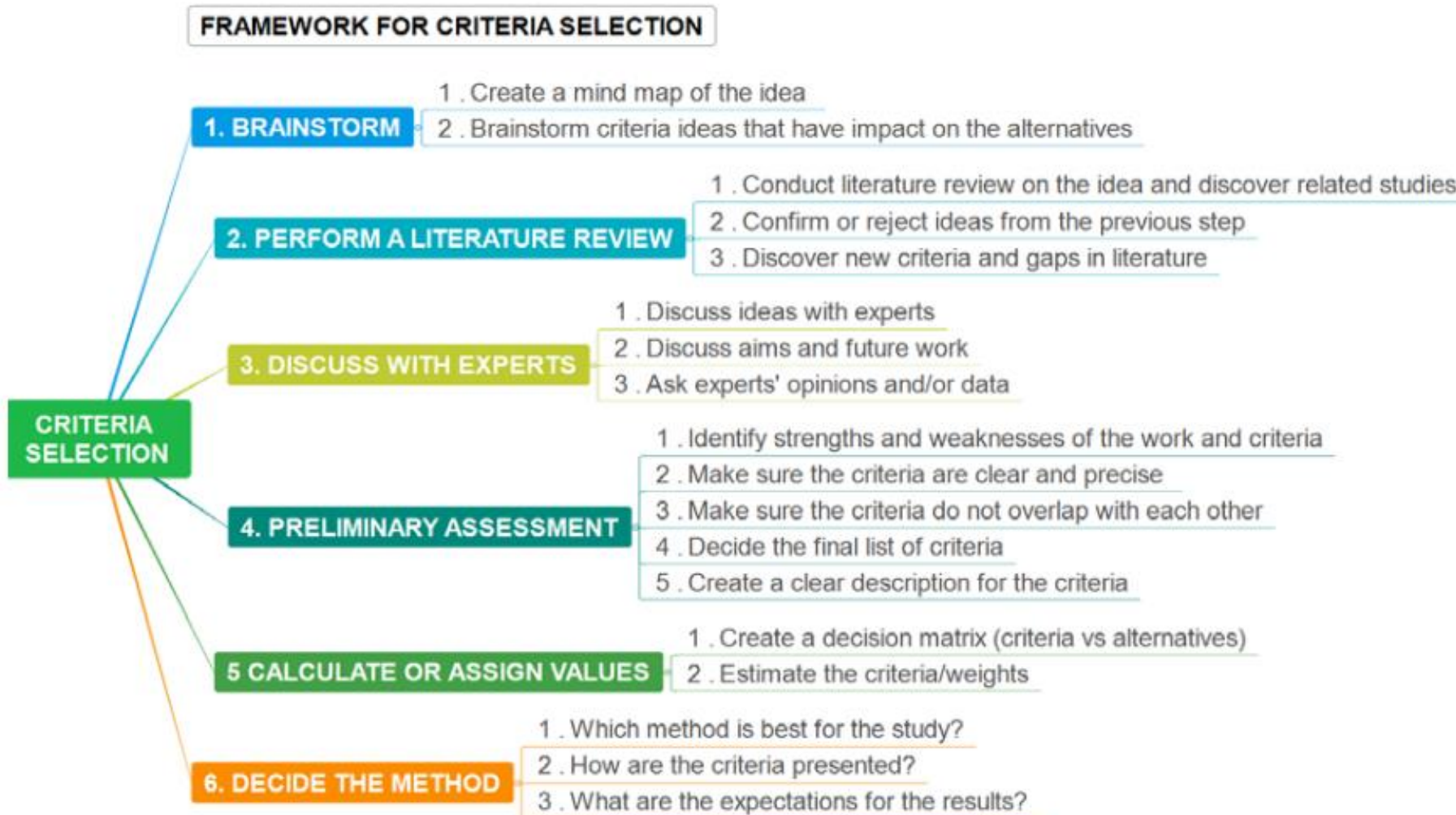
1. Accessibility
2. Operational environmental conditions
3. Environmental impact
4. Extreme environmental conditions
5. Grid Connection
6. Geotechnical conditions
7. LCOE



Outcome: A list of prioritised locations

Models and Digital Apps that are used as also, the logical steps to be followed in order to solve multi-criteria site-prospecting problems.

2. Active investigation (Examples)



How we select our criteria defining the problem?

Chapter Break (Any Questions?)



3. Creation

Gather evidence from observation

It is recommended to introduce group work at this stage. Guide the teachers to divide students in groups, each of which will be facilitated by the teacher to formulate and to evaluate explanations to the scientific questions based on the collected evidence.

Activity planning

Before the beginning of the activity, student are separated to groups of 2. One of the group members is responsible for the tasks' flowchart implementation, data acquisition and the appropriate steps to be followed during the activity. The second member is responsible for the results validation and communication, including the final report and the maps preparation.

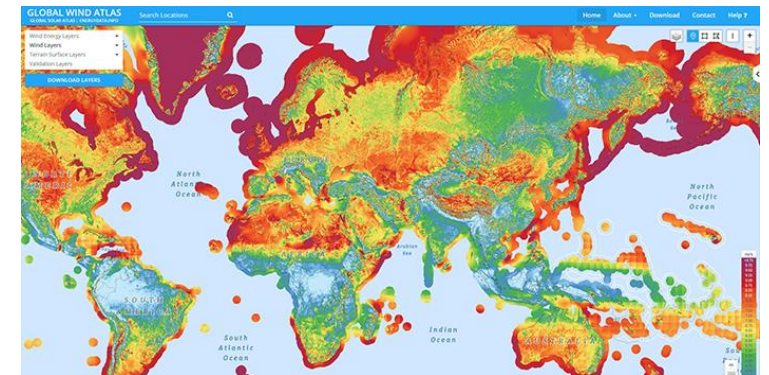


Preparative steps

1. Download QGIS 3.18.1 version



2. Visit Global Wind Atlas website and download wind and elevation/bathymetry data



3. Download environmental data (NATURA areas)

Creation – Part 1 (Open QGIS)



QGIS interface

Vector and Raster data:

One key concept that the students must deeply understand is how we “translate” and represent spatial information to spatial data

1. Navigate to your folders – Drag and drop datasets or inspect your progress and what you are saving

2. Open any Vector or Raster based files with Add command

3. All Vector data-based commands and Processes

4. All Raster data-based commands and Processes

5. Processing Toolbar, Button and Panel helps to find any command or Process we are looking for from all available Plug-Ins and Libraries of QGIS

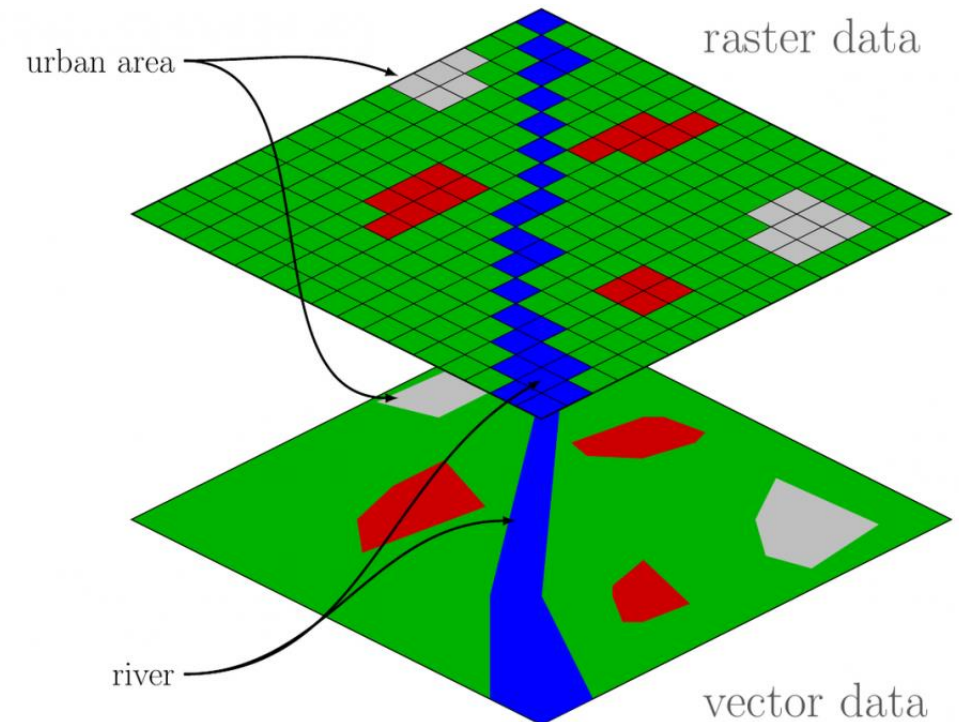
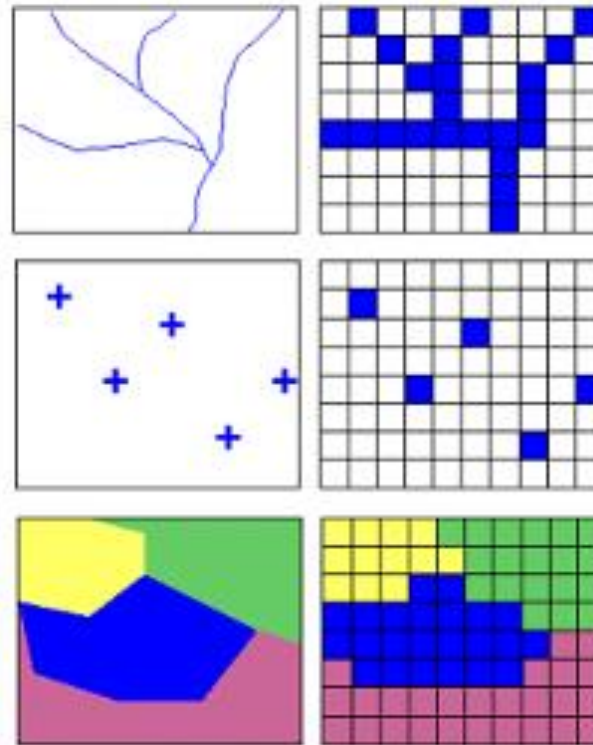
6. All added layers that the user “loads” (step 2) to QGIS

Creation – Part 1 (Open QGIS)



Vector and Raster data:

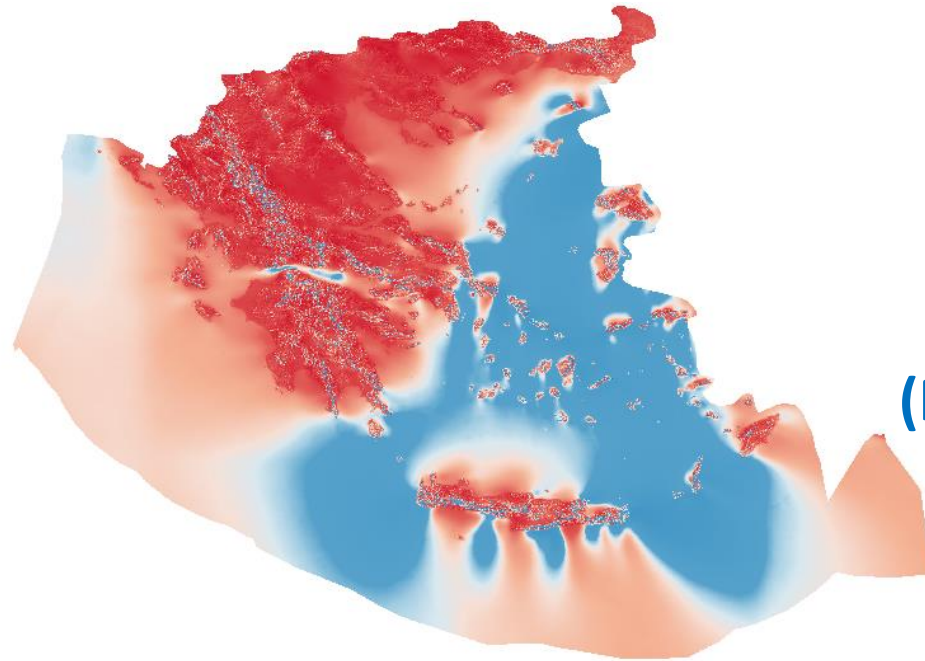
One key concept that the students must deeply understand is how we “translate” and represent spatial information to spatial data



WHY THIS IS IMPORTANT?

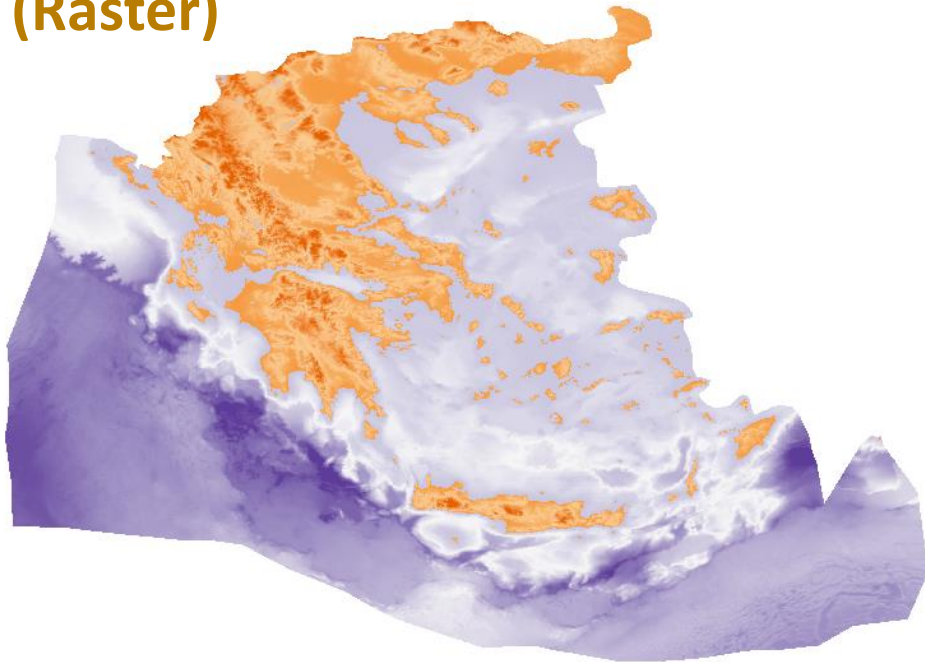
In order to understand spatial data structures, models' data inputs, data volume, spatial resolution, scale, computational efficiency and spatial data, big data manipulation-processing-visualization etc.

Creation – Part 1 (Load data)

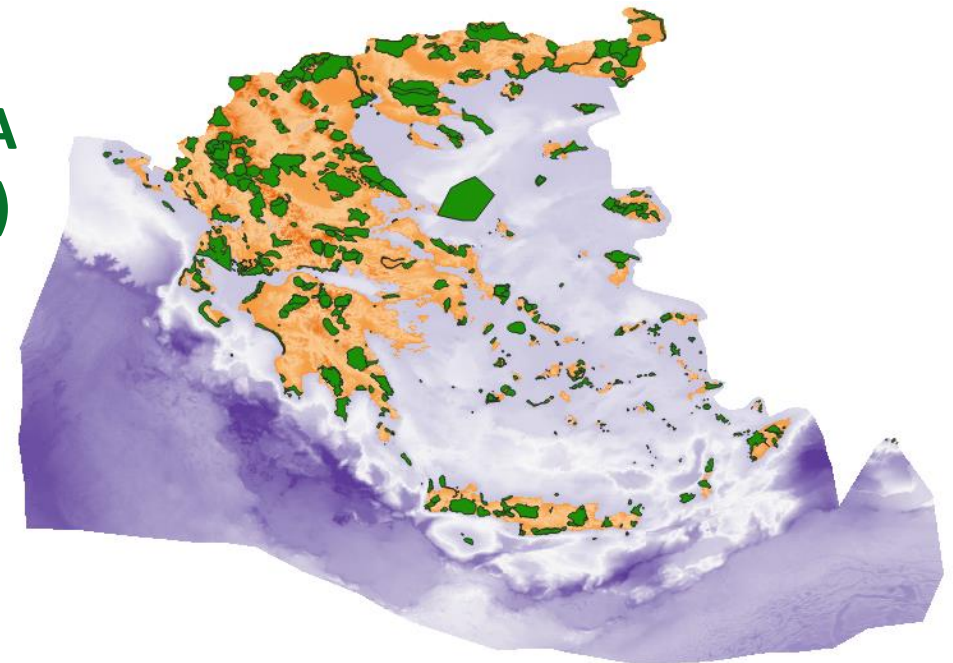


Wind
(Raster)

Elevation – Bathymetry
(Raster)



NATURA
(Vector)



Creation – Part 1 (Coordinate Systems - Reproject)



A first discussion may begin focusing on the coordinate systems, geographic transformations and projections!
(Geography and Mathematics)

Some of the spatial data
acquired may have different
coordinate system
(Geographic or Projected. But
what does it mean?). It is
crucial to transform all data to
a common coordinate system.

The image shows two overlapping dialog boxes in QGIS. The background dialog is 'Reproject Layer', and the foreground dialog is 'Coordinate Reference System Selector'.

Reproject Layer Dialog:

- Parameters | Log
- Input layer: NATURA [OGC:CRS84]
- Selected features only:
- Target CRS: EPSG:4326 - WGS 84
- Advanced Parameters:
 - Reprojected: [Create temporary layer]
 - Open output file after running algorithm:
- Progress: 0%
- Run as Batch Process...

Coordinate Reference System Selector Dialog:

- Filter: 2100
- Recently Used Coordinate Reference Systems: (Empty table)
- Predefined Coordinate Reference Systems: Hide deprecated CRSs
- Table of CRSs:

Coordinate Reference System	Authority ID
NAD83 / Montana	EPSG:32100
▼ Mercator	
WGS_1984_Web_Mercator_Auxiliary_Sphere	ESRI:102100
▼ Transverse Mercator	
GGRS87 / Greek Grid	EPSG:2100

Below the table, the selected CRS 'GGRS87 / Greek Grid' is shown with its WKT definition:

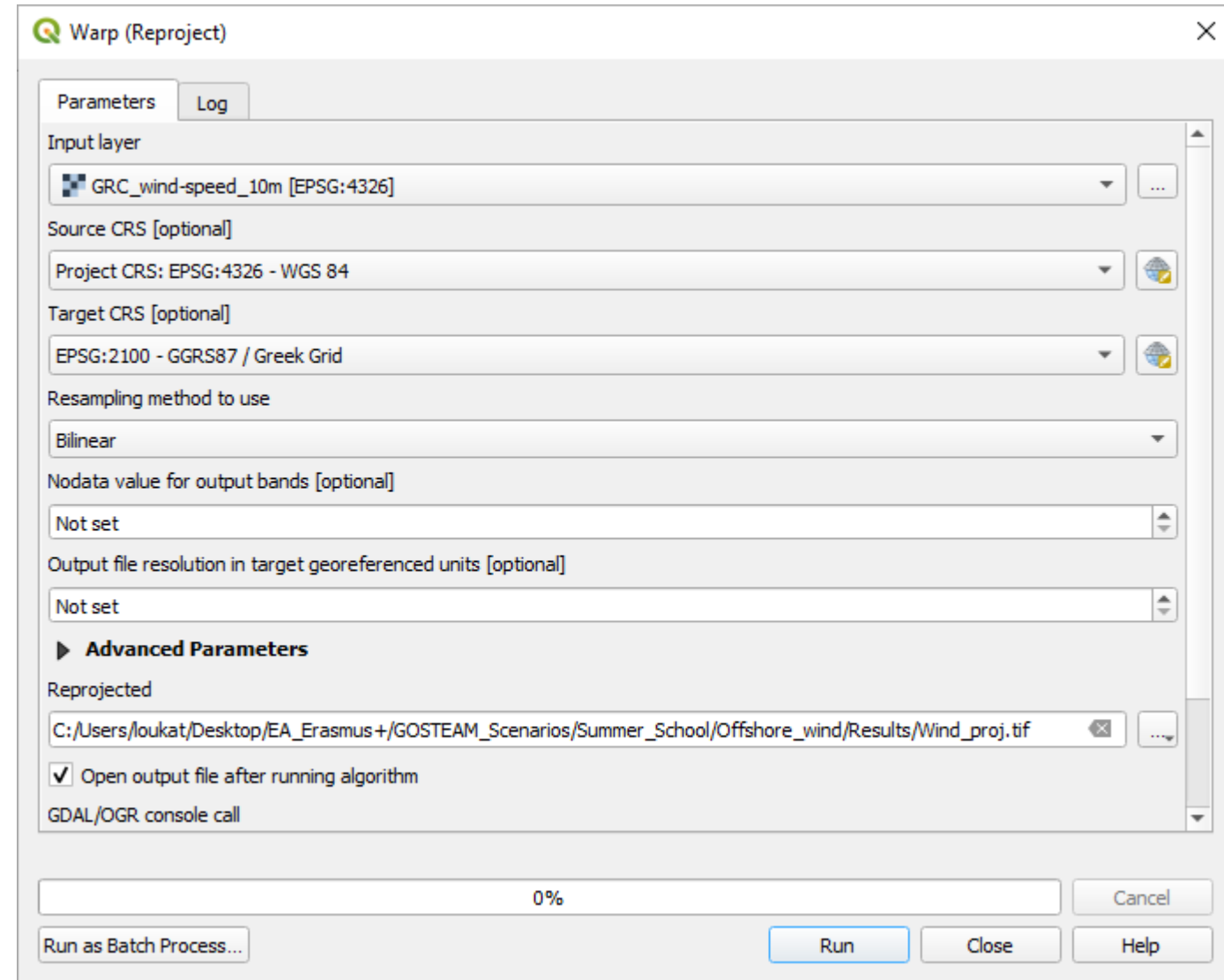
```
PROJCRS["GGRS87 / Greek Grid",  
  BASEGEOGCRS["GGRS87",  
    DATUM["Greek Geodetic Reference System 1987",  
      ELLIPSOID["GRS 1980",  
        6378137,298.257222101,  
        LENGTHUNIT["metre
```

A small map of Greece is shown in the bottom right corner of the dialog, with a red rectangle highlighting the area of interest.

Creation – Part 1 (Coordinate Systems - Reproject)



- Most of the times, we select coordinate systems based on spatial scale we work (i.e. national) and the agent that we will deliver our results (i.e. European Union, Greek Ministry etc.)
- Considering that we work for the Greek Ministry, all available data will be reprojected to the Hellenic Geodetic Reference System (GGRS87 - EPSG:2100)



Creation – Part 2 (Create Mask Layer)



Next step consists of cutting/clipping a specific area of interest; thus, we must create a new empty shapefile layer and create a polygon mask!

Why? To differentiate students' results and trigger their interest upon different areas!

A screenshot of the 'New Shapefile Layer' dialog box in a GIS application. The dialog is titled 'New Shapefile Layer' and has a close button (X) in the top right corner. It contains several fields and options for creating a new shapefile layer. The 'File name' field is set to 'C:/Users/loukat/Desktop/EA_Erasmus+/GOSTEAM_Scenarios/Summer_School/Offshore_wind/Results/new_layer.shp'. The 'File encoding' is set to 'System'. The 'Geometry type' is set to 'Polygon'. The 'Additional dimensions' are set to 'None'. The 'Coordinate system' is set to 'EPSG:4326 - WGS 84'. The 'New Field' section has a 'Name' field set to 'Mask', a 'Type' dropdown set to 'abc Text Data', a 'Length' field set to '80', and a 'Precision' field. There is an 'Add to Fields List' button below the 'New Field' section. The 'Fields List' section contains a table with the following data:

Name	Type	Length	Precision
id	Integer	10	

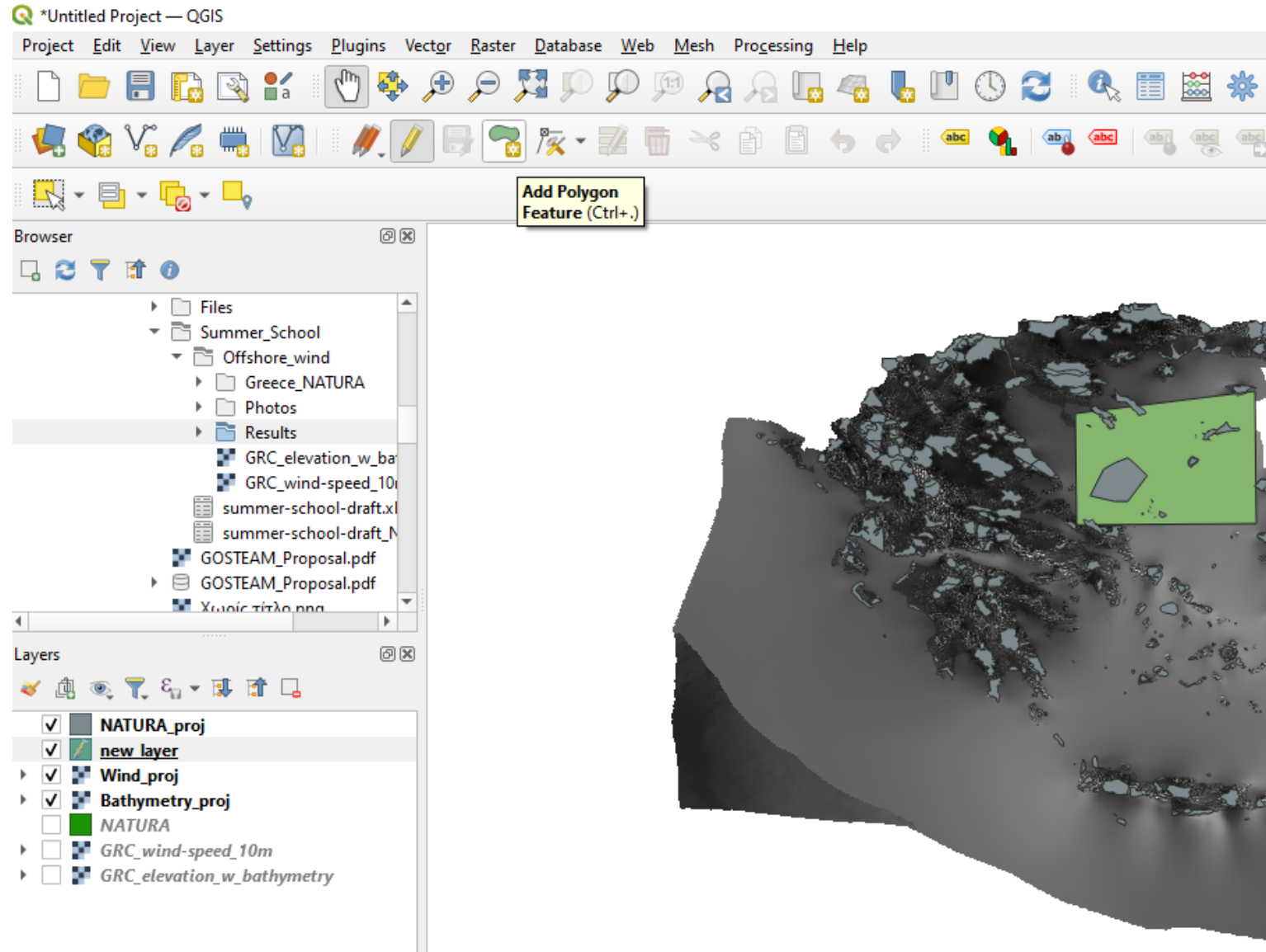
At the bottom right of the dialog, there is a 'Remove Field' button. At the very bottom, there are three buttons: 'OK', 'Cancel', and 'Help'.

Creation – Part 2 (Select Study Area as Polygon)



1. Select a folder to create a new empty polygon shapefile.
2. Select the new layer on the Layers menu and click on “Toggle Editing”.
3. Click on “Add Polygon” and draw a Polygon that will be used as a Mask.
4. To the final point we edited, we press right-click by adding number 1 as the Polygon “id”.

The bigger the Polygon is, the more the processing time increases to the next steps!

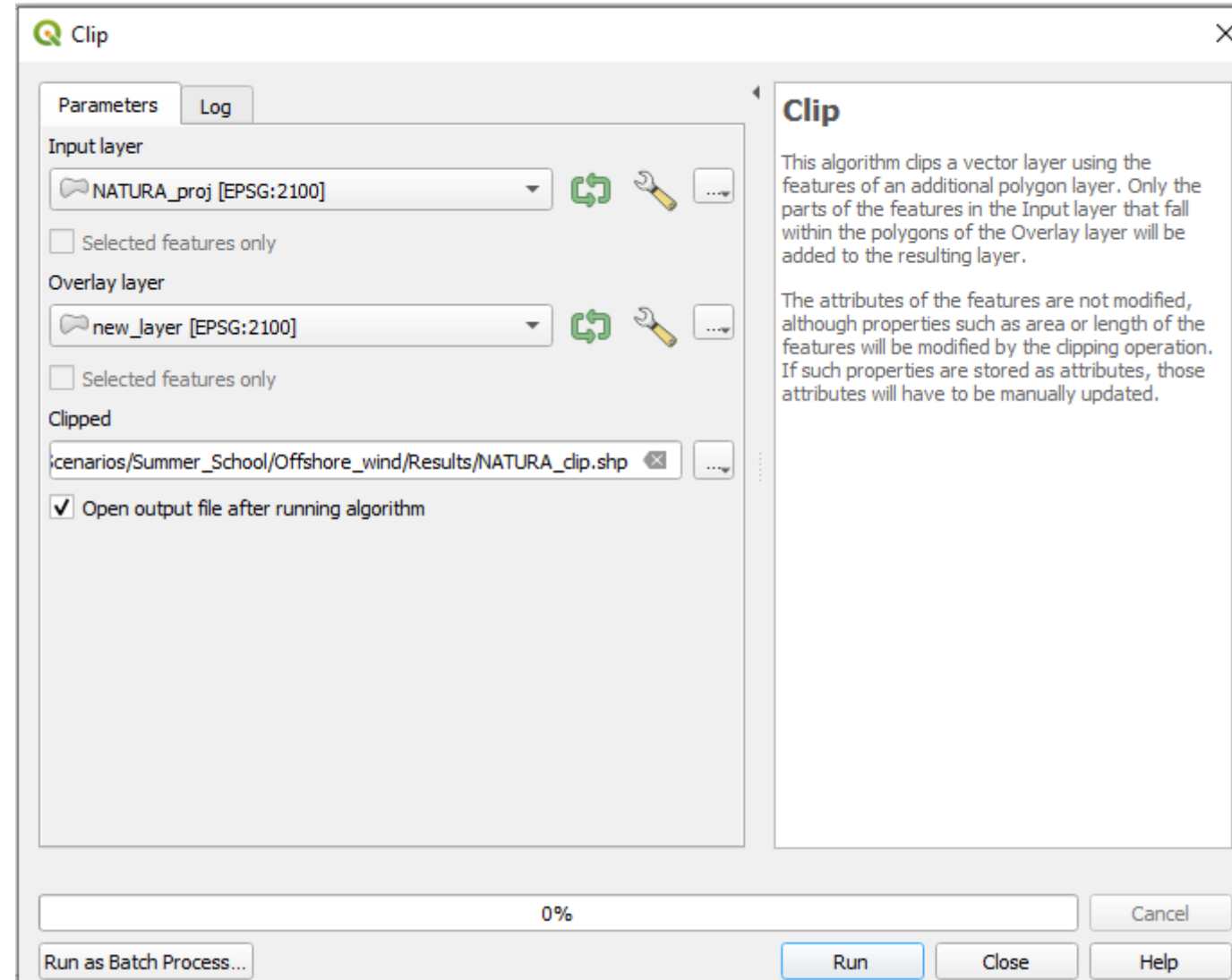


Creation – Part 2 (Clip NATURA areas)



1. Select Vector -> Geoprocessing -> Clip.
2. Select NATURA layer as input and the new_layer (Polygon Mask) as overlay layer.
3. Save as NATURA_clip.

Why we use Vector Toolbar? Because NATURA areas are illustrated as Polygon Features (Vectors) and we want to work only with raster data!

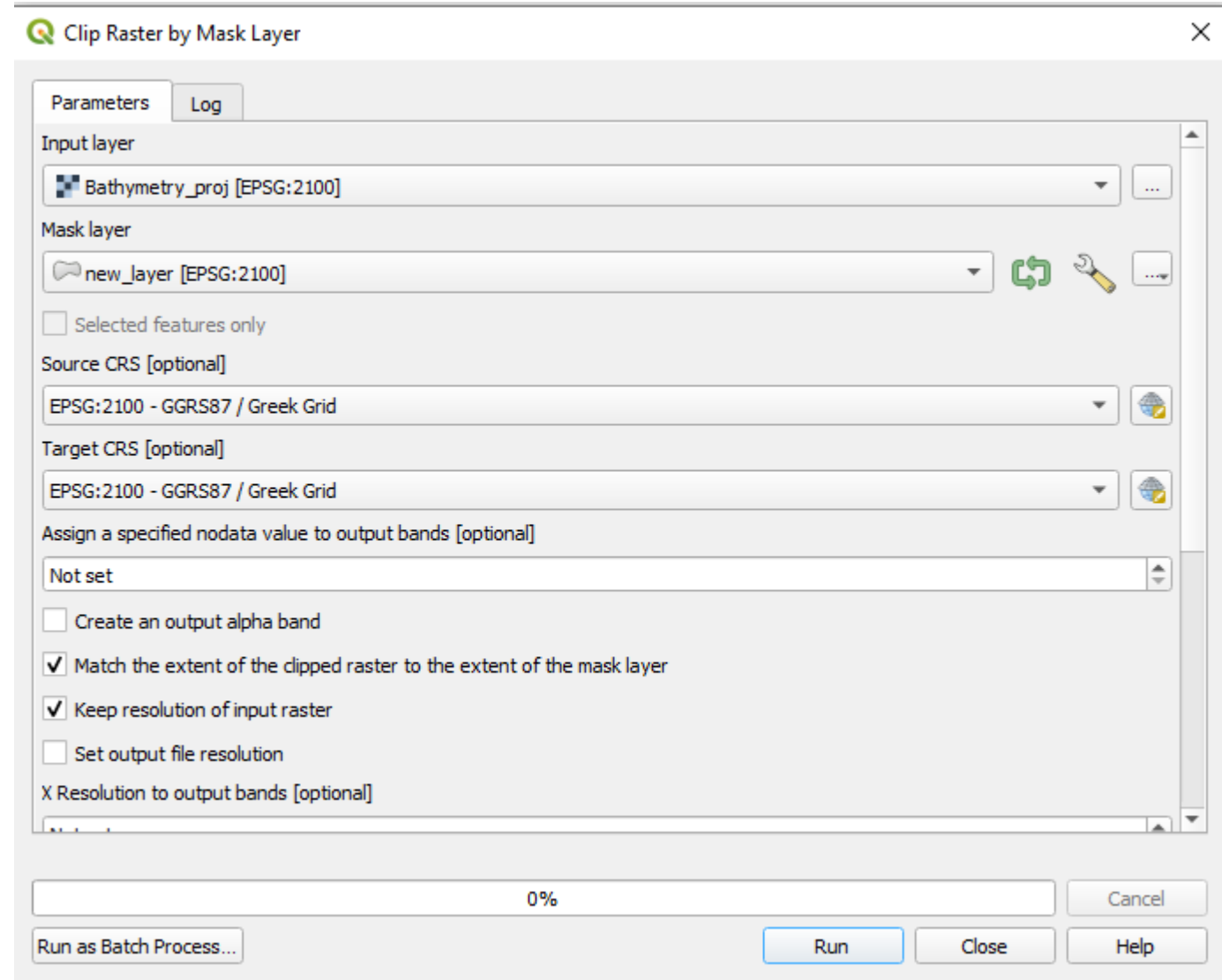


Creation – Part 2 (Clip Wind and Bathymetry rasters)



1. Select Raster -> Extraction -> Clip Raster by Mask Layer.
2. Select new_layer (Polygon Mask) as mask layer.
3. Source and Target CRS: 2100
4. Select Keep resolution of input raster and match the extent.
5. Save as Bathymetry_clip.

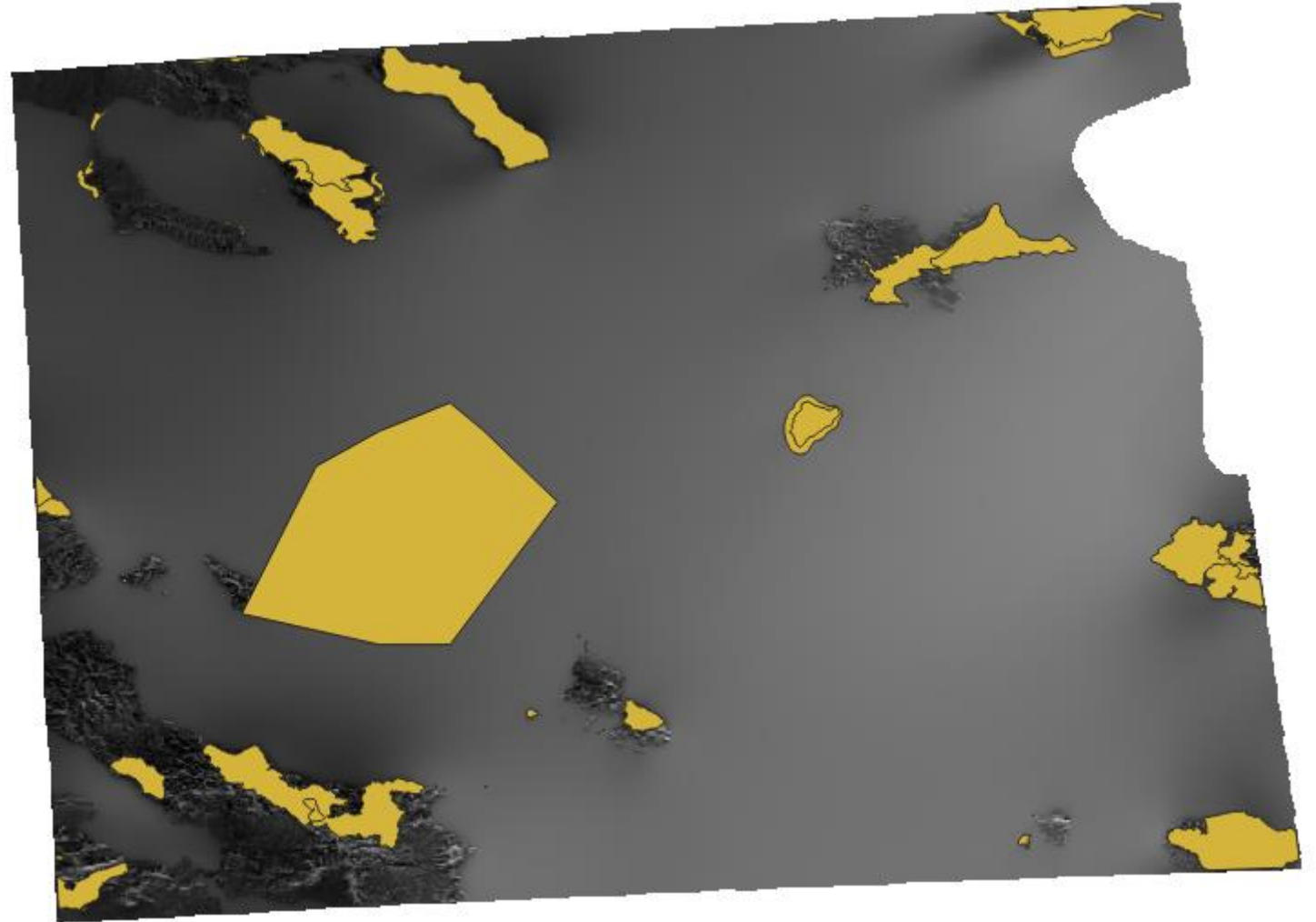
Why we use Raster Toolbar? Because Wind and Bathymetry data are illustrated as grid entities (georeferenced images)!



Creation – Part 2 (Clip Results)



Clipped data to the Polygon Mask
extent!



Chapter Break (Any Questions?)

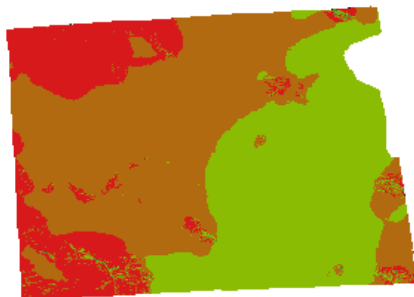


Creation – Part 3 (Bathymetry criterion)



In this step, we want to Reclassify (change) depth values (meters) in score values in the range between 0 and 10!

1. Select Processing -> Toolbox and type to the search area “Reclass”.
2. Select “Reclassify values (Table)”.
3. Grid -> Bathymetry_clip.
4. Operator: [1]
5. Save as “Bathymetry_fn”



Database Web Mesh Processing Help

Reclassify Values (Table)

Parameters Log

Lookup Table

	minimum	maximum	new
1	0	1700	0
2	-1600	-500	1
3	-500	-200	4
4	-200	-70	6
5	-70	-30	8
6	-30	0	10

Buttons: Add Row, Remove Row(s), Remove All, OK, Cancel

Processing Toolbox

reclass

- Recently used
- Raster analysis
 - Reclassify by layer
 - Reclassify by table
- Vector table
 - Add unique value index field
- GRASS
 - Raster (r.*)
 - r.reclass
 - r.reclass.area
 - Vector (v.*)
 - v.reclass
- SAGA
 - Raster analysis
 - Soil texture classification
 - Raster tools
 - Reclassify values
 - Reclassify values (range)
 - Reclassify values (simple)
 - Reclassify values (single)
 - Reclassify values (table)
 - Terrain Analysis - Morphometry
 - Curvature classification

0%

Run as Batch Process... Run Close

Coordinate 23.352740,368 Scale 1:1006951 Magnifier 100% Rotation 0,0° Render EPSG:4326

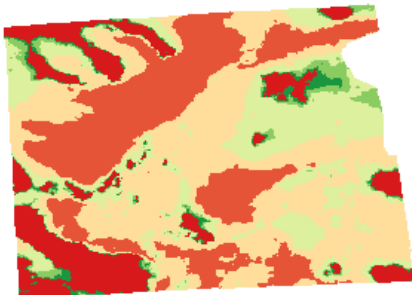
4:05 μμ 23/6/2021

Creation – Part 3 (Wind criterion)



In this step, we want to Reclassify (change) wind speed values (m/s) in score values in the range between 0 and 10!

1. Select Processing -> Toolbox and type to the search area “Reclass”.
2. Select “Reclassify values (Table)”.
3. Grid -> Wind_clip.
4. Operator: [1]
5. Save as “Wind_fn”



The screenshot displays the QGIS interface. The 'Reclassify Values (Table)' dialog box is open, showing a 'Lookup Table' with the following data:

	minimum	maximum	new
1	0	4	1
2	4	6	4
3	6	8	6
4	8	10	9
5	10	15	10

The dialog box also includes buttons for 'Add Row', 'Remove Row(s)', 'Remove All', 'OK', and 'Cancel'. The Processing Toolbox on the right shows a search for 'reclass', with 'Reclassify values (table)' selected under the 'SAGA' -> 'Raster analysis' -> 'Raster tools' category. The progress bar at the bottom indicates 0% completion.

Creation – Part 3 (Slope criterion)



Let's formulate Slopes criterion without any further instructions!

What do we need to estimate Slopes?

Is a Raster or Vector dataset?

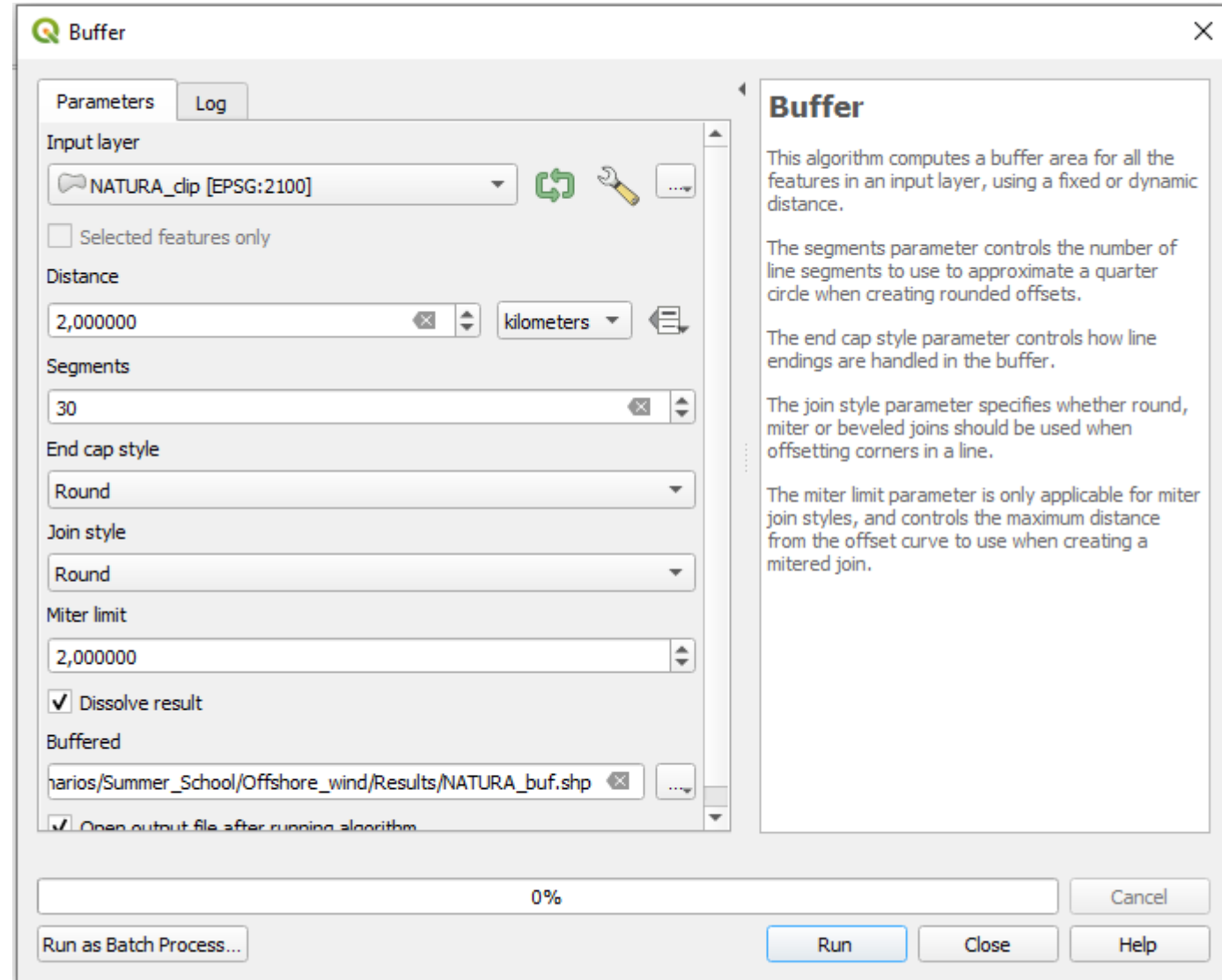
We prefer flat areas or not and why?

Creation – Part 3 (NATURA criterion / Buffer)



We want to create an exclusion zone (buffer) around all NATURA areas that might be potential sites for OWFs but not optimal.

1. Select Vector -> Geoprocessing -> Buffer.
2. Select NATURA_clip layer as input and Buffer distance 2km by selecting measuring units as “kilometers”.
3. Select 30 segments and tick Dissolve results.
4. Save as NATURA_buffer.

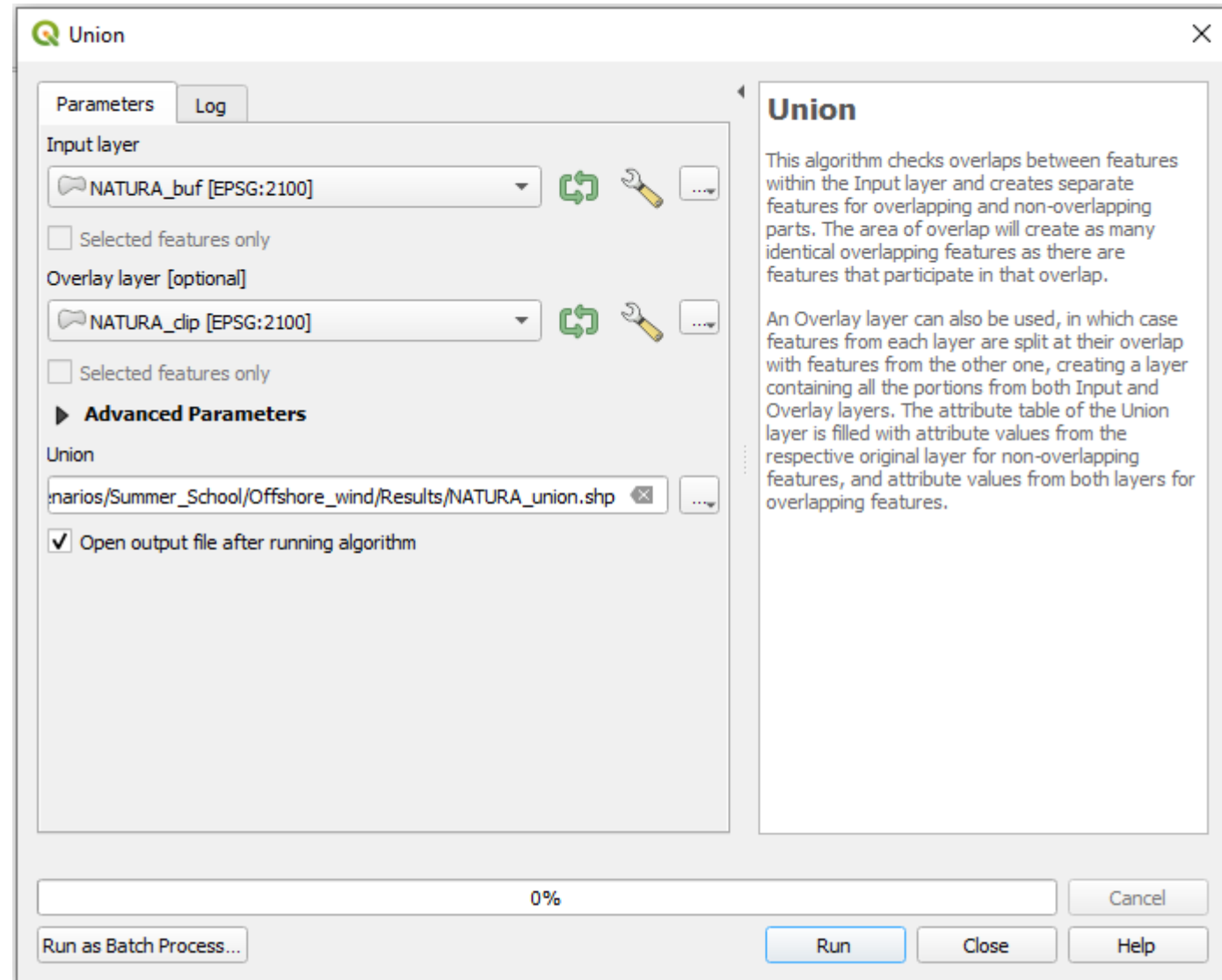


Creation – Part 3 (NATURA criterion / Union)



The scope of the Union tool is to merge the initial NATURA polygons with the Buffer zones created in the previous steps!

1. Select Vector -> Geoprocessing -> Union.
2. Select NATURA_buffer layer as input and NATURA_clip as overlay layer.
3. Save as NATURA_union.



Creation – Part 3 (NATURA criterion / Union)



Why we need this procedure? We need to set a low score inside NATURA areas (zero) and a higher score near to the NATURA areas (buffers). But outside these Polygons?

1. Right-click the NATURA_union layer and select “Open Attribute Table”.
2. In the line with the “NULL” input, add value 5 at the “score” field
3. Press “Toggle editing” again

	objectid_2	CODE_2	area_2	perimeter_	hectares_2	SITETYPE_2	PERIPHERY_	PREFECTU_1	NAME_LAT_1	score_2	
21	5	0 GR2420010	62433800,00000...	42337,20999999...	6243,380000000...	SPA	????? ??????	??????	OROS KANTILI	0	
22	5	145,0000000000...	GR4110003	208170368,0000...	137588,9700000...	20817,03700000...	SCI	? .??????	??????	LESVOS: DYTIKI ...	0
23	5	0 GR1270013	4395787,000000...	14707,51499999...	439,5790000000...	SPA	????????? ??????????	?????????	YGROTOPOI NE...	0	
24	5	146,0000000000...	GR4110004	183110368,0000...	99431,77999999...	18311,03700000...	SCI	? .??????	??????	LESVOS: KOLPO...	0
25	5	0 GR4110010	288194368,0000...	167785,3800000...	28819,43799999...	SPA	? .??????	??????	NOTIODYTIKI C...	0	
26	5	207,0000000000...	GR1110004	164377408,0000...	80184,83599999...	16437,74000000...	SCI	????????? ??????????	??????	FENGARI SAMO...	0
27	5	0 GR4110008	1252484,800000...	9558,03299999...	125,2480000000...	SPA	? .??????	??????	NISIDES KAI VR...	0	
28	5	NULL NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	5	
29	5	0 GR1430005	129673856,0000...	133592,4500000...	12967,38600000...	SPA	?????????	?????????	NISIA KYRA PA...	0	
30	5	0 GR1270004	6331518,500000...	15955,10299999...	633,1520000000...	SPASCI	????????? ??????????	?????????	LIMNOTHALAS...	0	
31	5	0 GR2420011	393081280,0000...	234656,8099999...	39308,12999999...	SPA	????? ??????	??????	ORI KENTRIKIS ...	0	
32	5	0 GR2420006	40889144,00000...	33497,69000000...	4088,914000000...	SPASCI	????? ??????	??????	SKYROS: OROS ...	0	
33	5	0 GR1270014	234511664,0000...	125018,6399999...	23451,16800000...	SPA	????????? ??????????	?????????	CHERSONISOS ...	0	
34	5	107,0000000000...	GR2420002	12977340,00000...	19668,47999999...	1297,733999999...	SCI	????? ??????	??????	DIRFYS: DASOS ...	0
35	5	143,0000000000...	GR4110001	182316624,0000...	81263,85000000...	18231,66200000...	SCI	? .??????	??????	LIMNOS: CHOR...	0

Creation – Part 3 (NATURA criterion / Rasterize)



1. Select Raster -> Conversion -> Rasterize
2. Select shapes as NATURA_union.
3. Attribute -> score.
4. Output extent -> Bathymetry_fn or Wind_fn
5. Cell_size: 241.1611050045360116
6. Save as NATURA_raster

We have to convert NATURA_union from shapefile to raster because Wind and Bathymetry data are also in raster format!

QGIS Rasterize dialog box parameters:

- Parameters | Log
- Shapes: NATURA_union [EPSG:2100]
- Selected features only
- Attribute: score_2
- Output Values: [2] attribute
- Method for Multiple Values: [4] mean
- Method for Lines: [1] thick
- Method for Lines: [1] cell
- Preferred Target Grid Type: [3] Floating Point (4 byte)
- Output extent [optional]: 426613.9948,688514.9548,4244435.4481,4484873.0698 [EPSG:2100]
- Cellsize: 100,000000
- Fit: [1] cells
- Progress: 0%
- Buttons: Run as Batch Process..., Run, Close

Creation – Part 3 (NATURA criterion / Fill No Data)



1. Select Processing -> Toolbox and type to the search area “Fill”.
2. Select Fill NoData cells.
3. Raster input -> NATURA_raster.
4. Fill value: 10
5. Do not save output raster, just Run the command (bug issues)

We need to fill all NoData values with the highest score (10)!

The screenshot shows the QGIS interface. The 'Fill NoData Cells' dialog box is open, displaying the following parameters:

- Parameters** (Log)
- Raster input:** NATURA_union_raster [EPSG:2100]
- Band Number:** Band 1
- Fill value:** 10
- Output raster:** [Save to temporary file]
- Open output file after running algorithm

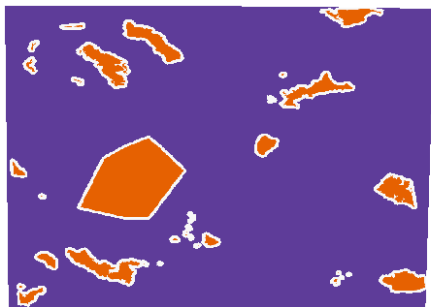
The dialog box also contains a description: "This algorithm resets the NoData values in the input raster to a chosen value, resulting in a raster dataset with no NoData pixels. This value can be set by the user using the Fill value parameter. The algorithm respects the input raster data type (eg. a floating point fill value will be truncated when applied to an integer raster)." The progress bar at the bottom shows 0% completion. Buttons for 'Run', 'Close', 'Help', and 'Cancel' are visible.

The Processing Toolbox on the right shows the search results for 'fill', listing various tools under categories like 'Recently used', 'Cartography', 'Raster tools', 'Vector geometry', 'GDAL', 'GRASS', and 'SAGA'. The 'Fill NoData cells' tool is highlighted in the 'Recently used' section.

Creation – Part 3 (NATURA criterion / Rasterize)



1. Select right-click to the output file -> Save Raster Layer as and name it as “NATURA_fn”.
2. Set CRS:2100
3. Extent -> Calculate from Layer -> Bathymetry_clip.
4. Resolution horizontal and vertical:
241.1611050045360116



The screenshot shows the QGIS interface with the 'Save Raster Layer as...' dialog box open. The dialog is configured with the following settings:

- Output mode: Raw data
- Format: GeoTIFF
- File name: _Erasmus+\GOSTEAM_Scenarios\Summer_School\Offshore_wind\Results\NATURA_fn.tif
- Layer name: (empty)
- CRS: EPSG:2100 - GGRS87 / Greek Grid
- Extent (current: layer):
 - North: 4484873,0698
 - West: 426614,9548
 - East: 688514,9548
 - South: 4244473,0698
 - Buttons: Current Layer Extent, Calculate from Layer (selected), Map Canvas Extent
- Resolution (current: layer):
 - Horizontal: 100
 - Vertical: 100
 - Buttons: Layer Resolution
 - Columns: 2619
 - Rows: 2404
 - Buttons: Layer Size
- Create Options: Create Options
- Profile: Default
- Buttons: Validate, Help
- Bottom: Add saved file to map, OK, Cancel, Help

Creation – Part 4 (Weighted Sum and Final Map)



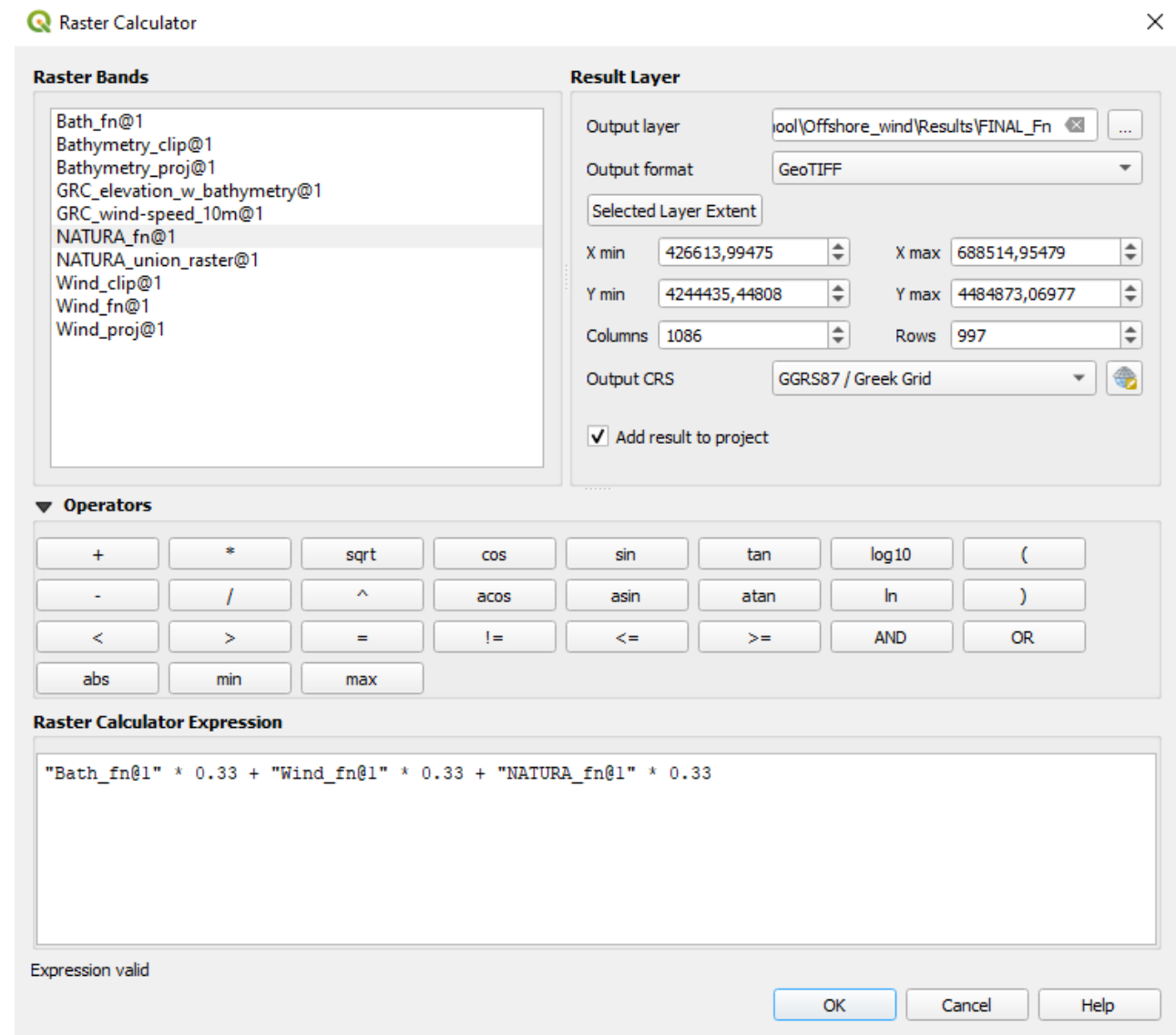
1. Select Raster -> Raster Calculator.

2. Type in the expression box:

"Bathymetry_fn@1" * 0.33 + "Wind_fn@1" *
0.33 + "NATURA_fn@1" * 0.33

3. Save as "Final_fn"

Our goal is to combine each pixel score for each criterion using an analytical expression (i.e. sum). A value of 0.33 is multiplied with each criterion as a weighting factor of "importance". We may consider different weights for the criteria!
All weights must sum up to 1!



Creation – Part 4 (Final Map)

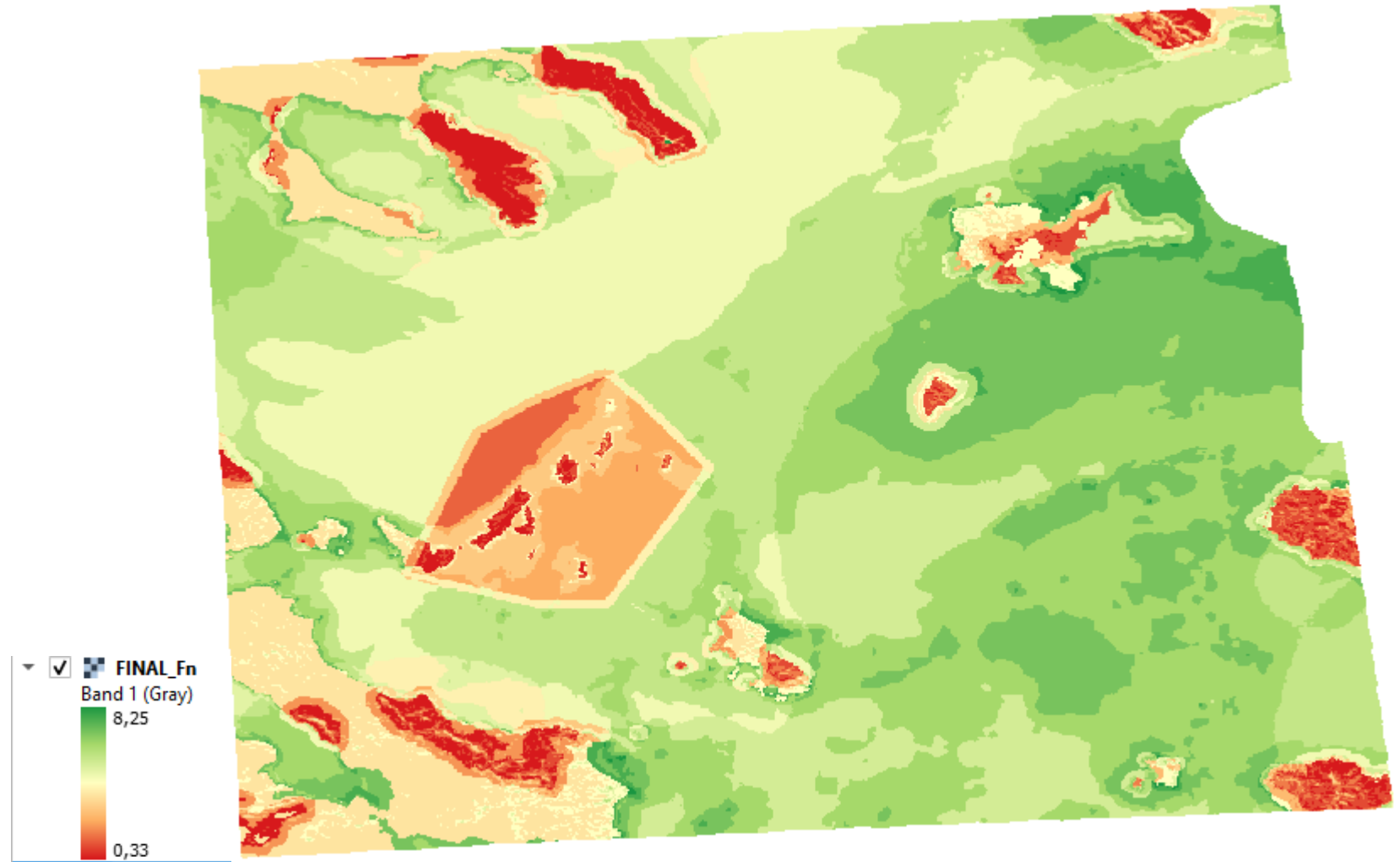


Final map extraction expressed as the weighted sum of all criteria in the range between 0.33 – 8.25.

These scores depend on the weight of each criterion.

With no weights the scale could be potentially between 0 and 30.

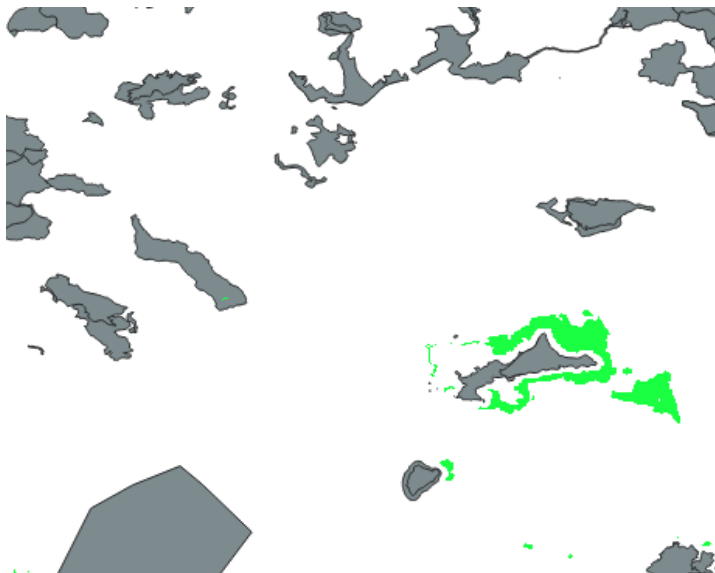
But how can we extract our final most suitable areas??



Creation – Part 5 (Screening of optimal areas)



1. Select Raster -> Raster Calculator.
2. Type in the expression box:
"Final_fn@1" >= 7 (cut-off value)



The screenshot shows the Raster Calculator dialog box in QGIS. The 'Raster Bands' list includes: Bath_fn@1, Bathymetry_clip@1, Bathymetry_proj@1, FINAL_Fn@1, Final_areas@1, GRC_elevation_w_bathymetry@1, GRC_wind-speed_10m@1, NATURA_fn@1, NATURA_union_raster@1, Wind_clip@1, Wind_fn@1, Wind_proj@1, and test@1. The 'Result Layer' section is configured with 'Output layer' (empty), 'Output format' set to 'GeoTIFF', 'Selected Layer Extent' (checked), X min: 426613,99475, X max: 688514,95479, Y min: 4244435,44808, Y max: 4484873,06977, Columns: 1086, Rows: 997, and Output CRS: EPSG:2100 - GGRS87 / Greek Grid. The 'Add result to project' checkbox is checked. The 'Operators' section shows various mathematical and logical operators. The 'Raster Calculator Expression' box contains the text: "FINAL_Fn@1" >= 7. The 'Expression valid' status is shown at the bottom left. Buttons for 'OK', 'Cancel', and 'Help' are at the bottom right.

Chapter Break (Any Questions?)



4. Discussion



Explanation based on evidence

Describe ways and they can use to this end and give them directions how to discover them.

Wind speed and depth importance!

Use the following apps (Wind Power Calculators):

<https://rechneronline.de/wind-power/>

<http://xn--drmstre-64ad.dk/wp-content/wind/miller/windpower%20web/en/tour/wres/pow/index.htm>

<https://power-calculation.com/wind-power-energy-calculator.php>

Foundations' cost

Consider other explanations

If we change criteria weights, what do you think will happen? (Do the optimal areas change?)

How do we select criteria weights? (i.e., based on the stakeholders, researchers and local communities' preferences)

Can you identify additional criteria that can be incorporated in the analysis? Why do you think they are important?

How we can be sure that the solution we propose is solid? (Sensitivity analysis, run of different scenario by adjusting the scoring and weighting factors)



5. Reflection

Communicate explanation

Provide content which the teacher can use to help the students to get familiarized and to become efficient in scientific writing.

The teacher may ask from the students to prepare a short report in order to demonstrate and discuss their results. Also, students may be guided to follow the appropriate steps in terms of the report outline including:

An introduction and scope of the Activity

The study area and data representation

The Methodology outline

Results and Discussion and finally,

Their conclusions





ELLINOGERMANIKI AGOGI

Loukas Katikas – R&D Department at Ellinogermaniki Agogi,
Environmentalist and Researcher,

Email: lkatikas@ea.gr



Thank you for your attention!

