

# **Cross-Border Sustainable Renewable Energy Acceleration in Ukraine - Mapping Synergy Renewable Energy Acceleration Areas between Ukraine, EU Member States, and Moldova**

## ***Task 8. GIS Mapping***

***Prepared by: Anastasiia Oleshchenko and Viktor Putrenko***

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## INTRODUCTION

At the XXII Ministerial Council meeting of the Energy Community in December 2024, the Ministerial Council adopted Recommendation 2014/1/MC-EnC on accelerating the deployment of renewable energy projects and implementing the energy efficiency principle first. This Recommendation calls on the Contracting Parties of the Energy Community to establish the necessary legal and institutional preconditions for the implementation of provisions related to Renewable Acceleration Areas and the streamlining of permitting procedures for renewable energy projects under Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 October 2023 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652 (Revised RED). Furthermore, the Recommendation mandates the Secretariat to assist Contracting Parties in these efforts and to report annually on the progress achieved.

In support of this mandate, the Energy Community Secretariat, with assistance from the European Climate Foundation (ECF) under its Ukraine Programme, is implementing a project aimed at establishing Cross-Border Renewable Energy Acceleration Areas (RAAs) in Ukraine.

This initiative targets five critical regions – Lvivska, Zakarpatska, Ivano-Frankivska, Chernivetska and Vinnytska Oblasts, chosen for their strategic positioning along Ukraine's borders with the EU and Moldova and their environmental significance. These oblasts encompass protected natural areas and substantial renewable energy potential, serving as a focal point for advancing Ukraine's green recovery, energy transition, and integration into the EU energy market.

This Report represents the results of the implementation by the Environmental and Spatial Planning Specialists of the Task 8, which was to develop GIS maps for potential REAAs, including explanatory notes on data sources and methodologies.

The Report is structured in three chapters: Chapter 1 of the Report describes the database used for mapping purposes; Chapter 2 describes the environmental constraints maps set, including its content, mathematical and thematic basis for map creation, as well as basic steps for creating printed thematic maps; Chapter 3 describes geodata package for the purposes of online publication.

## Chapter 1. Mapping information base

### 1.1. Structure of the database for mapping purpose.

The database contains feature classes representing input and output data of the environmental criteria analysis for the purposes of RAAs designation.

Name of database: RAAs\_proj\_fin

Format: GeoPackage

List of database classes:

Name	Type	Description
IBA	polygon	Important Bird and Biodiversity Areas
IBA_buffer	polygon	Buffer 700 m from Important Bird and Biodiversity Areas
migratory_routes	polygon	Major bird migratory routes
migratory_routes_buffer	polygon	Buffer 700 m from major bird migratory routes
border_line	line	National border of Ukraine
border_buffer	polygon	Buffer 5 km
elevation_higher_than_800	polygon	Area with elevation higher than 800 m
flooding	polygon	Area with flooding 1%
slopes_more_15	polygon	Area with slopes more than 15 degree
biosphere_reserves	polygon	Areas of UNESCO Biosphere Reserves
biosphere_reserves_buffer	polygon	Buffer 700 m from Biosphere Reserves
emerald_poly	polygon	Areas of Emerald Network Sites
emerald_buffer	polygon	Buffer 700 m from Areas of Emerald Network Sites
ramsar	polygon	Areas of Ramsar Sites
ramsar_buffer	polygon	Buffer 700 m from Areas of Ramsar Sites
endangered_species_areas	polygon	Areas with high level density of observations of endangered species
endangered_species_buffer	polygon	Buffer 700 m from Areas with high level density of observations of endangered species
forest_areas	polygon	Areas of forest fund
forest_buffer	polygon	Buffer 100 m from forest areas
nature_reserve_fund_buffer	polygon	Buffer 700 m from Nature Reserve Fund of Ukraine areas
nature_reserve_fund_poly	polygon	Nature Reserve Fund of Ukraine areas
peatlands_poly	polygon	Peatlands
peatlands_buffer	polygon	Buffer 700 m from Peatlands
recreational_lands	polygon	Recreational lands

Name	Type	Description
recreational_lands_buffer	polygon	Buffer 700 m from Recreational lands
waterbodies_buffer	polygon	Normative waterside protection zones
waterbodies_line	line	Line Waterbodies
waterbodies_poly	polygon	Polygon Waterbodies
agriculture_areas	polygon	Agriculture land
artificial_surfaces	polygon	Areas of high concentration of artificial and built surfaces
boundary	polygon	Area of interest
overlay_layer	polygon	Integration of criteria layers
recommended_areas	polygon	Areas without environmental restrictions

## 1.2. Lists of attributes for database classes.

Class Name	Type	Attribute	Description
IBA	Text	Country	National name
	Text	ISO3	Acronym of National name
	Text	NatName	Name of nature objects
	Text	IntName	Name of nature objects
	Text	SitSource	Important Bird and Biodiversity Areas
IBA_buffer	Text	Name	Buffer 700 m from Important Bird and Biodiversity Areas
	Short	Size	Size of buffer
migratory_routes	Text	Name	Major bird migratory routes
migratory_routes_buffer	Text	Name	Buffer 700 m from major bird migratory routes
	Short	Size	Size of buffer
border_line	Text	Name	National border of Ukraine
border_buffer	Text	Name	Buffer 5 km
	Short	Size	Size of buffer
elevation_higher_than_800	Text	Name	Area with elevation higher than 800 m
	Text	Source	Data source (SRTM)
flooding	Text	Name	Area with flooding 1%
	Text	Source	Data source (JRC)
slopes_more_15	Text	Name	Area with slopes more than 15 degree
	Text	Source	Data source (SRTM)
biosphere_reserves	Text	Name	Areas of UNESCO Biosphere Reserves
biosphere_reserves_buffer	Text	Name	Buffer 700 m
	Short	Size	Size of buffer
emerald_poly	Text	Name	Areas of Emerald Network Sites
	Text	Status	proposed / adopted

Class Name	Type	Attribute	Description
emerald_buffer	Text	Name	Buffer 700 m from Areas of Emerald Network Sites
	Short	Size	Size of buffer
	Text	Status	proposed / adopted
ramsar	Text	Name	Areas of Ramsar Sites
ramsar_buffer	Text	Name	Buffer 700 m from Areas of Ramsar Sites
	Short	Size	
endangered_species_areas	Text	Name	Areas with high level density of observations of endangered species
endangered_species_buffer	Text	Name	Buffer 700 m from Areas with high level density of observations of endangered species
	Short	Size	Size of buffer
forest_areas	Text	Name	Areas of forest fund
forest_buffer	Text	Name	Buffer 100 m from forest areas
	Short	Size	Size of buffer
nature_reserve_fund_poly	Text	NazObPZF	Ukr Name of Nature Reserve areas
	Text	ZnPZF	Ukr Status of Nature Reserve areas
	Text	KatObPZF	Ukr Category of Nature Reserve areas
	Text	NazObPZF_en	En Name of Nature Reserve areas
	Text	ZnPZF_en	En Status of Nature Reserve areas
	Text	KatObPZF_en	En Category of Nature Reserve areas
nature_reserve_fund_buffer	Text	Name	Buffer 700 m from Nature Reserve Fund of Ukraine areas
	Short	Size	Size of buffer
peatlands_poly	Text	Name	Peatlands
peatlands_buffer	Short	Size	Buffer 700 m from Peatlands
	Text	Name	Size of buffer
recreational_lands	Text	category	Recreational lands
recreational_lands_buffer	Text	Name	Buffer 700 m from Recreational lands
	Short	Size	Size of buffer
waterbodies_buffer	Text	Name	Normative waterside protection zones
	Short	Buffer_type	Type of buffer
	Short	Size	Size of buffer
waterbodies_line	Text	osm_type	Type of Waterbodies
	Text	waterway	Line Waterbodies
waterbodies_poly	Text	Name	Polygon Waterbodies
agriculture_areas	Text	Name	Agriculture land
boundary	Text	Name	Area of interest

Class Name	Type	Attribute	Description
artificial_surfaces	Text	Name	Areas of high concentration of artificial and built surfaces
overlay_layer	Text	Name	Integration of criteria layers
recommended_areas	Text	Name	Areas without environmental restrictions
Service fields	Double	SHAPE_Length	Object Length, degree
	Double	SHAPE_Area	Object Area, degree

## Chapter 2. Description of the environmental constraints maps set.

### 2.1. List of thematic maps.

To present the results of the analysis for each of the environmental criteria, the following thematic maps were created:

1. Areas protected under international legislation.
2. Areas designated under national protection schemes for nature and biodiversity conservation.
3. Major bird migratory routes.
4. Other sensitive areas identified through sensitivity maps and relevant tools.
5. Elevation.
6. Steep slopes.
7. Areas prone to flooding.
8. Areas of forest fund.
9. Areas of water fund.
10. Agricultural lands.
11. Recreational lands.
12. Artificial and built surfaces.
13. State border regime areas.

The integrated results of the environmental criteria analysis are represented at the final map – Integrated map by the result of environmental criteria assessment.

### 2.2. Table of relationships between maps and geodatabase classes.

Maps	Classes of database
Areas protected under international legislation	<ul style="list-style-type: none"> <li>• biosphere_reserves</li> <li>• biosphere_reserves_buffer</li> <li>• emerald_poly</li> <li>• emerald_buffer</li> <li>• ramsar</li> <li>• ramsar_buffer</li> </ul>
Areas designated under national protection schemes for nature and biodiversity conservation	<ul style="list-style-type: none"> <li>• nature_reserve_fund_buffer</li> <li>• nature_reserve_fund_poly</li> </ul>
Major bird migratory routes	<ul style="list-style-type: none"> <li>• migratory_routes</li> </ul>

Maps	Classes of database
	<ul style="list-style-type: none"> <li>migratory_routes_buffer</li> </ul>
Other sensitive areas identified through sensitivity maps and relevant tools	<ul style="list-style-type: none"> <li>IBA</li> <li>IBA_buffer</li> <li>endangered_species_areas</li> <li>endangered_species_buffer</li> </ul>
Elevation	<ul style="list-style-type: none"> <li>elevation_higher_than_800</li> </ul>
Steep slopes	<ul style="list-style-type: none"> <li>slopes_more_15</li> </ul>
Areas prone to flooding	<ul style="list-style-type: none"> <li>flooding</li> </ul>
Areas of forest fund	<ul style="list-style-type: none"> <li>forest_areas</li> <li>forest_buffer</li> </ul>
Areas of water fund	<ul style="list-style-type: none"> <li>waterbodies_buffer</li> <li>waterbodies_poly</li> </ul>
Agricultural lands	<ul style="list-style-type: none"> <li>agriculture_areas</li> </ul>
Recreational lands	<ul style="list-style-type: none"> <li>recreational_lands</li> <li>recreational_lands_buffer</li> </ul>
Artificial and built surfaces	<ul style="list-style-type: none"> <li>artificial_surfaces</li> </ul>
State border regime areas.	<ul style="list-style-type: none"> <li>border_buffer</li> </ul>
Integrated map by the result of environmental criteria assessment	<ul style="list-style-type: none"> <li>overlay_layer</li> <li>recommended_areas</li> </ul>

### 2.3. Mathematical basis for map creation.

The maps were created in the open source QGIS software. To create map layouts, digital maps were created, on the basis of which printing layouts were formed.

The mathematical basis for creating maps consists of choosing a coordinate system, scale and map layout.

The Web Pseudo-Mercator coordinate system (EPSG:3857) based on the WGS 84 datum was chosen as the coordinate system. This choice was due to several factors:

1. Reducing certain visual distortions of the territory in the coordinate system WGS 84.
2. Compatibility with web publication.
3. Speed of processing base map data.

The original data was not converted and remained in the coordinate system WGS 84.

The scale of the maps for printing was chosen taking into account the standard sizes of A3 paper sheets -1:2 500 000

The layout orientation was chosen in landscape format due to the configuration of the study area.

### 2.4. Thematic basis for map creation.

Thematic maps were created based on a combination of thematic layers that were collected in the database.

A base topographic map of the world was used as the base.

The basic order of layer organization:

- bottom layer - base topographic map;
- upper layers - thematic polygonal layers. In case of overlapping layers, hatching or transparency of layers was used.

Main elements of thematic content:

- map name – placed in the middle of the map;
- map legend – located in the lower left corner; the legend contains conventional designations of the thematic content of the map, namely graphic symbols for displaying thematic layers.

The colour scheme for colouring objects was selected based on the Protocol on GIS in the REAA project.

## **2.5. Basic steps for creating printed thematic maps.**

### 1. Start a New QGIS Project.

Launch QGIS: Open QGIS Desktop. It will start a new blank project by default. (If a project is already open, we can create a new one via Project > New).

Save QGIS project with Project > Save As to avoid losing work. QGIS project files (.qgz) store layer references, styles, etc., which is helpful if need to revisit the map design later.

Load the data: Add GeoPackage vector layers to the project. Click Layer > Add Layer > Add Vector Layer, choose .gpkg file, and select the relevant layers to import (it possible also drag and drop the GeoPackage from the Browser panel).

### 2. Add a Topographic Base Map and GeoPackage Layers.

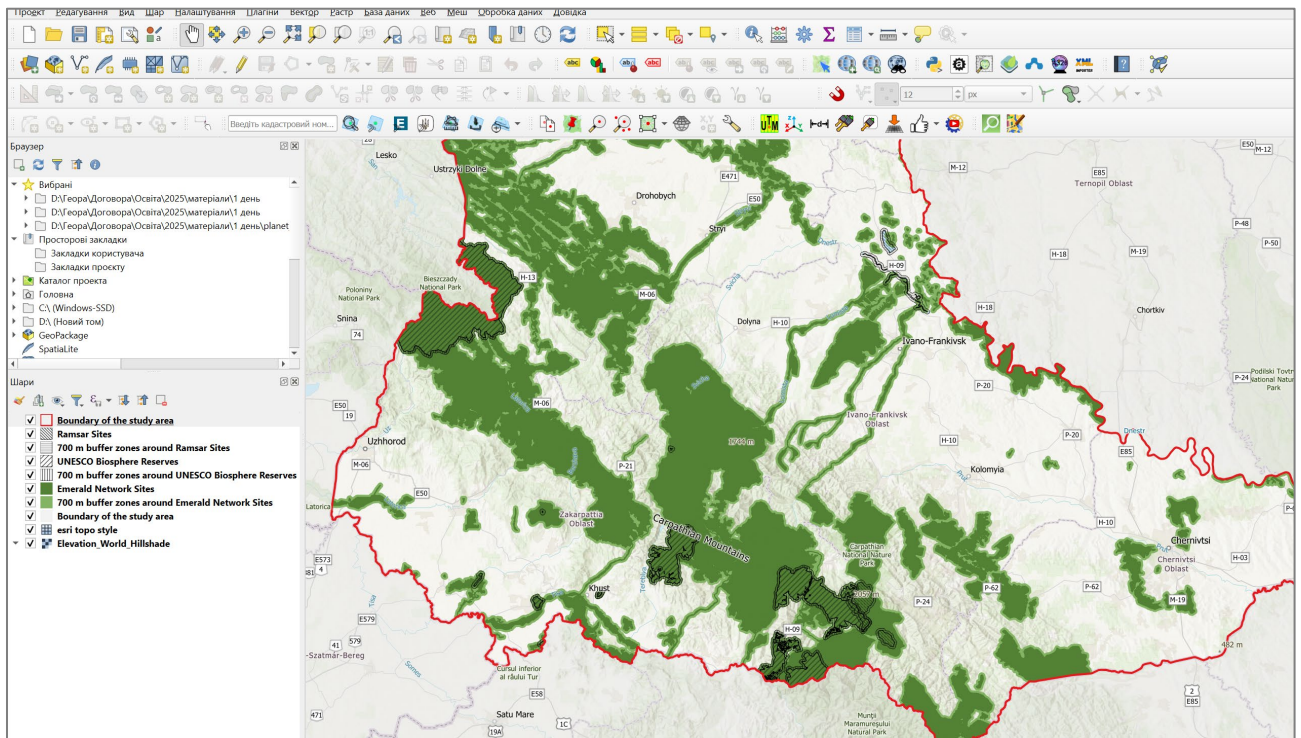
QGIS doesn't include detailed base maps by default, but we can add one via web services or plugins. A simple method is to install the QuickMapServices plugin (go to Plugins > Manage and Install Plugins, search for "QuickMapServices", and install it).

After the base map is in place, make sure that thematic data layers (the GeoPackage vectors) are added. They should draw on top of the base map. If not, reorder them in the Layers panel (drag layers so the base map is at the bottom). At this stage, each layer will have a random default color/symbol. Next, you'll customize their styling.

### 3. Style the Thematic Layers.

Open Layer Properties: To adjust a layer's appearance, open its Layer Properties window. Double-clicking the layer name or right-clicking and selecting Properties..., then go to the Symbology tab.

Choose symbol and color: In the Symbology tab, we will see options depending on the layer geometry (point, line, or polygon). For polygon layers, we can set a Fill color and an Outline (Stroke) color/width.

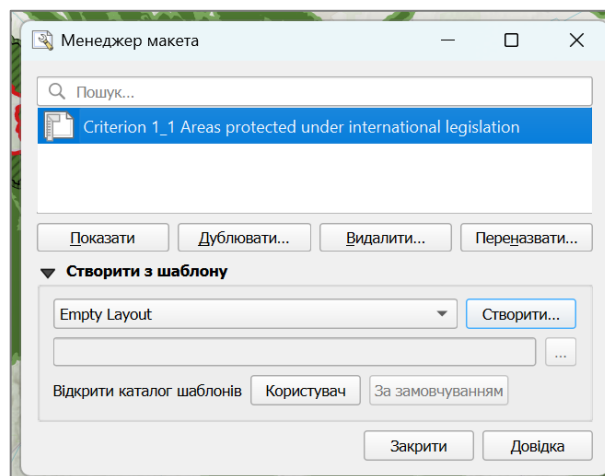


#### 4. Create a Print Layout.

The Print Layout allows to arrange the map and other map elements on a page for export.

In QGIS main window, go to Project > New Print Layout... When prompted, give the layout a name (e.g., "Final Map Layout") and click OK. A new layout window will open, showing a blank page.

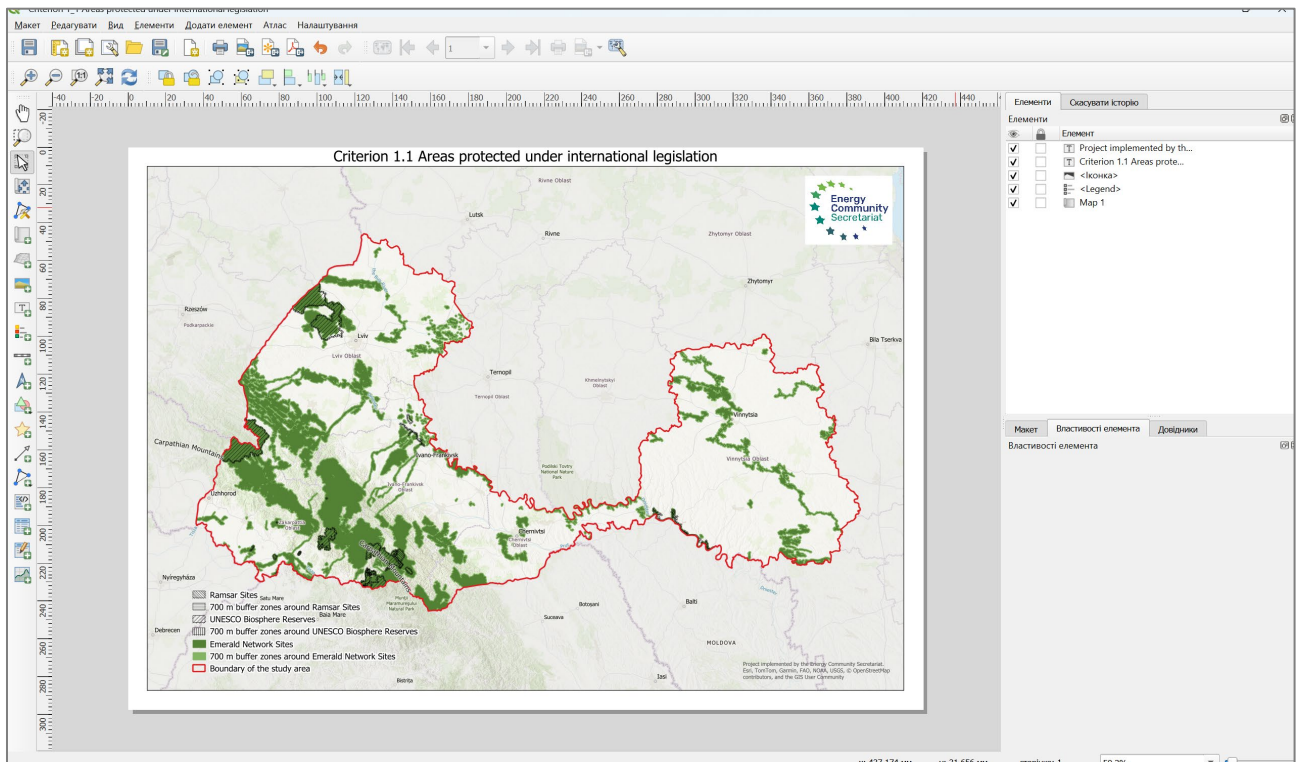
Go to Layout > Page Properties on the top menu. In the Item Properties panel on the right, set the page Size A3 and landscape Orientation. Add the map canvas to the layout: Click the Add Map button. Upon releasing the mouse, the current QGIS map view will appear in that frame on the layout.



#### 5. Design the Layout.

In QGIS Print Layout, we can insert various items via the toolbar or the Add Item menu. After adding each item, we can fine-tune its appearance in the Item Properties panel.

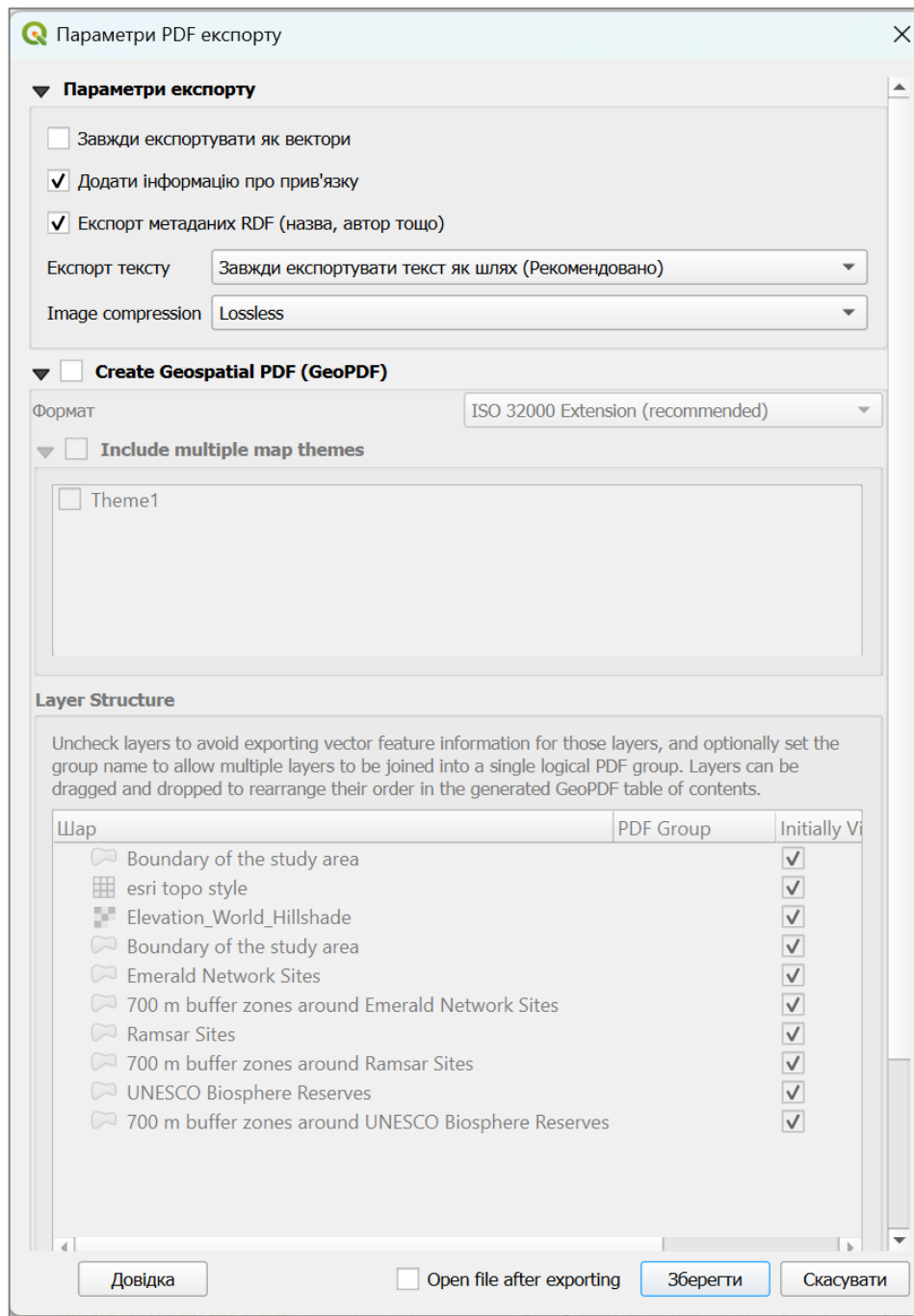
To add the legend, click the Add Legend tool, then click on the layout where you want the legend to appear. The legend reflects layer names and styles (colors/symbols) as set in the Layers panel.



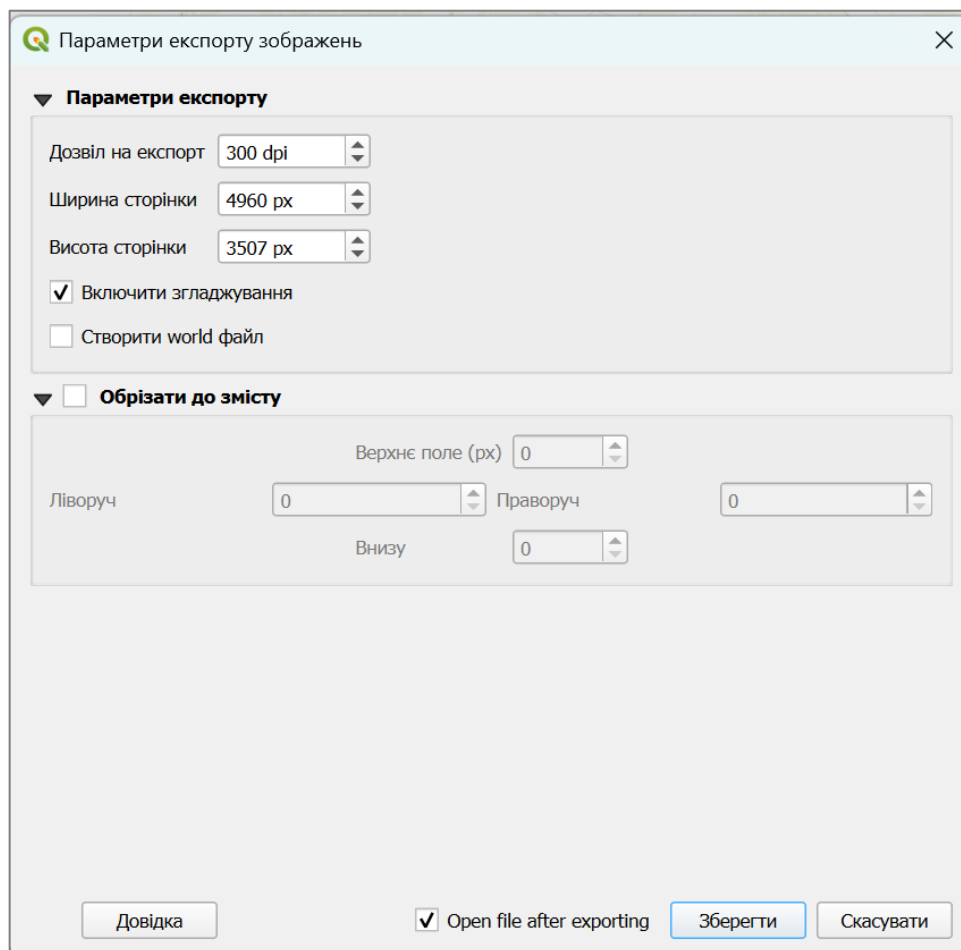
## 6. Export the Final Map to a Print-Ready Format.

QGIS supports exporting to PDF (vector) and image formats like TIFF, PNG, JPEG at chosen resolutions.

Export as PDF (vector): This is recommended for many academic purposes because PDF will preserve vector graphics (your linework, text, and vector shapes stay crisp at any scale). In the Layout window, click Layout > Export as PDF (or the PDF icon on the toolbar). Choose a save location and file name, then confirm. QGIS will generate a PDF of your layout. By default, text is embedded and vectors retained, so the PDF can be zoomed or printed high-res without quality loss.



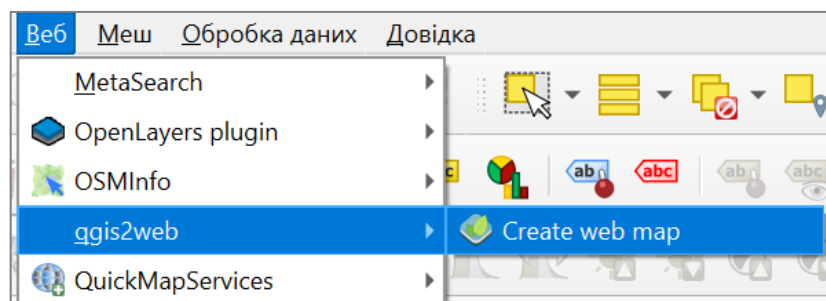
Export as Image (TIFF/JPEG): If a high-resolution image file is required. Use Layout > Export as Image. In the dialog, choose TIFF (or JPEG) and enter the resolution 300 DPI for print.



### Chapter 3. Geodata package for the purposes of online publication.

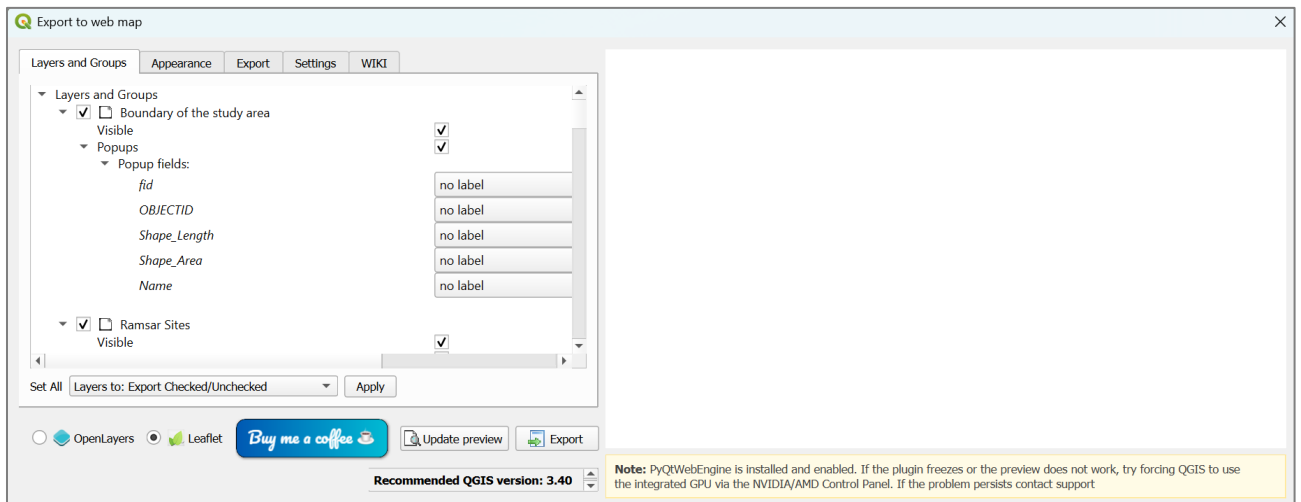
Publishing to the web is done using the qgis2web plugin, which allows you to get a web page project with an interactive map. It replicates as many aspects of the project as it can, including layers, extent and styles (including categorized and graduated). No server-side software required.

Latest stable version: 3.30.0



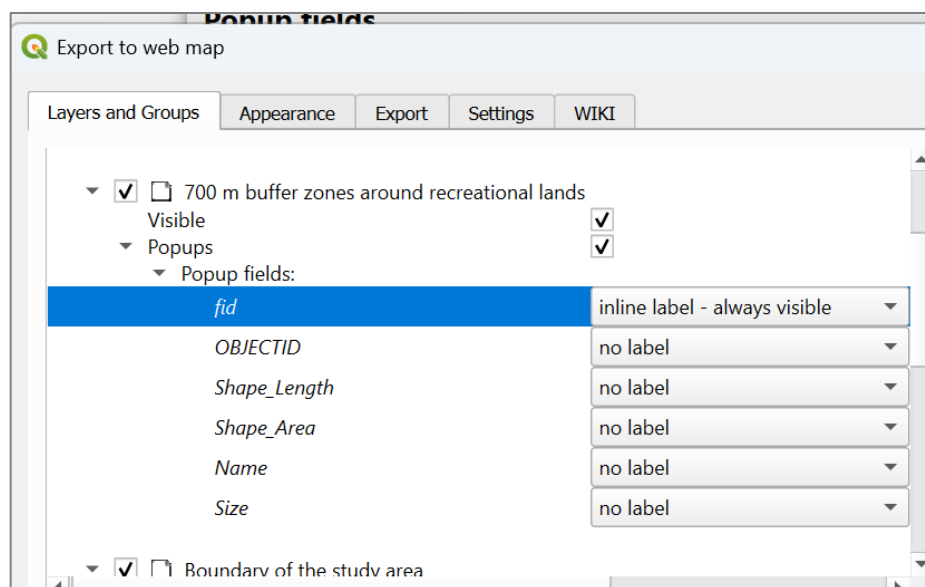
Before starting work, project settings were made:

- Set project title, abstract, background and highlight colours in Project > Properties... > General/Metadata.
- Give layers correct names in Layers Panel.
- Give layer columns correct names via Layer > Properties > Attributes Form > Fields > Alias.
- Hide fields which don't appear in popups by changing their Widget Type to "Hidden".

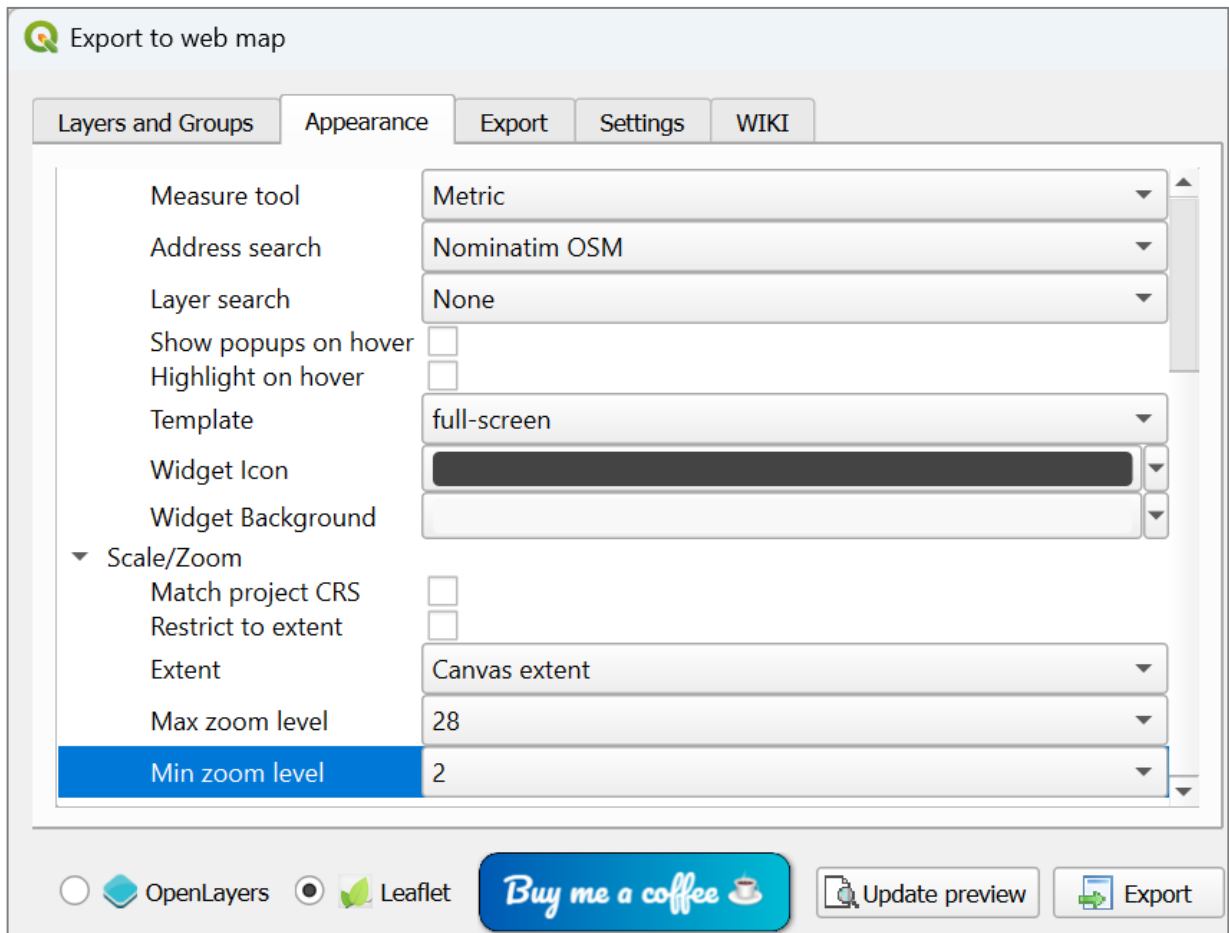


### Plugin settings:

- Leaflet library was selected as the publishing method.
- Visibility was selected for layers and fields during publishing.
- Attribute display method: inline label - always visible (displays field name on the same line as data)



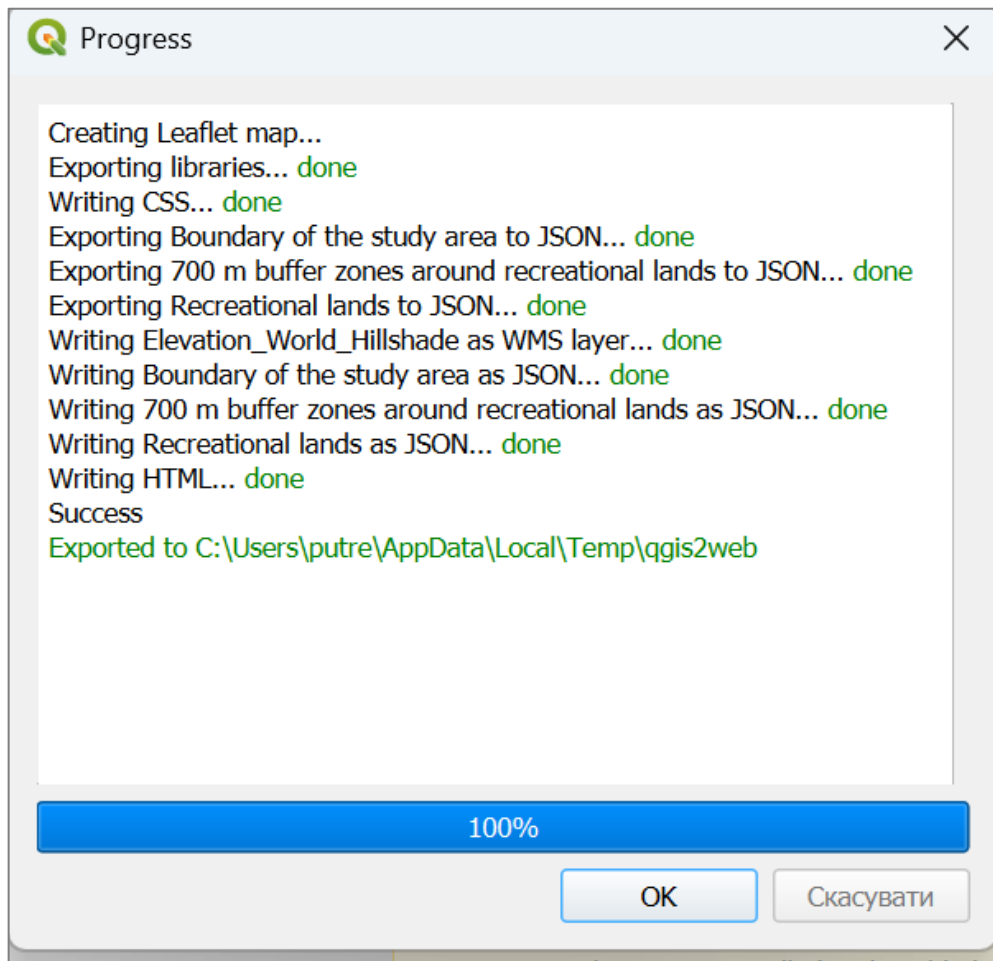
- Header placement: upper left
- Abstract: lower right
- Layers list: Collapsed
- Measure tool: Metric
- Address search: OSM
- Template: full-screen
- Extent: Canvas extent



On the export tab, select the folder to store the web map.

In the settings, you can change the number of objects visible during preview. The default is 1000 objects.

After clicking the export button, a web map is generated. The map creation process is displayed in the form of a progress window.



The finished map is checked. The name of the folder with the files is renamed according to the name of the map.