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Innovative Training Methods

December 2023

The project No.2018-1-0137 "EU-WATERRES: EU-integrated management system of cross-border groundwater resources and anthropogenic hazards" benefits from a € 2.447.761 grant from Iceland, Liechtenstein and Norway through the EEA and Norway Grants Fund for Regional Cooperation. The aim of the project is to promote coordinated management and integrated protection of transboundary groundwater by creating a geoinformation platform.

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Building the capacity of stakeholders to manage and maintain good status of transboundary groundwater is based on the organization of 7 interactive training in all target regions, including those carried out during 3 study visits. Trainings were based on an innovative method, which includes the principle of "learning by doing", when all participants take part in a joint action, benefiting from improved skills. As a result, stakeholders have learnt in practice the effects of a harmonized monitoring and joint assessment of the state of transboundary groundwater and the use of tools and resources of the EU-WATERRES integrated platform as well as the Program for the protection of transboundary groundwater against pollution and depletion.

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Preface

In an era marked by increasing interconnectedness and the imperative for sustainable resource management, the importance of transboundary groundwater management cannot be overstated. This report delves into the most important aspects of the topic by summarizing the key products available for the stakeholders that had been developed and promoted during the stakeholders meetings and workshops.

As our world faces complex challenges associated with water scarcity, climate change, and the intricacies of shared aquifers, the need for sophisticated understanding of transboundary groundwater management has never been more pressing. Stakeholders, ranging from governmental bodies to local communities, to NGOs, play a crucial role in safeguarding this vital resource. Recognizing this, the report explores innovative training methods designed to empower these key actors with the knowledge, skills, and tools required to navigate the intricate landscape of transboundary groundwater governance effectively.

Through an exploration of cutting-edge training strategies, case studies, and best practices, this report aims to contribute to the ongoing discourse on sustainable water resources management. By fostering a culture of continuous learning and adaptation, we aspire to inspire positive change in the way stakeholders approach the challenges of transboundary groundwater management, ultimately leading to enhanced resilience, cooperation, and the preservation of this invaluable shared resource.

We extend our gratitude to the contributors, researchers, practitioners whose insights have shaped not only this report but also our main product – Map Portal. We hope it serves as a valuable resource for all those committed to securing a sustainable and equitable future for transboundary aquifers.

Table of contents

Water Balance Calculation for a Transboundary Aquifer System between Estonia and Latvia

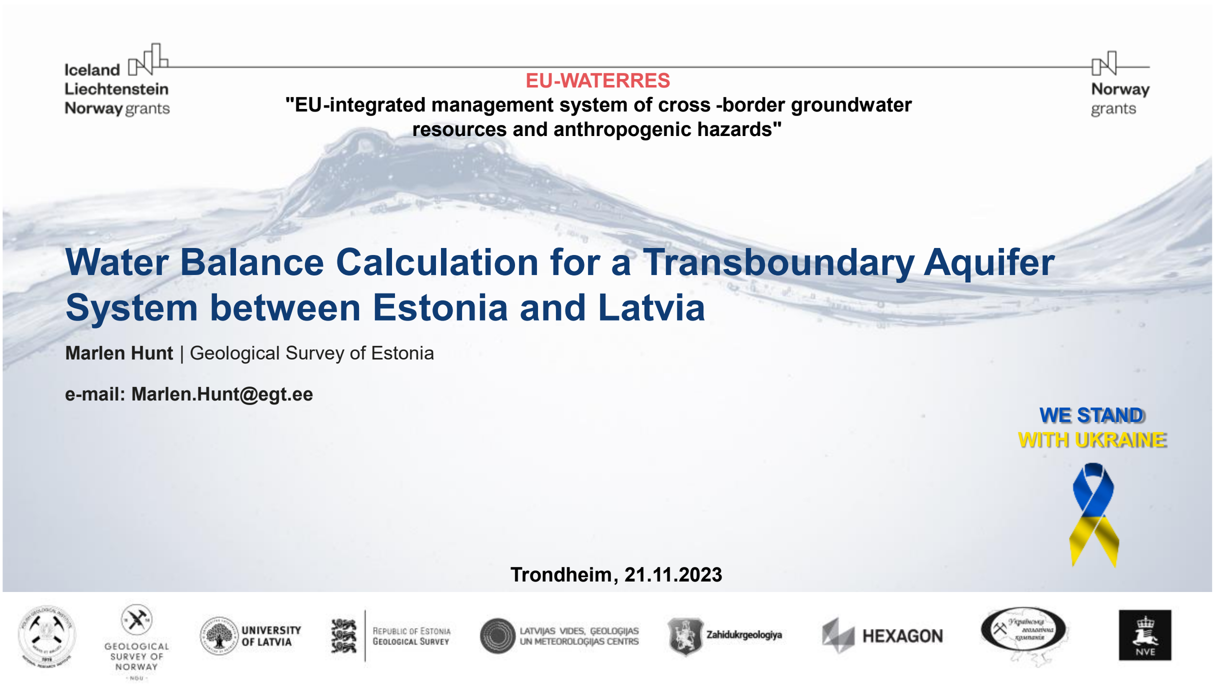
Within the framework of the EU-WATERRES project, specialists from Estonia and Latvia collaborated to develop a hydrogeological model (45,000 km²) for a cross-border area, employs a 3D MODFLOW-6 model with 11 layers, calibrated for transient conditions. Calibration results show a reasonable fit, with RMSE values of 4.5 m for water levels and 0.6 m³/s for stream baseflows.

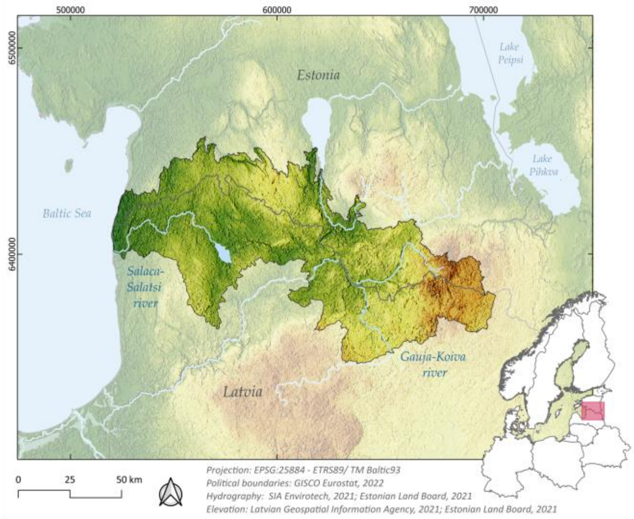
Water balance analysis reveals dynamic interactions in aquifer systems. The Quaternary aquifer primarily receives recharge from precipitation and inflow from Upper-Devonian and Upper-Middle-Devonian aquifers, discharging primarily to streams. Transboundary groundwater flow across the Estonian-Latvian border varies, with bidirectional flows in the Quaternary aquifer and predominant flow from Latvia to Estonia in the Upper-Middle-Devonian aquifer.

Refined hydraulic conductivities, ranging from 0.2 m/d to 5 m/d for the Quaternary aquifer, 0.3 m/d to 50 m/d for the Upper-Devonian aquifer, and 0.8 m/d to 6 m/d for the Upper-Middle-Devonian aquifer, enhance model reliability. Various boundary conditions simulate interactions with the Baltic Artesia Basin, surface water bodies, and anthropogenic influences from pumping wells.

Water balance analysis emphasizes groundwater's crucial role in sustaining baseflow in surface water bodies. The active water exchange zone, up to the Narva confining unit, is identified as sensitive to pollution and climate change.

In conclusion, the calibrated hydrogeological model provides valuable insights into groundwater dynamics, cross-border flow, and water balance in the Baltic Sea coastal region. The refined model is a robust tool for groundwater management, environmental assessments, but localized models are necessary for pollution flow analysis in specific areas. The model serves as a foundation for understanding and managing groundwater resources in this complex coastal landscape.



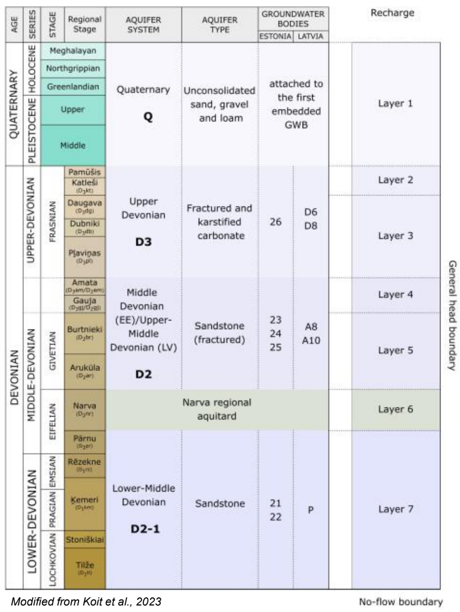


Study area

- ModelMuse v 4.3.0.0 (MODFLOW 6)
- 11 layers (3 main aquifers)
- Area of 45 000 km^2
- Cell size 1km x 1km

Conceptual model

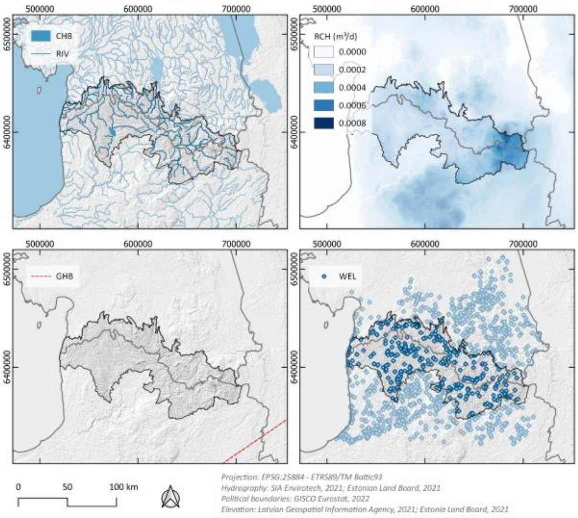
- Quaternary aquifer – layer 1
- Pļaviņas-Ogre aquifer – layers 2 and 3
- Aruküla-Amata aquifer – layers 4 and 5
- Narva aquitard – layer 6
- Lower-Middle Devonian aquifer – layer 7



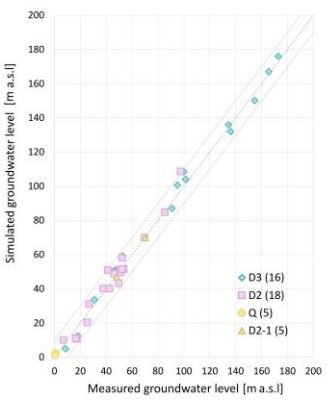
Modified from Koit et al., 2023

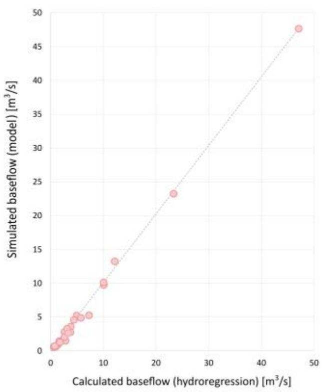
Boundary conditions

1. Time-Variant Specified-Head package (CHB)
   - Baltic sea
   - Lakes (Peipsi, Pihkva, Burtnieks, Võrtsjärve)
2. Recharge package (RCH)
   - Recharge from precipitation values ranges from 0 to 0.00081 m/d.
3. General-Head Boundary package (GHB)
   - $D_{2\text{-}1}$-S
4. River package (RIV)
   - Rivers
5. Well package (WEL)
   - All pumping wells



Model Calibration





Groundwater level | Base flow

Trial-and-error adjustment

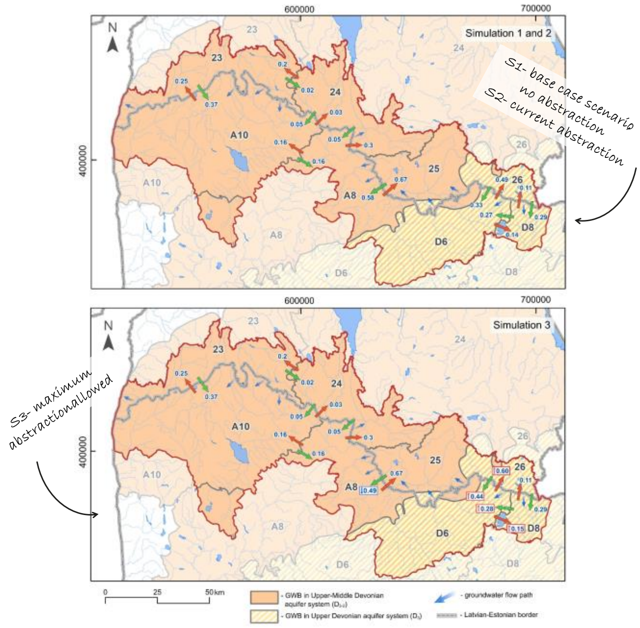
Hydraulic conductivity and net infiltration were calibrated

Correlation coefitsient 0.9

Results

! Existing water extraction in the territory does not significantly affect the transboundary groundwater flow

! Significant changes in cross-border groundwater flow patterns were not expected even with the maximum possible water abstraction.

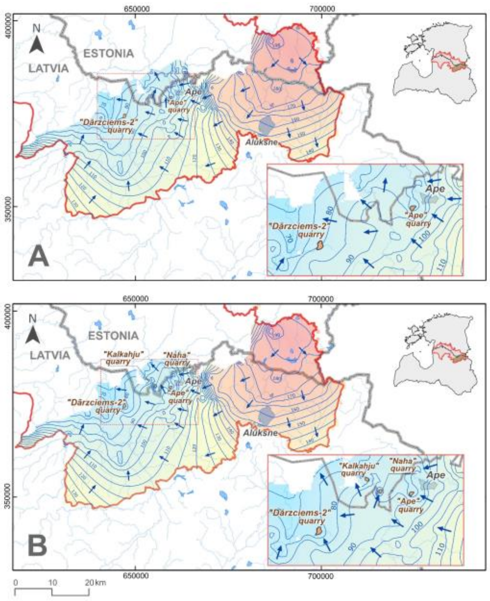


Results

Simulation 3- maximum allowed groundwater abstraction rates

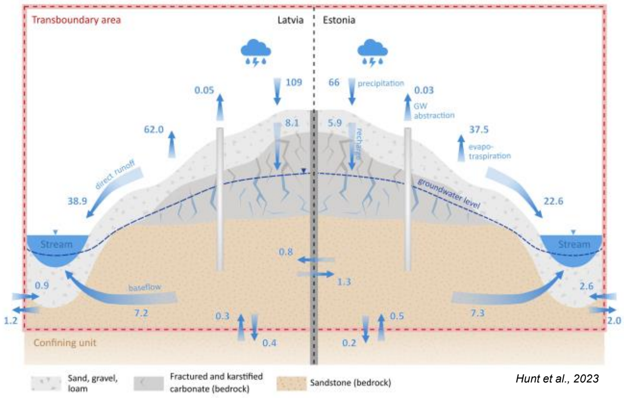
Three more additional quarries - "Dārzciems - 2" (LV) "Kalkahju" (EE) and "Naha" (EE) were inserted into the model

Changes are mainly observed near the quarries, however, no significant changes in transboundary flow pattern are observed



Results

- Strong hydrological connection between groundwater and surface water within the initial 200 meters
- Approximately 90% of infiltrated groundwater contributes to the baseflow of local rivers
- Only a small proportion recharges deeper layers within the cross-section



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Thank you!

WE STAND WITH UKRAINE

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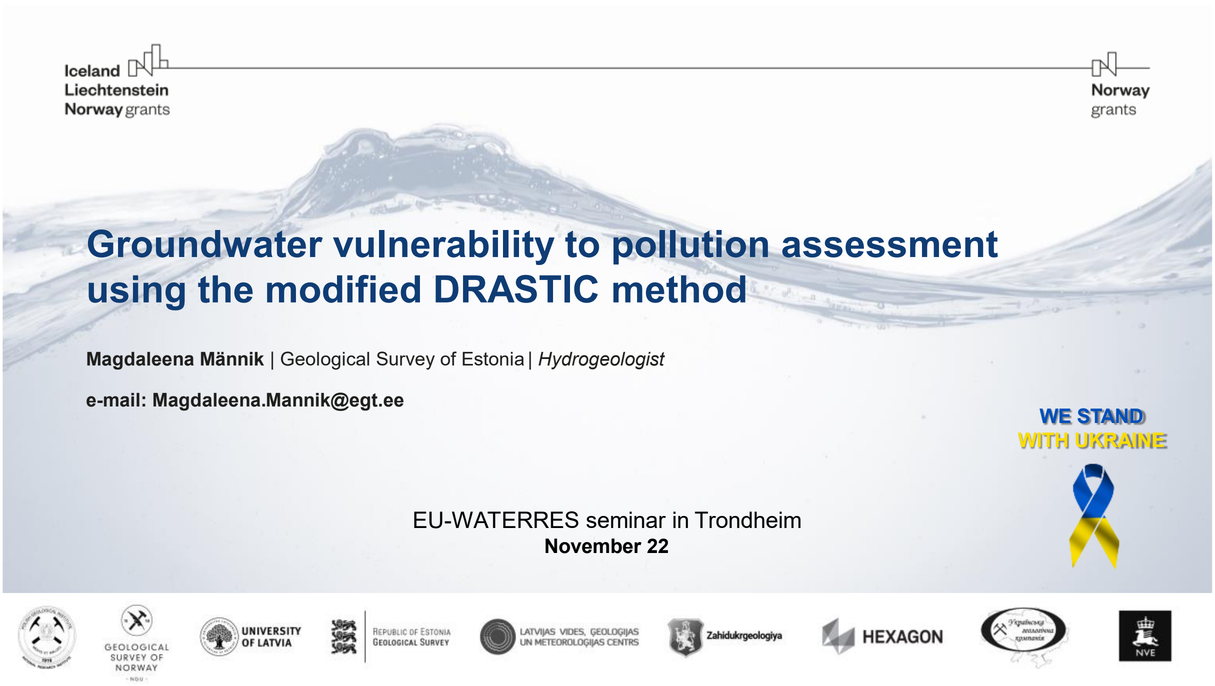
Groundwater vulnerability to pollution assessment using the modified DRASTIC method

Groundwater protection is crucial in order to ensure the long-term quality and sustainability of the resource. Groundwater vulnerability assessment provides crucial information for effective land planning and environmental decision-making. Various methods, including the widely used overlay-index method, are employed to create groundwater vulnerability maps.

The DRASTIC method is a vulnerability assessment approach, which employs a weighted sum of seven parameters (depth to water, recharge, aquifer type, soil type, topography, impact of the vadose zone, and hydraulic conductivity) to determine vulnerability. Parameters have weights from 1 to 5 based on their impact on pollution potential. Adjustments to the DRASTIC method were made to account for Quaternary sediments, which in many cases, make the main useful (first bedrock) aquifer confined in the Estonian-Latvian transboundary area. Parameters such as Quaternary sediment type, thickness of Quaternary deposits, and depth to the piezometric head compared to the bedrock surface were added to make the assessment more precise. Additionally, the real pollution risk is determined by combining the DRASTIC formula with the land use parameter rating using Corine land use data.

As a result, vulnerability maps and real pollution risk maps of both the Quaternary, and main useful aquifer were made in the Estonian-Latvian transboundary area. The DRASTIC method, with its comprehensive parameters and adjustments for specific geological conditions, serves as a valuable tool in identifying and mitigating potential pollution risks, ensuring the protection and sustainability of this crucial water resource.

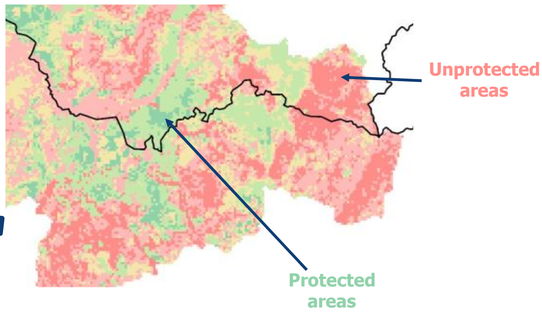


How to protect groundwater?

Groundwater provides nearly half of the drinking water in the world

In spite of groundwater's overall abundance, it remains vulnerable to pollution

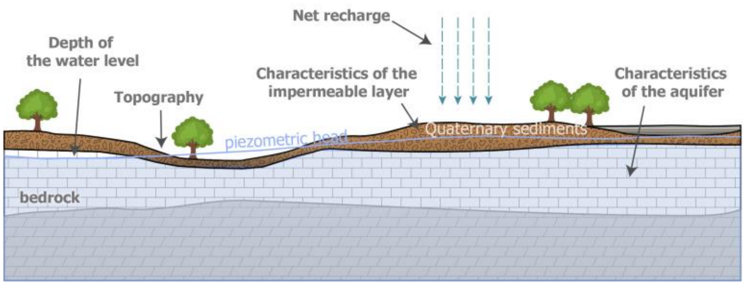
A sustainable approach to managing groundwater quality is to ensure its protection by developing groundwater vulnerability maps to avoid contamination



What is groundwater vulnerability?

Groundwater vulnerability assessment is used to delineate areas that are more vulnerable to contamination than others.

Groundwater vulnerability is determined by the pathway from the contamination to groundwater

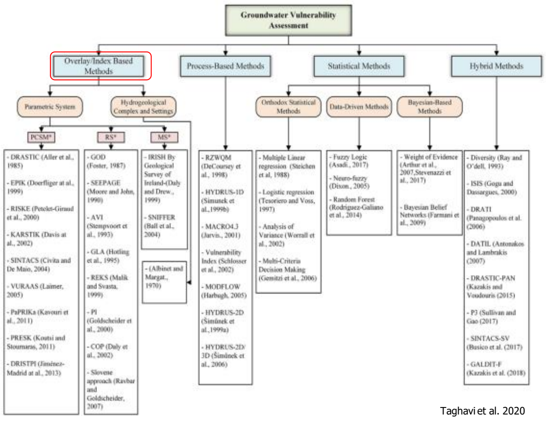


What are groundwater vulnerability maps?

Most groundwater vulnerability maps are based on the overlay-index method

The combination of maps with spatial distributions of specific parameter data (soil, geology, depth to water, etc.) leads to an assigned numerical index or score for each parameter.

Maps are combined to produce a vulnerability score.



Taghavi et al. 2020

How does the DRASTIC method work?

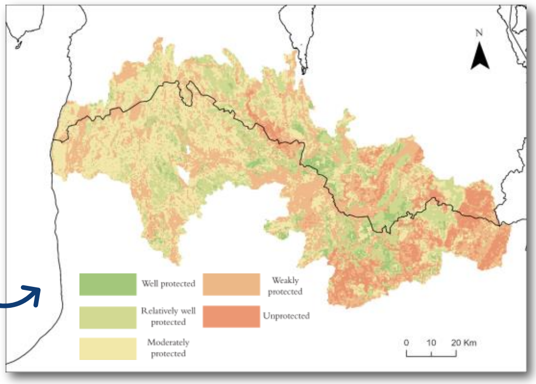
D	R	A	S	T	I	C
Depth to water	Net Recharge	Aquifer media	Soil media	Topography	Impact of the vadose zone	Hydraulic conductivity

Each parameter is classified based on the impact on pollution potential (Aller et al. 1987).

All parameters have weights ranging from 1 to 5 to balance and enhance their importance.

The vulnerability index is a weighted sum of the seven parameters.

Groundwater vulnerability map of the Quaternary aquifer composed using the DRASTIC method (Aller et al. 1987)



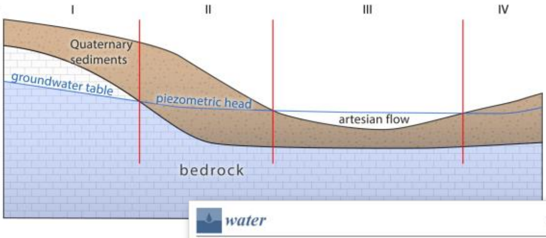
How to assess areas with Quaternary sediments?

D	R	A	S	T	I	C
Depth of the piezometric head compared to the bedrock surface	Net Recharge	Aquifer media	**Quaternary sediment type**	Topography	**Thickness of the Quaternary sediments**	Hydraulic conductivity

the D-parameter was adjusted to consider the overlying Quaternary deposits that, in some cases, make the aquifer confined,

the S-parameter was replaced by the **Quaternary sediment type parameter** to assess the hydraulic characteristics of the highly variable deposits,

the I-parameter was replaced by the **thickness of the Quaternary deposits parameter** to describe the distance from the ground surface to the main useful aquifer.




water
MDPI

Article

Application of Modified DRASTIC Method for the Assessment and Validation of Confined Aquifer Vulnerability in Areas with Diverse Quaternary Deposits

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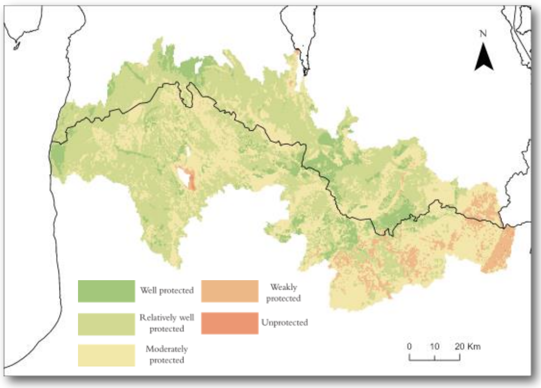
https://doi.org/10.3390/w15203585

Vulnerability of the main useful aquifer

D	R	A	S	T	I	C
Depth of the piezometric head compared to the bedrock surface	Net Recharge	Aquifer media	**Quaternary sediment type**	Topography	**Thickness of the Quaternary sediments**	Hydraulic conductivity

The vulnerability of the main useful (first bedrock) aquifer using the modified DRASTIC method (Männik et al., 2023)



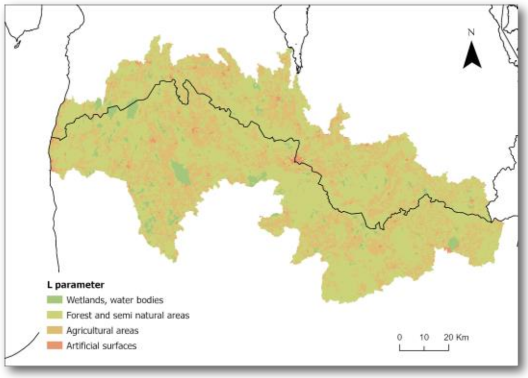
How to assess the real pollution risk?

D R A S T I C + L

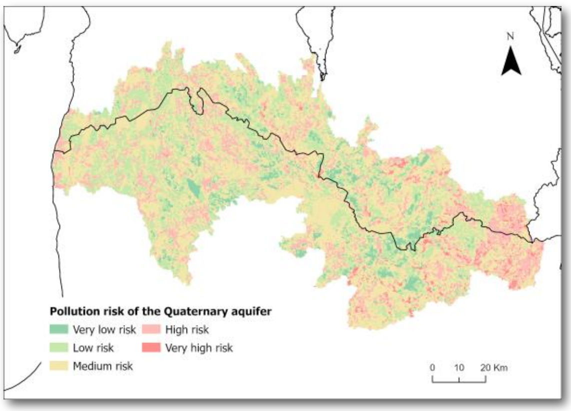
D	R	A	S	T	I	C	+	L
Depth of the piezometric head compared to the bedrock surface	Net Recharge	Aquifer media	**Quaternary sediment type**	Topography	**Thickness of the Quaternary sediments**	Hydraulic conductivity		**Land use**

To assess the pressures and real pollution risk on groundwater, the natural vulnerability is combined with pollution source: land use

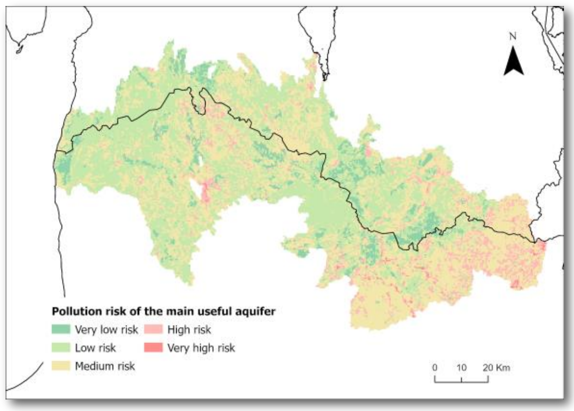
New parameter is added to the formula – Land use



Real pollution risk



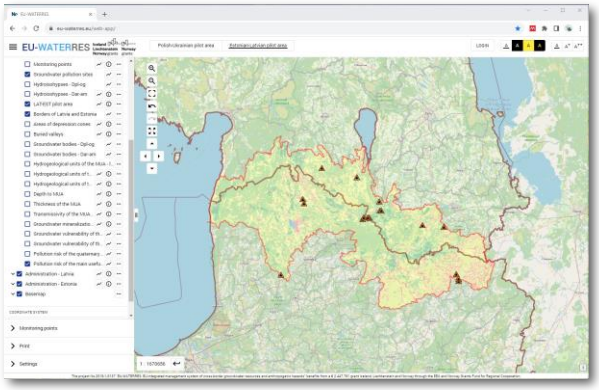
Groundwater pollution risk map of the Quaternary aquifer in the Latvian-Estonian TBA



Groundwater pollution risk map of the main useful aquifer in the Latvian-Estonian TBA

Where to find information?

EU-Waterres project MapPortal
https://eu-waterres.eu/web-app/



Groundwater vulnerability maps (and other project result map layers) of the EE-LV and PL-UA transboundary areas

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Thank you!

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Factors determining the resources of the Poland-Ukraine transboundary groundwater reservoir

The transboundary groundwater reservoir shared between Poland and Ukraine stands as critical natural resource,, essential for sustaining ecosystems, supporting agriculture, and meeting the water needs of both nations. Dear Jacek,

The assessment of the Polish-Ukrainian cross-border aquifer system and groundwater abstraction reveals critical insights into renewable resources and potential threats. Guided by the Water Framework Directive, the study emphasizes the renewability of groundwater resources and environmental constraints. Advanced hydrodynamic modeling, based on the general groundwater flow equation, is employed to capture the complexity of the aquifer system in the diverse borderland regions.

A notable revelation is the significant scale of unregistered groundwater abstraction in rural towns on both sides of the border, surpassing registered amounts. The model successfully incorporates this unreported consumption, highlighting the need for accurate resource assessments. Simulation scenarios illustrate potential consequences of groundwater exploitation, with a focus on the Lviv intake area in Ukraine showing a potential drawdown, emphasizing the importance of cautious management.

Water balance components, including interstate exchange, reveal imbalances between Poland and Ukraine. The assessment extends to estimating available resources, considering restrictions on exploitation. Results emphasize varying resource availability across administrative units, particularly in the sensitive San catchment area.

In conclusion, the project lays a crucial foundation for understanding the transboundary aquifer system, addressing concerns such as unregistered consumption. Findings inform future initiatives, including the "GroundWater-Union" project, aiming to develop sustainable cross-border groundwater resource infrastructure. This collaborative effort seeks responsible management for the benefit of both nations, marking a significant step towards ensuring the long-term viability of this shared vital resource.

Groundwater resources

Division of groundwater resources

<u>**Generic criterion:**</u>

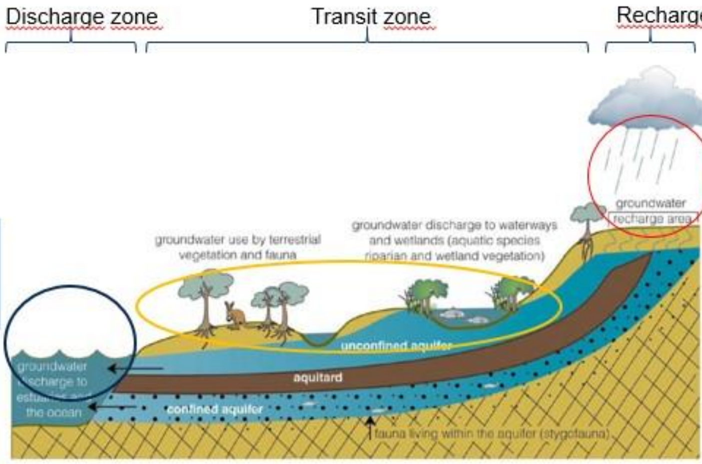
- **Natural groundwater resources** – total of groundwater that results from natural phenomena such as precipitation (which infiltrates into aquifers) and infiltration of water from surface water.
- **Artifical groundwater resources** – volume of water that is created by human activities, ex. artificial aquifer recharge or damming of surface water, irrigation

<u>**Hydrodynamic criterion:**</u>

- **Static groundwater resources** – the total volume of free water contained in pores and other voids in aquifers in a given moment (no flow).
- **Dynamic groundwater resources, called also renewable** – it is a volume of water that flows through a cross section of a water bearing layer in a given time. It depends on the volume of recharge and drainage and is connected to the hydraulic cycle.

Groundwater resources

50% of river flows in the Central European lowlands are shaped by groundwater runoff



infiltration of rainwater, longer distance to groundwater table, high fluctuations of groundwater table, BUT no pollution

high hydraulic gradients = faster flow rates, water susceptible to surface pollution

Groundwater resources

Division of groundwater resources

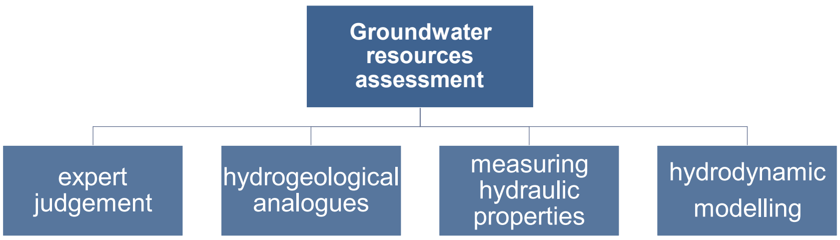
<u>Spatial criterion</u>:

- **Regional – established for catchments, hydrostructural and administrative units – <u>Disposable (available) groundwater resources</u>** – volume (mass) of groundwater in the water-bearing layers that can be abstracted without any harm to groundwater status and condition of groundwater-dependent ecosystems.
- **Local – relating to a specific intake – Exploited resources** – refers to an abstraction point – it is a volume of water that can be withdrawn from a well (or well field) under given hydrogeological, engineering, economical and nature-protection conditions.

Key factors defining groundwater resources:
- Size of an aquifer (extent and depth)
- Its' location with respect to surrounding geology (important for recharge)
- Hydrogeological properties of an aquifer
- Recharge conditions

Groundwater resources

Methods for determining groundwater resources



Assessment of available groundwater resources in the study area based on hydrodynamic modeling

For this purpose, a mathematical model of the filtration field was developed, in which the general flow equation was used:

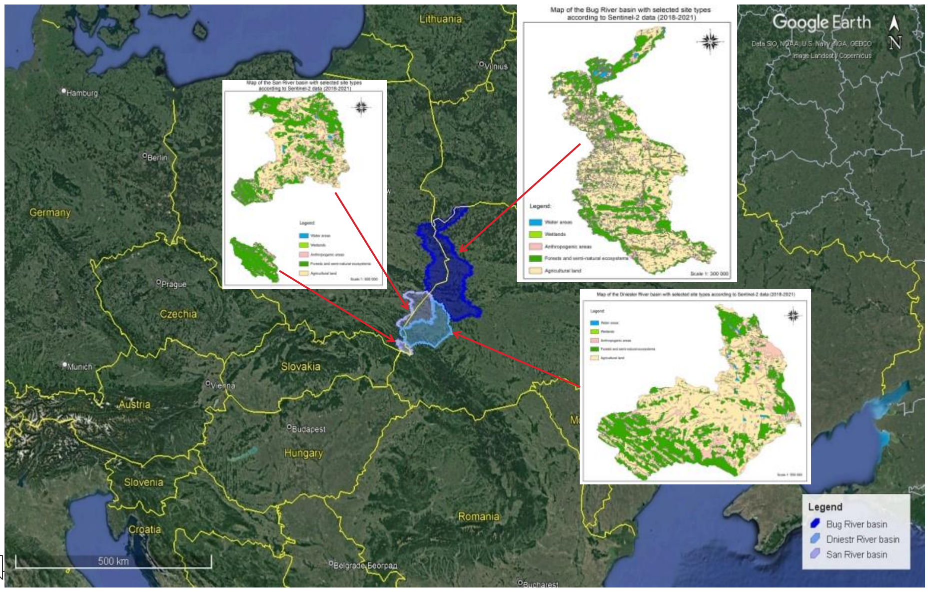
$$\frac{\partial}{\partial x} k_x \frac{\partial H}{\partial x} + \frac{\partial}{\partial y} k_y \frac{\partial H}{\partial y} + \frac{\partial}{\partial z} k_z \frac{\partial H}{\partial z} + W(x, y, z, t) = S \frac{\partial H}{\partial t}$$

H – hydraulic gradient [L]
k – filtration coefficient [L/T]
S – storage coefficient [L^{-1}]
W(x,y,z,t) – input-output function
x, y, z – spatial variables [L]
t – czas [T]

NUMERICAL MODEL

- The solution to the above equation is **the continuous** state function and its derivative (flow function)
- The project sought an approximate solution to the general flow equation for **discrete** space
- The finite difference method was used to prepare the model
- The method used allowed for taking into account the heterogeneity of the aquifer system and the spatial distribution of groundwater recharge and discharge.

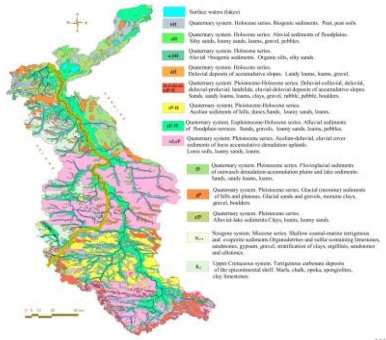
Polish – Ukrainian transboundary area



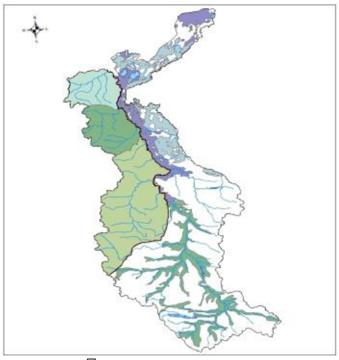
Identification of transboundary aquifers in the Bug catchment

The transboundary aquifers:

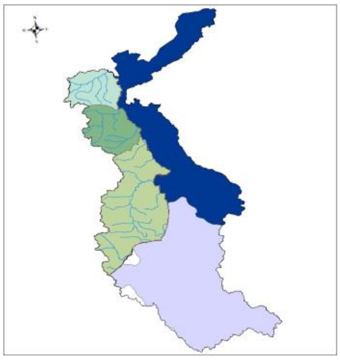
- Quaternary (Q) aquifer
- Upper Cretaceous (K_2) aquifer

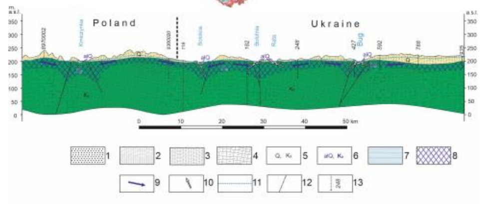


Q aquifers



K_2 aquifers



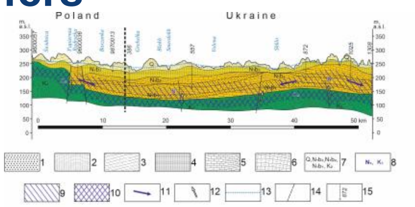


1 - sand, 2 - loamy sand, 3 - clay, 4 - marl, 5 - stratigraphic units, 6 - aquifers, 7 - porous type of aquifer, 8 - fracture type of aquifer, 9 - direction of groundwater flow, 10 - direction of interaquifer flow, 11 - potentiometric surface, 12 - tectonic fault, 13 - borehole (well) and its national number

Identification of transboundary aquifers in the San catchment

The transboundary aquifers:

- Quaternary (Q) aquifer
- Miocen ($N1b_2$+N1b3) aquifer
- Upper Cretaceous (K_2) aquifer

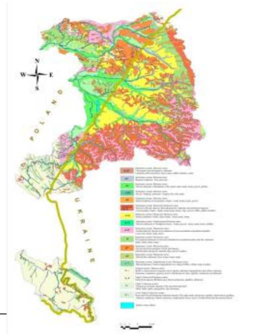


1 - sand, 2 - loamy sand, 3 - loam, 4 - clay, 5 - limestone, 6 - marl, 7 - stratigraphic units, 8 - aquifers, 9 - porous-fracture-cavern type of aquifer, 10 - fracture type of aquifer, 11 - direction of groundwater flow, 12 - direction of interaquifer flow, 13 - potentiometric surface, 14 - tectonic fault, 15 - borehole (well) and its national number

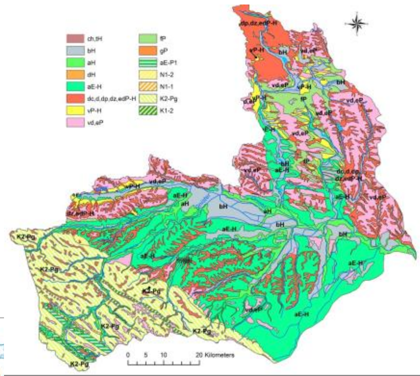
Q aquifers

N_1 aquifers

K_2 aquifers

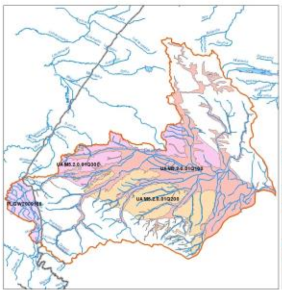


Identification of transboundary aquifers in the Dniester catchment



Dniester catchment area – no transboundary aquifers

Q aquifers

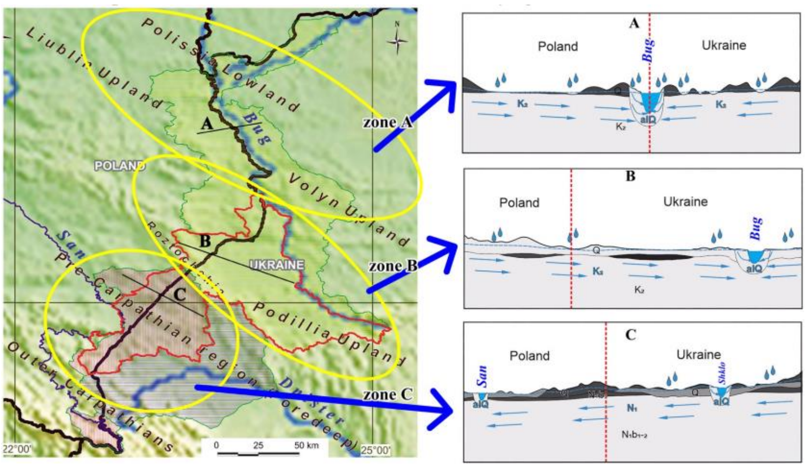


N_1 aquifers

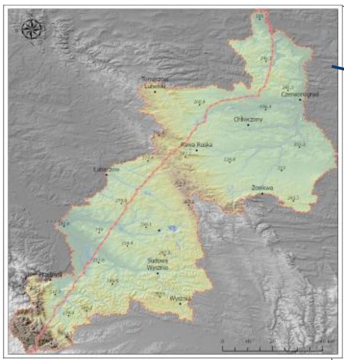
K_2 aquifers

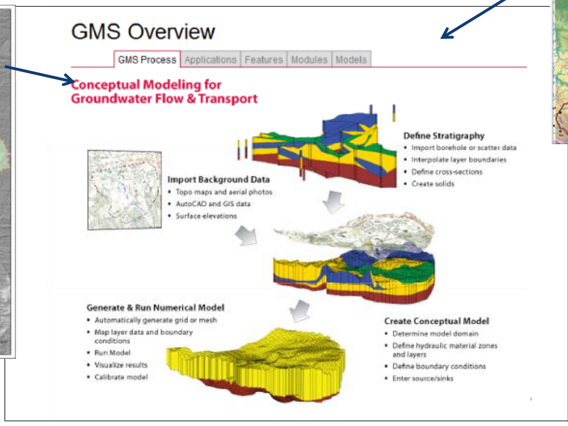
Model area

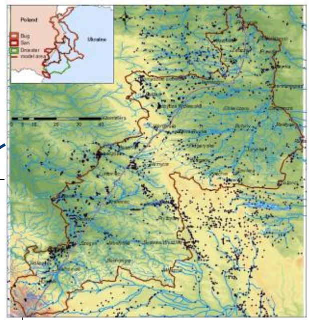
- The study area is 26,073 km^2 and is located within the cross-border parts of the Bug, San and Dniester catchments.
- The transboundary flow of groundwater occurs in a limited area - 7023.5 km^2 - for which the model was created.



METHODOLOGY

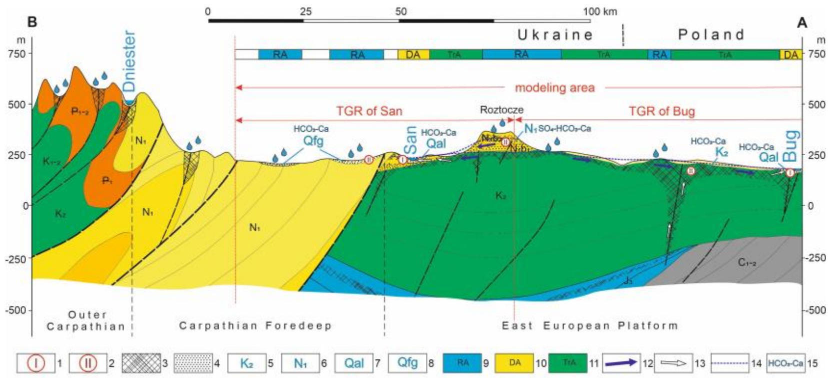






- series of measurements of groundwater levels in 57 monitoring wells;
- hydrogeological profiles from 2926 boreholes:
- meteorological data from 10 observation stations;
- documentation of ca. 200 groundwater intakes

CONCEPTUAL MODEL



1 - 1st layer of the model; 2 - 2nd layer of the model; 3 - fissure type of aquifer; 4 - pore type of aquifer; 5 - Upper Cretaceous aquifer; 6 - Lower Neogene aquifer; 7 - Quaternary alluvial aquifer; 8 - Quaternary fluvioglacial aquifer; 9 - recharge area;10 - discharge area; 11 - transite area; 12 - direction of groundwater flow; 13 - flows between aquifers;14 - potentiometric surface; 15 - water type of aquifer

Structure of the hydrodynamic model

- ✓ Rectangular frame with dimensions of 132 x 140 km.
- ✓ Calculation blocks size 500 x 500 m.
- ✓ A total of 73,920 computational blocks.
- ✓ Two-layer model:

layer I

- *Lublin Trough* – Upper Cretaceous layer 30 m thick below the groundwater table;

- *Carpathian Foredeep* – Quaternary/Miocen layer with a thickness of 25 m below the groundwater table in highlands and 35 m in river valleys;

- *Carpathians* – fissure layer in fractured flysch rocks 30 m thick below the groundwater table.

layer II

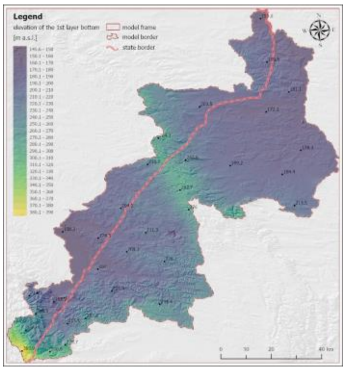
- *Lublin Trough* – Upper Cretaceous layer - 30 - 120 meters below the groundwater table

- *Carpathian Foredeep* – lack of layer;

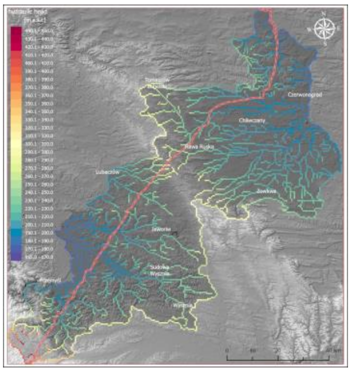
- *Carpathians* – lack of layer.

Structure of the hydrodynamic model

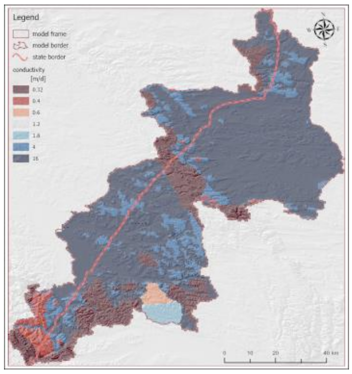
Distribution of the elevation of the bottom of the first layer of the model against the background of the morphology of the area



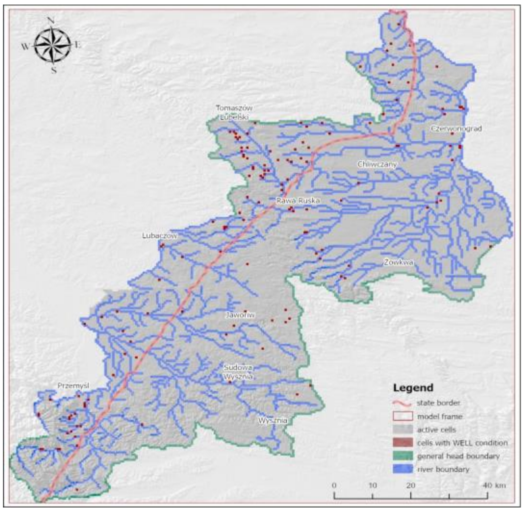
Groundwater table elevation values assigned to blocks with type III condition



Distribution of filtration coefficient values in the first layer of the model



Types of boundary conditions used in the first layer of the model

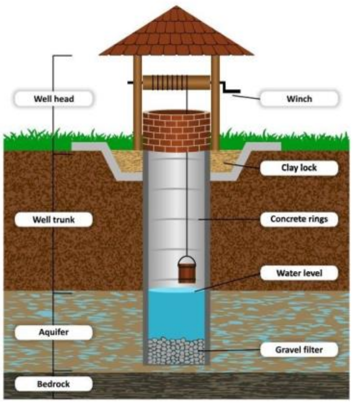


Groundwater abstraction

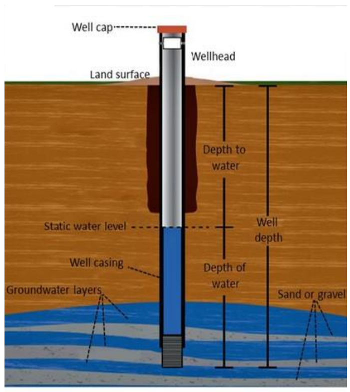
Water well construction

The correct construction of the well guarantees the protection of groundwater!

Dug well

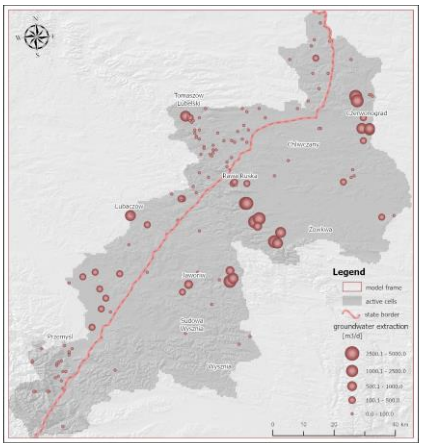


Drilled well

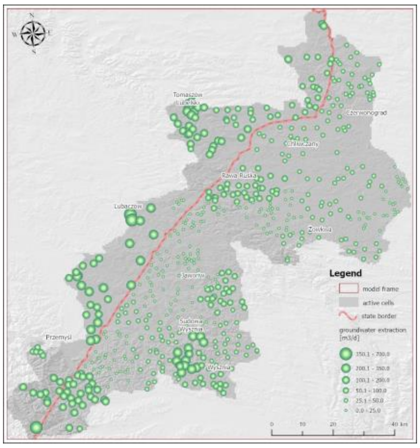


Groundwater abstraction

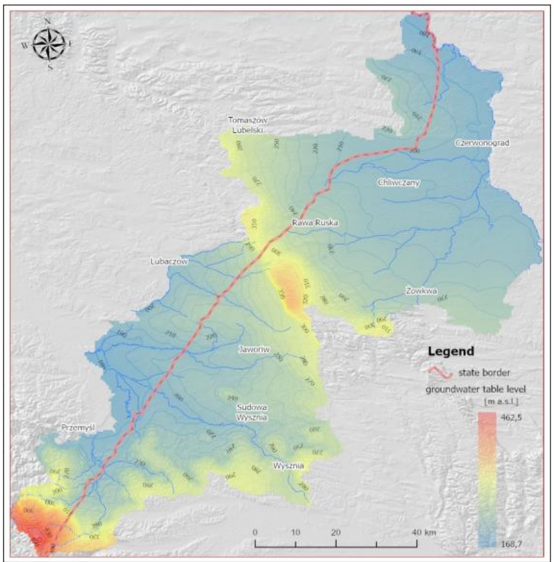
Spatial distribution of registered groundwater abstraction reflected in the model using the Well condition



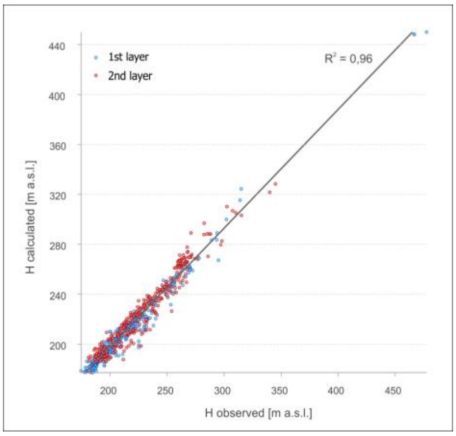
Distribution of unregistered exploitation
(demand of 0.4 m^3/d/person)



Calculated groundwater tabel level (first layer of the model)



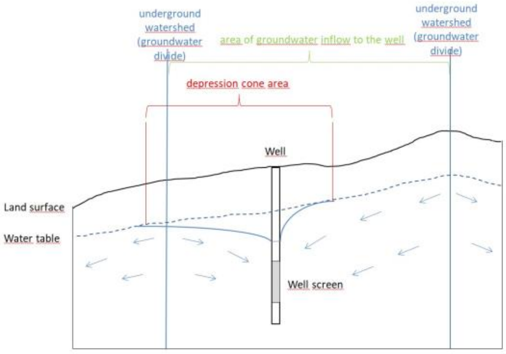
Fitting curve between measured and calculated values

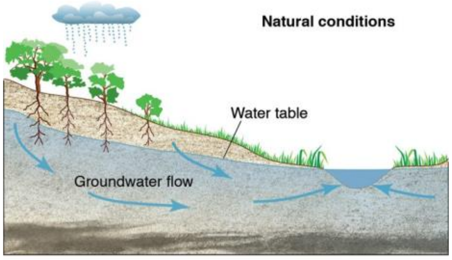


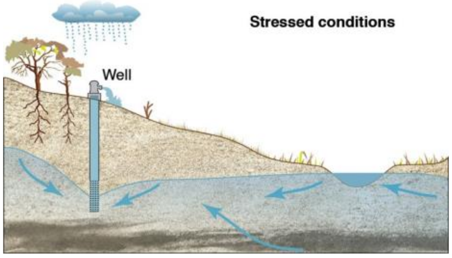
GROUNDWATER ABSTRACTION – DRAWDOWN CONE

Consequences:

- Lowering the groundwater table
- Changing the direction of water flow
- Changeing the water flow velocity
- Creating a drawdown cone

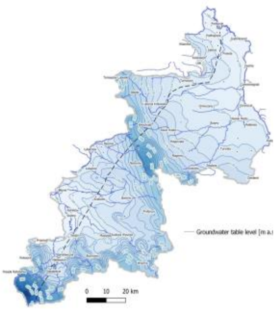




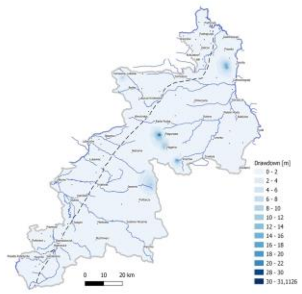


Lowering of the groundwater table due to groundwater abstraction

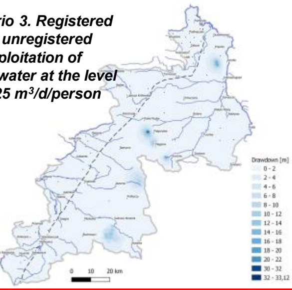
Scenario 1. Natural state without exploitation of groundwater



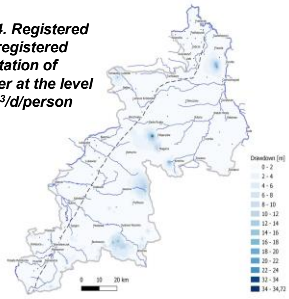
Scenario 2. Registered groundwater exploitation from 2018 -2021



Scenario 3. Registered and unregistered exploitation of groundwater at the level of 0.25 m^3/d/person



Scenario 4. Registered and unregistered exploitation of groundwater at the level of 0.4 m^3/d/person

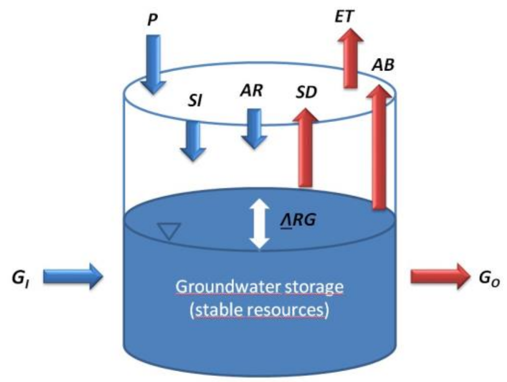


Groundwater balance

$$P + G_I + SI + AR = SD + ET + AB + G_O \pm \underline{\Lambda}RG$$

Water balance components

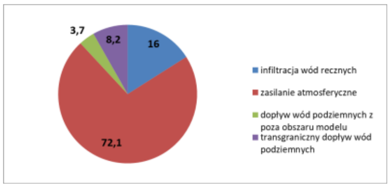
- **P** – Precipitation
- **G_I** – Groundwater lateral inflow
- **SI** – Infiltration from surface waters
- **AR** – Managed Aquifer Recharge (MAR)
- **SD** – Underground discharge to rivers
- **ET** – Evapotranspiration
- **G_O** – Groundwater lateral outflow
- **AB** – Groundwater abstractions
- **ΛRG** – Change in groundwater retention



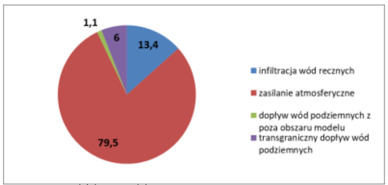
WATER BALANCE

Inflow

Poland

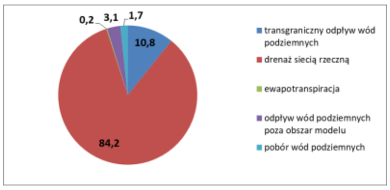


Ukraine

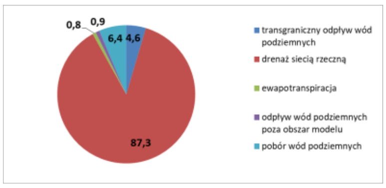


Outflow

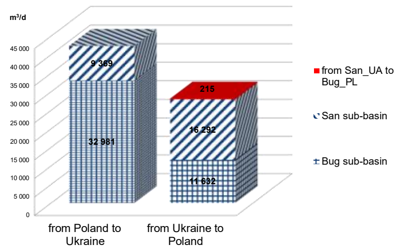
Poland



Ukraine



Transboundary groundwater flow



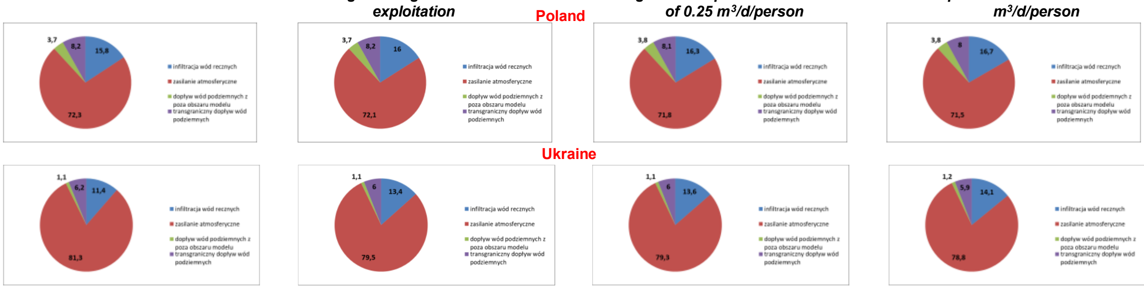
THE IMPACT OF GROUNDWATER ABSTRACTION ON THE WATER BALANCE

Inflow

Scenario 1. Natural state	*Scenario 2. Registered groundwater exploitation*	*Scenario 3. Registered and unregistered exploitation at the level of 0.25 m³/d/person*	*Scenario 4. Registered and unregistered exploitation at the level of 0.4 m³/d/person*

Poland

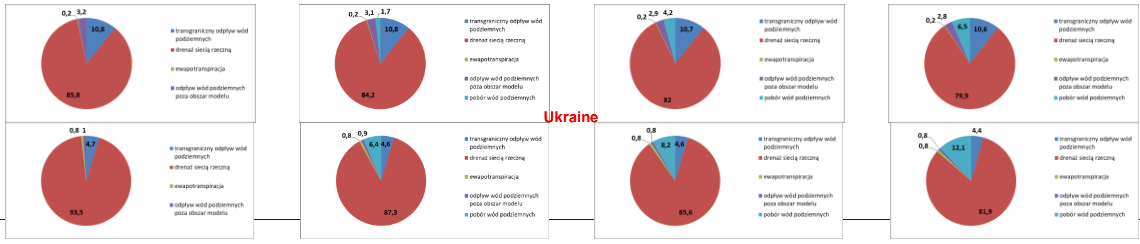
Ukraine



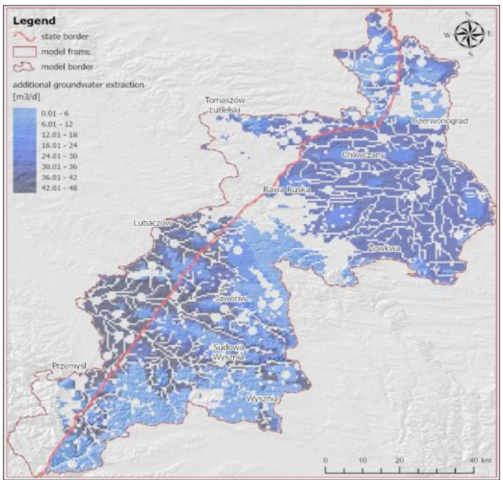
Outflow

Poland

Ukraine



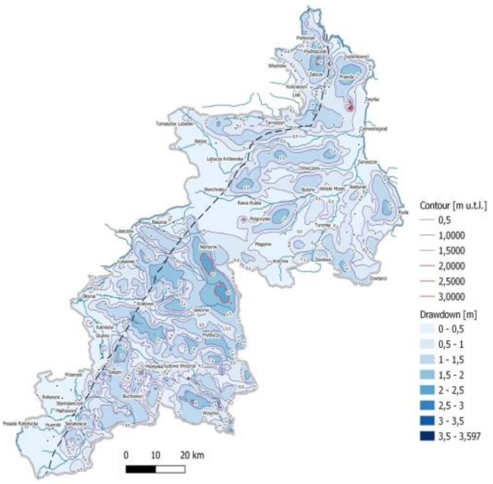
ADDITIONAL MAXIMUM ABSTRACTION AVAILABLE FOR EXPLOITATION RESERVES OF GROUNDWATER RESOURCES



There was no pressure on the aquifer system in the following areas :

- Surroundings (1 km buffer) of model blocks with existing groundwater intakes;
- Surroundings (0.5 km buffer) of centroids of virtual intakes with unregistered consumption;
- National parks;
- Reserves;
- Groundwater Dependent Ecosystems;
- Natura 2000 areas.

Modeling of lowering the groundwater table when exploiting the available resources - maximum permissible pressure on the system



- The San sub-basin, compared to the Bug sub-basin, is characterized by greater sensitivity to lowering the groundwater table, primarily due to the low natural abundance of the aquifer system;
- areas with a regional lowering of the groundwater table exceeding 1.0 m are located in zones outside the river valleys;
- areas with the highest decrease in the groundwater table exceeding 2.0 m are located in areas where two unfavorable factors coexist - low natural abundance of the aquifer system and concentration of groundwater intakes.

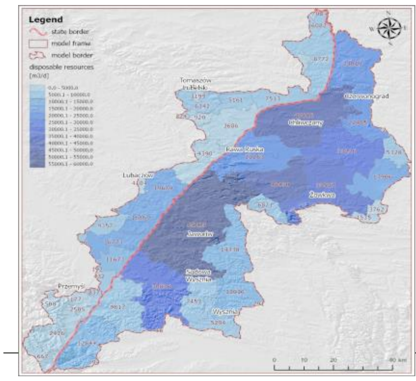
Divided into administrative units, the areas with the highest lowering of the groundwater table exceeding 2.0 m are located in the following towns:

Poland: Dołhobyczów;

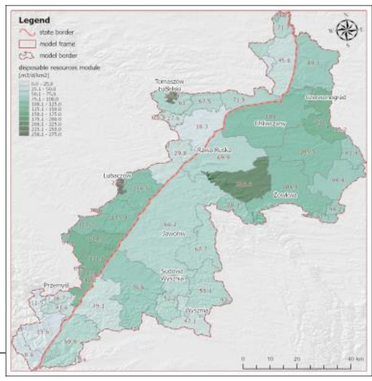
Ukraine: Mostyska (OTG Mostyska), Melnyky (OTG Yavorivska), Shysherowychy, Dydiatychy, Dmytrovychy, Makuniv (OTG Sudovovyshnianska), Starychi (OTG Novojiavorivska), Zamok (OTG Dobrosynsko-Maherivska), Savchym (OTG Sokalska).

Transboundary disposable (available) groundwater resources within administrative units

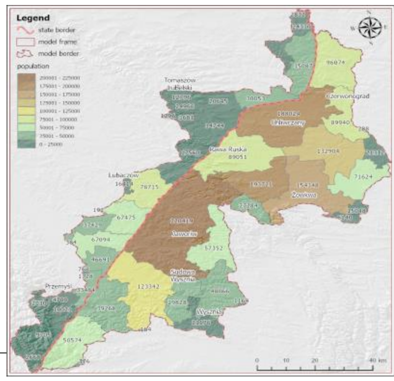
Transboundary groundwater resources available for exploitation (disposable) within the boundaries of administrative units



Transboundary groundwater resources available for exploitation (disposable) within the boundaries of administrative units per module – m³/d/km²



The number of people within the commune whose water needs can be met from transboundary available groundwater resources



CONCLUSIONS AND PERSPECTIVES

1. The implementation of the EU-Waterres project allowed the identification of transboundary aquifers, assessment of their resources and the risk of deterioration of their quantitative status.
2. The main factor determining the quantitative status of groundwater in the Poland-Ukraine transboundary area is unregistered abstraction, especially in Ukraine.
3. In Ukraine, only 16% of the population uses group water supplies, and unregistered consumption from individual water intakes is more than twice as high as the reported data.
4. The assessment of available water resources was used in analyzes of the potential for the development of municipal groundwater intakes in PL-UA border communes.
5. The results of the calculation of the resources of transboundary aquifers of the PL-UA border initiated a new project under Interreg NEXT Poland - Ukraine **„GroundWater-Union: Development of water supply infrastructure for sustainable use of transboundary groundwater resources".**

How can Map Portal be useful to me? Short intro to the data layers.

The main product of the EU-Waterres project is the Map Portal where you can easily find many useful information that can help you in your daily tasks if you are involved into water management process in transboundary areas. The first information that is available to every user is thematic maps that can be divided into 4 groups: 1) Maps of hydrogeological parameters, 2) Maps of groundwater exploitation, 3) Maps of groundwater sensitivity and quality, and 4) Base map - Open Street Map and Corine Land Cover, and in the Ukrainian part its original version. The thematic layers have been prepared for both pilot areas – Polish- Ukrainian and Estonian – Latvian.

The basic map compositions have already been prepared for the user. Of course it is possible to mix them add new ones, remove layers that are not needed any more. The set of basic compositions differs slightly depending on the selected pilot territory: Polish-Ukrainian or Estonian-Latvian. It depends on some features of these territories. For instance, there are the buried valleys in Estonia-Latvia but this layer is not present in Poland – Ukraine. That is because there are no such structures in this area.

Another information that can be obtained from the portal is the geological map. It is worth to mention that the geological map of the Polish – Ukrainian borderland is the very first map based on the harmonized data between both countries.

Another valuable information on the portal is the groundwater monitoring network of both pilot areas. In total it contains the data from over 100 monitoring points. Each monitoring point has it`s "business card". The basic information about the borehole, like its location, type of the groundwater table, when the point had been drilled, type of data that are available for this point, can be found here.

In terms of quantity data – they are already available for all the points from the database. It means that you can get the information about the position of groundwater table level variations in time. Our data cover the period of time from early 2000s till the end of 2021. If needed, you can generate a graph of groundwater table level fluctuations.

On the Polish-Ukrainian pilot territory there is a layer with the cross-sections lines drown on the map. Some hydrogeological information were also included on the sections.

All functionalities have been presented and discussed in details in the report "Coherent spatial database" that is also available on the project website.

Iceland Liechtenstein Norway grants

EU-WATERRES

"EU-integrated management system of cross -border groundwater resources and anthropogenic hazards"

Norway grants

How can Map Portal be useful to me? Short intro to the data layers.

WE STAND WITH UKRAINE

Trondheim, November 23, 2023

Hanna KOLOS | PGI-NRI
Małgorzata PRZYCHODZKA | PGI-NRI

GEOLOGICAL SURVEY OF NORWAY · UNIVERSITY OF LATVIA · REPUBLIC OF ESTONIA GEOLOGICAL SURVEY · LATVIJAS VIDES, ĢEOLOĢIJAS UN METEOROLOĢIJAS CENTRS · Zahidukrgeologiya · HEXAGON · NVE

What is portal?

- **MAP** – a drawing of the earth`s surface, or part of that surface, showing the shape and position of different countries, political borders, natural features such as rivers and mountains, and artificial features such as roads and buildings.

(Cambridge Dictionary)

- **PORTAL** – (1) an entrance to a building, especially a large or important one; (2) a website or a page in the internet that allows people, especially a group of people who are interested in a particular subject, to get useful information and to find other websites.

(Cambridge Dictionary)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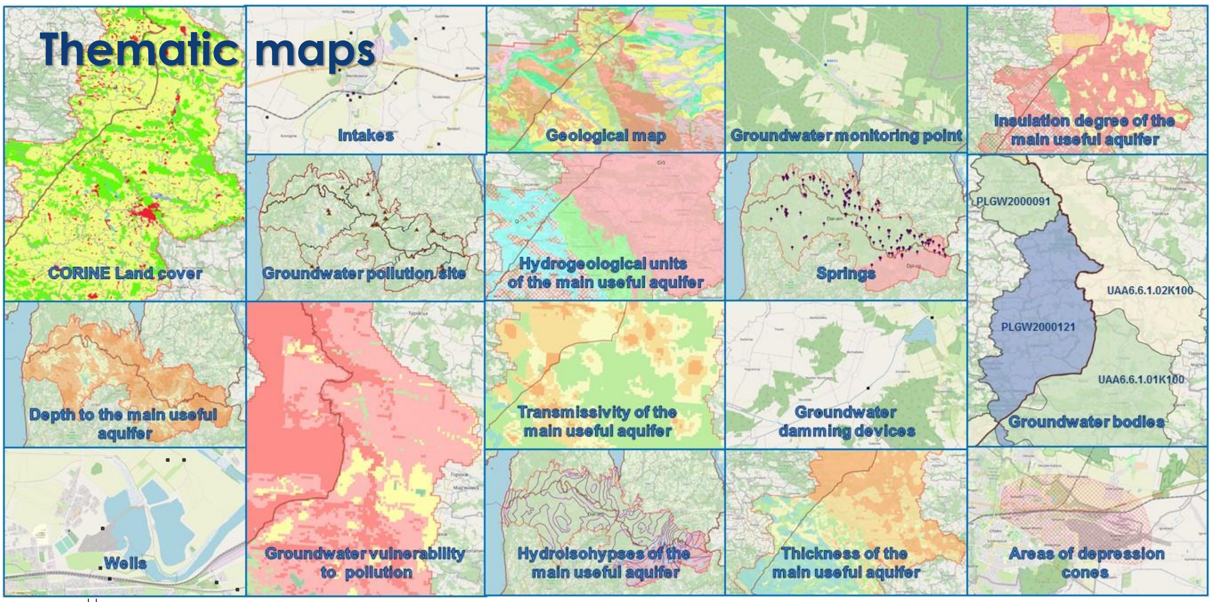
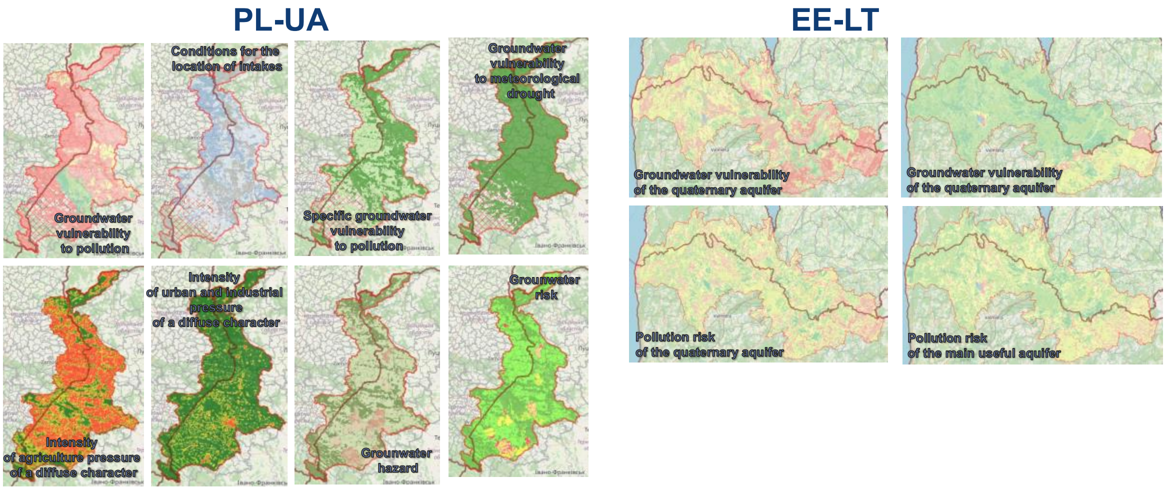


Maps of Vulnerability, Pressure, Hazard, Risk



Map composition

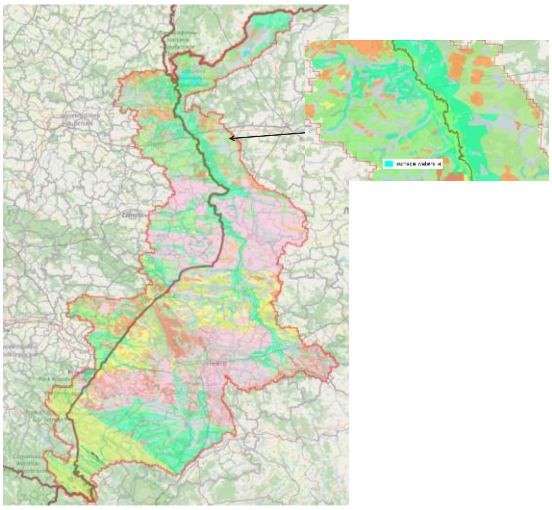
	Polish – Ukrainian pilot area	Estonian – Latvian pilot area
Hydrogeological units of the main useful aquifer	✓	✓
Depth to the main useful aquifer	✓	✓
Hydroisohypses of the main useful aquifer	✓	✓
Thickness of the main useful aquifer	✓	✓
Transmissivity of the main useful aquifer	✓	✓
Springs	✓	✓
Insulation degree of the main useful aquifer	✓	✗
Wells / Boreholes	✓	✓
Intakes	✓	✓
Groundwater damming devices	✓	✗
Areas of depression cones	✓	✓
Groundwater bodies	✓	✓
Groundwater pollution source – wastewater treatment plants	✓	✗
Groundwater pollution source – waste landfills	✓	✗
Groundwater vulnerability to pollution	✓	✓
Groundwater monitoring points	✓	✓
Buried valleys	✗	✓
The thickness of the impermeable layer over main useful aquifer	✗	✓
Groundwater mineralization for main useful aquifer	✗	✓
Groundwater pollution sites	✗	✓

Thematic layers

Polish-Ukrainian pilot area
Intakes
Wells / Boreholes
Springs
Monitoring points
Groundwater damming devices
Groundwater pollution source – wastewater treatment plants
Groundwater pollution source – waste landfills
Hydroisohypses-labels
Hydroisohypses
PL-UA pilot area
State border
Areas of depression cones
Geological map
GWB-Poland
GWB-Ukraine Q
GWB-Ukraine M
GWB-Ukraine Cr3
GWB-Ukraine D3
Hydrogeological units of the MUA -labels
Hydrogeological units of the MUA
Depth to the MUA
Thickness of the MUA
Transmissivity of the MUA
The insulation degree of the MUA
Groundwater vulnerability to pollution
Conditions for the location of intakes
Specific groundwater vulnerability to pollution
Groundwater vulnerability to meteorological drought
Intensity of agriculture pressure of a diffuse character
Intensity of urban and industrial pressure of a diffuse character
Groundwater hazard
Groundwater risk

Estonian-Latvian pilot area
Intakes
Wells / Boreholes
Springs
Monitoring points
Groundwater pollution sites
Hydroisohypses – Dpl-og
Hydroisohypses – Dar-am
LAT-EST pilot area
Border of Latvia and Estonia
Areas of depression cones
Buried valleys
Grounwater bodies – Dpl-og
Grounwater bodies – Dar-am
Hydrogeological units of the MUA -labels
Hydrogeological units of the MUA – Dpl-og
Hydrogeological units of the MUA – Dar-am
Depth to the MUA
Thickness of the MUA
Transmissivity of the MUA – Dpl-og
Transmissivity of the MUA – Dar-am
Groundwater mineralization for MUA
Groundwater vulnerability of the quaternary aquifer
Groundwater vulnerability of the MUA
Pollution risk of the of the quaternary aquifer
Pollution risk of the of the MUA

Geological map

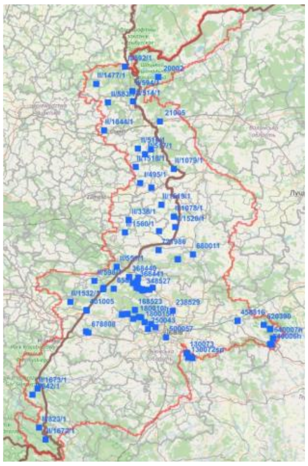


Legend:

ch,tH	Chemogenic and antropogenic sediments. Limestone tuffs (travertine), clays, loams, rubble, boulders, sands
bH	Quatenary system. Holocene series. Biogenic sediments. Peat, peat soils.
aH	Quatenary system. Holocene series. Aluvial sediments of floodplains. Silty sands, loams, gravel, pebbles
a,bH	Quatenary system. Holocene series. Aluvial+biogenic sediments. Organic silts, silty sands
dH	Quatenary system. Holocene series. Deluvial deposits of accumulative slopes.Landy loams, loams, gravel
aE-H	Quatenary system. Eopleistocene-Holocene series. Aluvial sediments of floodplain terraces. Sands, gravels, loamy sands, loams, pebbles.
aE-P1	Quatenary system. Eopleistocene series. Alluvial deposits of ancient longitudinal river valleys. Pebbles, rubble, loam, boulders.
dc,d,dp,dz,edP-H	Quatenary system. Pleistocene- Holocene series. Deluvial-colluvial, deluvial-proluvial, landslide, eluvial-deluvial deposits of accumulative slopes. Sands, sandy loam, loams, clays, gravel, rubble, boulders.
vP-H	Quatenary system. Pleistocene- Holocene series. Aeolian sediments of hills, dunes. Sands, loamy sands, loams.
vd,eP	Quatenary system. Pleistocene series. Aeolian-deluvial, eluvial cover sediments of loess accumulative-denudation uplands. Loess soil, loamy sands, loams
fP	Quatenary system. Pleistocene series. Fluvioglacial sediments of outwasch denudation plains and lake sediments. Sands, sandy loams, loams.
gP	Quatenary system. Pleistocene series. Glacial (moraine) sediments of hills and plateaus. Glacial sands and gravels, moraine clays, gravel, boulders.
alP	Quatenary system. Pleistocene series. Alluvial-lake sediments. Clays, loams, loamy sands
N1-2	Neogene system. Miocene series. Shallow coastal-marine terrigenous and evaporite sediments. Organodetrites and sulfur-containing limestones, sandstones, gypsum, gravel, stratification of clays, argillites, sandstones and siltstones
N1-1	Neogene system. Miocene series. Deep sea sediments conglomerates, siltstones. Layering of argillites, siltstones, sandstones.
K2-Pg	Upper Cretaceous-Paleogen system. Deep flysch deposits. Rhythmic gray flysch (sandstones, argillites, siltstones)
K2	Upper Cretaceous system. Terrigenous carbonate deposits of the epicontinental shelf. Marls, chalk, opoka, spongiolites, clay limestones.
K1-2	Lower-Upper Cretaceous system. Deep-water flysch terrigenous-carbonate deposits. Thin-plate marls, limestones, argillites, black silicon argillites, siltstones, sandstones, siderite inclusions, conglomerate lenses, layers of multicolored and fine-grained flysch.
surface waters	Surface waters

Monitoring points

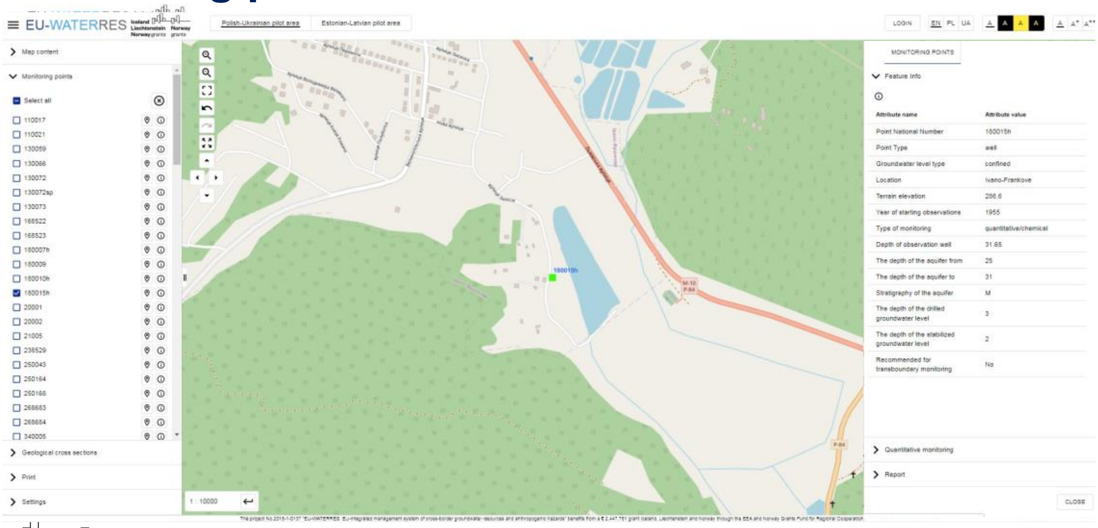
Polish – Ukrainian pilot area



Estonian – Latvian pilot area

Attribute name	Attribute value
National number of point	9602
WFD code	LV391RIMA10_9602
Type of point	well
Type of groundwater table	confined
Terrain elevation (m a.s.l)	68.87
Year of starting observations	1972
Type of monitoring	Quantitative
Depth of observation well (m b.g.l)	28.8
The depth of the screen from (m b.g.l)	23.3
The depth of the screen to (m b.g.l)	28.2
Stratigraphy of the aquifer	Dar-am
The depth of the stabilized groundwater level (m b.g.l)	4.82
Groundwater level (m a.s.l)	64.05

Monitoring points



Monitoring points - data

MONITORING POINTS | MUNICIPALITY

Feature Info

Attribute name	Attribute value
Point National Number	II/551/1
Point Type	well
Groundwater level type	confined
Location	Werchrata
Terrain elevation	275.0
Year of starting observations	1986.0
Type of monitoring	quantitative/chemical
Depth of observation well	30.0
The depth of the aquifer from	12.0
The depth of the aquifer to	30.0
Stratigraphy of the aquifer	Cr3
The depth of the drilled groundwater level	12.0
The depth of the stabilized groundwater level	4.0
Recommended for transboundary monitoring	Yes

REPORT

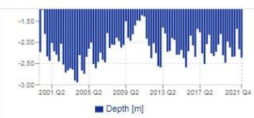
From: January 1995 — To: November 2023

- [x] Description
- [x] Feature Info
- [x] Quantitative monitoring - chart
- [x] Quantitative monitoring
- [x] Qualitative monitoring - chart
- [x] Qualitative monitoring

GENERATE REPORT

MONITORING POINTS | MUNICIPALITY

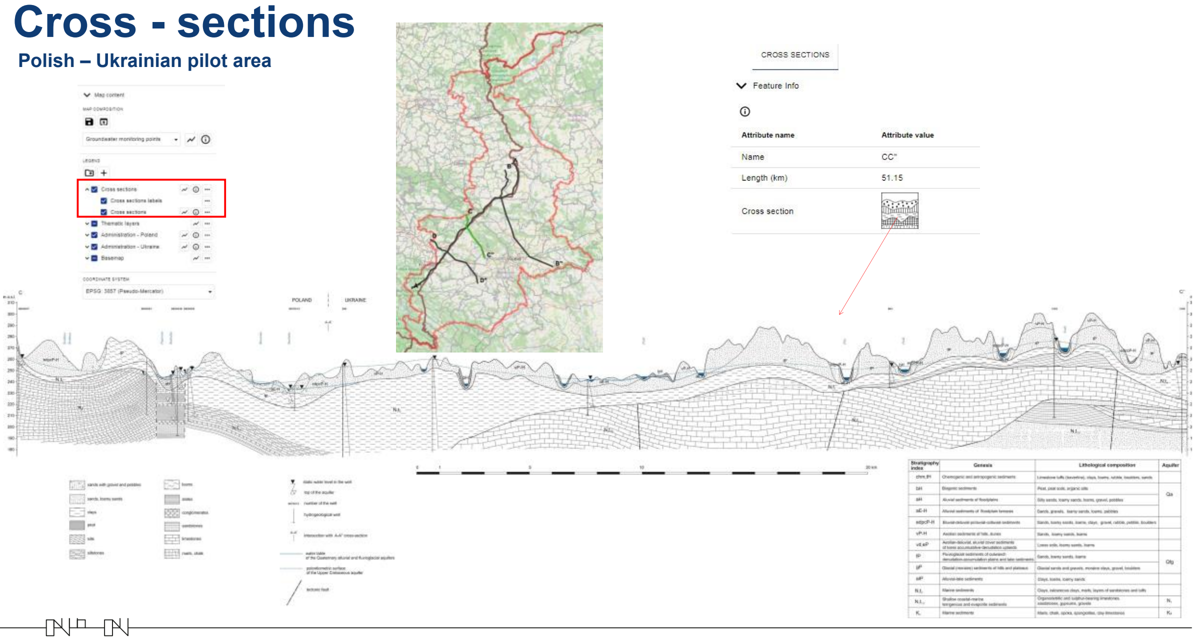
Feature Info



Period	Depth [m]	Range
2000 Q1	-2.23	1999-11 - 2000-01
2000 Q2	-1.23	2000-02 - 2000-04
2000 Q3	-1.80	2000-05 - 2000-07
2000 Q4	-2.33	2000-08 - 2000-10
2001 Q1	-2.43	2000-11 - 2001-01
2001 Q2	-2.01	2001-02 - 2001-04
2001 Q3	-2.21	2001-05 - 2001-07
2001 Q4	-2.29	2001-08 - 2001-10
2002 Q1	-2.45	2001-11 - 2002-01
2002 Q2	-2.03	2002-02 - 2002-04
2002 Q3	-2.52	2002-05 - 2002-07
2002 Q4	-2.71	2002-08 - 2002-10
2003 Q1	-2.66	2002-11 - 2003-01
2003 Q2	-2.61	2003-02 - 2003-04

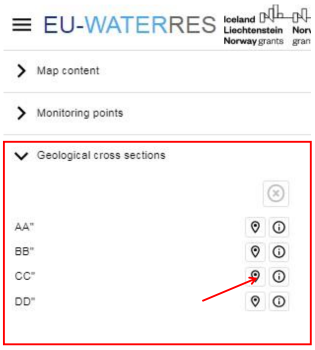
Cross - sections

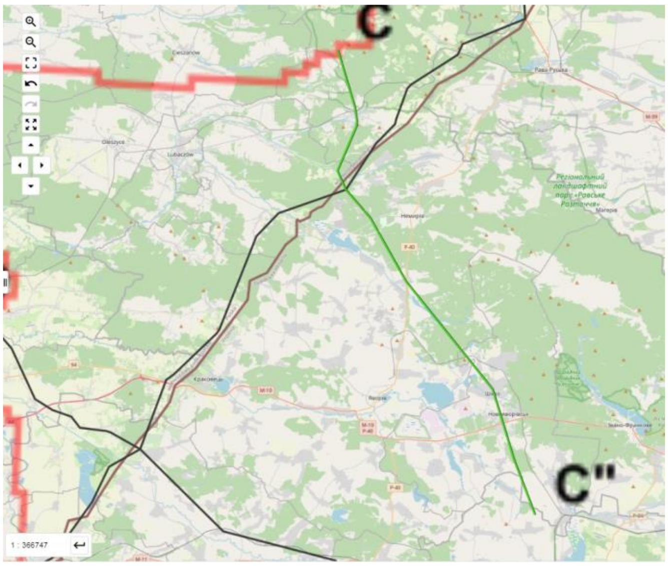
Polish – Ukrainian pilot area



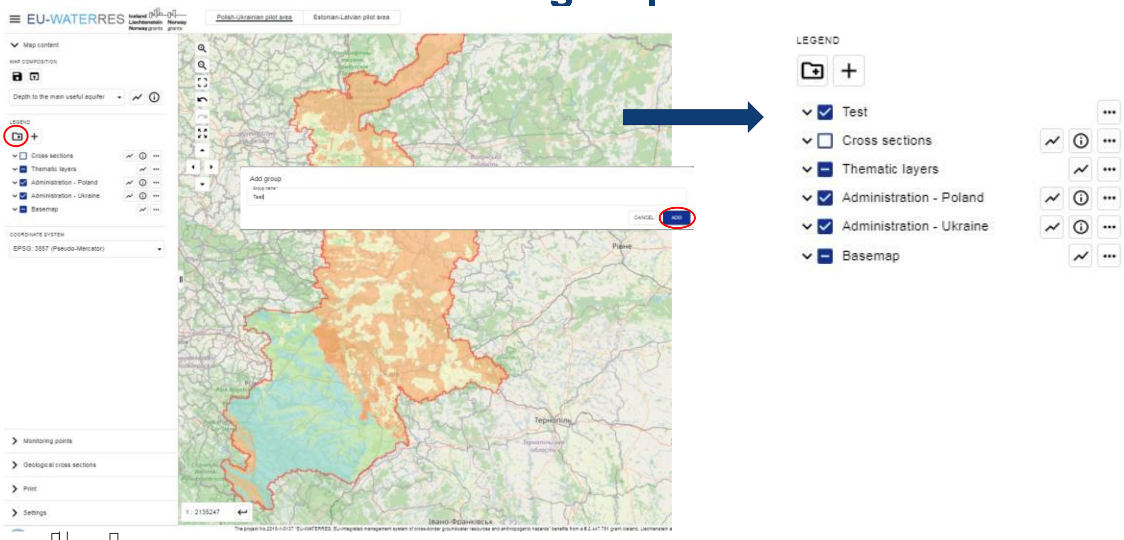
Cross - sections

Polish – Ukrainian pilot area

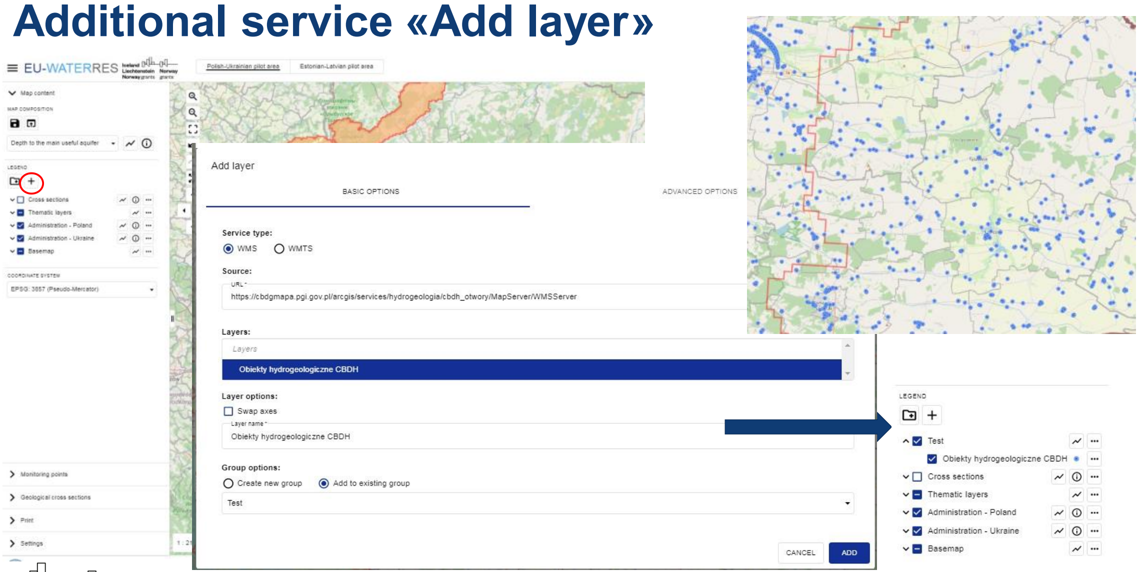




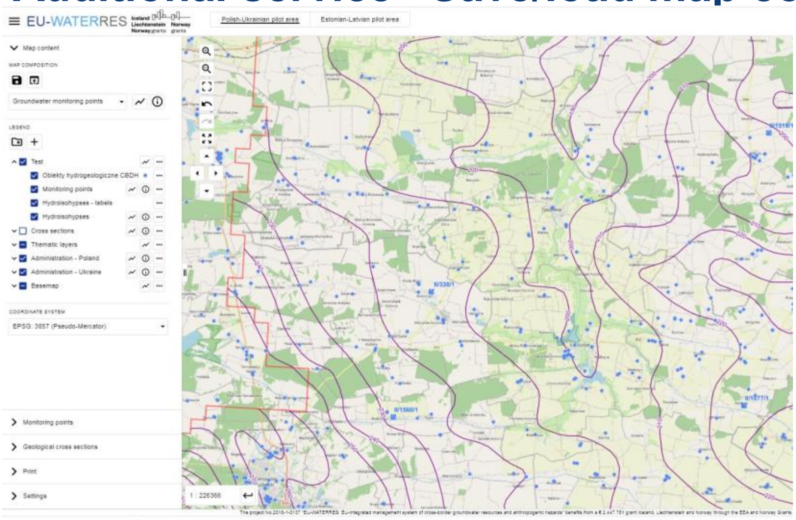
Additional service «Add group»



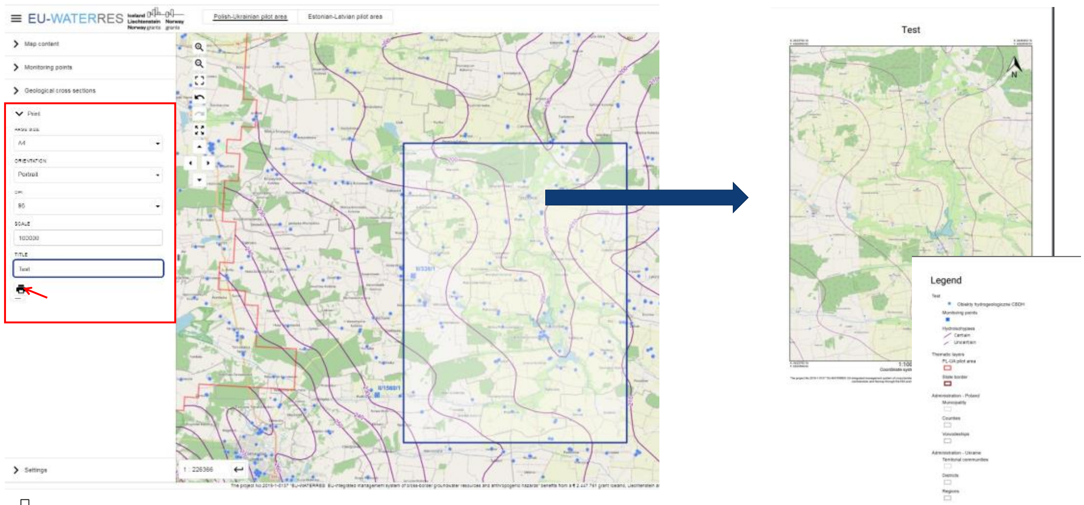
Additional service «Add layer»



Additional service «Save/load map composition»



Additional service «Print»



Welcome to EU-Waterres Map Portal

https://eu-waterres.eu/web-app/

Iceland
Liechtenstein
Norway grants

Norway
grants

Thank you!

WE STAND
WITH UKRAINE

The project No.2018-1-0137 "EU-WATERRES: EU-integrated management system of cross-border groundwater resources and anthropogenic hazards" benefits from a € 2.447.761 grant Iceland, Liechtenstein and Norway through the EEA and Norway Grants Fund for Regional Cooperation.

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