

Karstic groundwater in Hungarian-Slovakian transboundary groundwater bodies under the scope of “ENWAT” and “TRANSENERGY” EU projects

Peter MALÍK*; **Radovan ČERNÁK***; **György TÓTH****

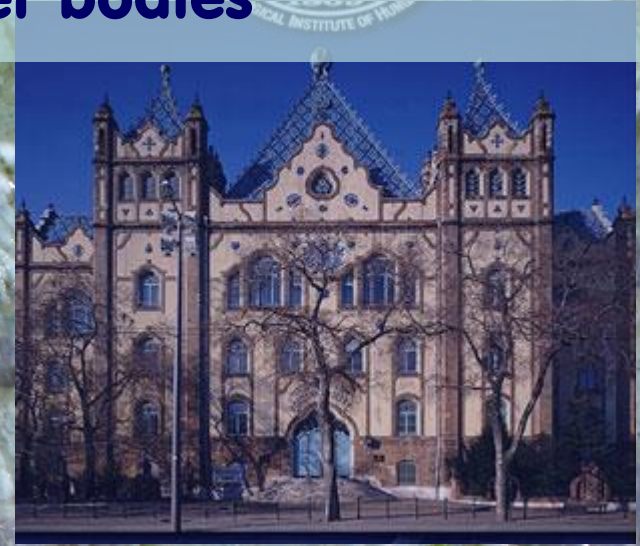
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ENWAT

Environmental state and sustainable management of Hungarian-Slovakian transboundary groundwater bodies



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Maglay, J., Malík, P., Marcin, D., Michalko, J., Nádor, A., Rapant,
S., Slaninka, I., Szőcs, T., Tóth, G., Tullner, T., Turczi, G., Viktor, Zs.**

ENWAT PARTICIPANTS

Hungary:

MÁFI (Geological Institute of Hungary)

Slovakia:

**ŠGÚDŠ (Štátny geologický ústav Dionýza Štúra
- Geological Survey of Slovak Republic)**

Main subcontractors:

SMARAGD GSH

- Modelling

GST (Geologian Tutkimuskeskus / Geological Survey of Finland)

- Support for water management

SHMU (Slovak Hydrometeorological Institute)

- data

2006 - 2008



INTERREG
III A



MAGYARORSZÁG
SLOVENSKO
УКРАЇНА
Neighbourhood Programme

Funding of the project

ENWAT project was funded due to

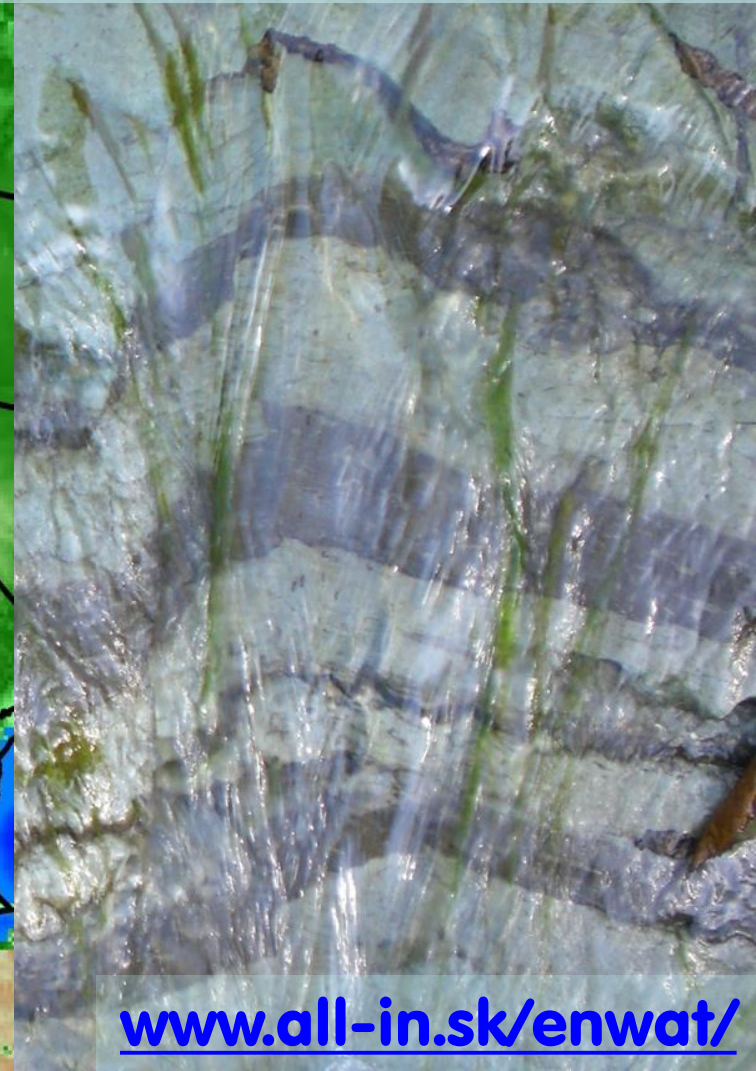
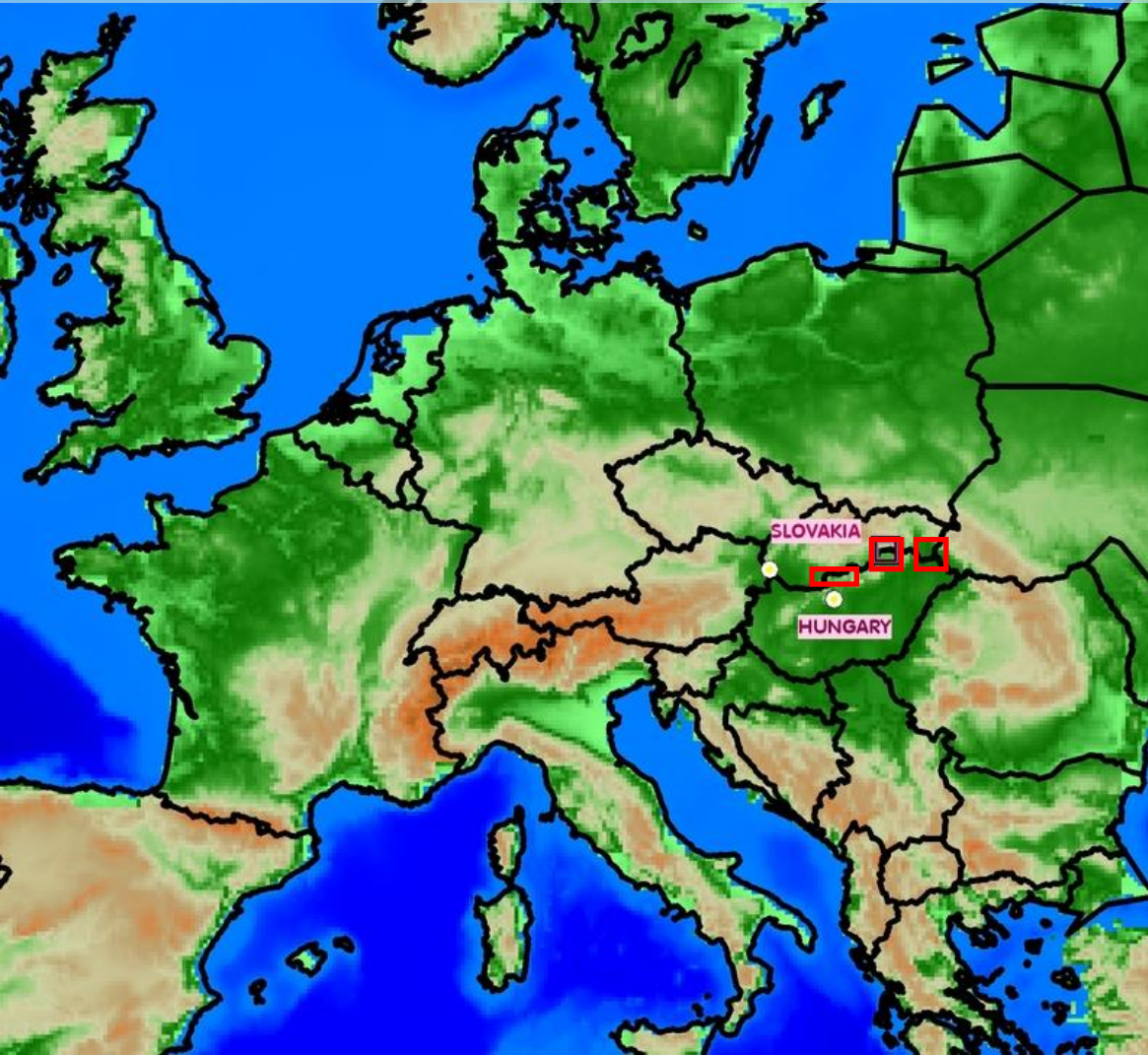
INTERREG III A

Program's sources of funding

National Organs of Hungary-Slovakia-Ukraine Neighbourhood
Program **HU-SK-UA**

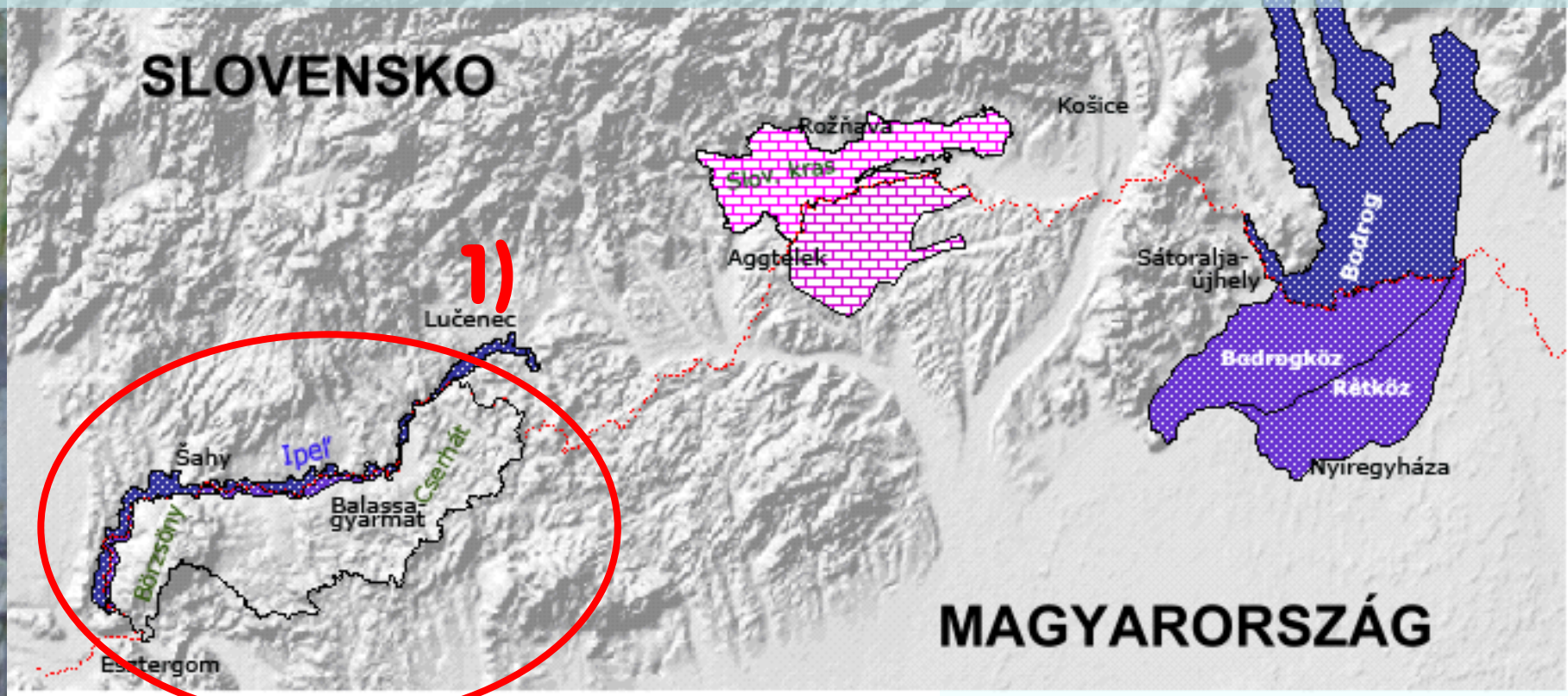
STUDIED AREAS

Activity of ENWAT project were realized during 2006 - 2008 in three Slovak-Hungarian transboundary groundwater bodies:



STUDIED AREAS

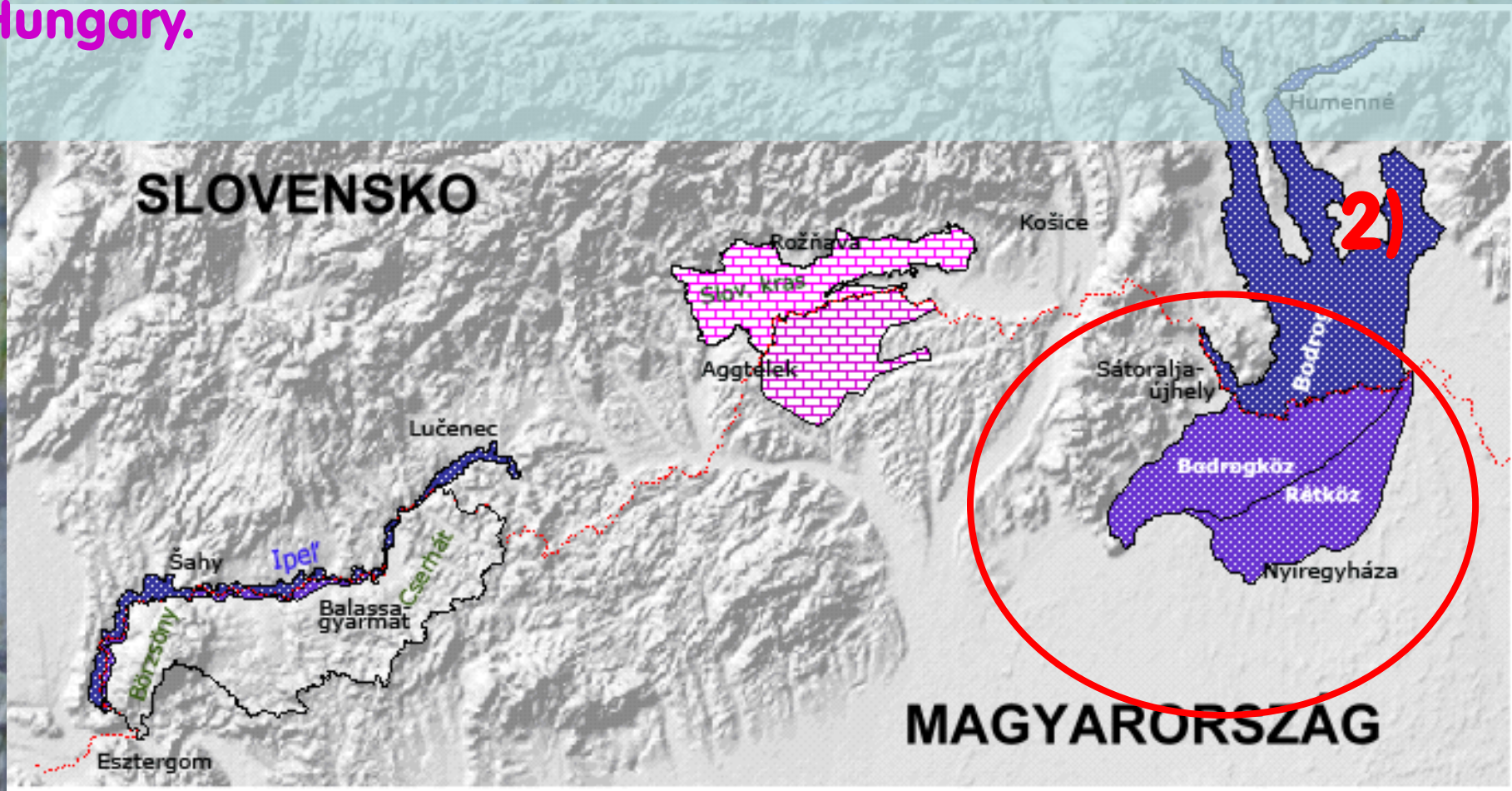
1) Groundwater bodies in Quaternary of the Ipeľ/Ipoly river basin (Slovakia and Hungary), and the connecting mixed Oligocene, Miocene mountainous groundwater bodies in Hungary.



STUDIED AREA 1) Groundwater bodies in Quaternary of the Ipel/Ipoly river basin (Slovakia and Hungary), and the connecting mixed Oligocene, Miocene mountainous groundwater bodies in Hungary.

STUDIED AREAS

2) Groundwater bodies in Quaternary alluvial sediments of Bodrog river basin in Slovakia and in Rétköz and Bodrogköz in Hungary.

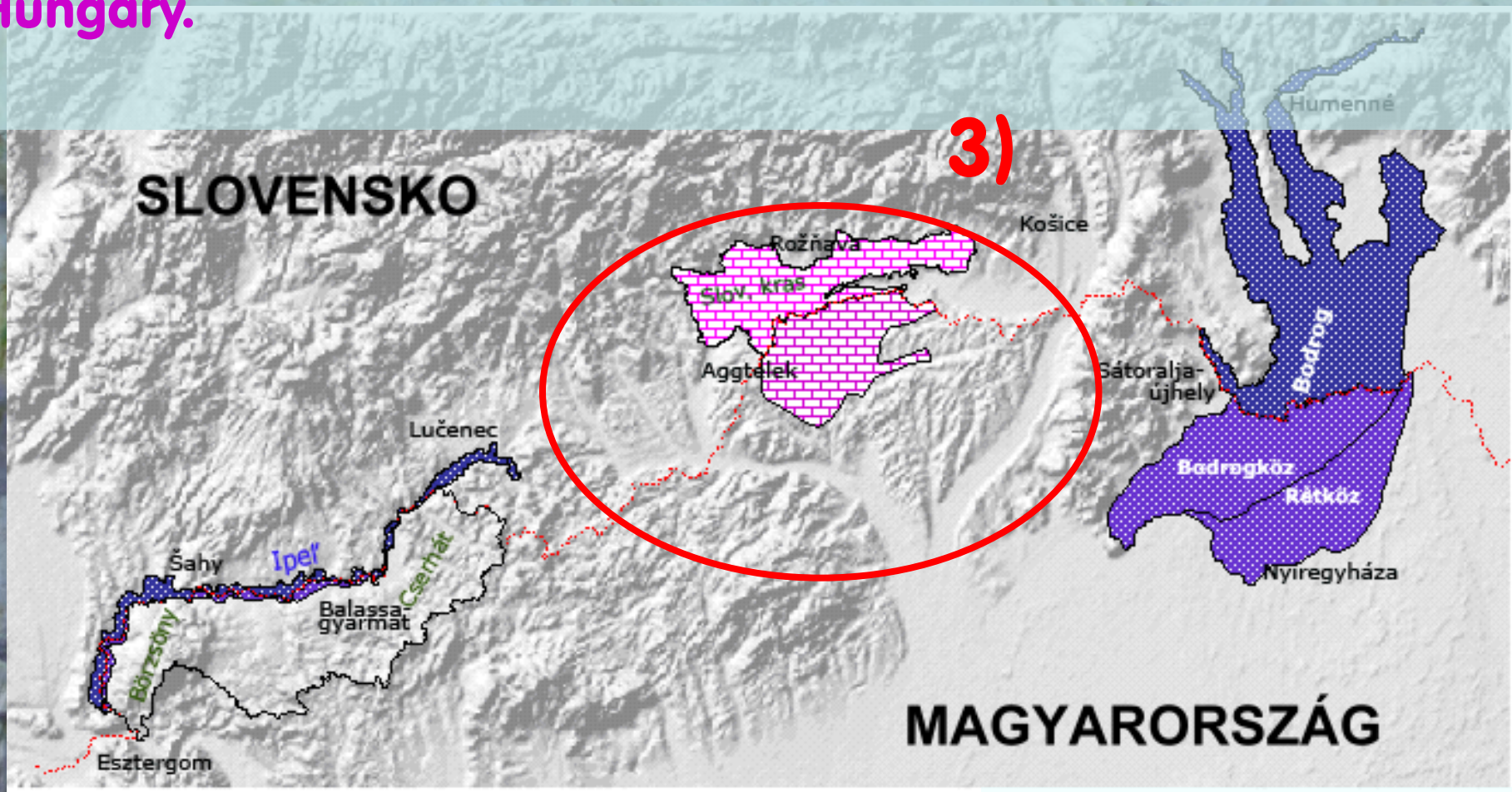


STUDIED AREA 2) Groundwater bodies in Quaternary alluvial sediments of Bodrog river basin in Slovakia and in Rétköz and Bodrogköz in Hungary.



STUDIED AREAS

3) Groundwater bodies in Mesozoic carbonate formations in Slovensky kras mts. in Slovakia and in Aggtelek-hegység in Hungary.



STUDIED AREA 3) Groundwater bodies in Mesozoic carbonate formations in Slovensky kras Mts. in Slovakia and in Aggtelek-hegység in Hungary.



GIS database of hydrogeological information:

Čerpacia skúška

Č. skúšky: Medveď Juraj
Autor č. s.: 43405
Č. správy: 1990
Rek správy: 27.10.1979
Čerp. od: 13.11.1978
Trvanie: 17
Hľad. pred: 0.48

Čerpacie stupne

Č. stupňa	s	Q
1	29.5	5
2	49.45	6.45
3		
4		
5		

Ustalenie mernej výdatnosti

- Vyber automaticky Q a s
- Z grafu
- Vyber dvojicu q = Q/s
- Použiť archívnu

Mapa

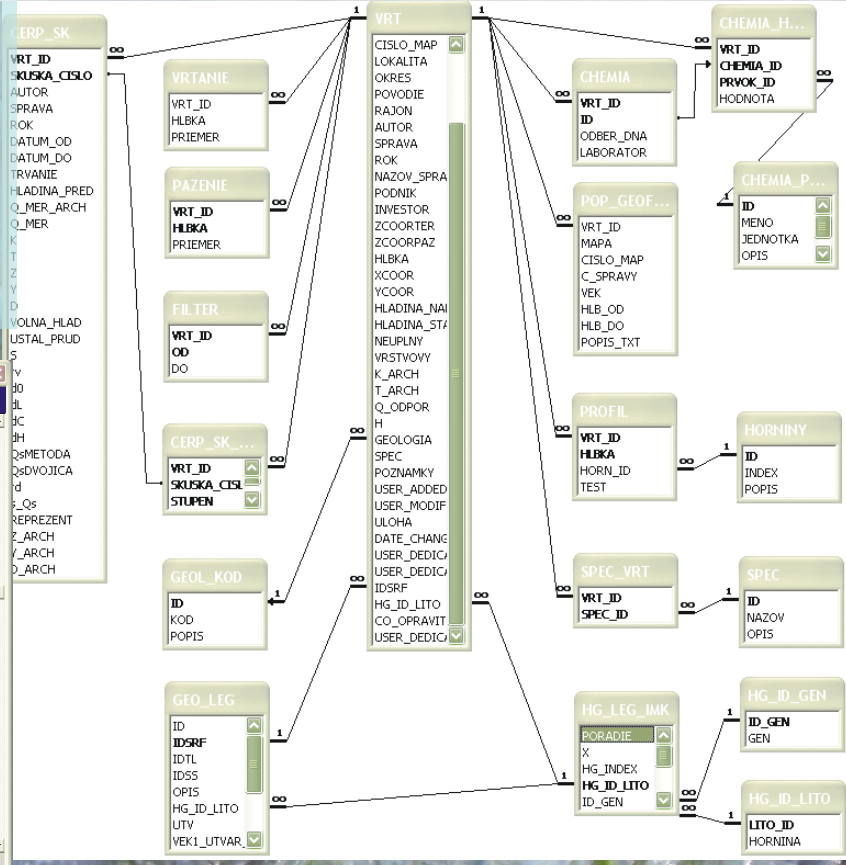
Hydrois ID: 9999

Prac. č.: 6
Hľad. narazená: 0.5
Označ.: DL-2
Hľad. statická: 1.5
Č. v mape: 6
Kolektor vrstvomý:
Lokalita: Horné Plachtince
Okres: Veľký Krtíš
Povodie: Ipeľ
Rajón: V 094
Autor vrtu: Medveď
Č. správy: 1990
Výška tor.: 417.09
Výška paš.: 418.14
Hĺbka: 206
X súrad.: -413602.97
Y súrad.: -1277179.7

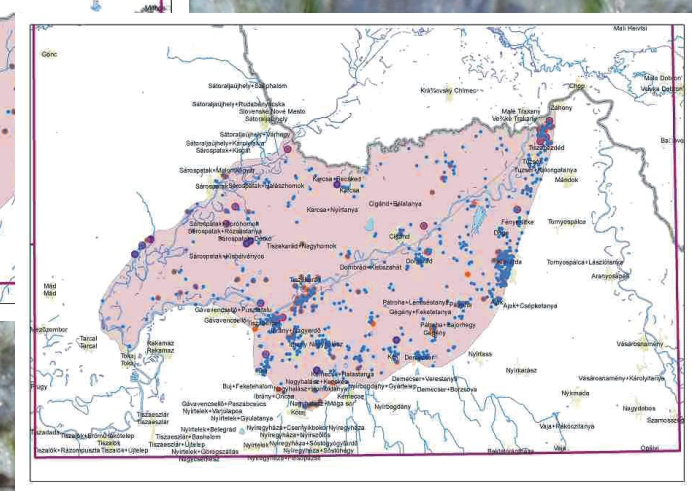
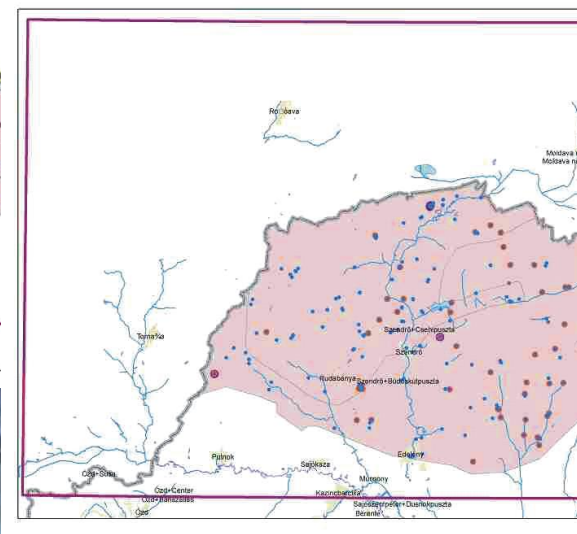
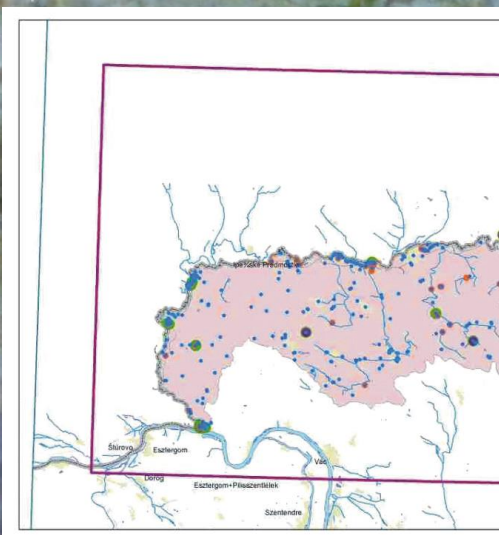
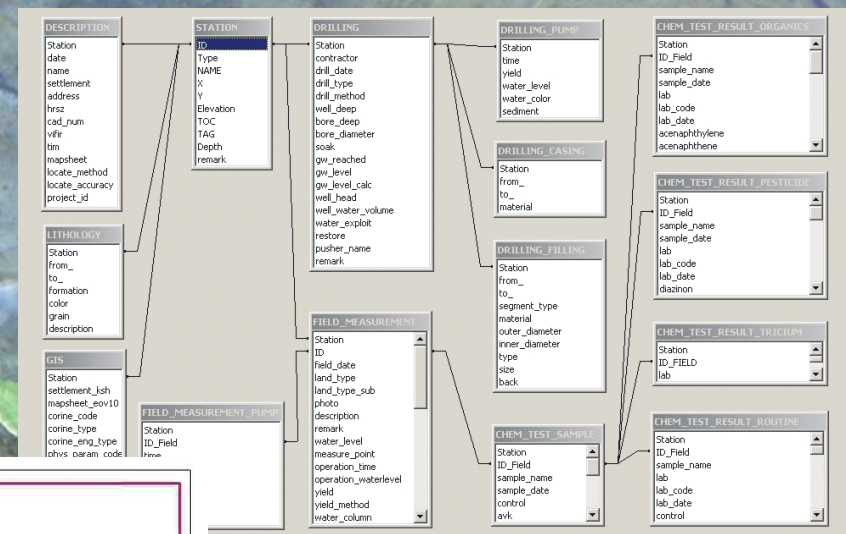
Chemická analýza

Číslo analýzy: 12.6.1979
Dátum odberu: VZ Prešov
Laboratórium: VZ Prešov

Prvok	Hodnota	Jednotka
Na	13.5	mg/l
K	4.5	mg/l
NH	0.01	mg/l
Mg	5.78	mg/l
Ca	20.04	mg/l
Fe2+	0.027	mg/l
Cl	1.06	mg/l
F	0.08	mg/l
NO3	1.6	mg/l
SO4	3.8	mg/l
HPO4	0.12	mg/l
HCO3	110.99	mg/l
CO vol	8.8	mg/l
CO sat hev	6.6	mg/l



GIS database of hydrogeochemical information:



Field work - groundwater sampling



Field work - groundwater sampling and chemical analyses:

(•) routine parameters Na^+ , K^+ , Ca^{2+} , Mg^{2+} , NH_4^+ , Fe_{total} , Mn , HCO_3^- , CO_3^{2-} , NO_3^- , NO_2^- , Cl^- , SO_4^{2-} , PO_4^{3-} , SiO_2 , TOC , COD_{Mn} - at 140 sites

(•) trace elements Ag, Al, As, B, Ba, Be, Cd, Co, Cr, Cu, Hg, Li+, Mo, Ni, Pb, Sb, Se, Sn, Sr, Tl, V, Zn - at 140 sites

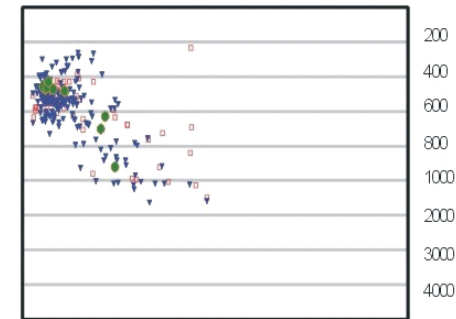
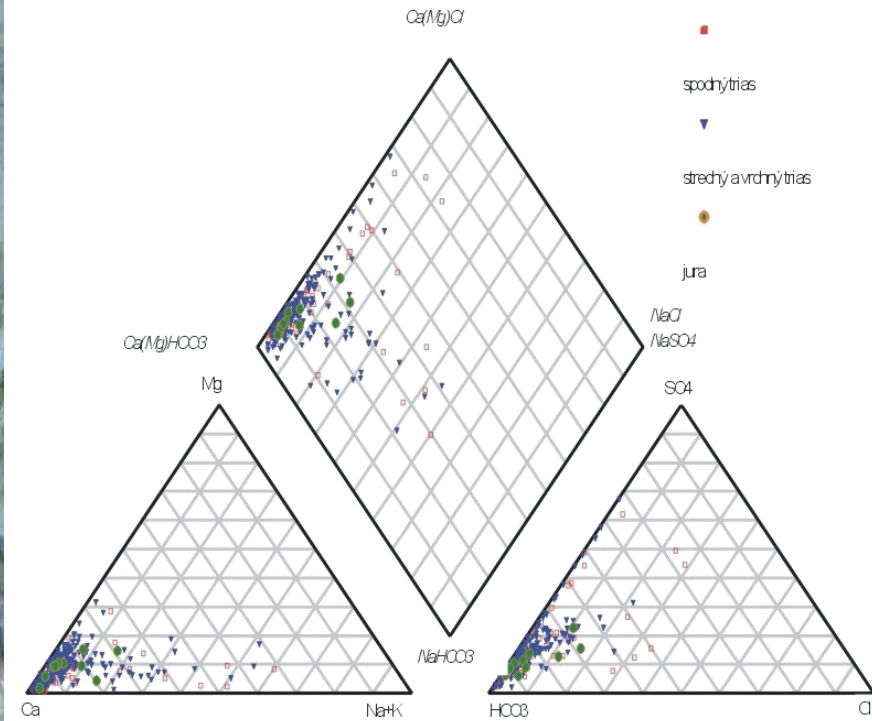
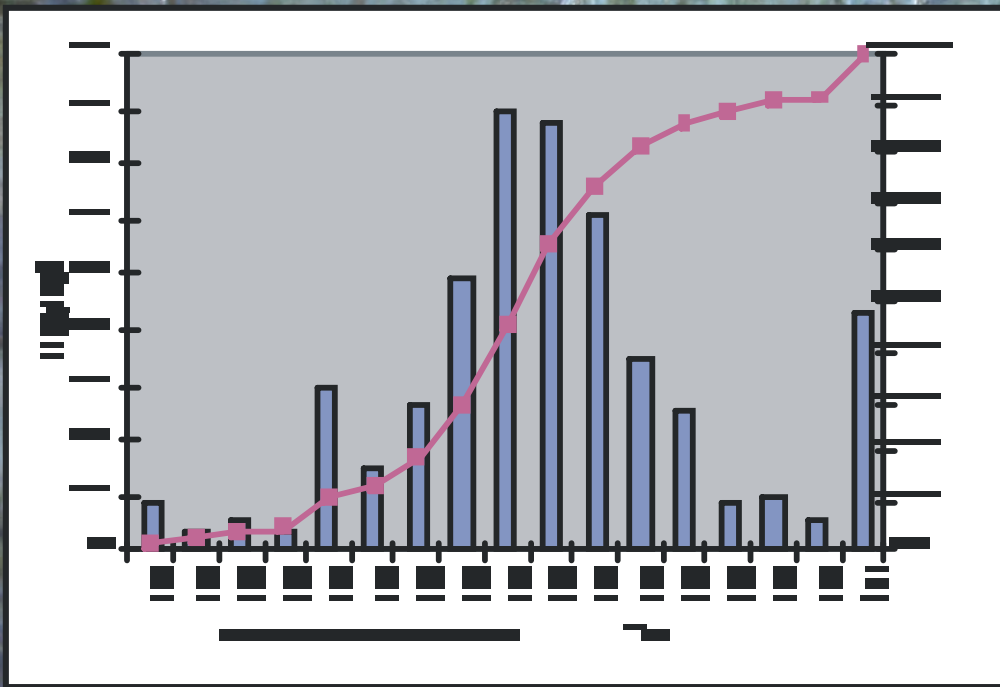
organic compounds TPH C10-C40, PAU, AOX, PCB, BTX - 35 sites

(•) pesticides - at 35 sites

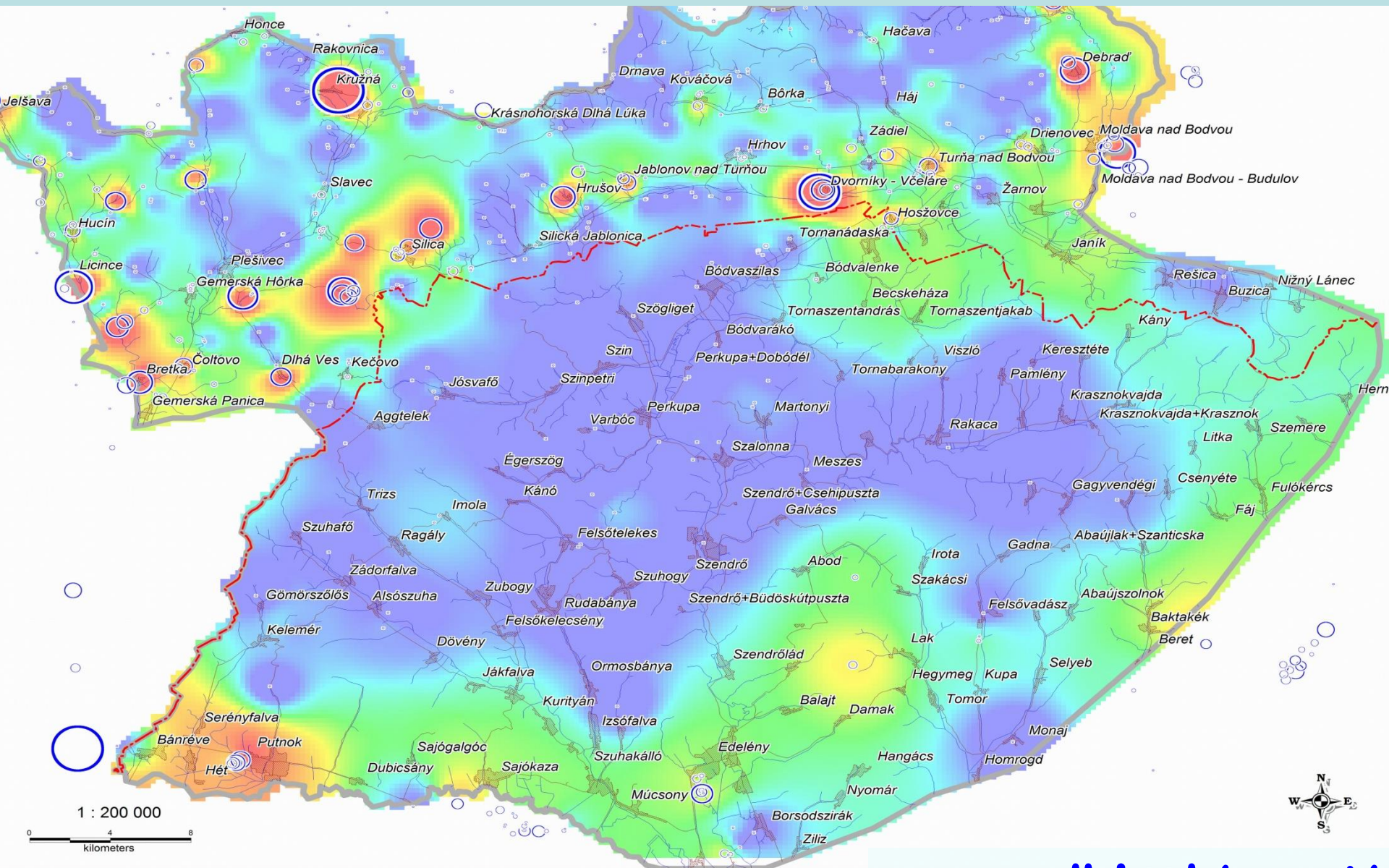
(•) isotopes - ^3H (85 sites), ^{14}C (25 sites), $^{18}\text{O}/^2\text{H}$ (65 sites)

(•) 10% of control analyses realised for every group of chemical parameters

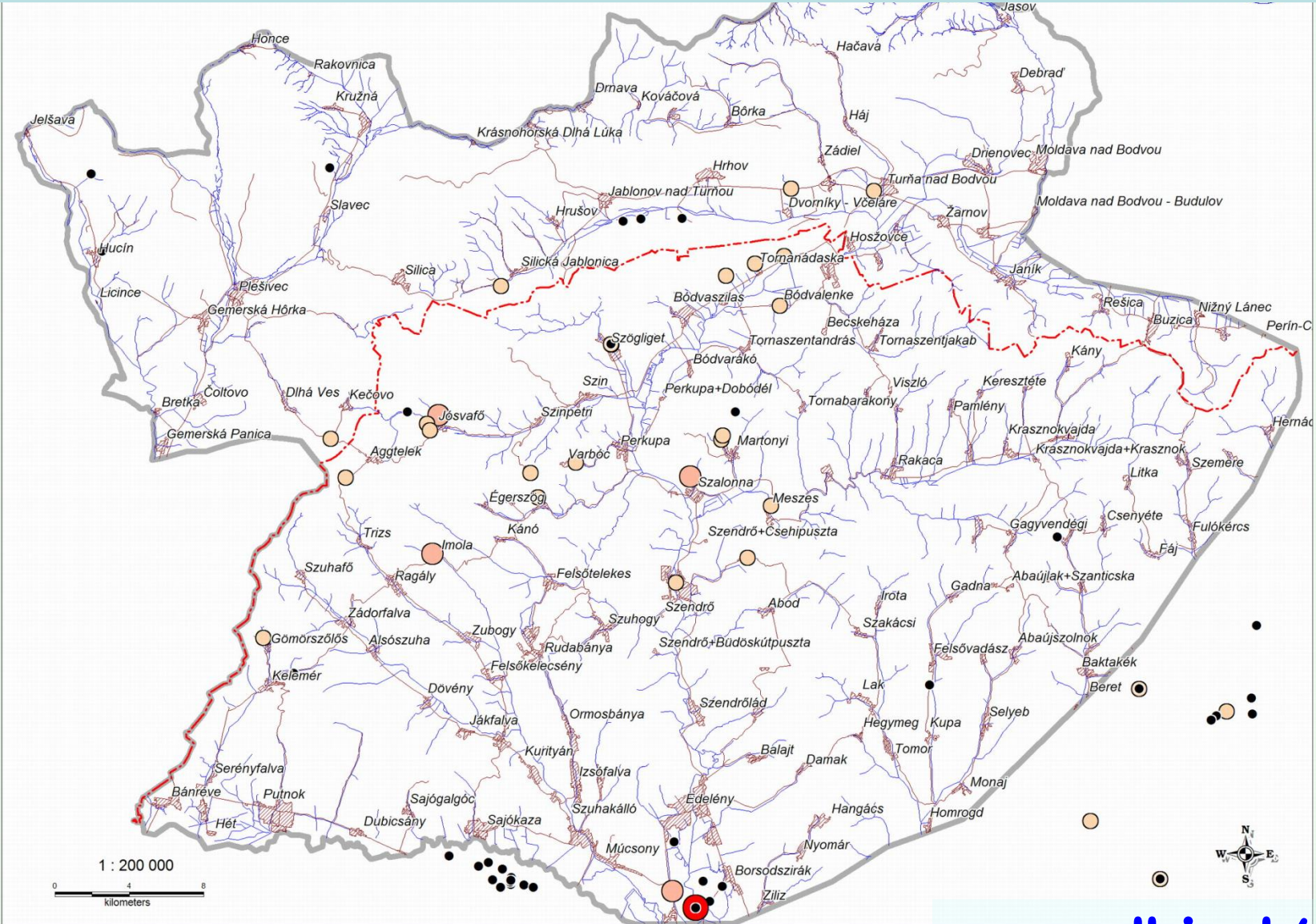
Hydrogeochemical map processing



Monoelement map – NO₃⁻

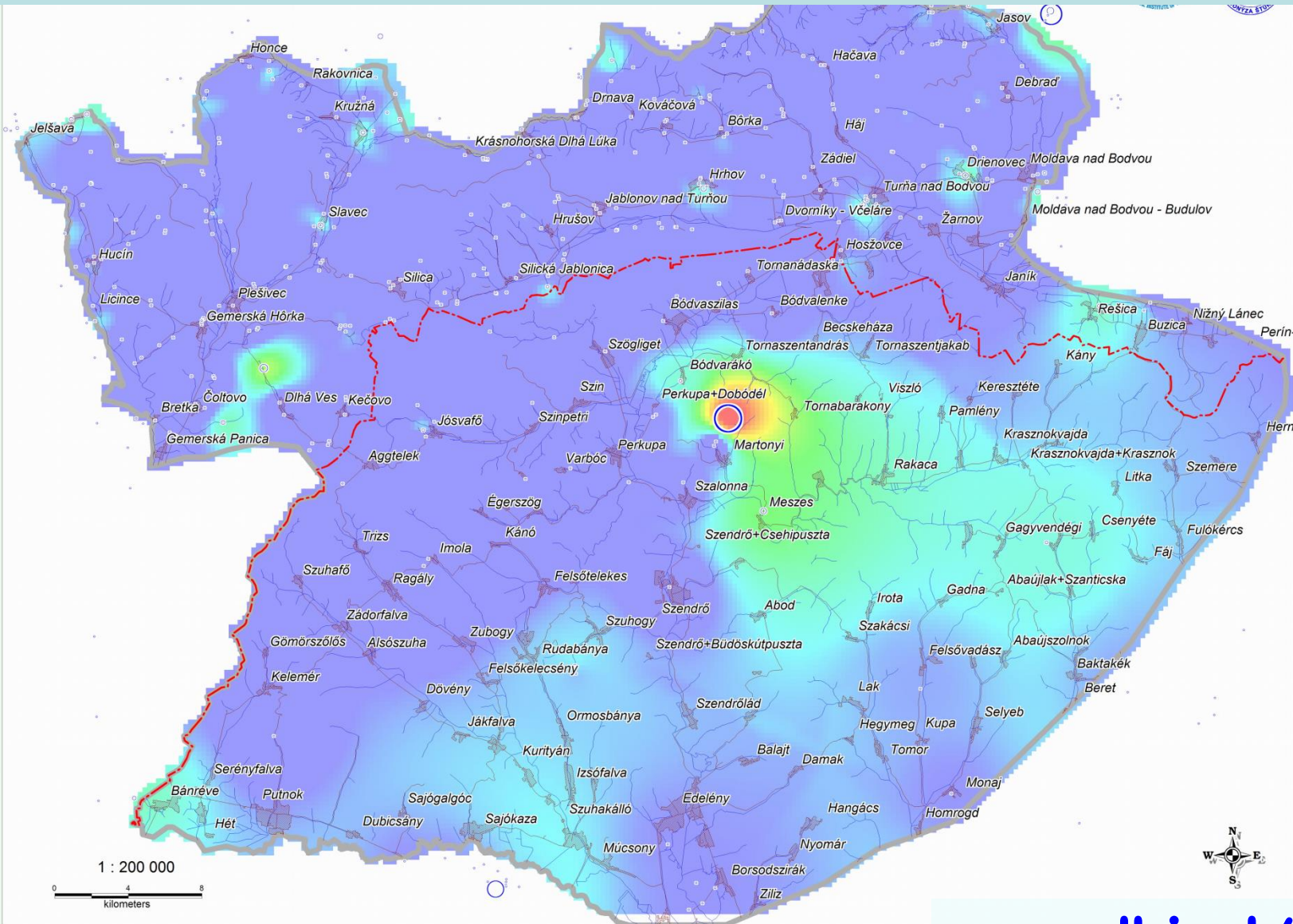


Monoelement map – PESTICIDES



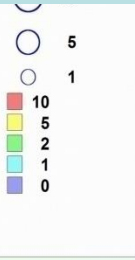
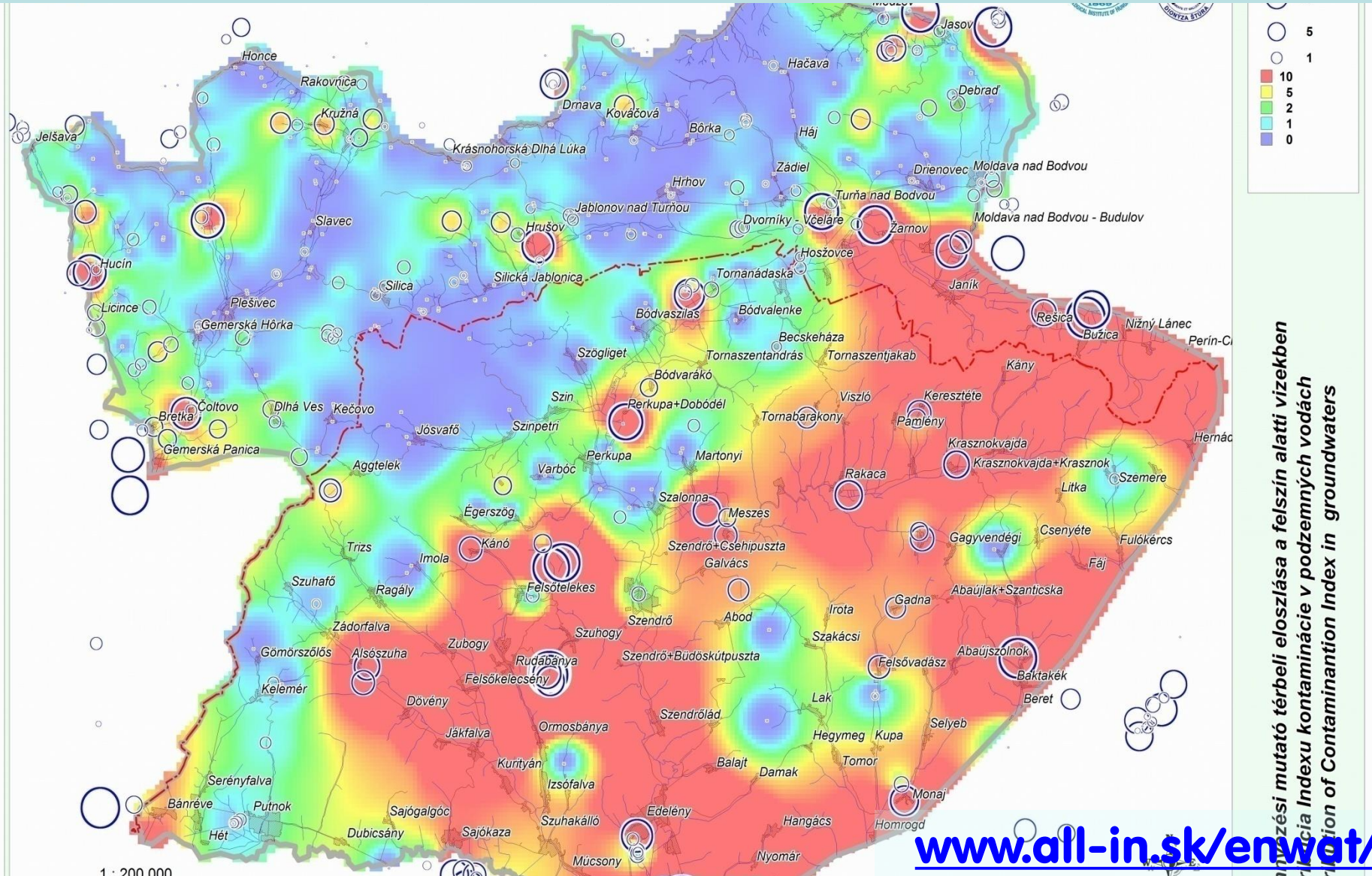
Peszticidek a felszín alatti vizekben
Distribúcia súmy pesticidov v podzemných vodách - bodová mapa
Distribution of sum of pesticides in groundwaters - point map

Monoelement map – As

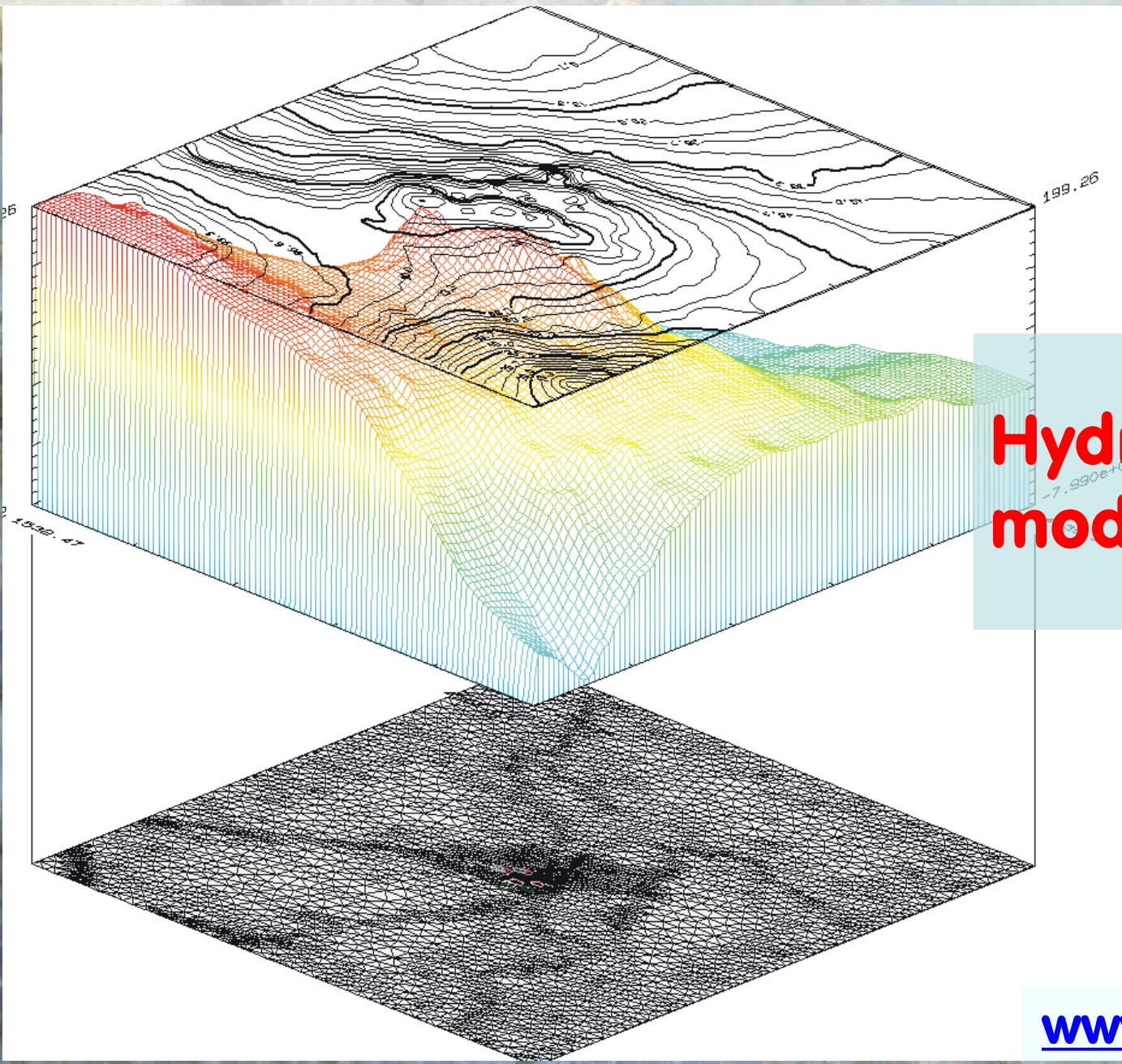


Az arzén térbeli eloszlása a felszín alatti vizekben
Distribúcia arzénu v podzemných vodách
Distribution of arsenic groundwaters

contamination index map

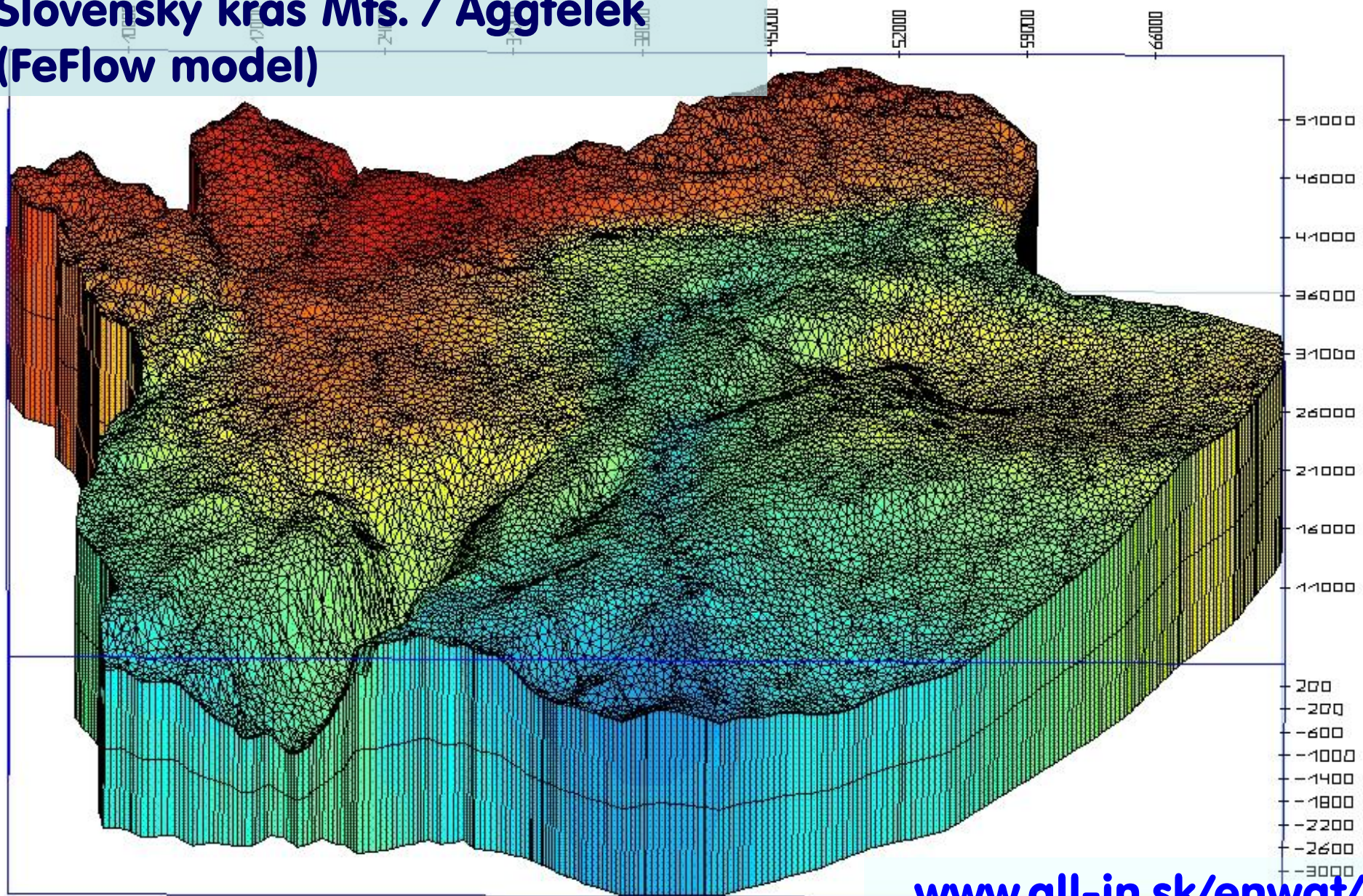


mutató térbeli eloszlása a felszín alatti vizekben
 Indexu kontaminácie v podzemných vodách
 Distribution of Contaminant Index in groundwaters



Hydrogeological modelling

Slovenský kras Mts. / Aggtelek (FeFlow model)



lessons learned:



**hydrostratigraphic
units**

???



???

lithopedogeomorphotopy

the same water, but different ...

2,74

!!!

236

!!!



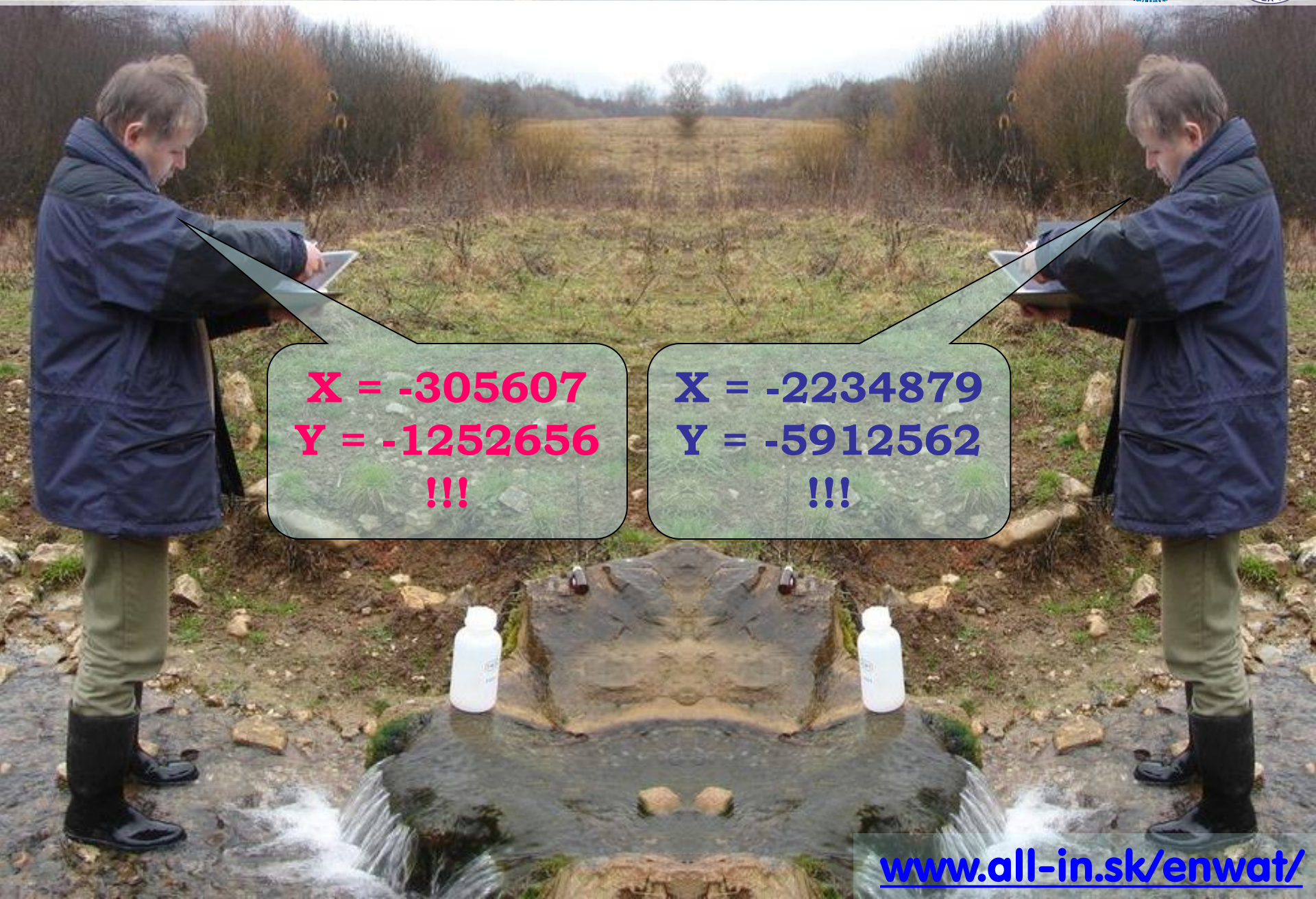
... different units !

l·s⁻¹



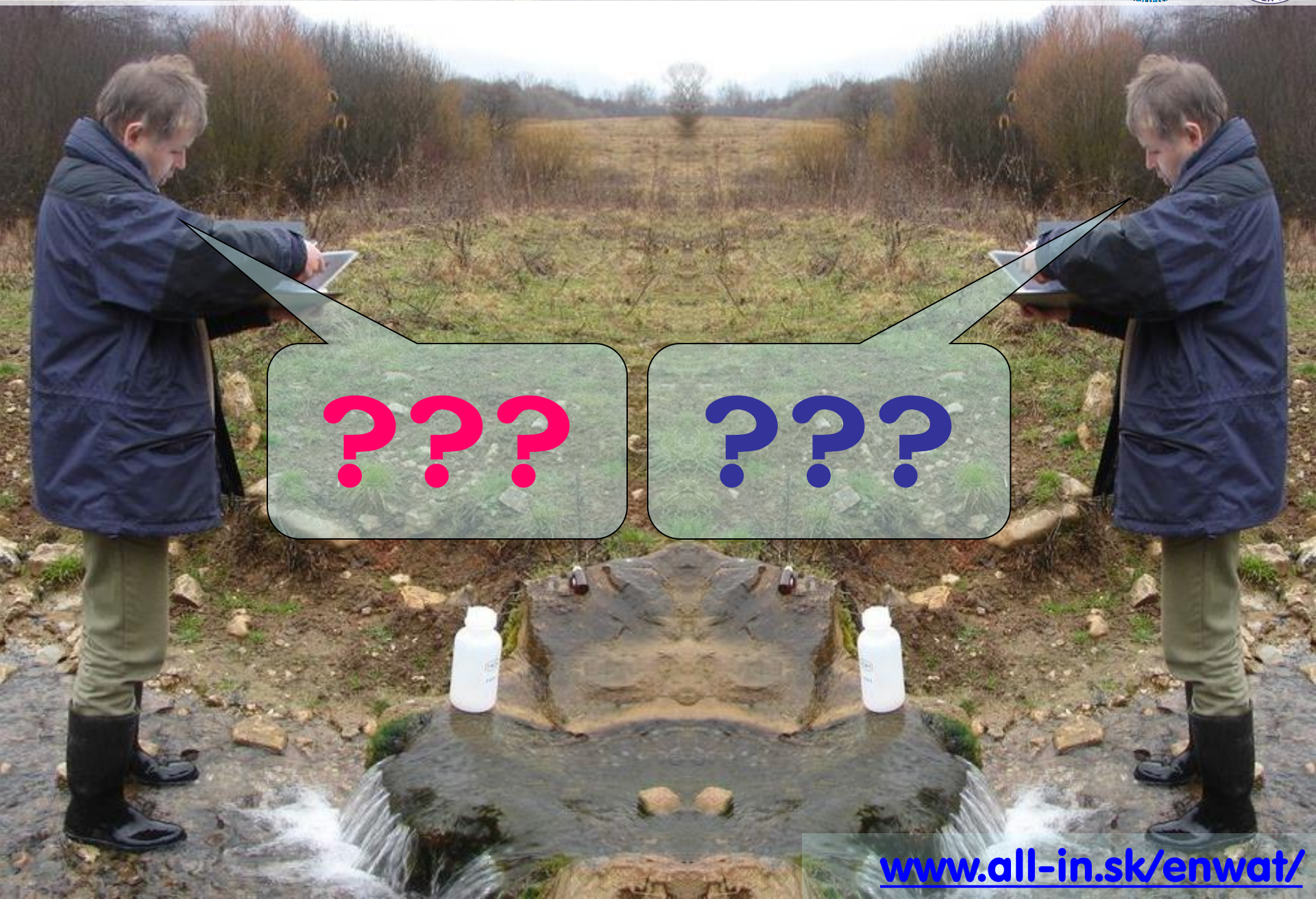
m³·day⁻¹





X = -305607
Y = -1252656
!!!

X = -2234879
Y = -5912562
!!!



???

???

**Jednotná
trigonometrická síť
katastrální
(S-JTSK)
former Czechoslovak
coordinate system
!!!**

**Egységes Országos
Vetület
(EOV)
Hungarian Unified
National Projection
system
!!!**



**Longitude/Latitude (WGS 84)
???**

**Gauss-Krüger (Pulkovo 1942)
GK Zone 4 ???**

Universal Transverse

Mercator (WGS 84)

UTM Zone 33 N !!!



DISSEMINATION OF RESULTS:

- (•) Conferences & Seminars
- (•) Scientific publications
- (•) Directly in the field
- (•) Printed materials are distributed to regions
- (•) DVD – available at MAFI, SGUDS on request
- (•) Web page www.enwat.eu

2006 - 2008



conference 2008

www.all-in.sk/enwat/

ENWAT



Environmentálny stav a udržateľný
manažment cezhraničných
Maďarsko-slovenských útvarov
podzemných vôd



Magyar-Szlovák határmenti
közös felszínalatti víztestek
környezetállapota és
fenntartható használata

brochures and leaflets

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Environmentálny stav a udržateľný
manažment cezhraničných Maďarsko-
slovenských útvarov podzemných vôd



Magyar-Szlovák határmenti közös
felszínalatti víztestek környezet-
állapota és fenntartható használata



... DVDs ... for everybody



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home

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INTRODUCTION

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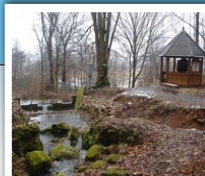
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"Environmental state and sustainable management of Hungarian-Slovakian transboundary groundwater bodies (ENWAT)"

This project will contribute to a water management plan for three transboundary groundwater bodies of Northern Hungary and Southern Slovakia based on hydrogeological models, local needs, cost aspects and best practices.... [\[more\]](#)

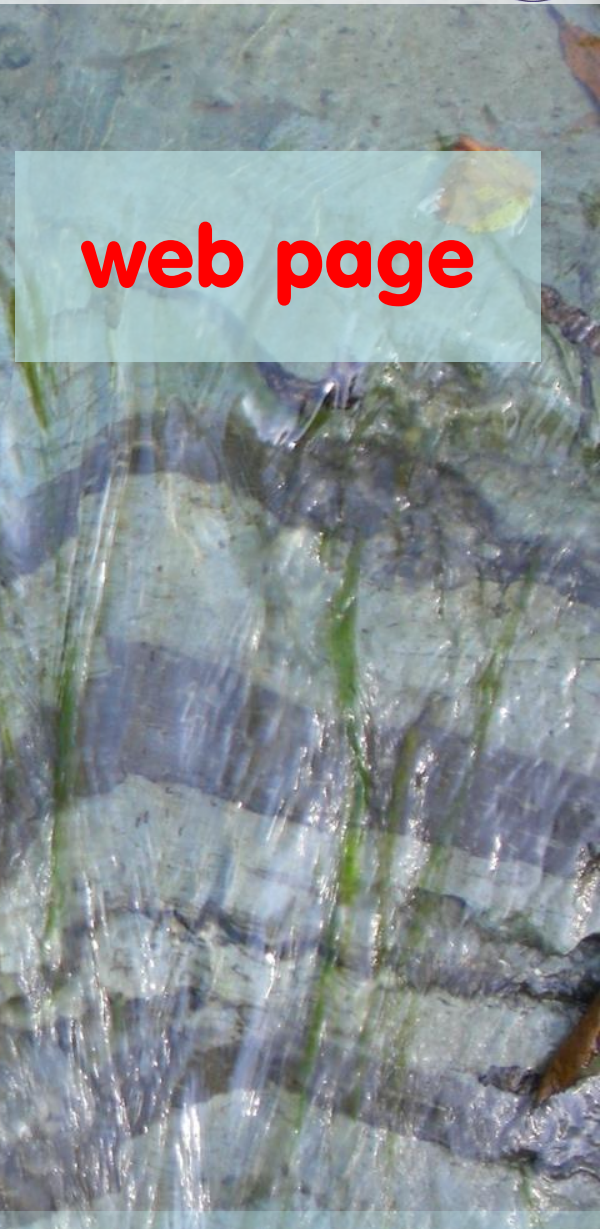


- Introduction
- The Project
- Project Participants
- Organization Chart
- Photogallery
- Downloads
- Contact

Photogallery



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ENWAT [Interreg IIIA]



home

Environmental state and sustainable management of
Hungarian-Slovakian transboundary groundwater bodies

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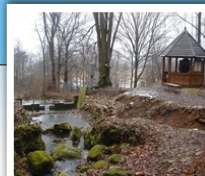
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- Introduction
- The Project
- Project Participants
- Organization Chart
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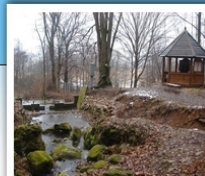
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home

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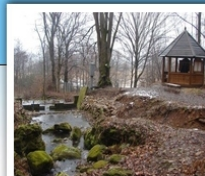
Spheres of cooperation: economic cooperation; institutional cooperation; small scale projects fund (cooperation between local municipalities also in the sphere of culture); environmental protection and concerned small scale investments; nature protection development of the transport infrastructure and small scale telecommunications.

Non profit legal persons who have at least one cross border partner from the eligible border region and have legal address or a branch in the Program's area can participate in the Program's calls. In case of Hungary also small and medium enterprises are entitled for participation regarding the economic development priorities. Eligible border territory In Hungary: Győr-Moson-Sopron megye, Komárom-Esztergom megye, Budapest főváros, Pest megye, Nógrád megye, Heves megye, Borsod-Abaúj-Zemplén megye, Szabolcs-Szatmár-Bereg megye. In Slovakia: Bratislavský kraj, Trnavský kraj, Nitriansky kraj, Banskobystrický kraj, Košický kraj, Prešovský kraj. In Ukraine: Zakarpatska oblast.

Ministry of construction and regional development of the Slovak republic and the Regional development support agency as National Organ of Hungary-Slovakia-Ukraine Neighbourhood Program, based on recommendation of Joint Management Committee from the day May 24-25th 2006 decided about assignment of non-recurring grant from ERDF fund resources and National budget for project proposal named:

"Environmental state and sustainable management of Hungarian-Slovakian transboundary groundwater bodies (ENWAT)"

This project will contribute to a water management plan for three transboundary groundwater bodies of Northern Hungary and Southern Slovakia based on hydrogeological models, local needs, cost aspects and best practices.... [\[more\]](#)



- Introduction
- The Project
- Project Participants
- Organization Chart
- Photogallery
- Downloads
- Contact

Photogallery



Search ENWAT [Interreg IIIA]



2013:

www.enwat.eu

web page

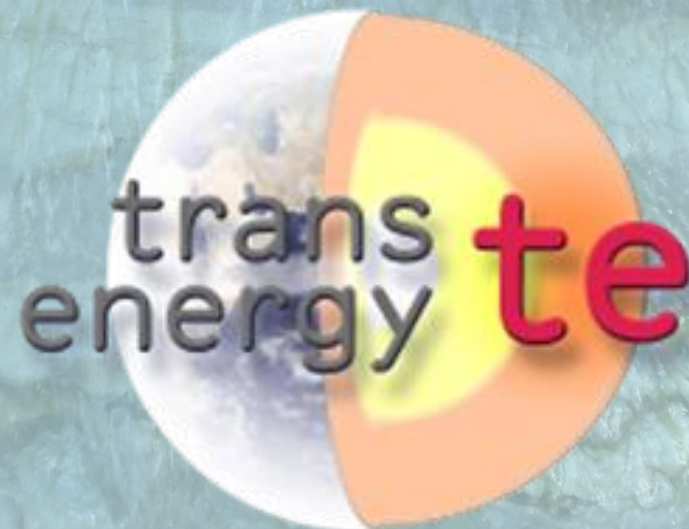
www.all-in.sk/enwat/

www.all-in.sk/enwat/

TEAM SPIRIT ? and

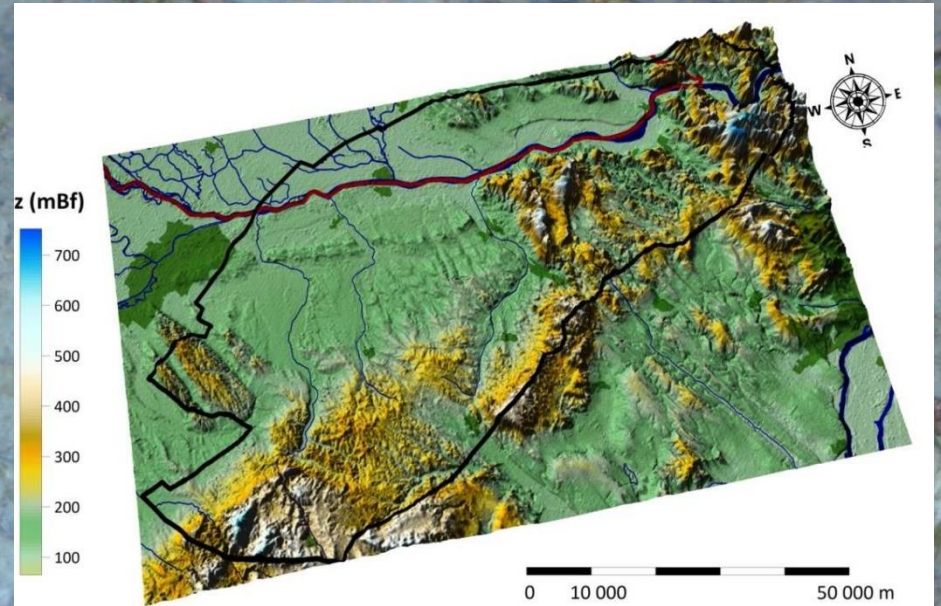


**... and
TRANSENERGY
another transboundary
groundwater project**

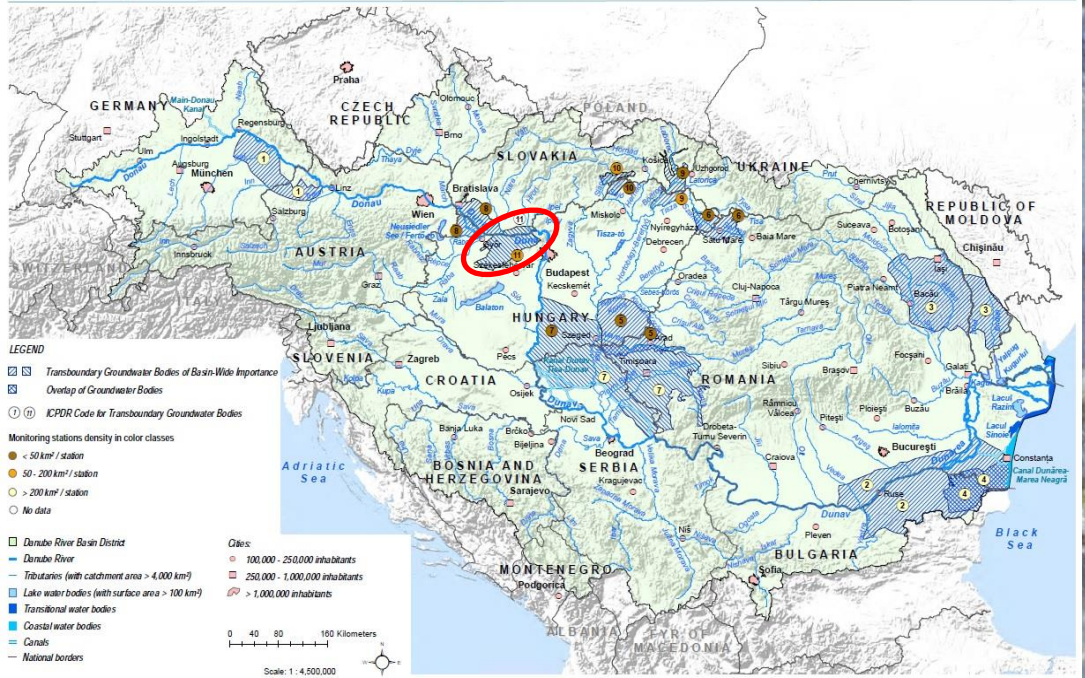


... and
TRANSENERGY
another transboundary
groundwater project





Danube River Basin District:
Transboundary Groundwater Bodies of Basin-Wide Importance and their Transnational Monitoring Network MAP 4

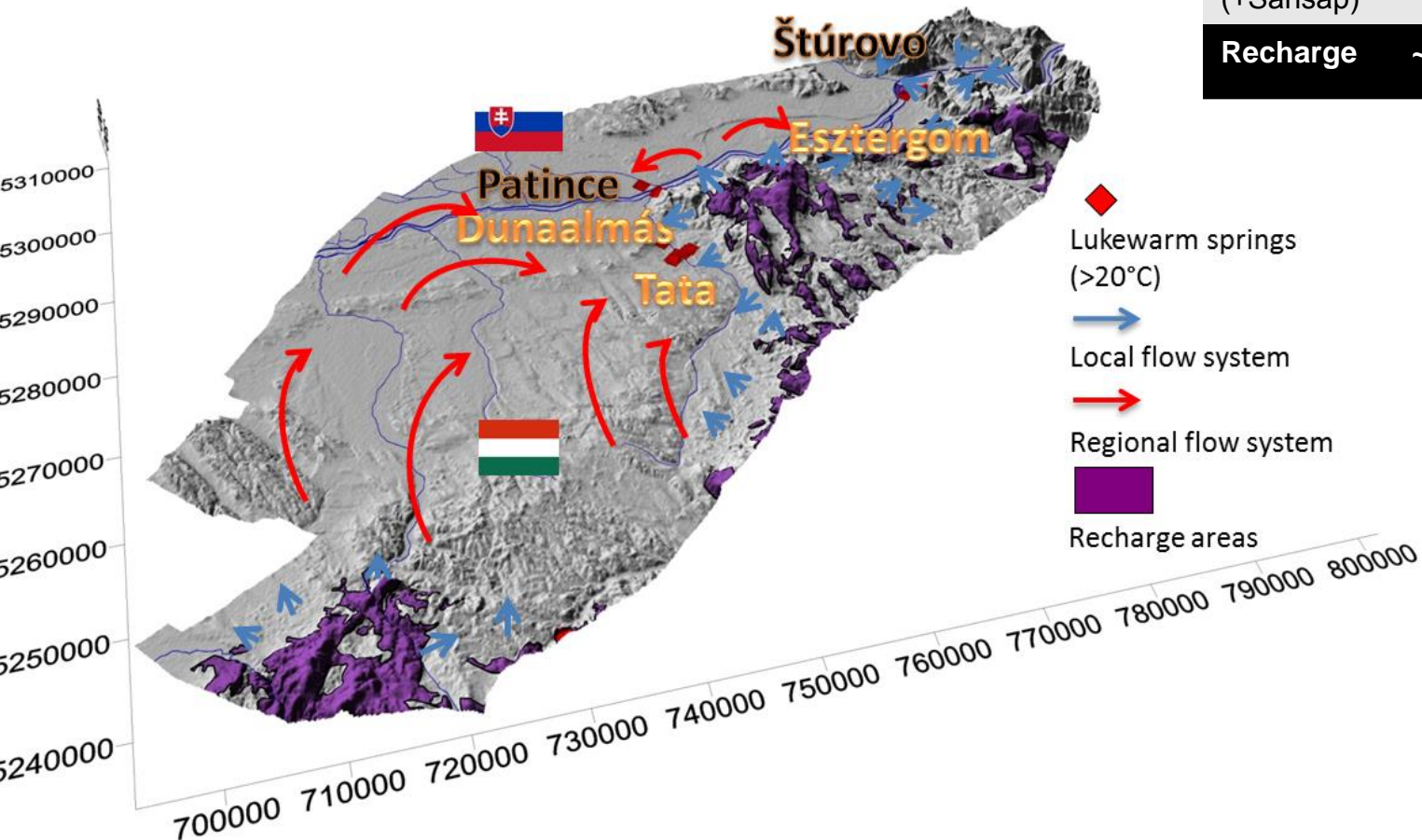


Transboundary regional cold-thermal karst system – in focus of ICPDR

Natural groundwater recharge and discharge

- recharge in Hungary
- natural discharge springs (HU, SK)
- groundwater dependent ecosystems in both countries

Group of springs	Water T (°C)	Yield (original) (m ³ /d)
Tata	20-22	~115 000
Dunaalmás + Patince	22-24 - 25-27	~3 000-4 500
Esztergom (+Sárisáp)	11-15	~12 000-13 000
Recharge		~190 000 m³/d



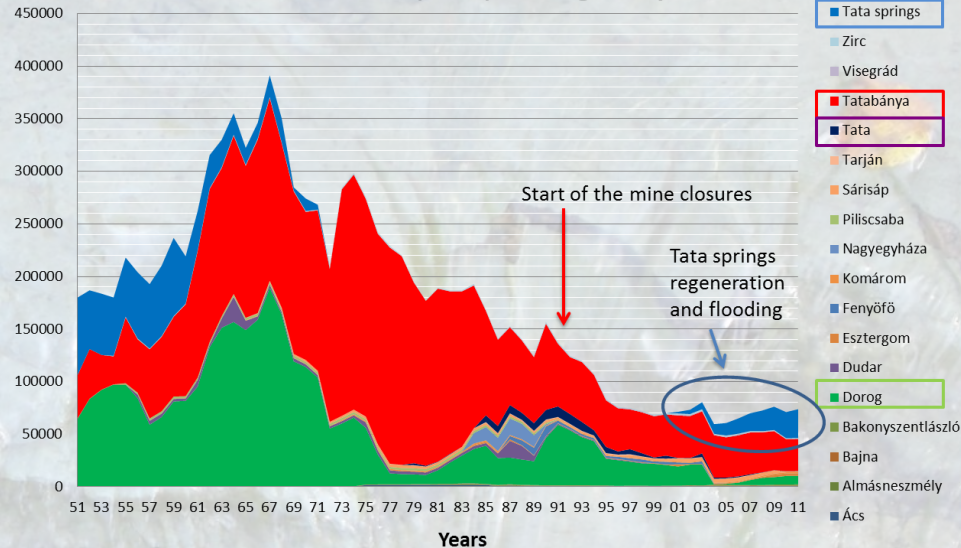
Cold and thermal karst aquifer – T₃, K₁ limestones and dolomites
 (Cold and thermal water porous aquifer – Upper Pannonian sandstones)

Changes to natural conditions

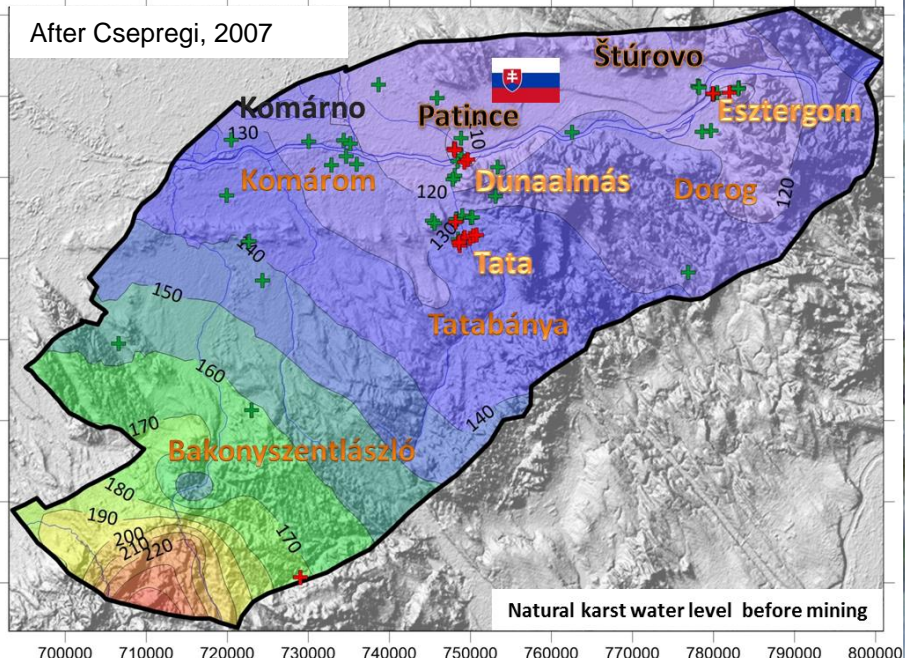
>130 main abstraction sites in the last 75 years

- average 18-year-long time series between 1951 and 2011
- mine dewatering more than 50 year-long
- today:
 - thermal water utilizations – spas, balneology, agriculture (green-houses)
 - drinking water utilization
 - mineral water production

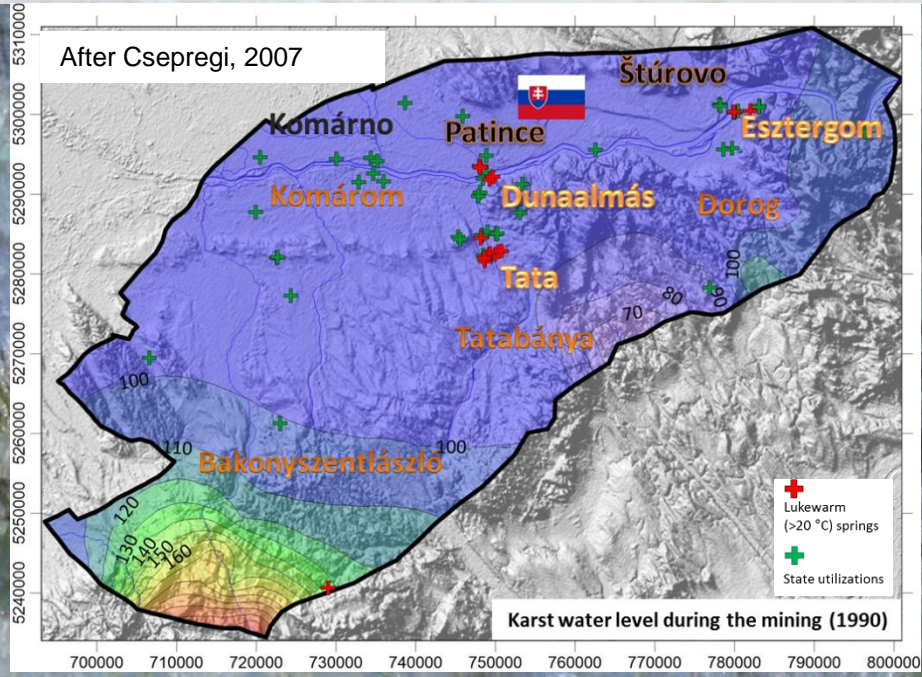
Karst water abstractions (m³/d) in Hungarian part of the area



After Csepregi, 2007



After Csepregi, 2007



Important questions

- **Karst water abstractions:**
 - **What was the effect of the mine water-abstraction on the karst flow system?**
 - **How and how long does it take the refilling of the karst system after the mine closure?**
 - **What is the present state of the system?**
- **How could we protect of the regional flow system during the planning of the local productions?**

Management Issues

- **The state of the protection of the groundwater resources – adequate the present protection?**
- **The main geothermal utilizations and development possibilities**
- **Utilization efficiency (waste heat utilization, reinjection possibilities)**
- **Electric power generation possibilities in the area (as in feasibility studies)**

Management Issues

Tata

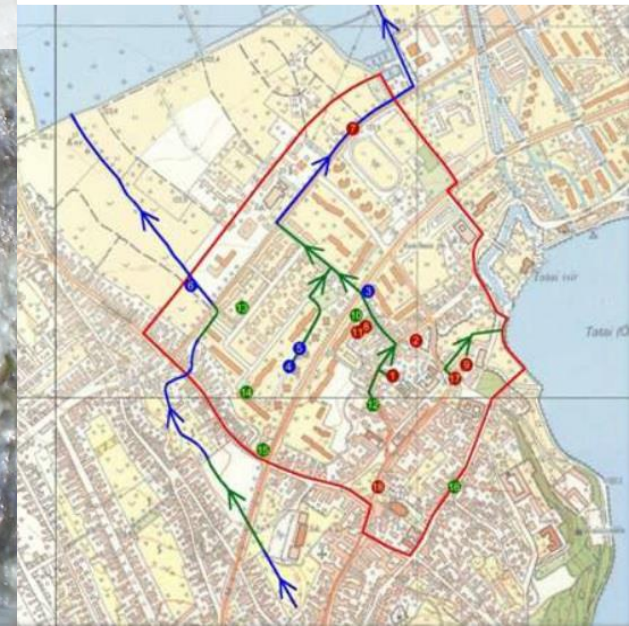


Groundwater dependent ecosystems

- Rising water level – „good” for ecosystems, „bad” for build environment
- Yield:
 - ~115 000 m³/d = 1330 L/s **before** mining
 - 0 m³/d = 0 L/s **during** mining
 - ~30 000 m³/d = 350 L/s **after** mining
- „Surplus” spring water drainage and/or utilization
- **Proposals by the help of regional modeling**
 - e.g. design of additional abstraction points



Tata springs in the downtown; possible water drainage and utilization
Maller et al., 2013.



Tata, Fényes springs; 2012. winter



Tata, Fényes springs; 2012. winter



**thermal
groundwater is
back !!!**

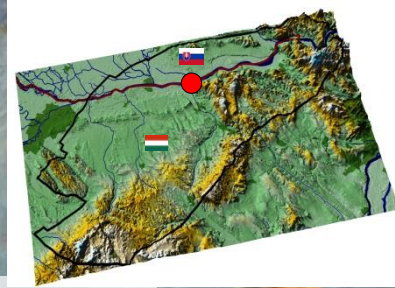


Tata, Fényes springs; winter 2012

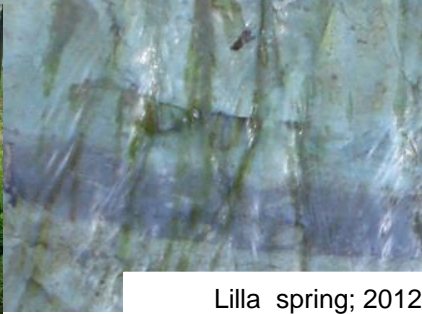
Management Issues

Dunaalmás - Patince

- Dunaalmás vulnerable drinking water resources
- Provide drinking water for 3 settlements (5200 inhabitants)
- Protected yield: 500 m³/d = 5.8 L/s
- Aquifer: T3 karst aquifer



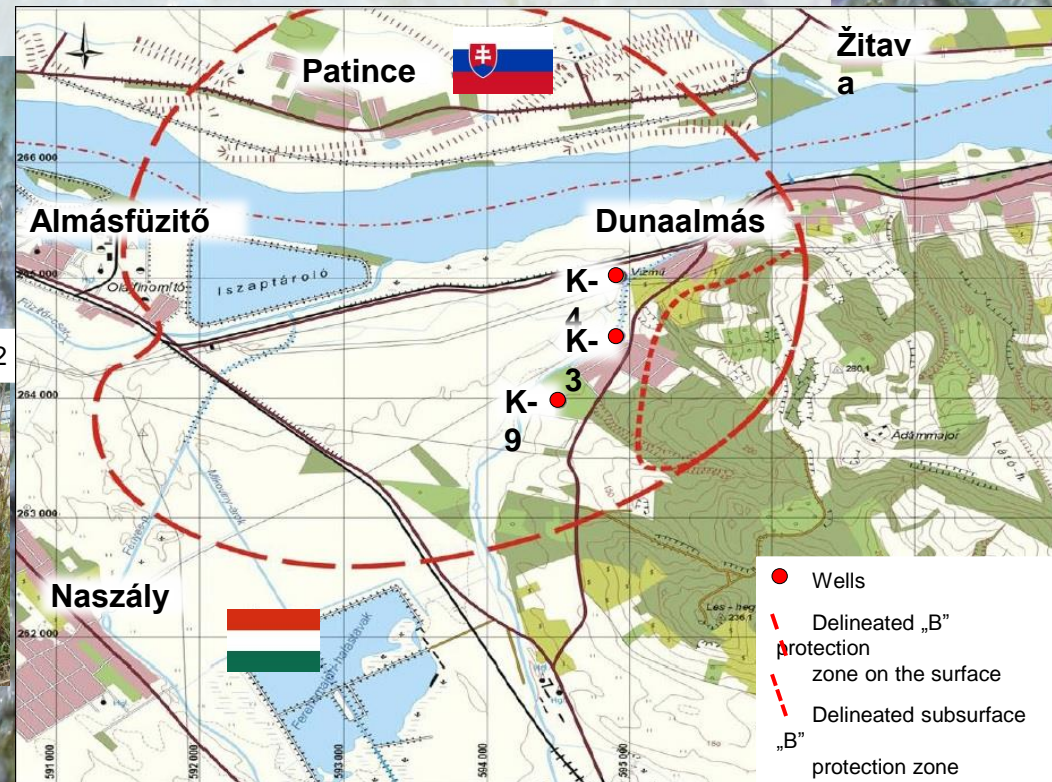
Lilla spring; 2012



Lilla spring; 2012



Lukewarm seepage, Patince; 2012



VIZITERV Consult Kft.
2002.

**thermal
groundwater is
back also here !!!**



Lukewarm seepage, Patince: 2012

Management Issues

Štúrovo - Esztergom

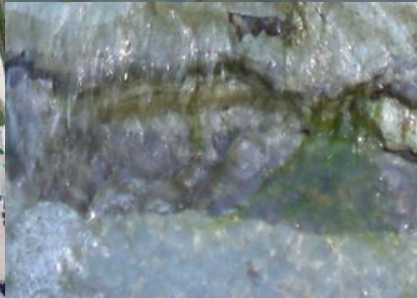


Esztergom, historical Turkish bath



Thermal water utilization - spas

- Baths in both countries, in Esztergom historical baths
- Where should we focus in development?
 - Protection zones for existing and ancient utilizations
 - Štúrovo (~40 °C) ↔ Esztergom (28 °C)
 - higher temperatures and/or historical heritage



Esztergom, bath

Štúrovo, bath



Conclusions – further proposals

- **Revision** of the existing protection zones (Dunalmás-Patince)
- **Delineation** of the protection zones of the existing utilizations (Esztergom, Štúrovo)
- **Geothermal aquifer monitoring** and **transient modeling** for the examination of the changing system
- **Harmonized further developments** in agreement of the countries: priority of utilization (wellness, balneology, heating, waste heat utilization, cascadian type of utilizations, etc.)



THE END

POZOR!
Štátna hranica
prechádza
stredom rieky

(transboundary cooperation in hydrogeology ... to be continued!!!)