Geothermal energy utilization at the S-ern part of the Pannoninan basin - the latest results of DARLINGe project

Annamária Nádor

Rotárné Szalkai Á., Zilahi-Sebess L., Gulyás Á., Maros Gy., Szőcs T., Gál N., Kerékgyártó T., Kun É., Ádám L., Mérész E., Babóczky M., Szanyi J., Marković, T., Lapanje, A.,Rman, N.,Vranjes, A., Milenić, D., Samardžić, N., Jolović, B., Vîjdea, A.,

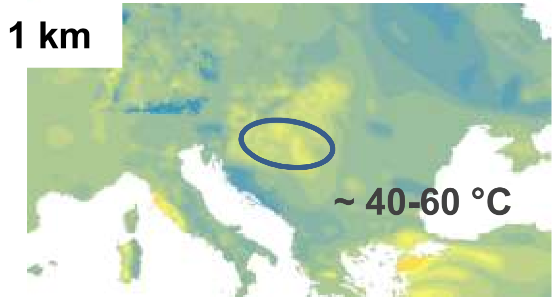
Karst and thermal water – global challenges in water management and energy use
April 16, 2018, Budapest

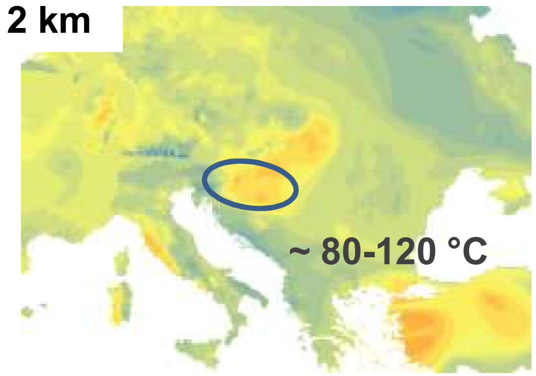
DARLINGe (Danube Region Leading Geothermal Energy) – S-ern part of the Pannonian Basin

Project area: 95 000 km^2
(HU, SLO, HR, BH, SRB, RO)

To contribute to energy security and energy efficiency in the Danube Region by enhancing the efficient use of deep and still untapped geothermal resources in the heating sector

Subsurface temperature.

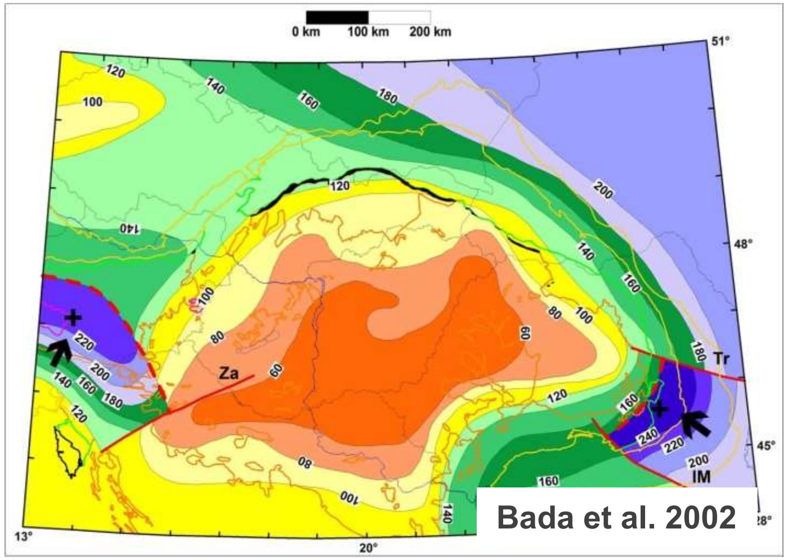




Limberger and van Wees 2013

Although some deeper, higher temperature systems suitable for CHP are known, the low-hanging fruit is direct use

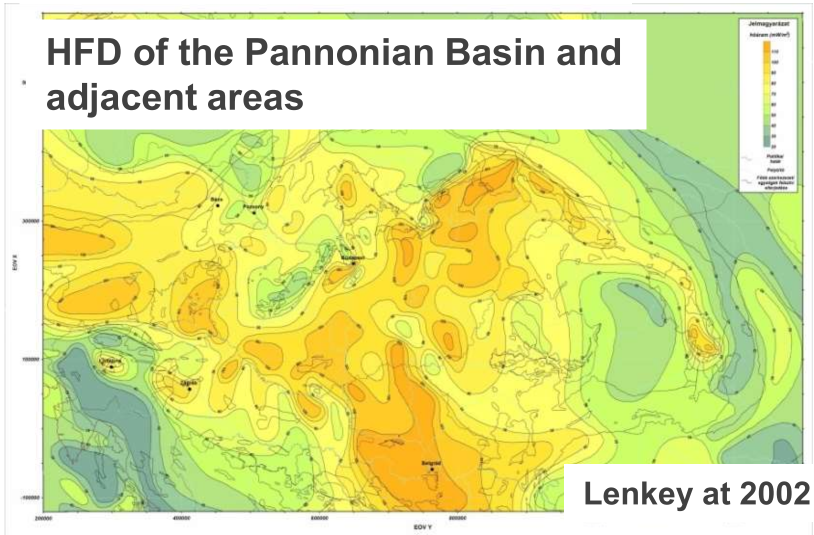
Pannonian Basin – hot sedimentary aquifer



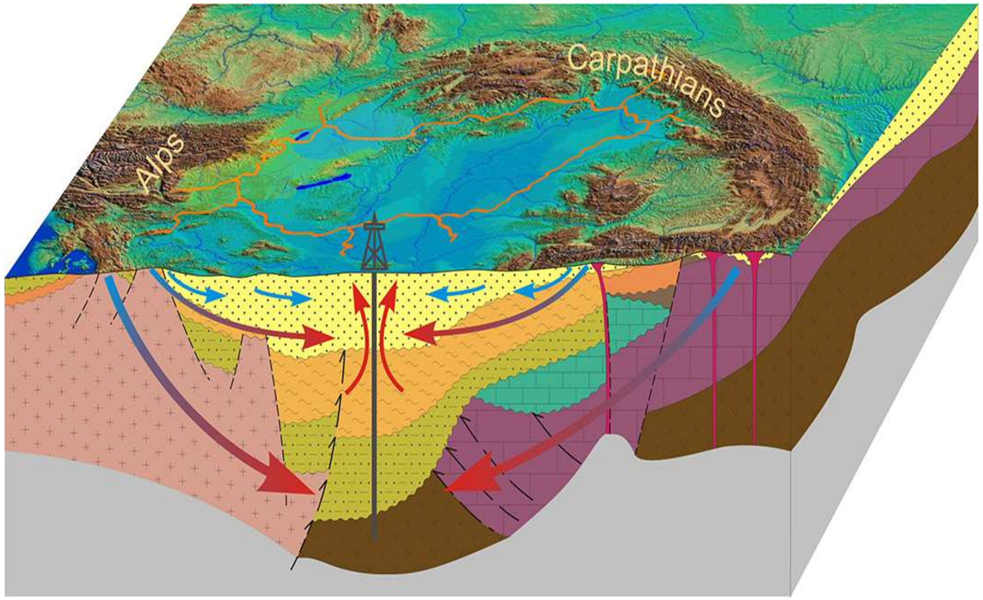
Bada et al. 2002

Thickness of the lithosphere in the Pannonian Basin

HFD of the Pannonian Basin and adjacent areas



Lenkey at 2002



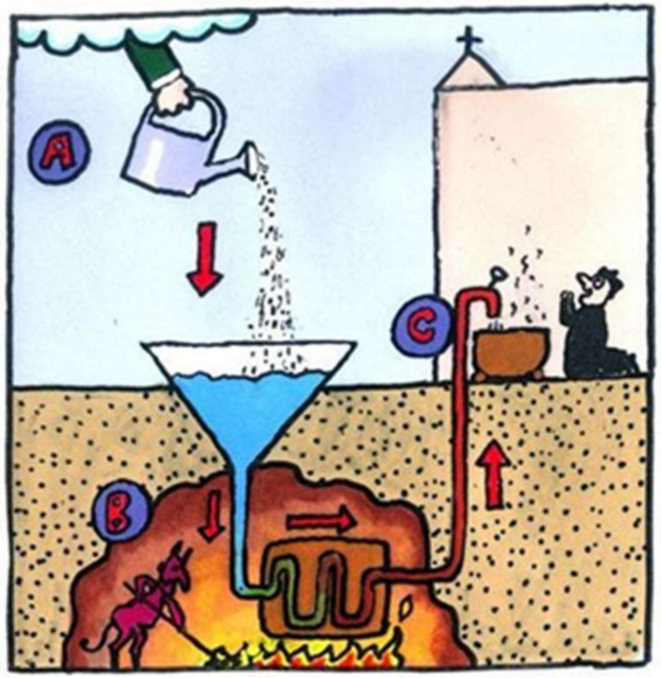
utilization of geothermal energy
≈ thermal groundwater / fluid abstraction

Is it possible to match „energy” and „environmental” goals ?

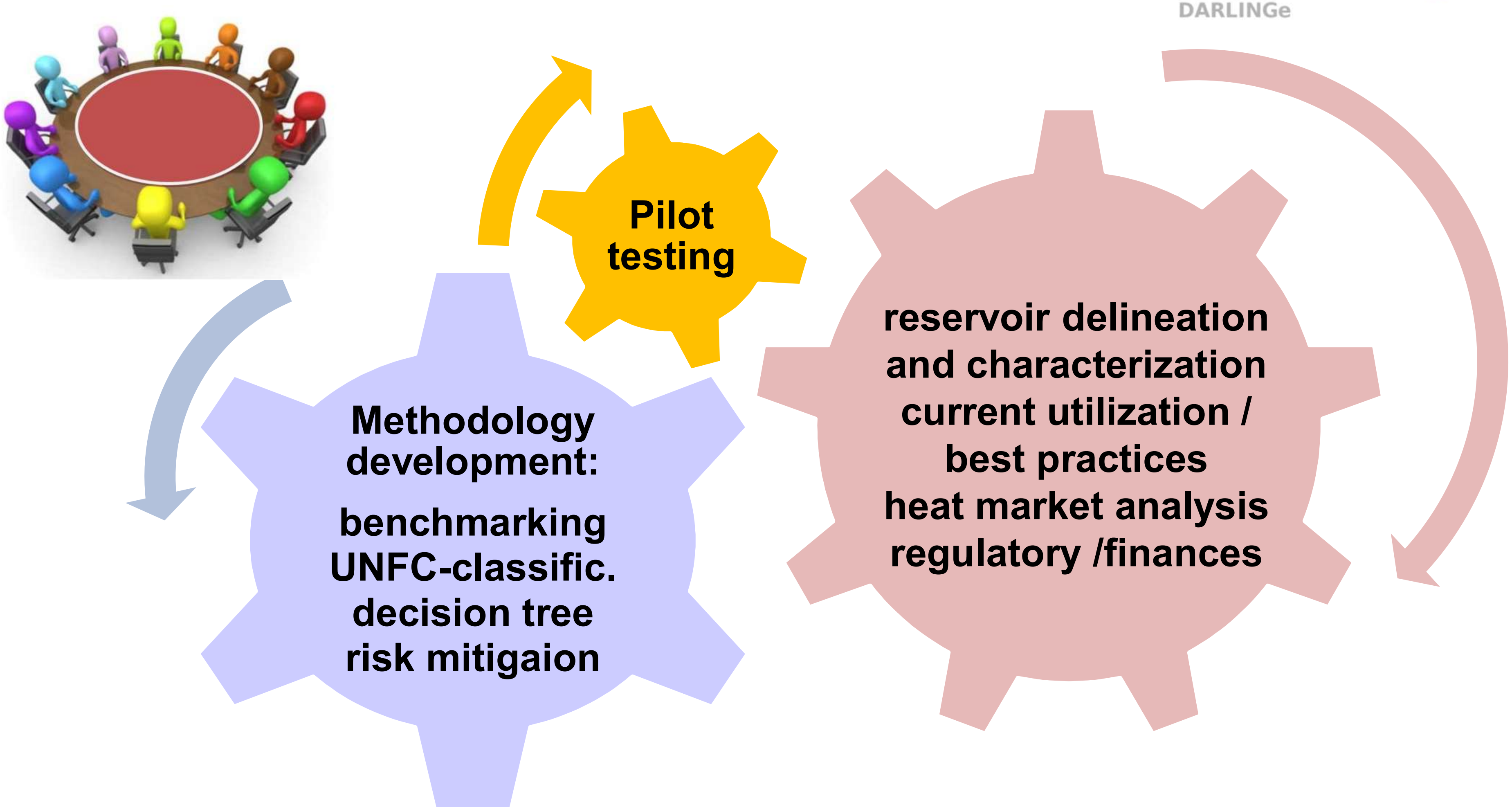
Can the abstraction of thermal water be increased without threatening the quality and quantity status of the geothermal aquifers?

If yes, what are the boundary conditions / levels for sustainable production?

What are the „best practices” to increase utilization of geothermal energy without increasing water abstraction? (reinjection, cascade use, increasing energy/thermal efficiency, etc.)



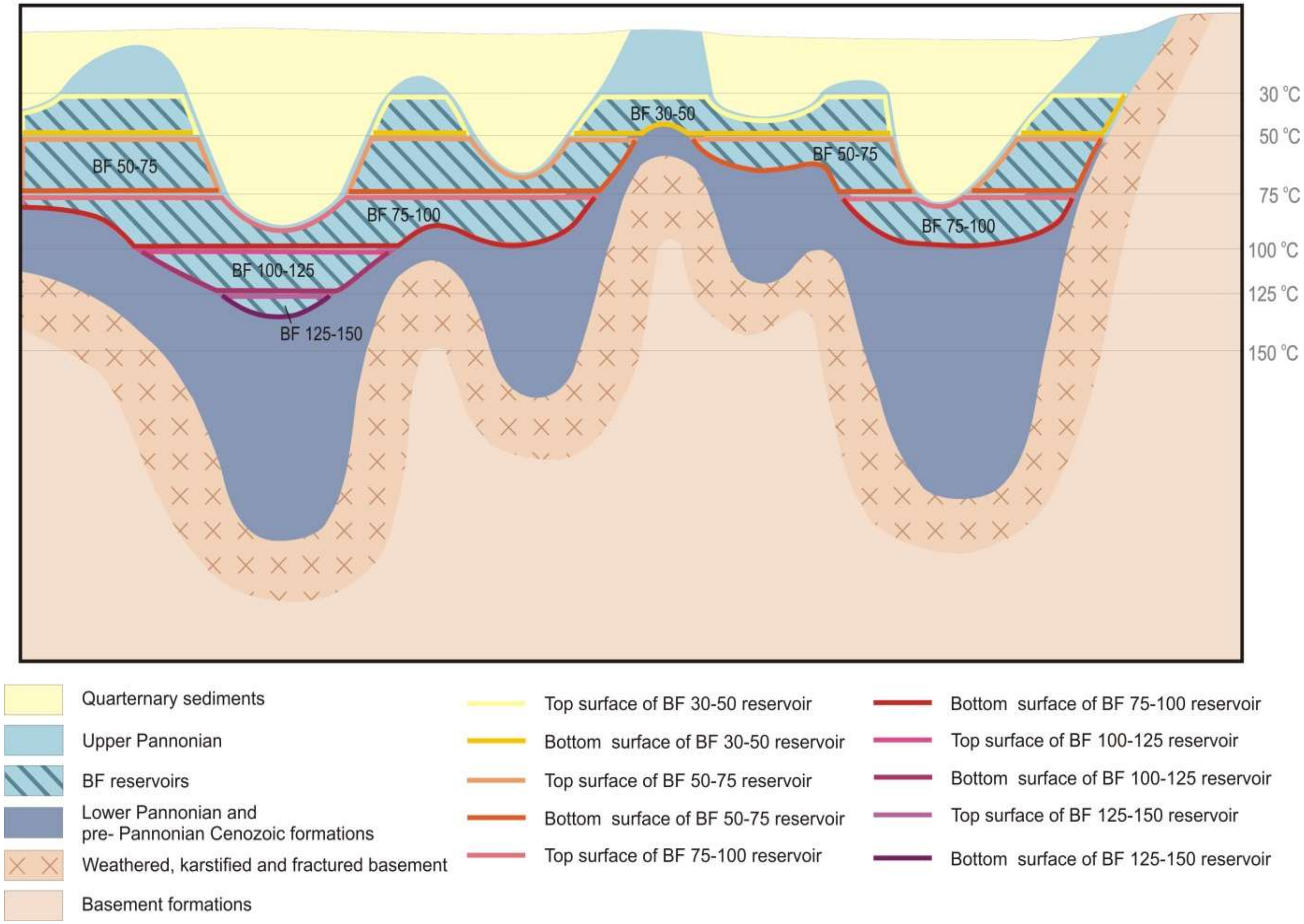
DARLINGe concept



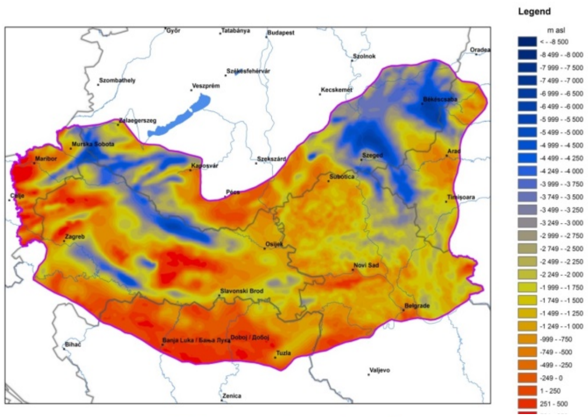
Danube Region Geothermal Strategy and Action Plans

Danune Region Geothermal Information Platform (DRGIP) – interactive web-portal

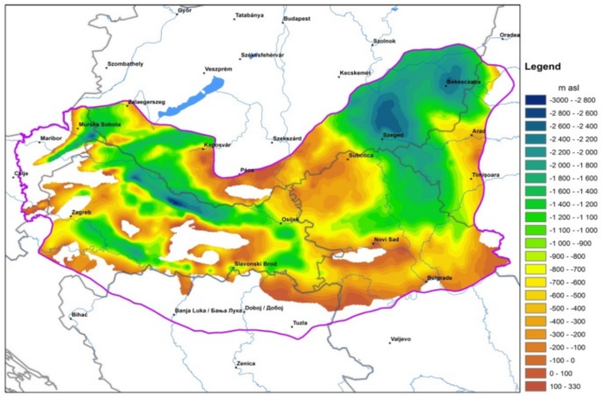
Delineation and characterization of potential geothermal reservoirs



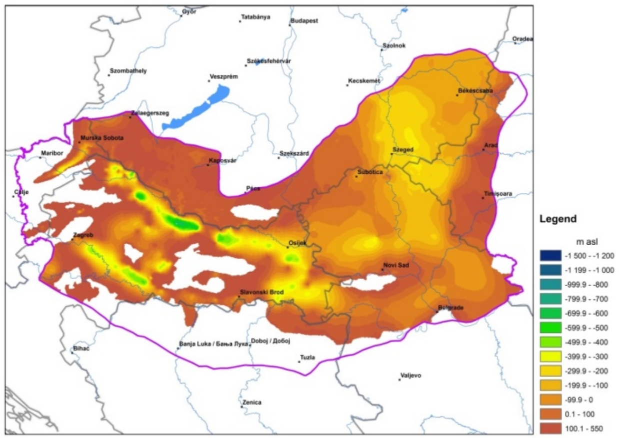
Geology (depth of key surfaces) + Isotherm surfaces (Neogene)



depth of the pre-Cenozoic basement formations (BM top)

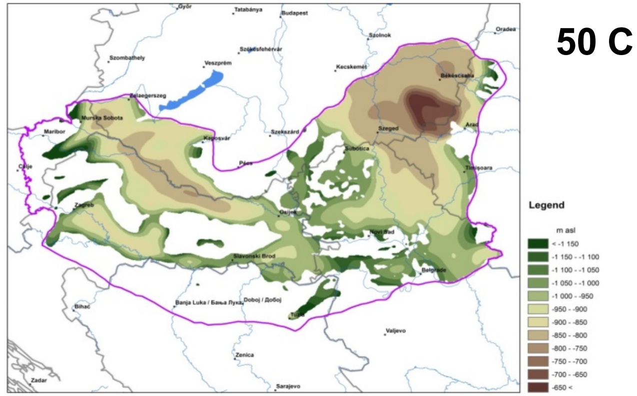


depth of the bottom of the nearshore sandy succession deposited in the Pannonian lake (BF bottom)

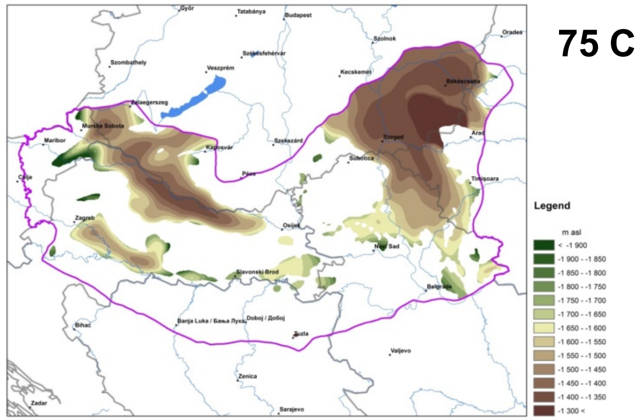


depth between the Pannonian lake deposits and Quaternary terrestrial sequences (BF top)

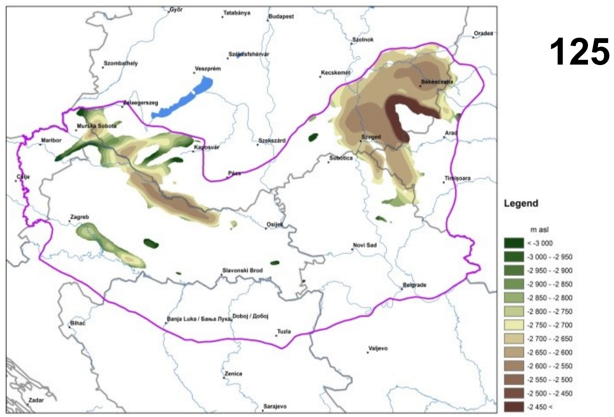
50 C

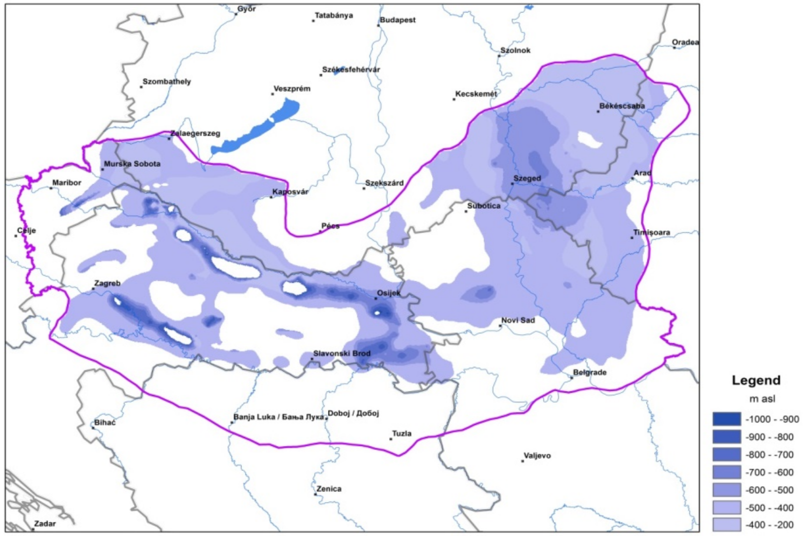


75 C

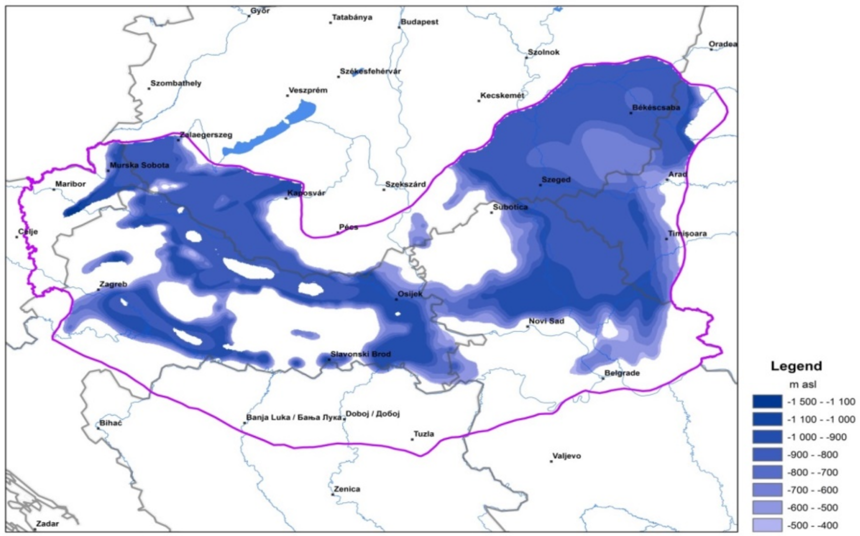


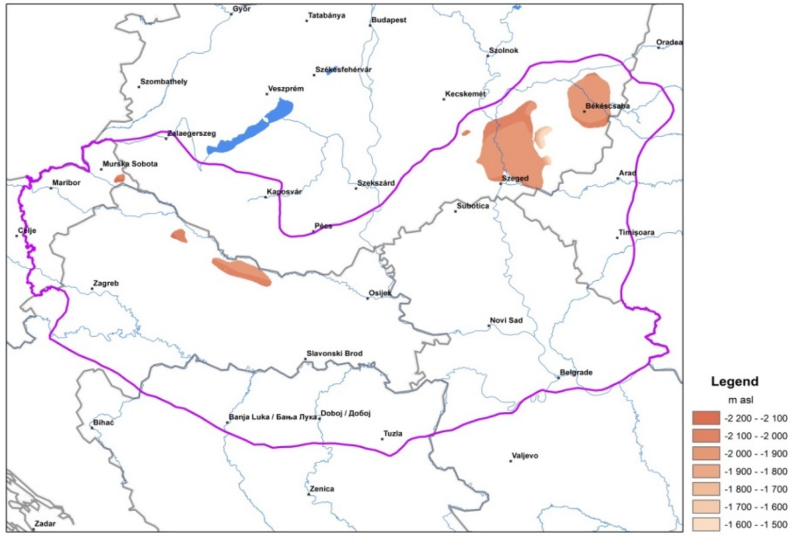
125 C



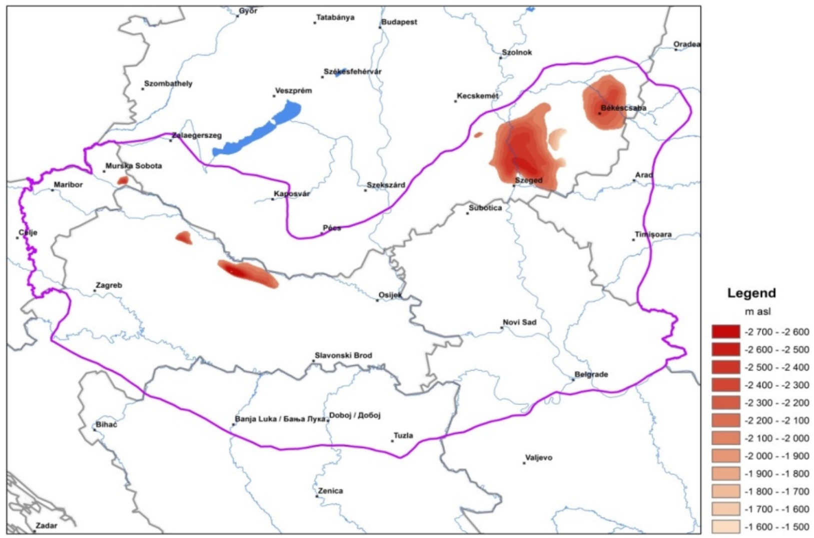


Top and bottom of BF 30-50 C reservoirs

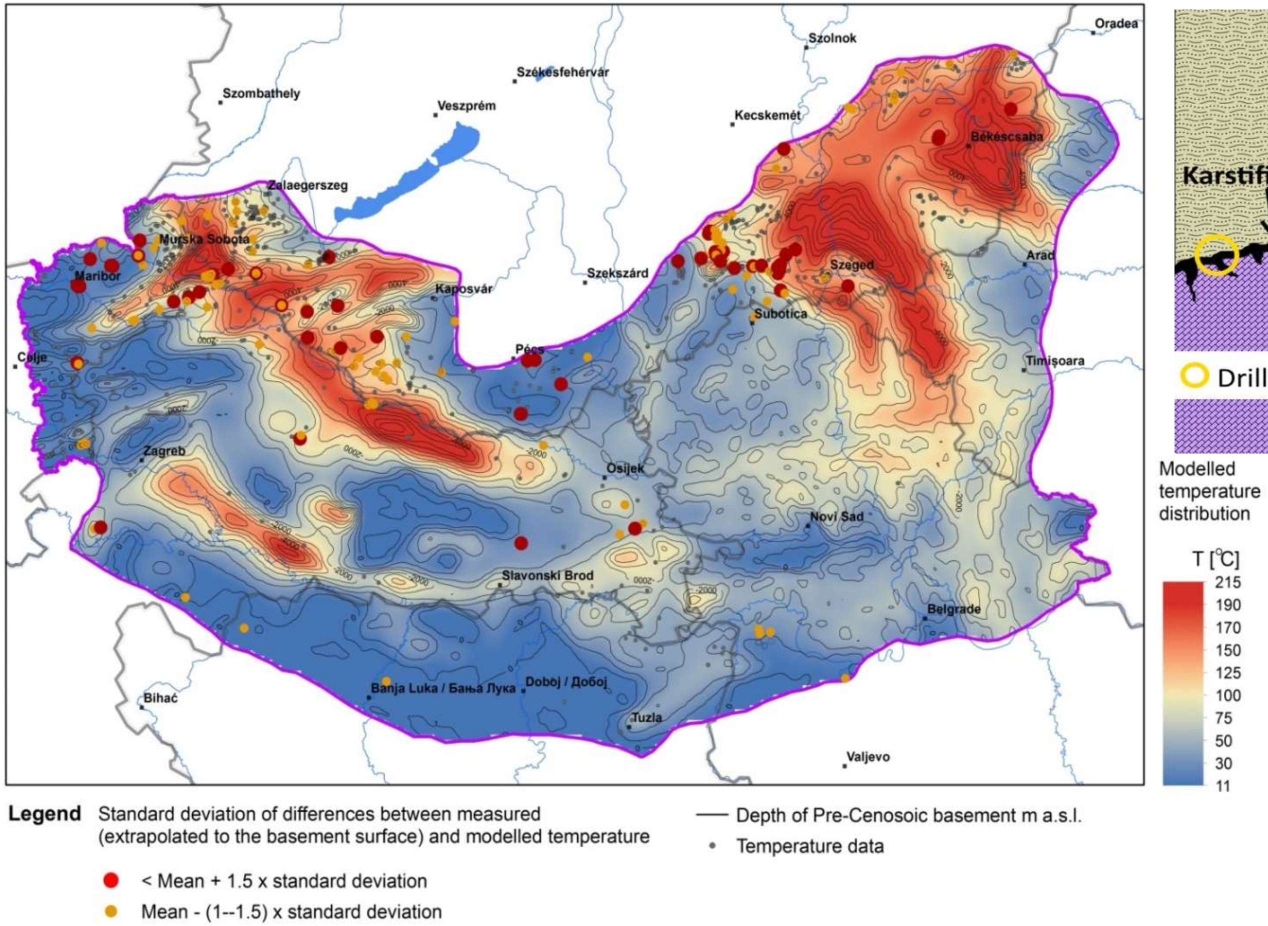


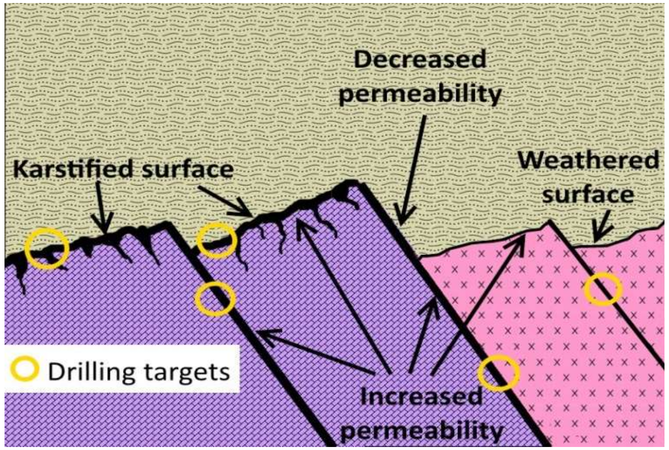


Top and bottom of BF 100-125 C reservoirs

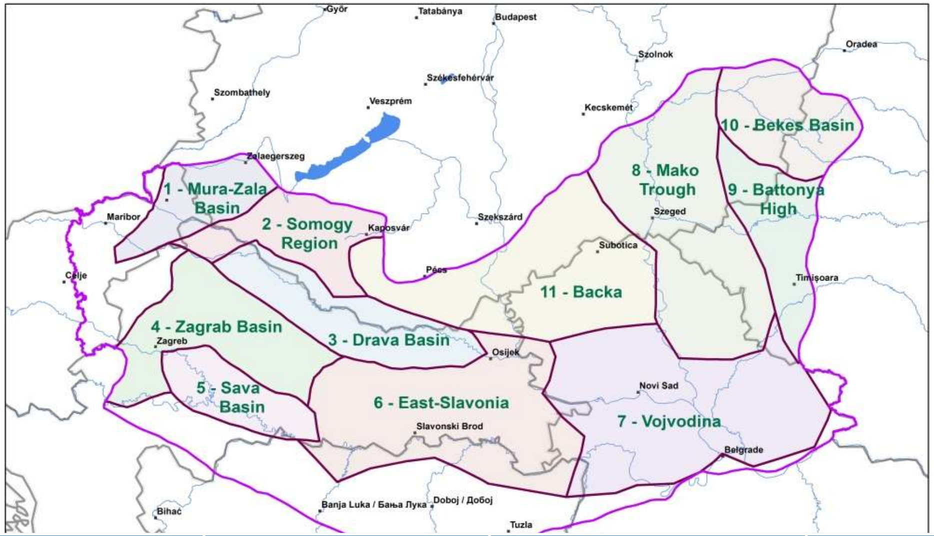


Basement reservoirs





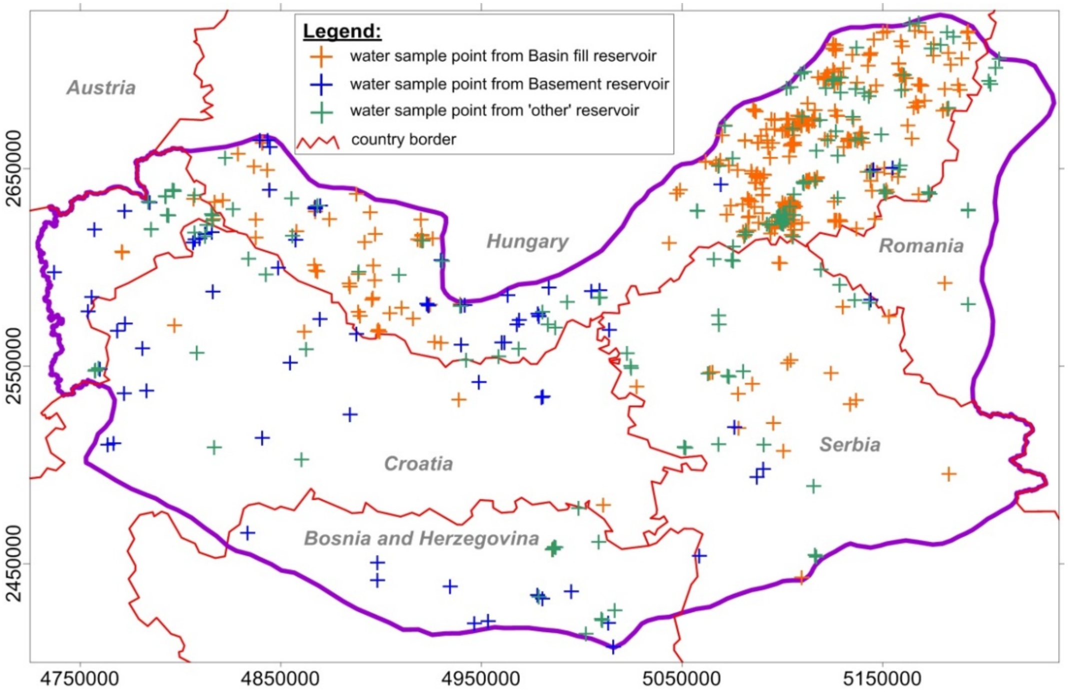
Geothermal potential map of the basement reservoirs ***(Comparison of the temperature estimated (by the conductive model) at the top of the basement to the measured temperature values extrapolated to the top of the basement)***

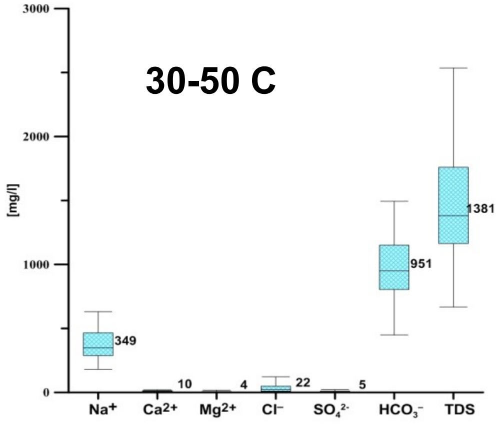


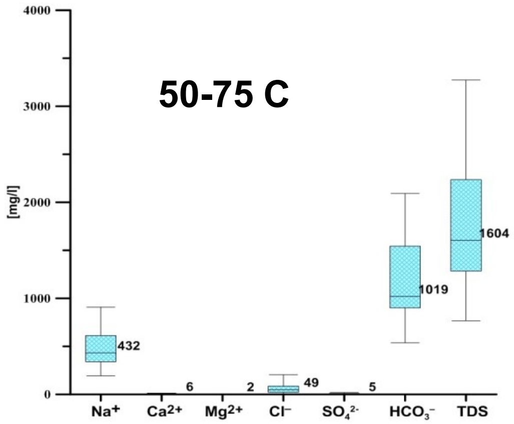
Resource estimation (BF reservoirs)

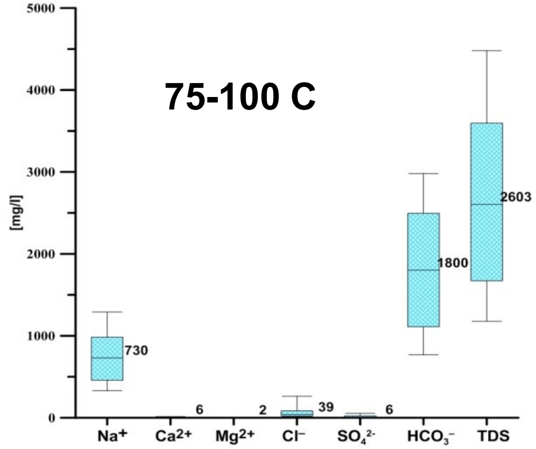
Region ID	30-50 °C			50-75 °C			75-100 °C			100-125 °C			125-150 °C		
	P90	P50	P10	P90	P50	P10	P90	P50	P10	P90	P50	P10	P90	P50	P10
	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ
1. region Mura-Zala Basin	5365	7399	9750	6782	9395	12329	874	1201	1579	103	143	189			
2. region Somogy region	8308	11522	15169	10937	15154	20055	235	325	427						
3. region Drava Basin	9500	13014	17228	22945	32041	42005	10265	14164	18798	1933	2691	3531	90	125	164
4. region Zagrab Basin	3119	4317	5667	892	1227	1628									
5. region Sava Basin	4820	6665	8837	6888	9510	12545	372	513	680						
6. region East-Slavonia	4870	6745	8900	2159	2979	3933									
7. region Vojvodina	7776	10683	14052	1497	2075	2751									
8. region Mako Trough	27219	37607	49658	78234	108496	143502	42474	59153	78067	9575	13278	17482			
9. region Battonya High	5562	7628	10077	6499	8924	11835	1597	2213	2930						
10. region Bekes Basin	10057	13925	18391	26802	37267	49258	17255	23648	31213	3509	4832	6410			
11. region Backa	3637	5032	6633	1629	2267	2976									

Hydrogeochemical characterization

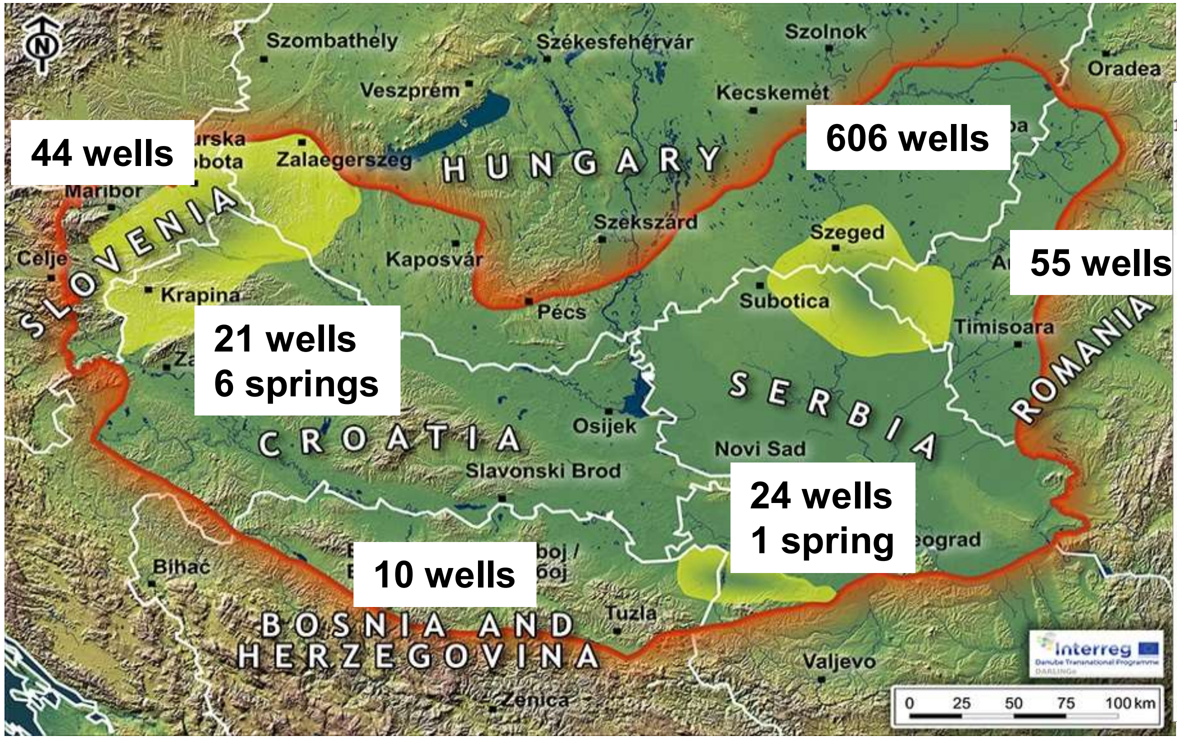


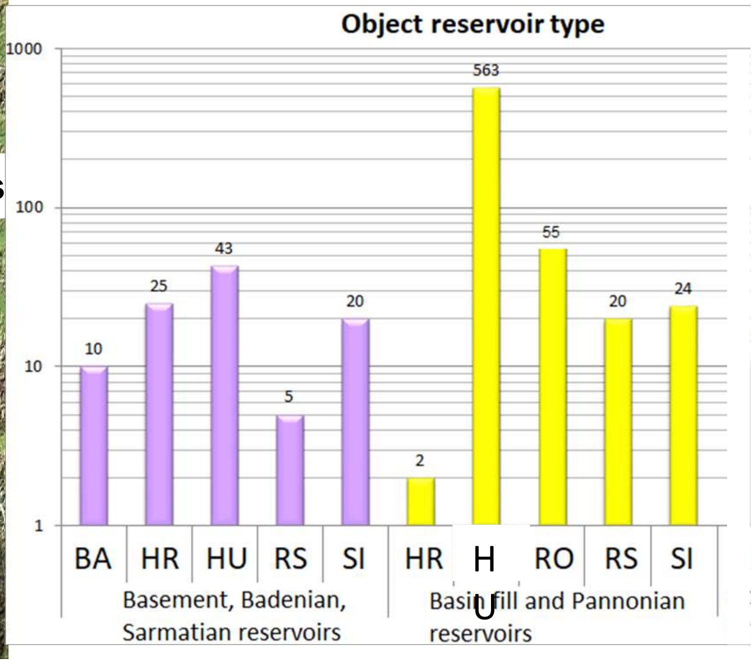






Overview of current utilization



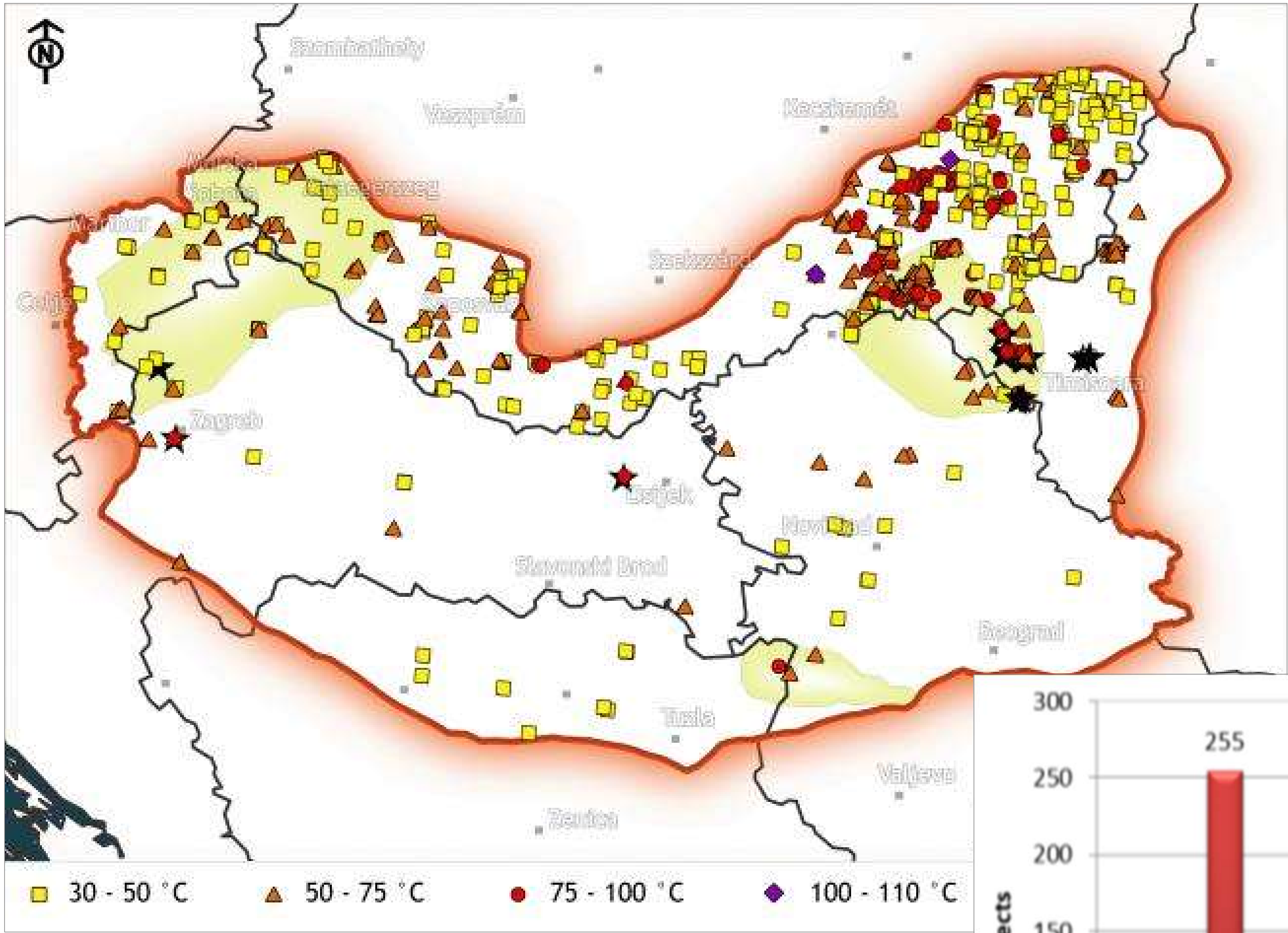


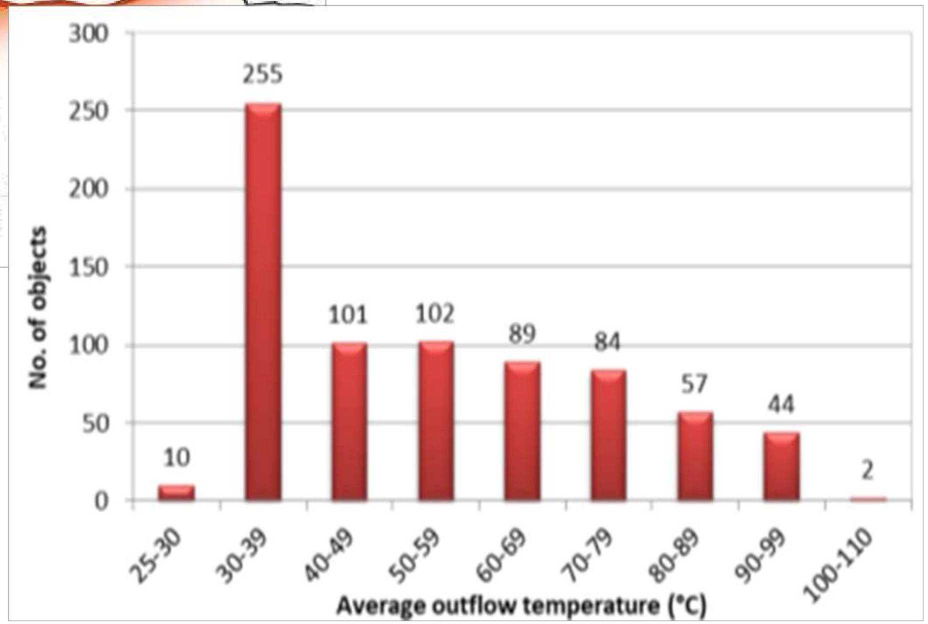
Compilation of a comprehensive database (outflow T ≥ 30 ℃)

- **basic well data,**
- **utilization data (type of utilization, users),**
- **hydrogeological and hydrogeochemical data,**
- **geothermal data,**
- **production data,**
- **monitoring data (observation wells, production wells, discharged water)**

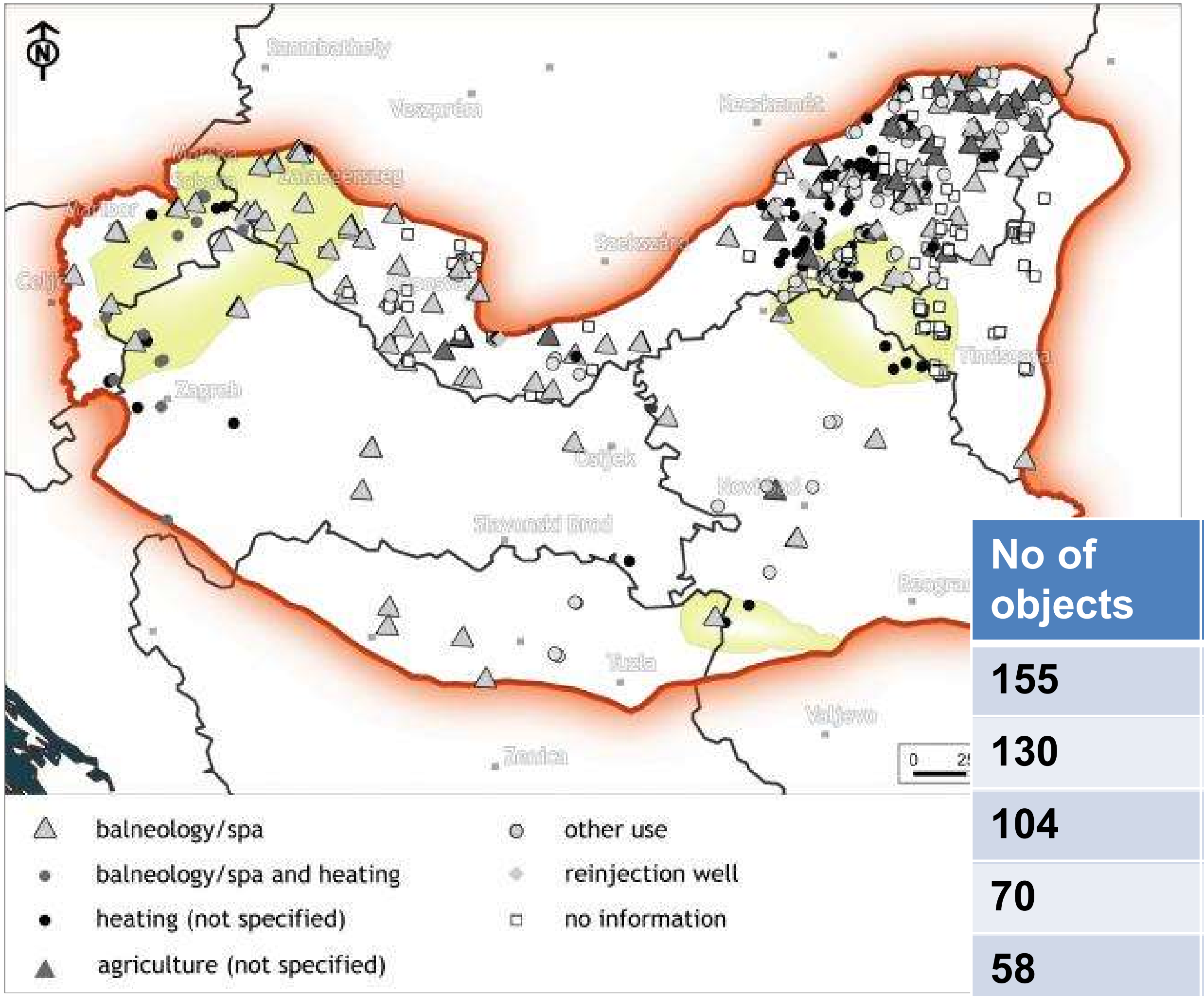
Outflow temperature

Interreg
Danube Transnational Programme
DARLINGe





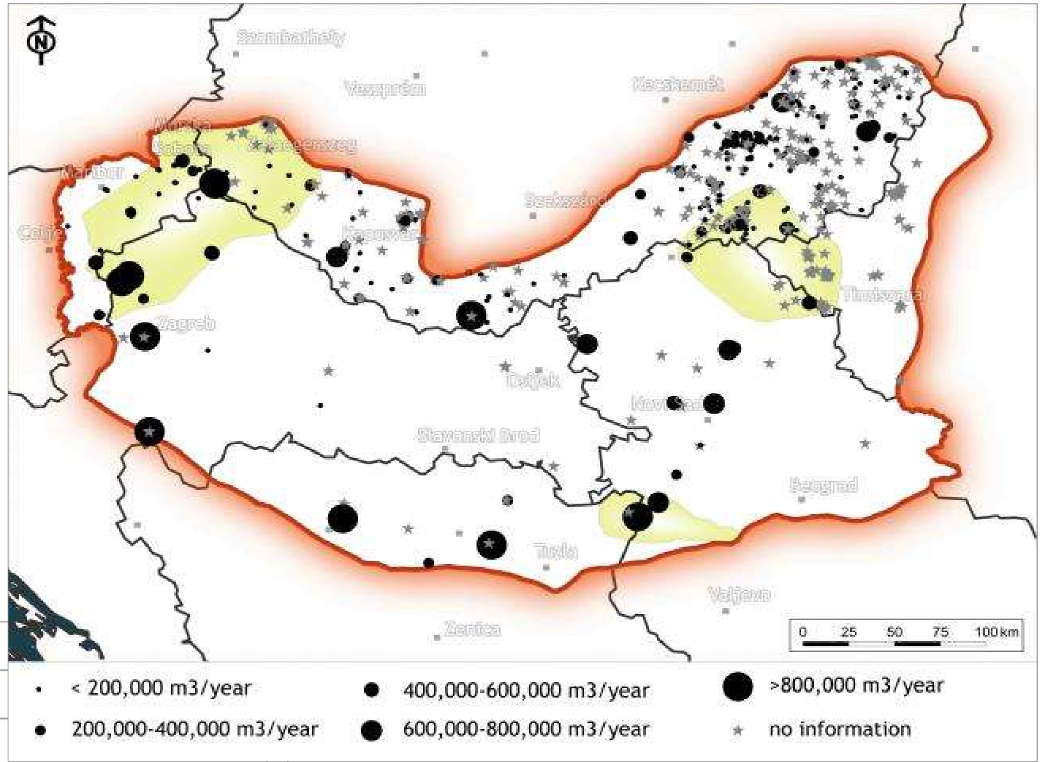
Utilization



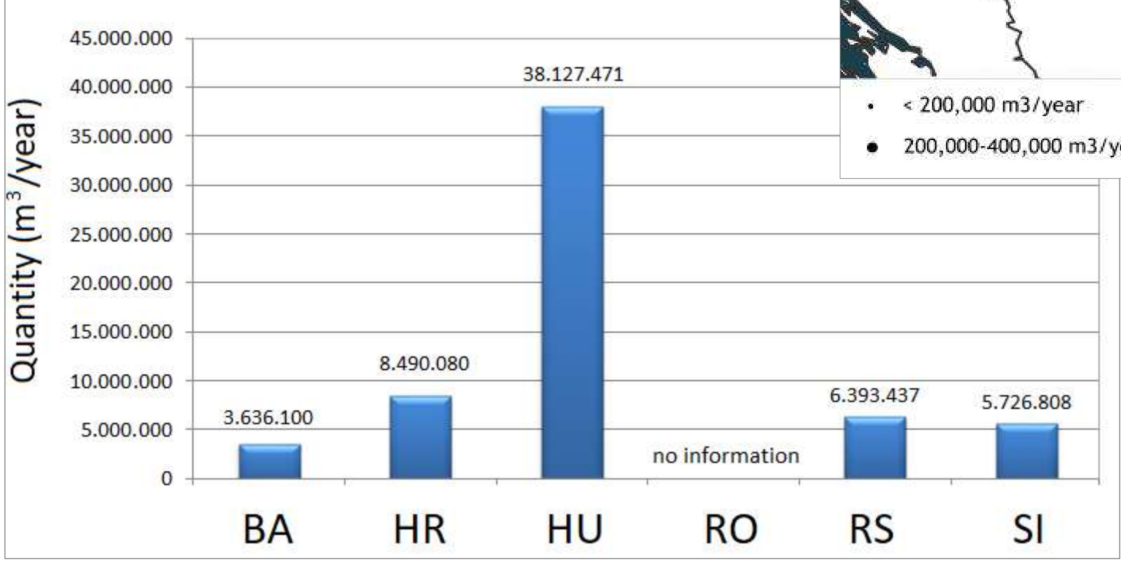
No of objects	Type of use
155	balneology
130	drinking water
104	heating
70	agriculture (mostly heating)
58	unknown
39	reinjection
36	industrial
11	monitoring

Production

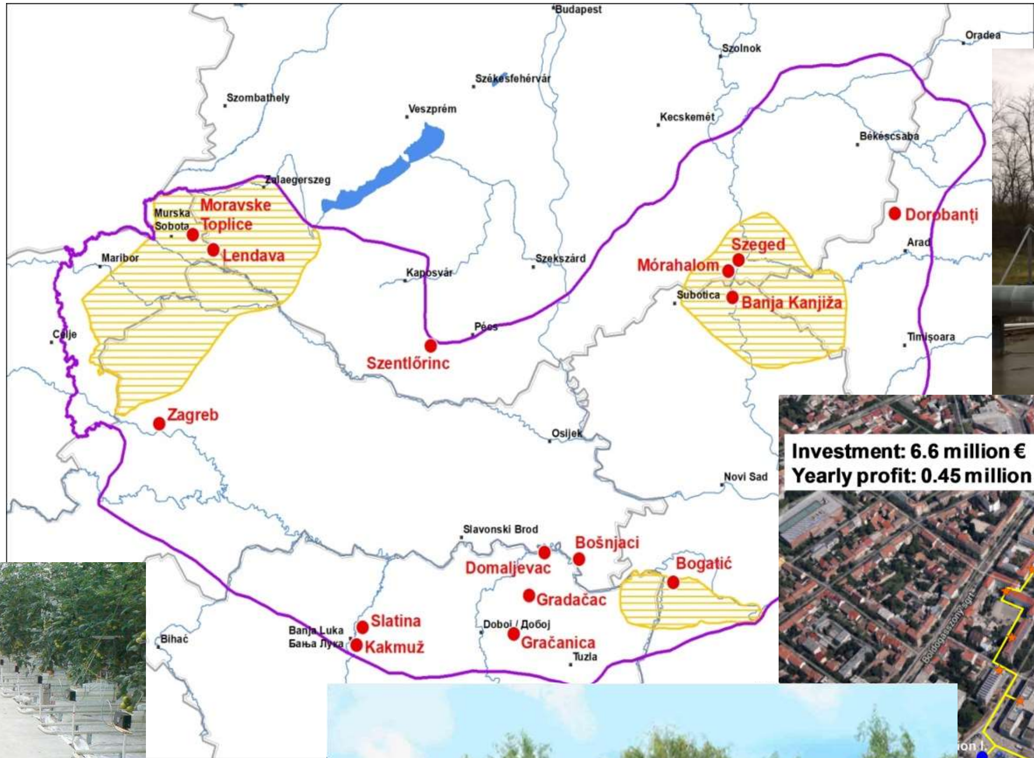
Interreg
Danube Transnational Programme
DARLINGe



Summed licensed annual production



Evaluation of case studies – „best practices”



Evaluation of case studies – „best practices”

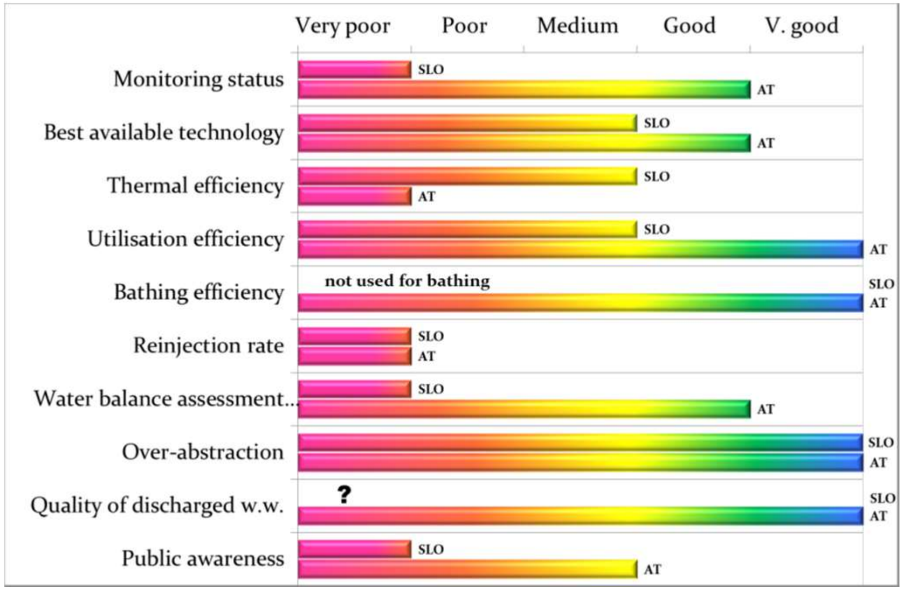
Interreg Danube Transnational Programme DARLINGe

	Bosnia and Herzegovina (BiH)							Croatia (HR)		Hungary (HU)					Serbia (SRB)		Slovenia (SLO)		Romania (RO)	
Name of location	Domaljevac	Slatina	Kamuž	Gračanica	Gradačac			Bošnjaci	Zagreb	Szentlőrinc	Mórahalom town			Szeged town	Bogatić	Banja Kanjiža	Lendava	Moravske Toplice	Dorobanti locality, Arad County	
User		Zavod za fizikalnu medicinu i rehabilitaciju Dr Miroslav Zotović	TGP ad Kakmuž	Terme Gračanica & Messer BH gass	Spa Ilidža Gradačac	Mliječna industrija 99	Swity	Ruris d.o.o	Mladost sport center	entlőrinc tov	The system of the Szent Erzsébet Spa of Mórahalom	The Geothermal District Heating system of Mórahalom	The Norwegian Geothermal Public Utility system	University of Szeged	Municipality of Bogatić	Banja Kanjiža spa	Petrol Geot	Terme 3000	Agricola Agrador; Operator: S.C. Ecologica Arser	„Gradina Termala”
Type of aquifer	BM: Triassic carbonate, Badenian and Sarmatian limestones	BM: Triassic limestone	BM: Triassic limestone	BM: Triassic limestone	Badenian and Sarmatian limestones			BF: Upper Panonian sand (Vera fm)	BM: Triassic carbonate, Badenian and Sarmatian limestones (Prečec fm)	BM: metamorphic rocks of Paleozoic age, mainly gneisse	BF: Upper Panonian sandstones			BF: Upper Panonian sandstones	BM: Triassic carbonate	BF: Upper Panonian sediments	BF: Upper Pannonian sandy aqufer (Mura-Ujfalu Fm.)	BF: Upper Pannonian sandy aqufer (Mura-Ujfalu Fm.); Badenian sandstone	BF: Upper Pannonian sandstone	
Production Well name	Do-1	SB-1, SB-4, SL-1	GB-6, TGP-1, TGP-2	PEB-4	B-6	BZ-1	EB-1	Boš-1	Mla-3	K-22	B-40, B-45	B-45	K-43	860, 1551, 1703, 1895, 1950, 2000	BB-1, BB-2	Kz-1/H, Kz-2/H, Kz-3/H	Le-2g	Mt-1, Mt-4, Mt-5, Mt-6, Mt-7	1655 and 1613 only in the winter time	1655
Water temperature (oC)	96	41-44	39	37,7	30	30	30	65	78-80	77-85	60-62	62	60-62	92-95	75-78	45-72	66	60-75	60	60
Type of utilization	heating of greehouses	Cascade system (heating, balneology, recreation)	extraction of CO2	for swiming pools and extraction of CO2	Balneology and space heating in spa	Industrial processes in dairy industry	Fruit and vegetable processing industry	Greenhouses (tomatoes)	cascade system (swiming pool, space heating, cooling)	for district heating of the town	heating – balneology	heating - domestic hot water	heating - domestic hot water	for district heating of the University	distric heating - project in development	balneology , space heating and cooling and as domestic warm water	cascade use: heating of public buildings, apartments and deicing of pavement, innovative heat pump	cascade system: space heating; indirect pool and sanitary water heating, air heating; tomato greenhous	heating of 6 ha of greenhouses and fish farm	swimming pools
Waste water treatment	released into surface recipient	released into surface recipient	released into surface recipient	released into surface recipient (Spreča river)	released into surface recipient	released into surface recipient	released into surface recipient	released into surface recipient (melioration channel)	rejection in	rejection in	rejection into B-46	rejection into VS-1	rejection into K-44	rejection into 1750, 1300, 1700	released into surface recipient	released into surface recipient	rejection in	released to channel; reinjection around 1993		The water released from the swimming pools is treated for adjusting the pH in order to be used at the fish farm

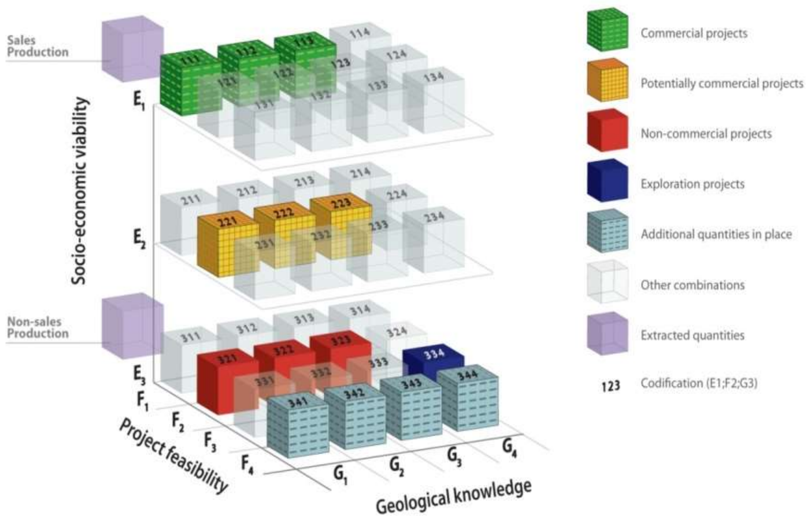
What is next?
Novel methods to be tested on pilot areas

Interreg
Danube Transnational Programme
DARLINGe

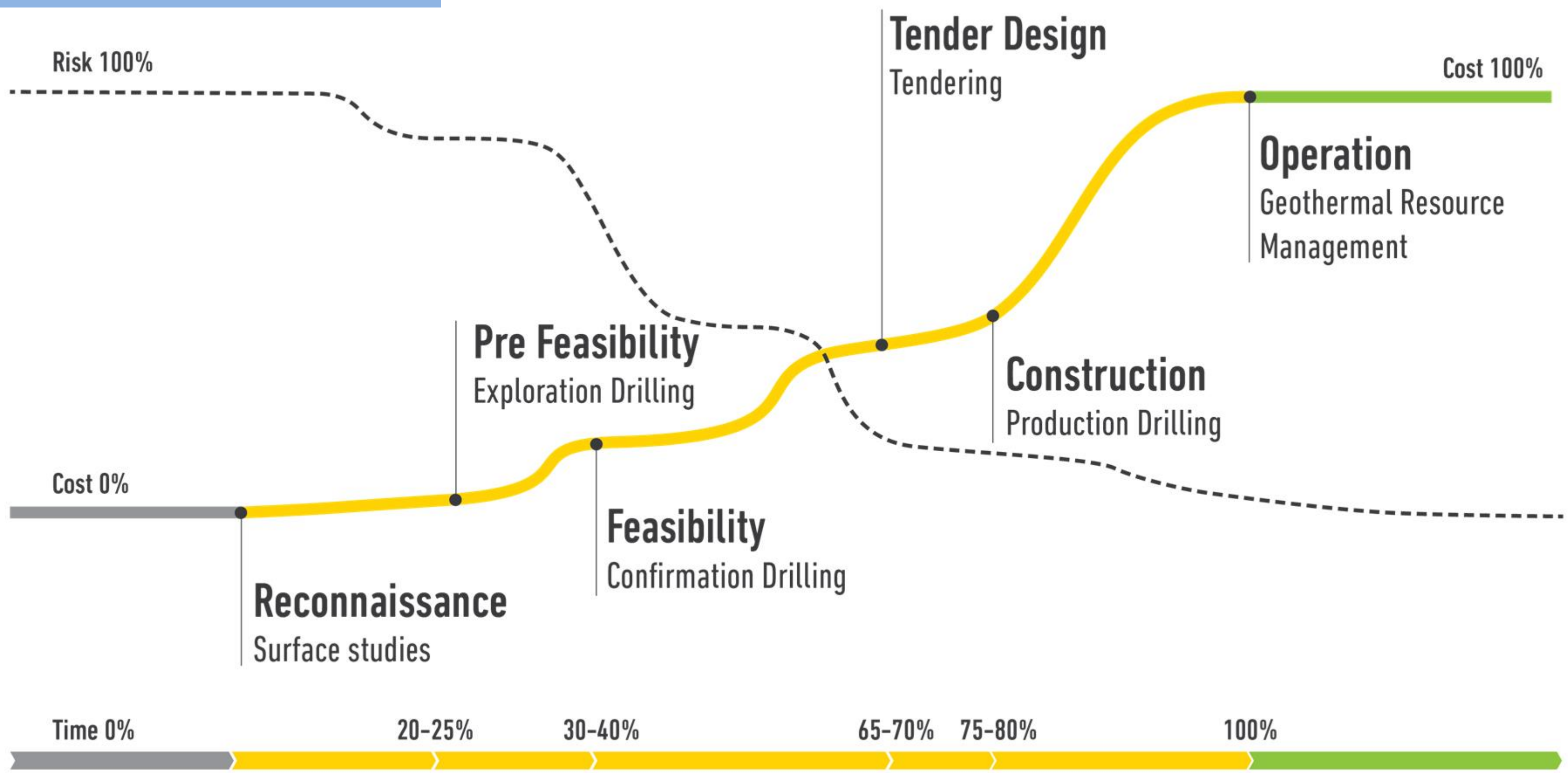
Benchmark (independent indicators)



Application of the UNFC-2009 classification (testing of the geothermal specifications elaborated in 2016)



Geological risk mitigation



Source: Geoelec project

Increased geological knowledge – more confident estimation of reservoir prameters (temperature, flow-rate) – to be known only after the first successful drilling

Thank you for your attention!

LEA Pomurje
Lokalna energetska agencija za Pomurje
Local Energy Agency Pomurje

MBFSZ

InnoGeo

Ministry of Foreign Affairs and Trade of Hungary

HGI 1909
HRVATSKI GEOLOŠKI INSTITUT
CROATIAN GEOLOGICAL SURVEY

IGR

GeoZS
Geološki zavod Slovenije

ZAGORSKA RAZVOJNA AGENCIJA

BOSNIA AND HERZEGOVINA
FEDERATION OF BOSNIA AND HERZEGOVINA
Federal Institute for Geology
Sarajevo

TERRA TECHNIK

MANNVIT

GEOLOGICAL SURVEY OF THE REPUBLIC OF SRPSKA

www.interreg-danube.eu/darlinge