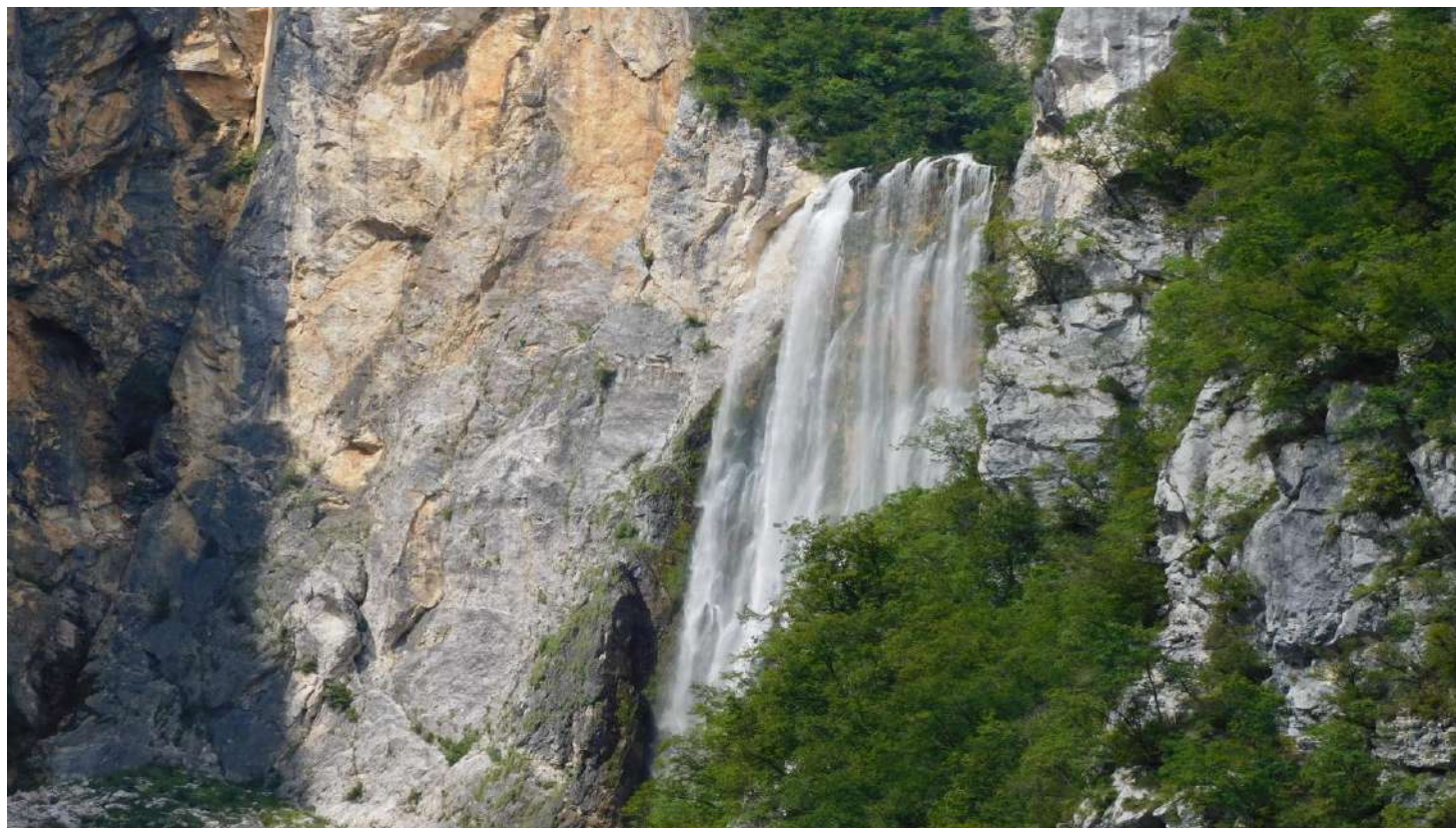


# Vodni viri v gorskih območjih



Slap Boka, Photo: N. Ravbar

Dr. Nataša Ravbar

Inštitut za raziskovanje krasa ZRC SAZU

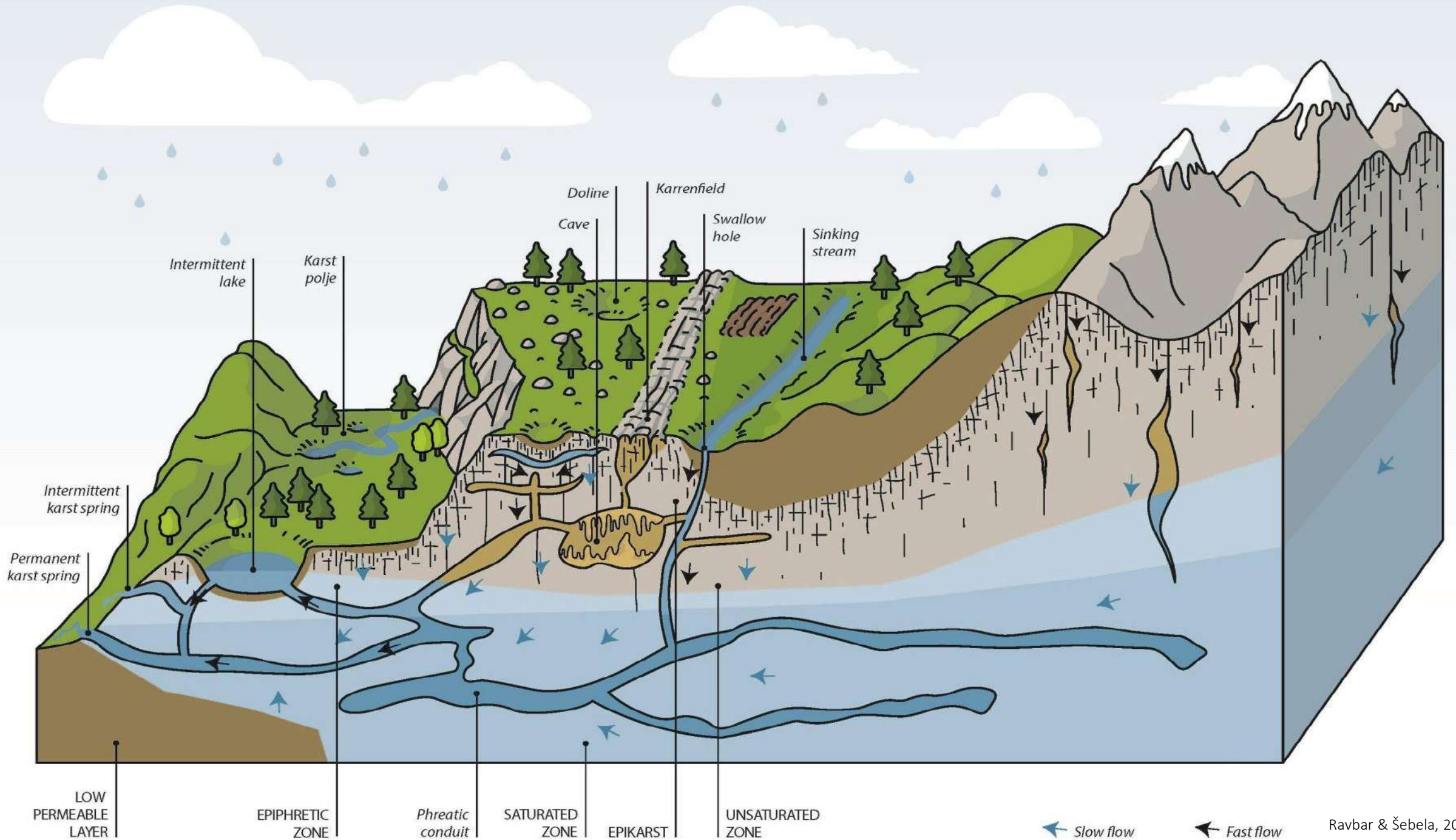
# UVOD

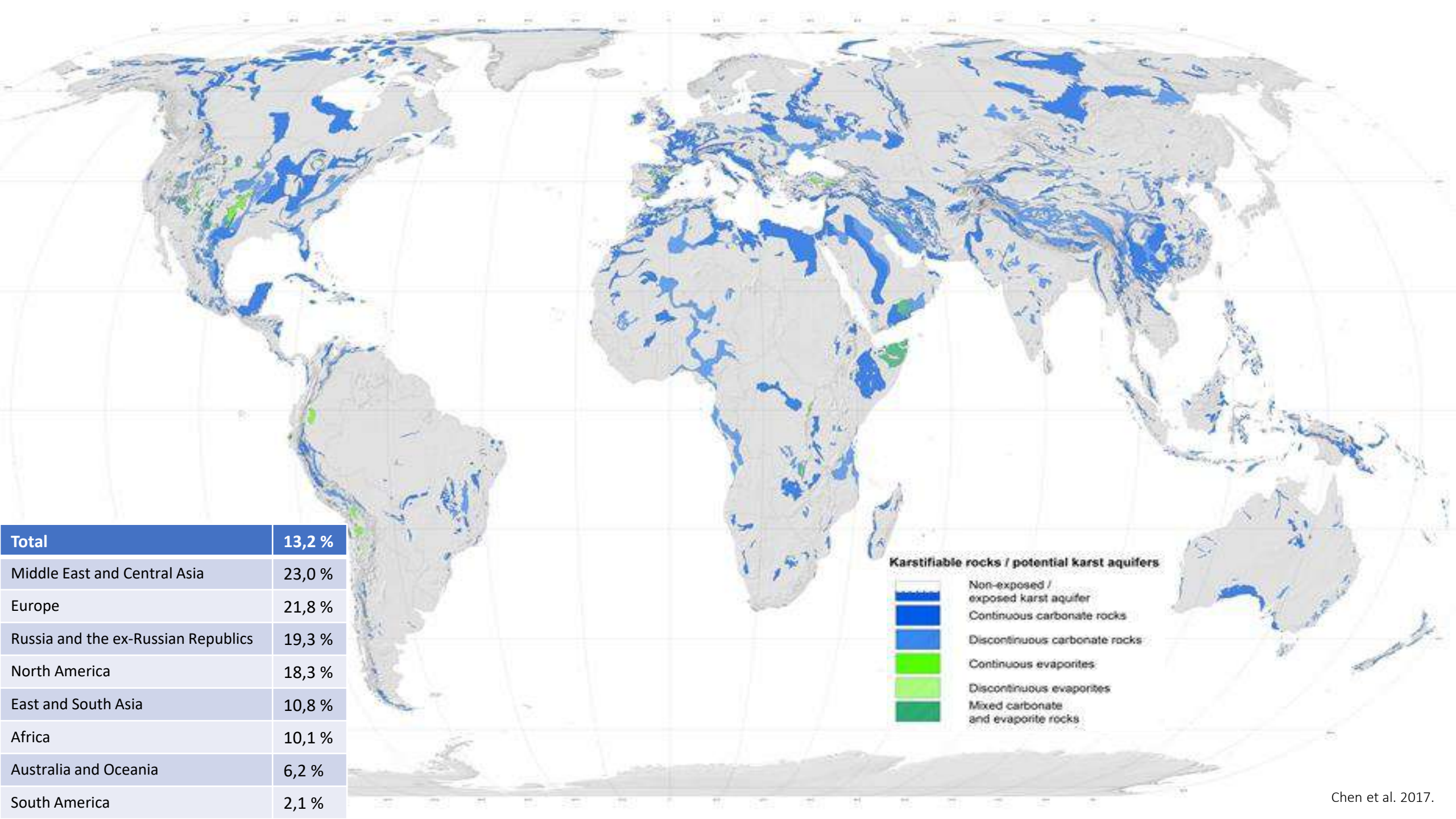
Oj, Triglav, moj dom, kako si krasan  
kako me izvabljaš iz nizkih ravan  
v poletni vročini na strme vrhe,  
da tam si spočije v samoti srce

**kjer potok izvira v skalovju hladan,**  
oj Triglav, moj dom, kako si krasan.

(Matija Zemljič, Jakob Aljaž)









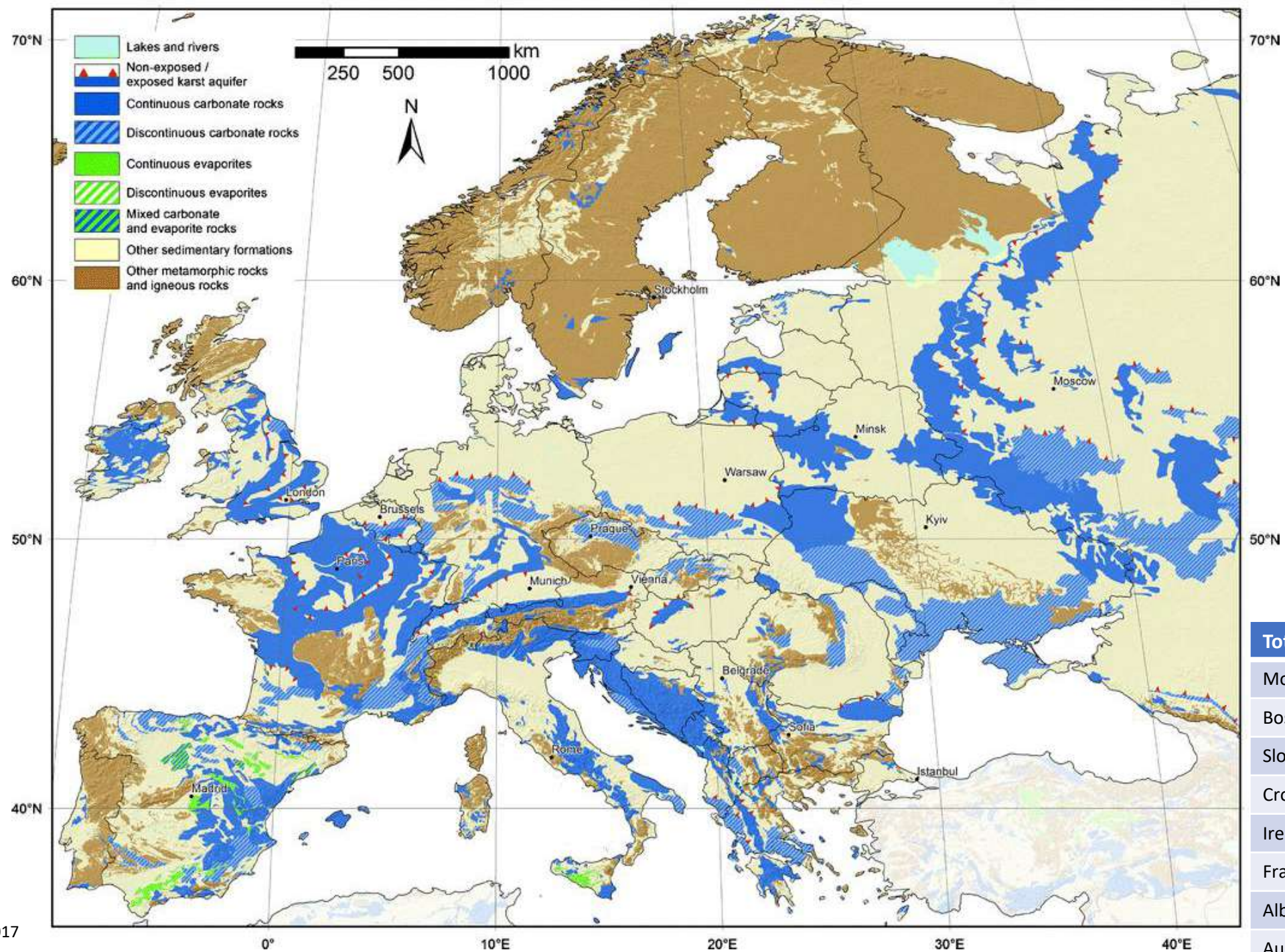




<b>Total</b>	<b>13,2 %</b>
Middle East and Central Asia	23,0 %
Europe	21,8 %
Russia and the ex-Russian Republics	19,3 %
North America	18,3 %
East and South Asia	10,8 %
Africa	10,1 %
Australia and Oceania	6,2 %
South America	2,1 %

**Karstifiable rocks / potential karst aquifers**

-  Non-exposed / exposed karst aquifer
-  Continuous carbonate rocks
-  Discontinuous carbonate rocks
-  Continuous evaporites
-  Discontinuous evaporites
-  Mixed carbonate and evaporite rocks

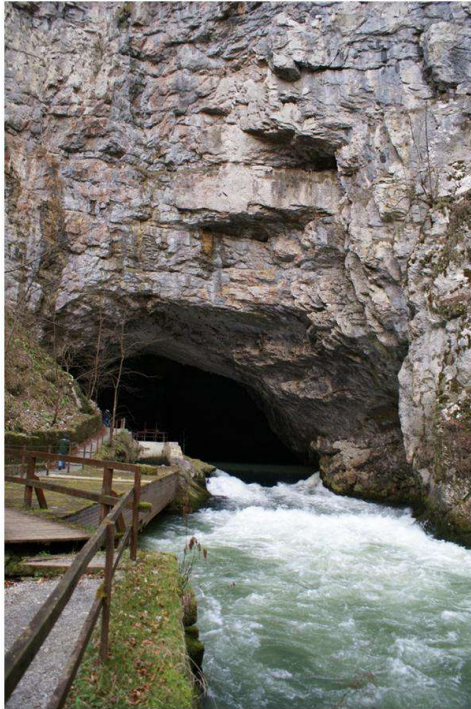


<b>Total</b>	<b>21,8 %</b>
Montenegro	80,1 %
Bosnia and Herzegovina	60,5 %
Slovenia	44 %
Croatia	40,9 %
Ireland	35 %
France	35 %
Albania	34,3 %
Austria	25 %

# POMEN KRASA

- Pestra geodiverziteteta in biodiverziteteta;
- Vodni viri (pokrivajo potrebe 10-25% svetovnega prebivalstva);
- Bogata biomasa;
- Gospodarstvo - turizem;
- Gradbeni material, ...

Photos: N. Ravbar, J. Hajna

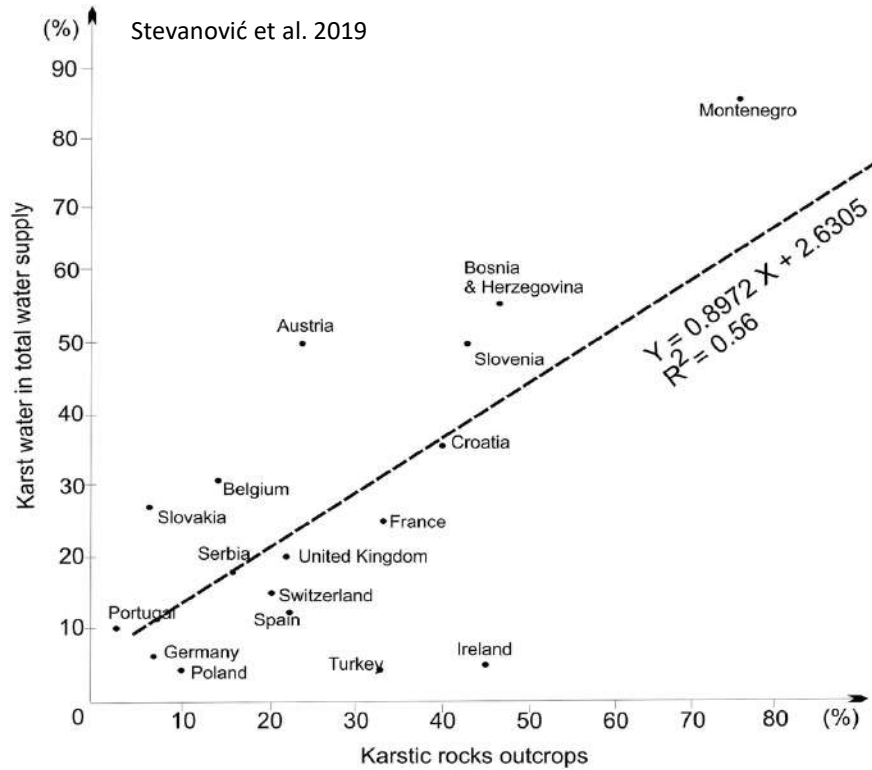




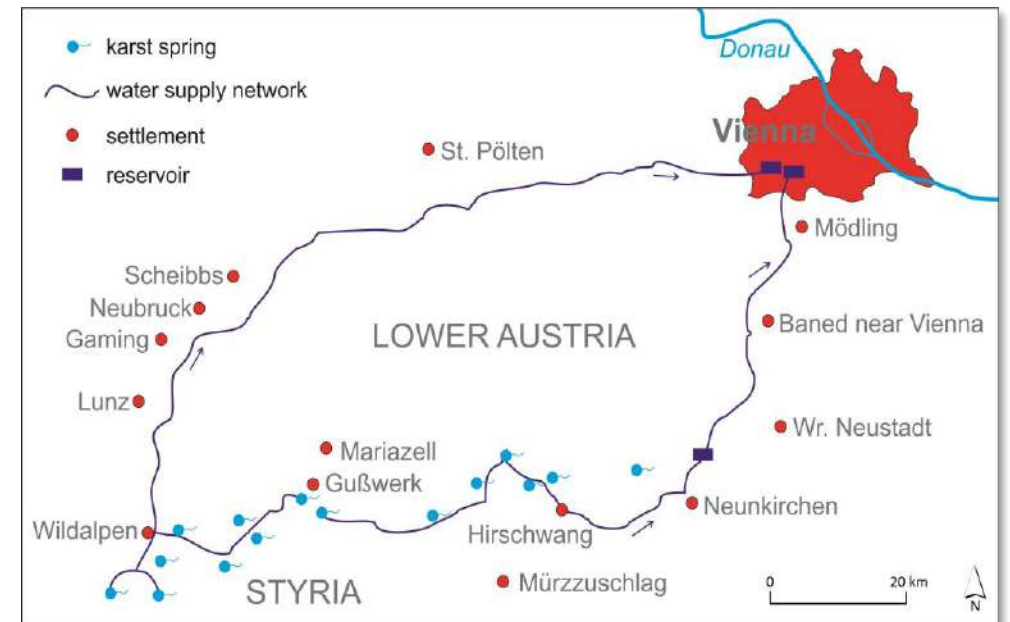
Lez spring, France



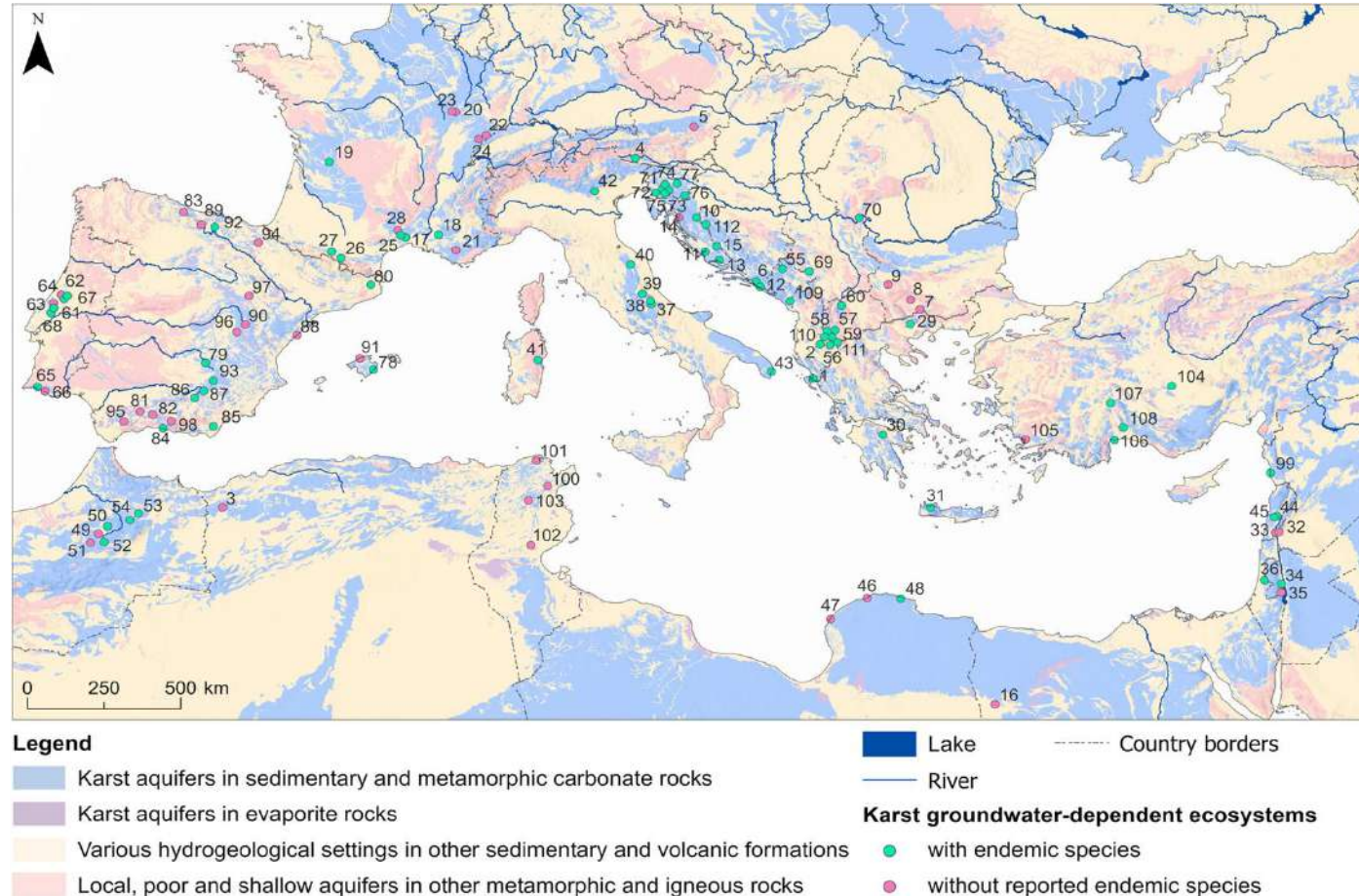
Jadro spring, Croatia, Photos: N. Ravbar



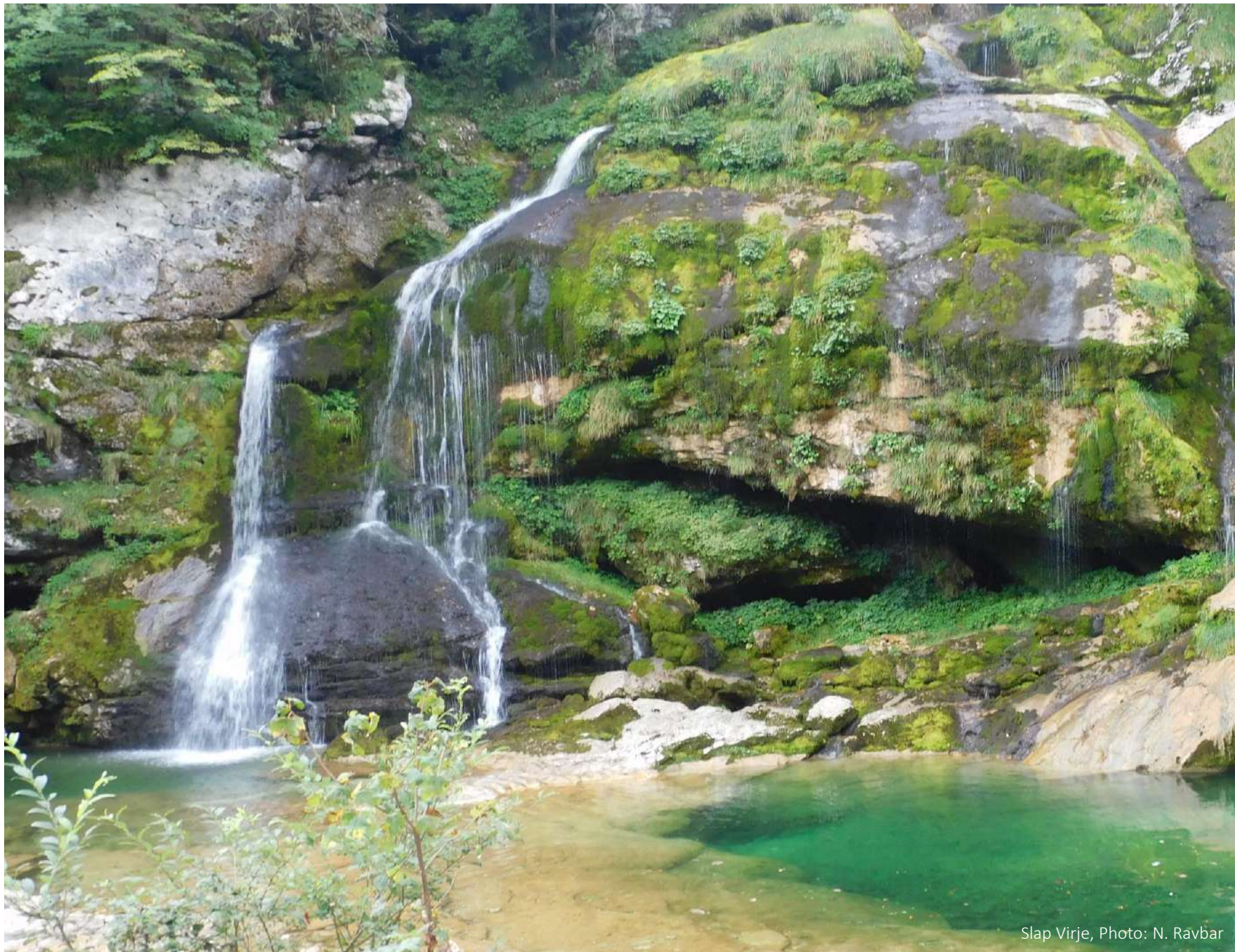
Oskrbujejo velika mesta, kot so: Rim, Montpellier, Damask, Dunaj ...



# KRAŠKI EKOSISTEMI



- izviri, jame, presihajoča jezera;
- Dinarski kras – svetovno pomembno območje biotske raznovrstnosti;
- najvišja stopnja endemizma;
- zibelka biospeleologije v 18. stoletju;



Slap Virje, Photo: N. Ravbar



Cerkniško Polje, SW Slovenia, Photo: M. Blatnik

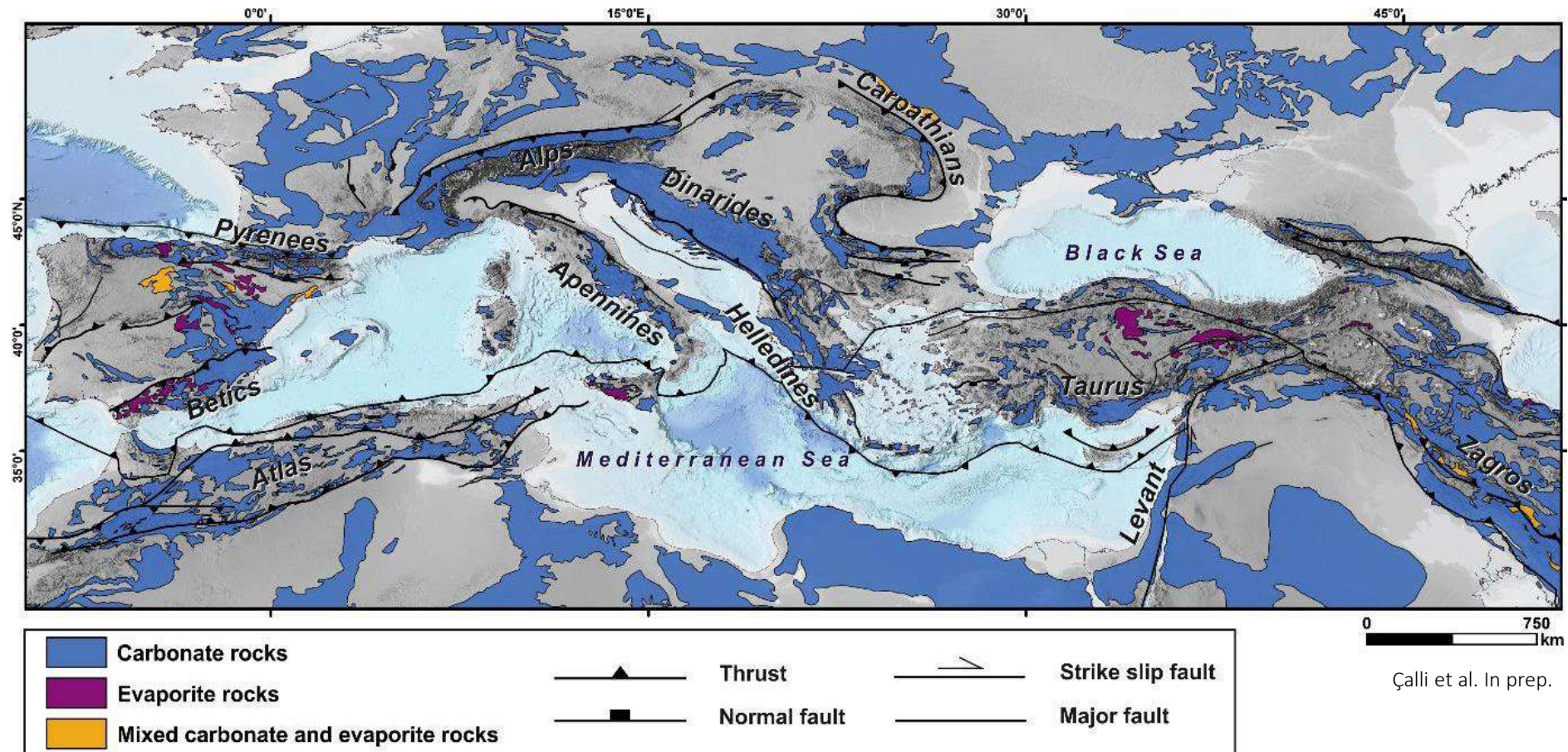
# KRAS V HRBOVITEM IN GORSKEM SVETU

Continent	Total carbonate rock areas (CC, DC and mixed)					
	Plains		Hills		Mountains	
	1,000 km <sup>2</sup>	%	1,000 km <sup>2</sup>	%	1,000 km <sup>2</sup>	%
Africa	1,859	46.1	1,494	37.1	677	16.8
Asia	1,322	16.0	2,017	24.4	4,915	59.6
Australia & Oceania	272	55.3	79	16.0	141	28.6
Europe	787	36.9	730	34.2	617	28.9
North America	1,875	44.2	1,110	26.2	1,258	29.6
South America	71	9.4	168	22.1	520	68.5
World	6,186	31.1	5,598	28.1	8,128	40.8

Iran, J Kitajska  
in JV Azija

Andi

# KRAS V HRBOVITEM IN GORSKEM SVETU



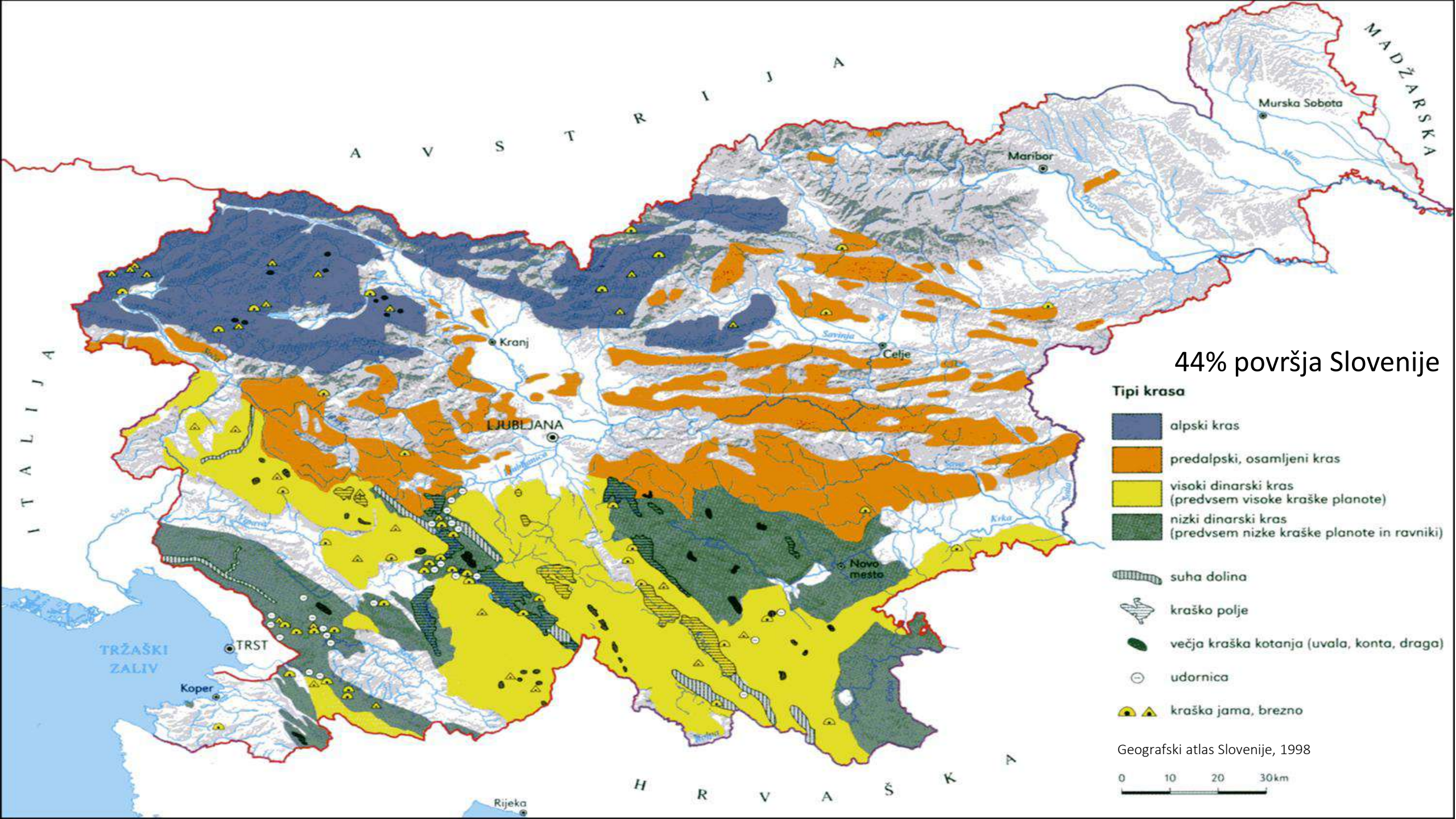
Çalli et al. In prep.

# KRAS V HRBOVITEM IN GORSKEM SVETU

- izrazite zemljepisne, podnebne in okoljske **razlike**;
- močne razlike v padavinskem režimu, trajanju snežne odeje, rastlinskem pokrovu in sezonskih nihanjih pri napajanju vodnih virov;
- raztezajo se od **vlažnih visokogorskih** območij srednje in zahodne Evrope do **polsušnih sredozemskih in vzhodnih gorskih pasov**;



Luoe spring, Photo: N. Ravbar



44% površja Slovenije

Tipi krasa

- alpski kras
- predalpski, osamljeni kras
- visoki dinarski kras (predvsem visoke kraške planote)
- nizki dinarski kras (predvsem nizke kraške planote in ravniki)
- suha dolina
- kraško polje
- večja kraška kotanja (uvala, konta, draga)
- udornica
- kraška jama, brezno

Geografski atlas Slovenije, 1998



# ALPSKI KRAS

- Več 1000 m debeli skladi;
- Gorske verige;
- Podi, globoka brezna, konte, izdatni izviri ob vznožju;
- Nad gozdno mejo, golo površje;
- > 3,000 mm padavin letno.



Photo: G. Kovačič

# DINARSKI KRAS

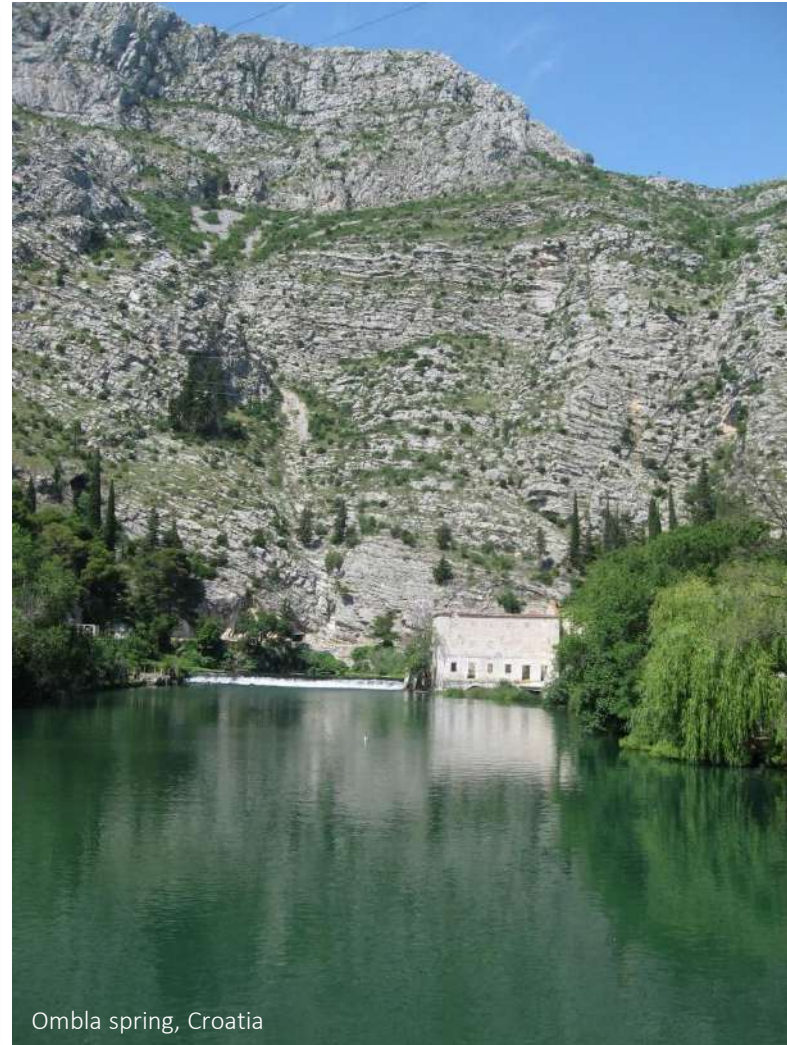
- Veliki kraški masivi, kraške planote;
- Kraška polja in doline, območja plitvega krasa;
- Več 100 metrov debele sekvence karbonatnih kamnin.



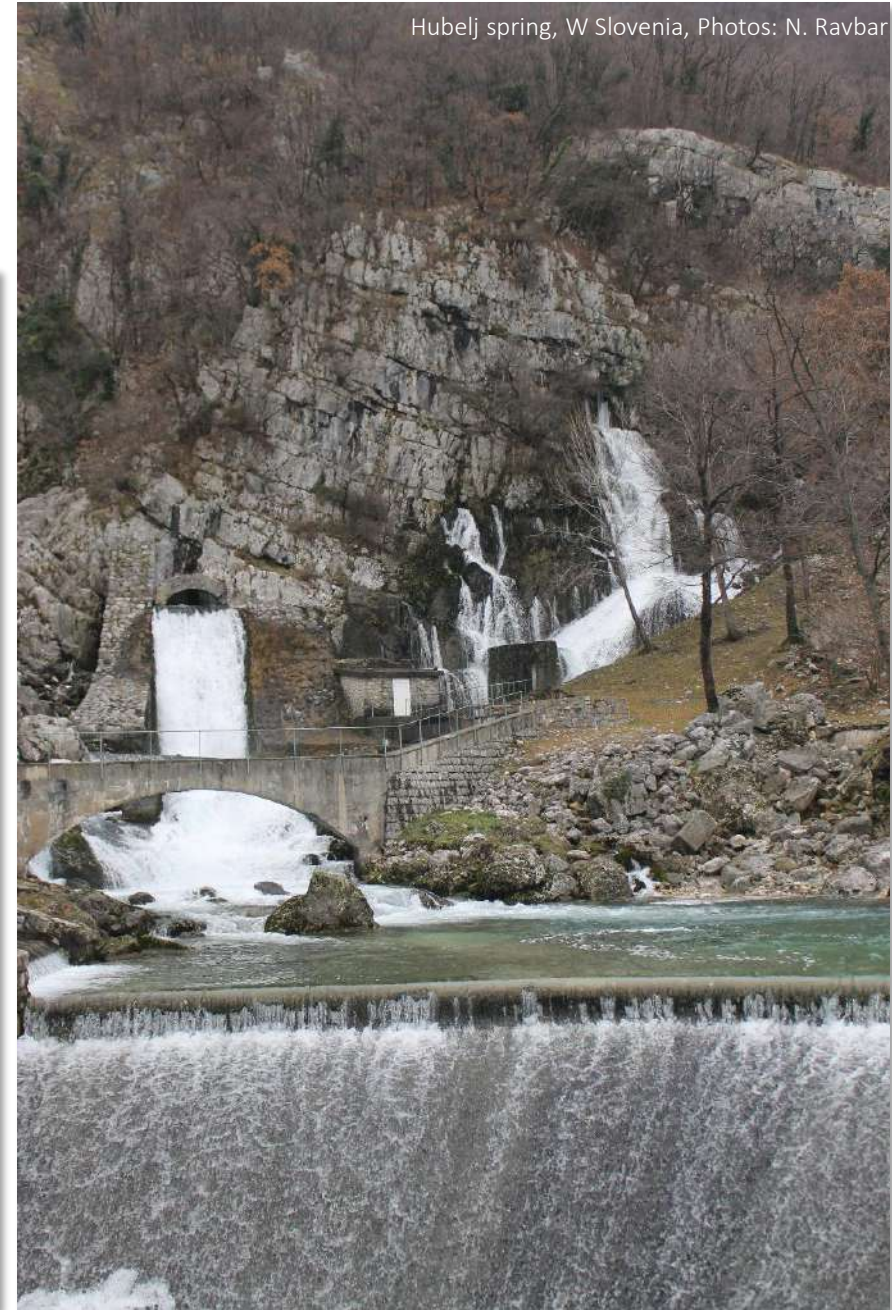
# IZDATNI IZVIRI



Sopot spring, Montenegro

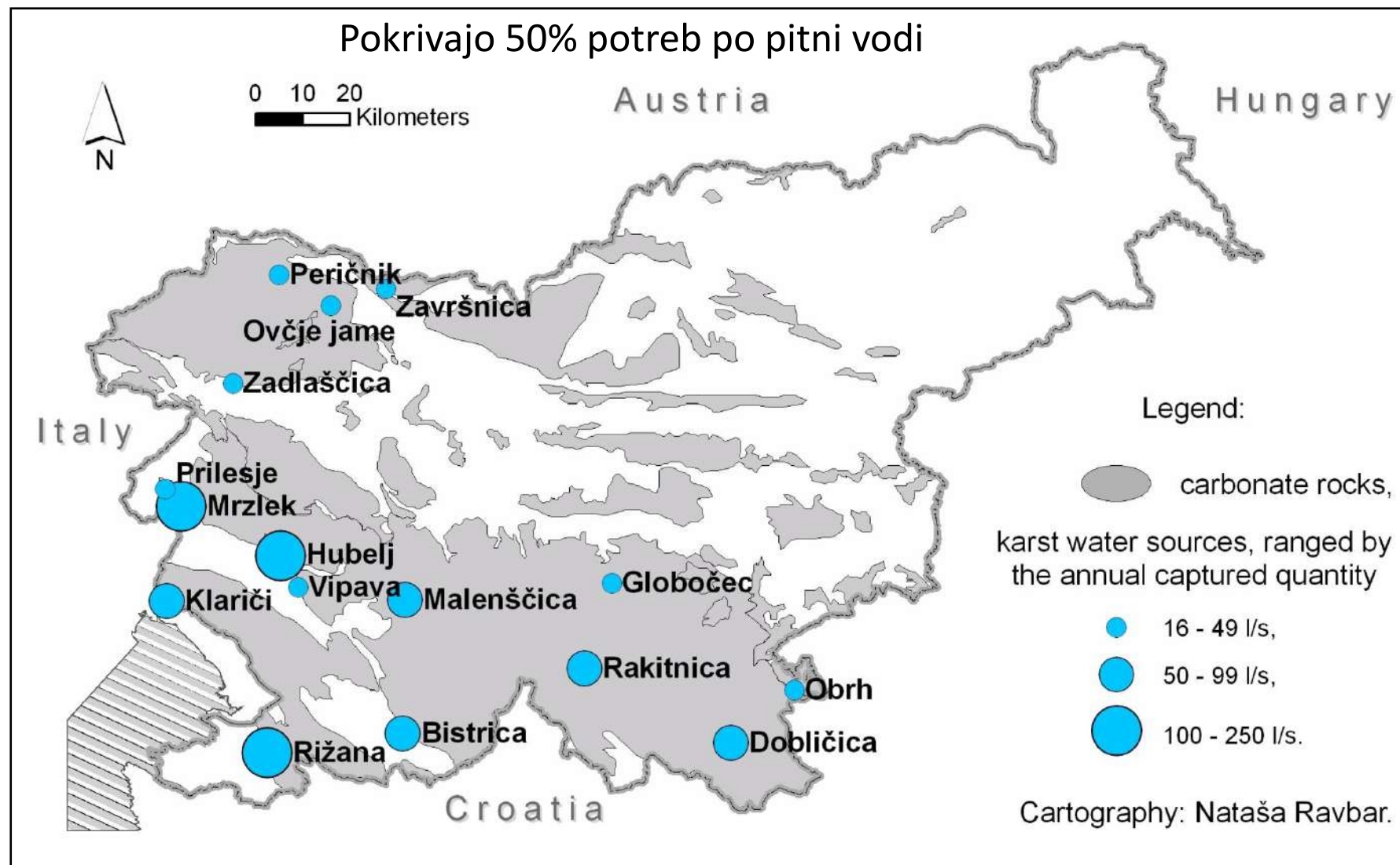


Ombla spring, Croatia



Hubelj spring, W Slovenia, Photos: N. Ravbar

# IZDATNI IZVIRI



# IZDATNI IZVIRI

Name of water source	Type of water source	Location		Discharge [m <sup>3</sup> /s]			Recharge area [km <sup>2</sup> ]	No. of supplied population
		Region	Altitude [m asl]	Min.	Mean	Max.		
Sveti Ivan	perennial karst spring	Istria	47	0.13	0.818	2.15	70	60,000
Riječina*	temporary karst spring	Kvarner bay	352	0	7.8	150	220	200,000
Jadro	perennial karst spring	Split bay	34.6	0.22	9.7	78.1	300 – 500	300,000 (350,000)
Omla	perennial karst spring	Rijeka Dubrovačka	2.3	2.3	24.4	154	850 – 1,060	46,000
Rižana*	perennial karst spring	Slovenian Istria	70	0.27	4.3	80	244	86,000 (120,000)
Klariči	pumping well	Kras plateau	16	pumping discharge up to 250 l/s			approx. 750	20,000
Mrzlek	perennial karst spring	Soča valley	77	0.5	nd	40	217	30,000
Hubelj	perennial karst spring	Vipava valley	240	0.04	2.7	60	50-80	24,000

Osrbujejo obalna območja in mesta: Koper, Reka, Zadar, Split, Dubrovnik – že iz antičnih časov



# NEVARNOSTI IN ZAŠČITA

- non-karst aquifer

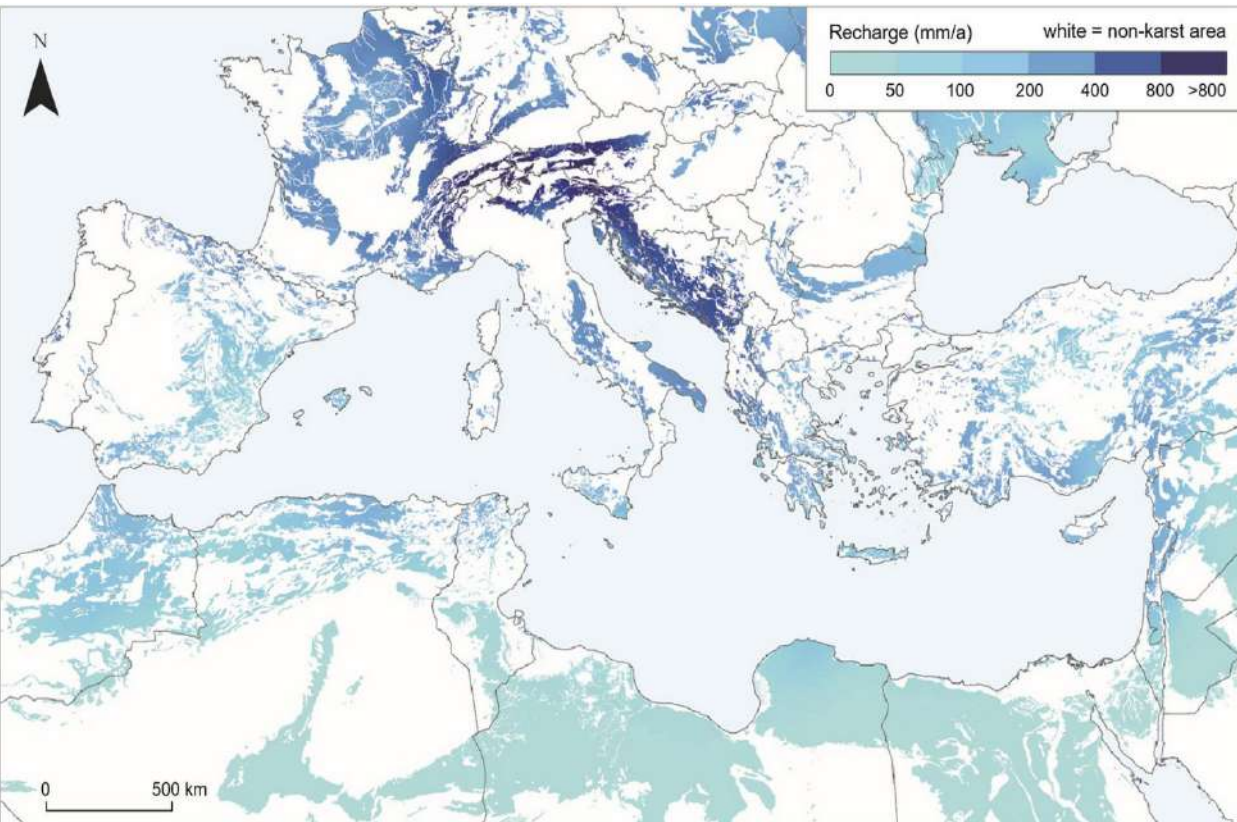


- karst aquifer

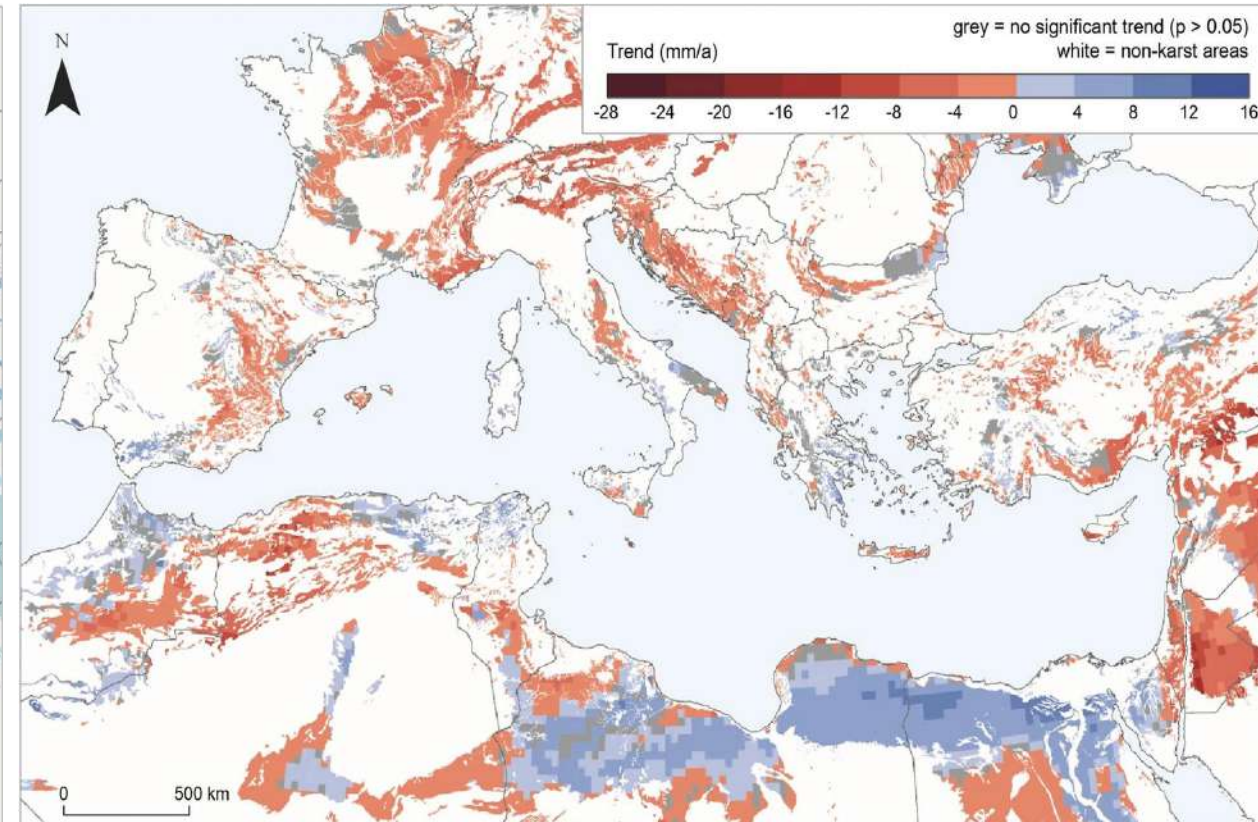


# NEVARNOSTI IN ZAŠČITA

- napajanje (povprečje med 1990–2019)

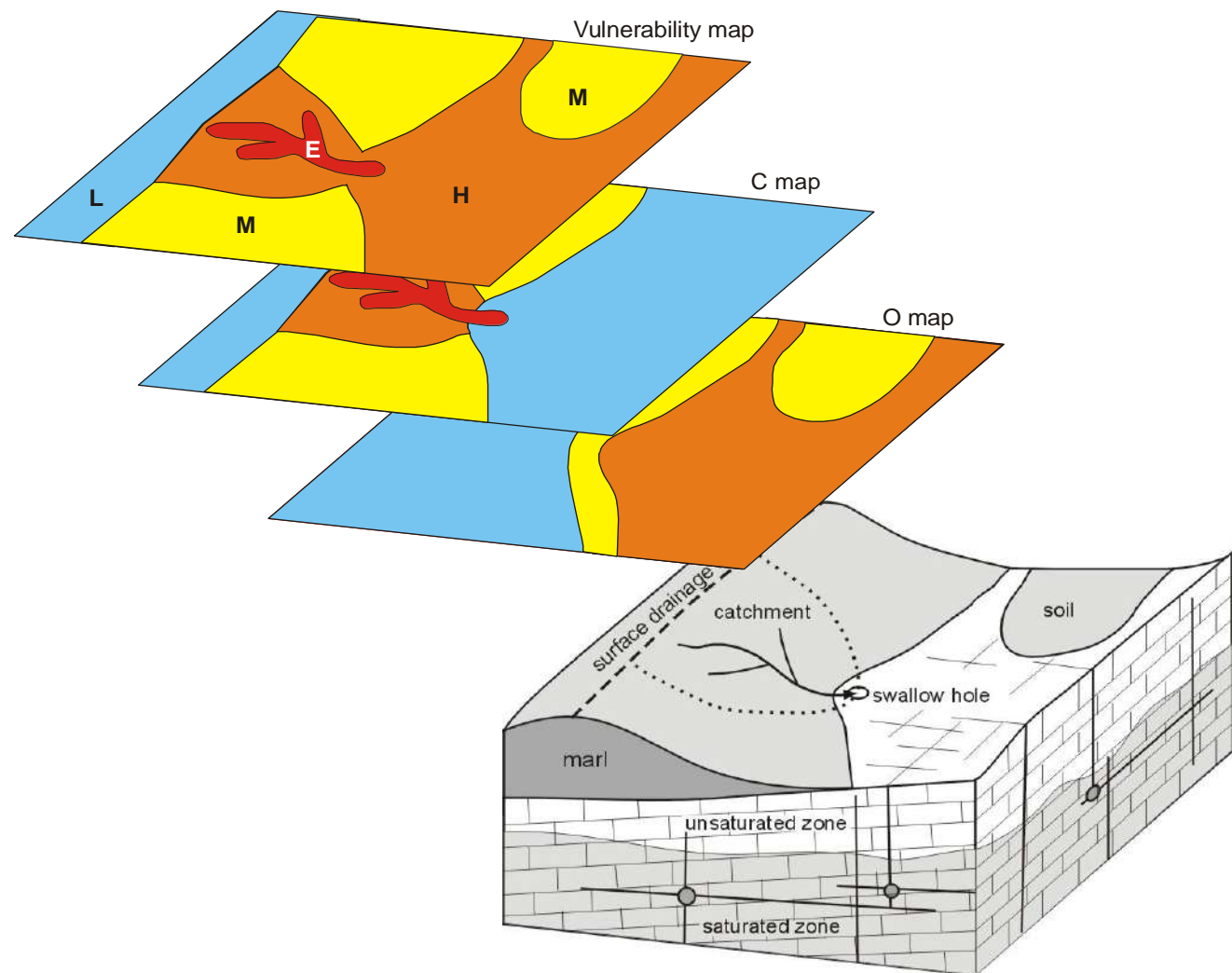


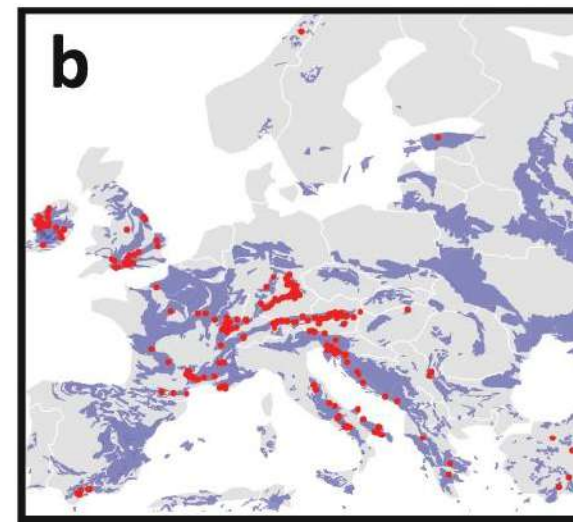
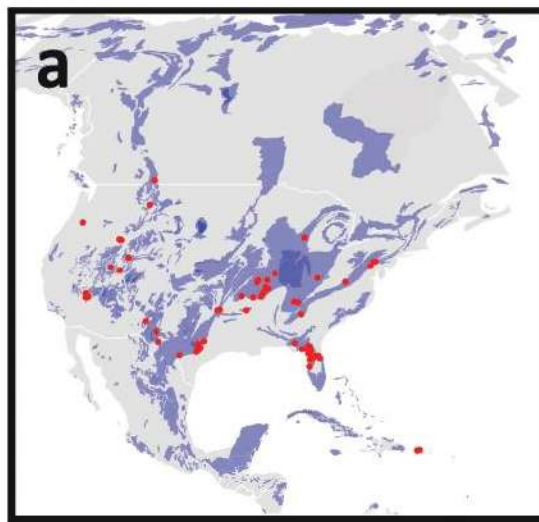
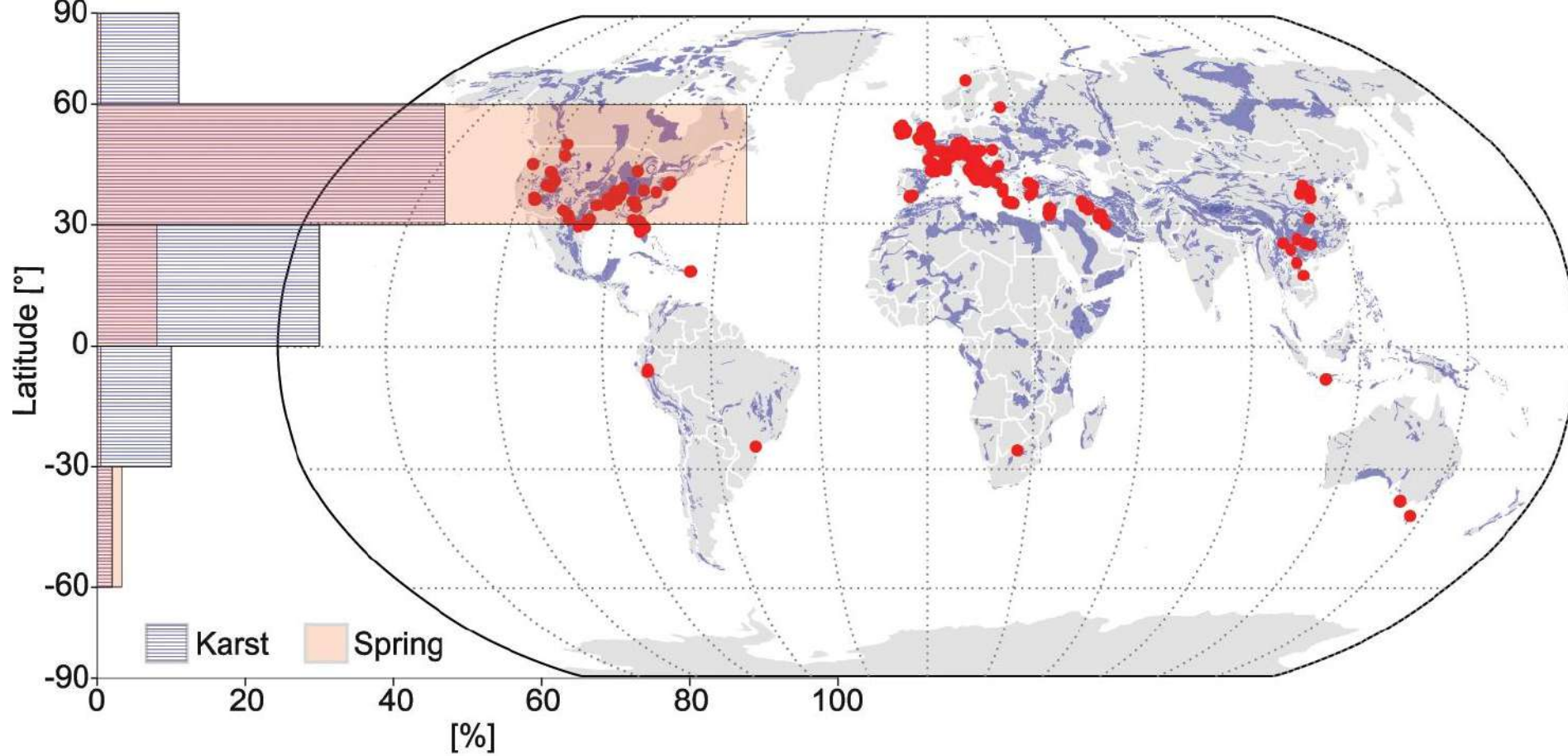
- trendi zalog podzemne vode (v obdobju 2003–2020)



# NEVARNOSTI IN ZAŠČITA

- Viri, zaščiteni v okviru nacionalne zakonodaje;
- Razdalja ali hitrost pretoka nista edina merila;
- Jame običajno niso zaščitene;
- Regionalni ali naravni parki;







Photos: N. Ravbar



### CONNECTION INFO

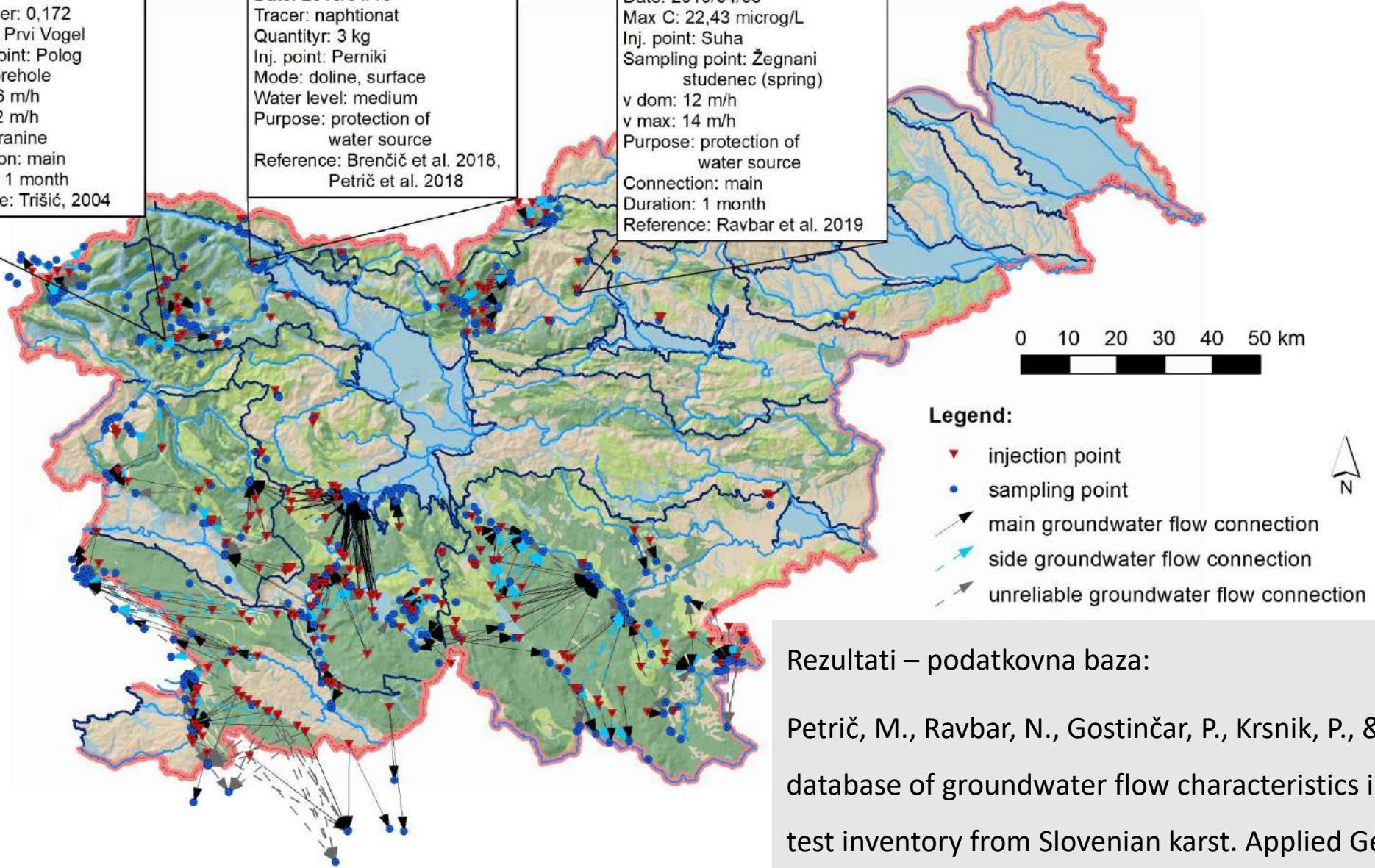
Date: 2002/09/10  
Max\_tracer: 0,172  
Inj. point: Prvi Vogel  
Sampl. point: Polog  
Mode: borehole  
v dom: 26 m/h  
v max: 62 m/h  
Tracer: uranine  
Connection: main  
Duration: 1 month  
Reference: Trišič, 2004

### INJECTION INFO

Date: 2018/04/16  
Tracer: naphionat  
Quantity: 3 kg  
Inj. point: Perniki  
Mode: doline, surface  
Water level: medium  
Purpose: protection of water source  
Reference: Brenčič et al. 2018, Petrič et al. 2018

### SAMPLING INFO

Date: 2019/04/03  
Max C: 22,43 microg/L  
Inj. point: Suha  
Sampling point: Žegnani studenec (spring)  
v dom: 12 m/h  
v max: 14 m/h  
Purpose: protection of water source  
Connection: main  
Duration: 1 month  
Reference: Ravbar et al. 2019



### Legend:

- ▼ injection point
- sampling point
- main groundwater flow connection
- side groundwater flow connection
- unreliable groundwater flow connection

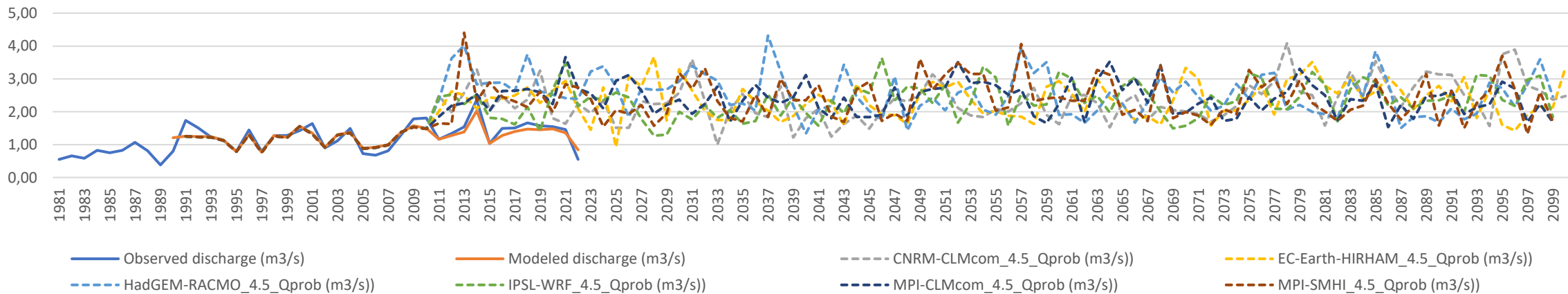
Rezultati – podatkovna baza:

Petrič, M., Ravbar, N., Gostinčar, P., Krsnik, P., & Gacin, M. (2020). GIS database of groundwater flow characteristics in carbonate aquifers: Tracer test inventory from Slovenian karst. *Applied Geography*, 118, 102191.

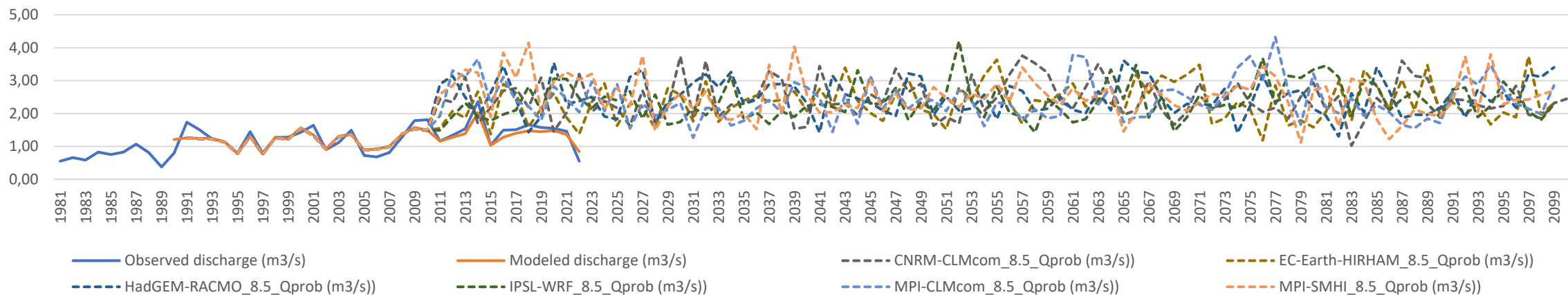
<https://doi.org/10.1016/j.apgeog.2020.102191>

# ZELENCI - PRETOČNE RAZMERE

## RCP 4.5

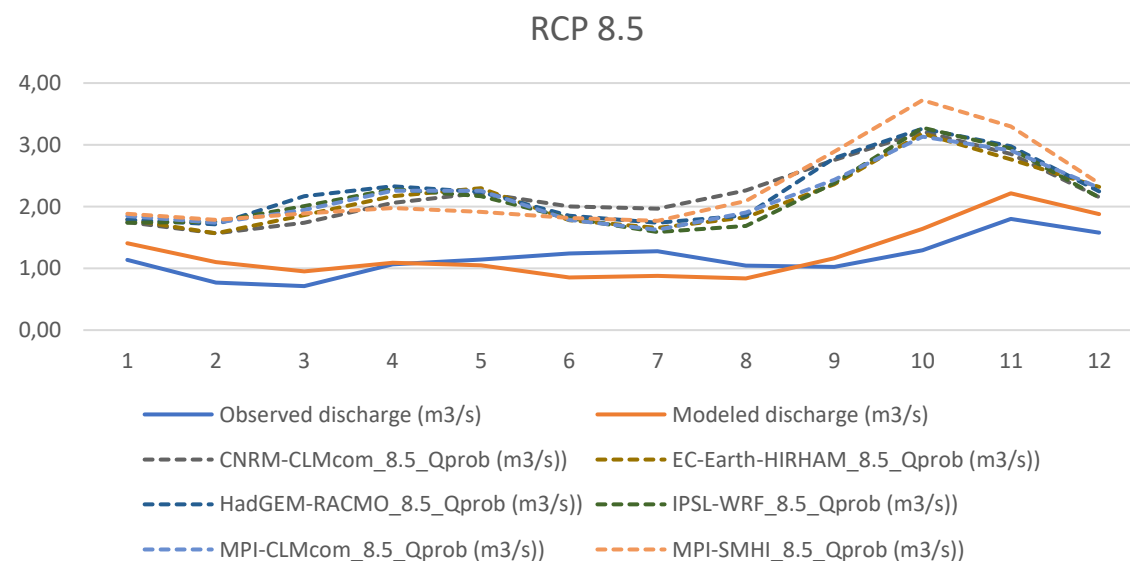
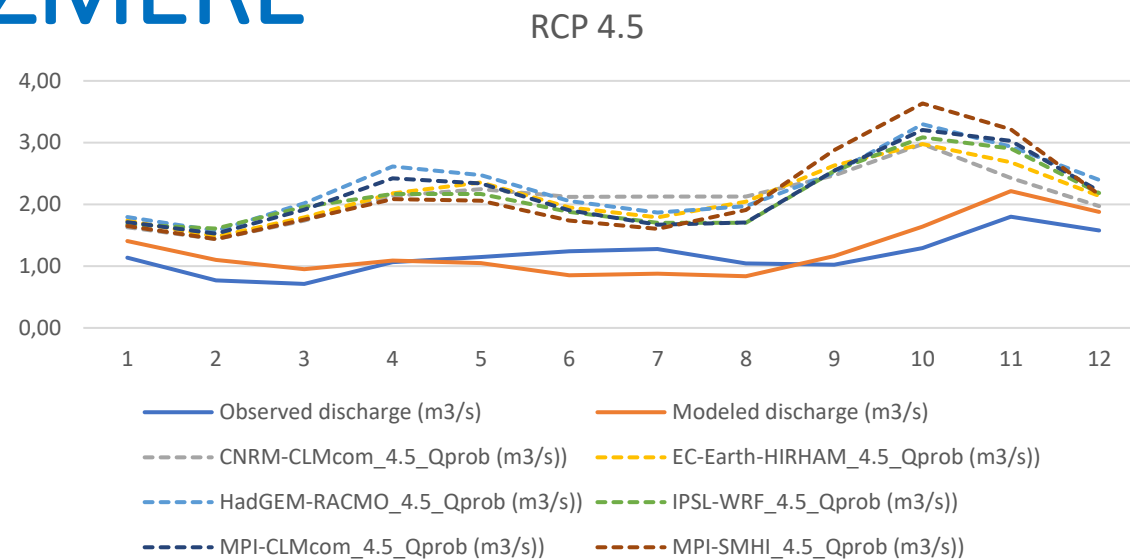


## RCP 8.5



# ZELENCI - PRETOČNE RAZMERE

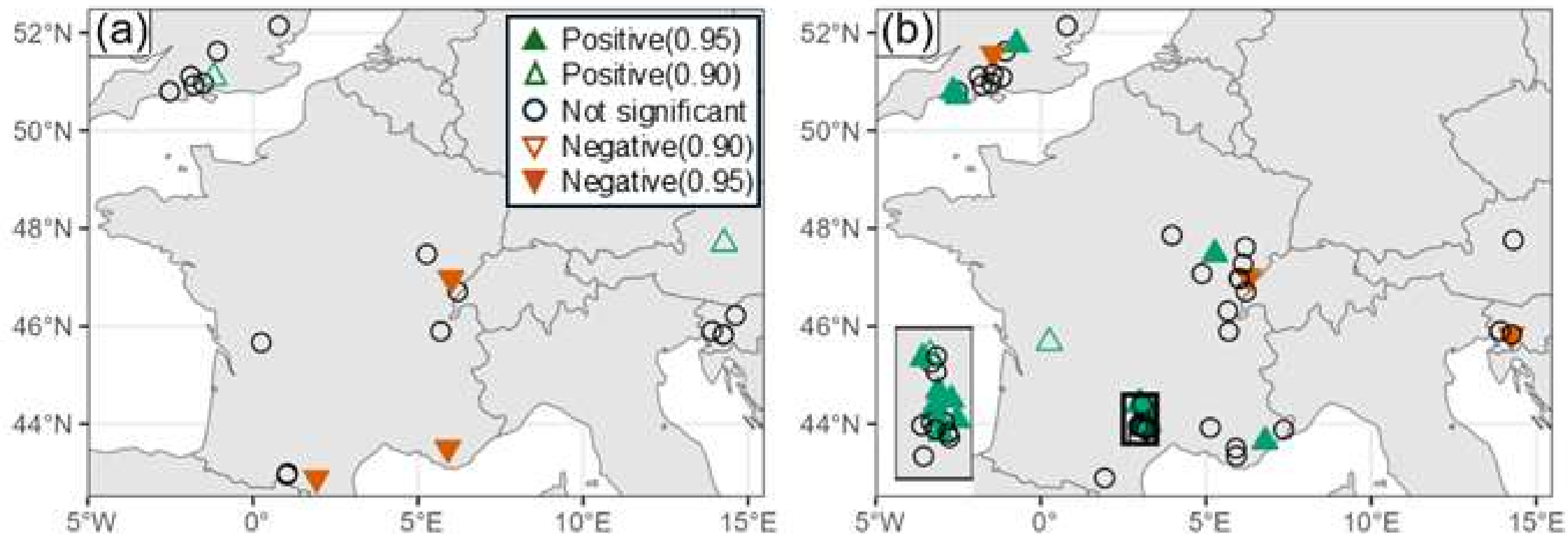
- povečanje Q spomladi (predvsem mar) in jeseni (okt) - premik jesenskega “vrha” proti zgodnejši jeseni;
- **Zgodnje-zimsko (nov, dec) + poletno znižanje Q (jul);**
- Največji razpon je v **jeseni**.



# TRENDI PRETOKOV

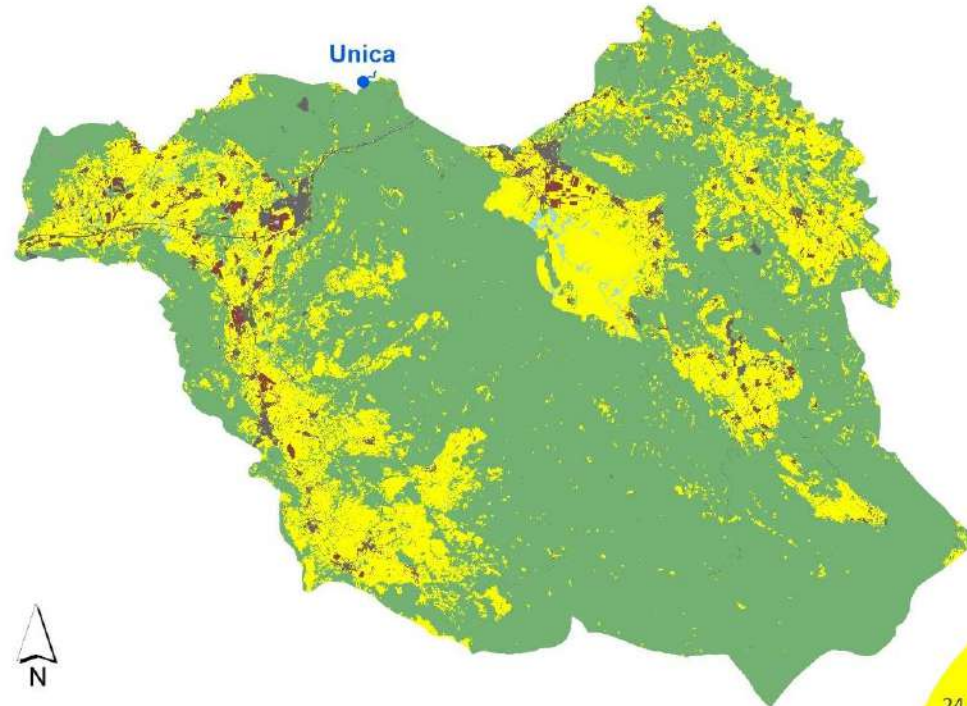
a) v 40-letnem (1982–2021) in

b) 20-letnem (2002–2021) obdobju.

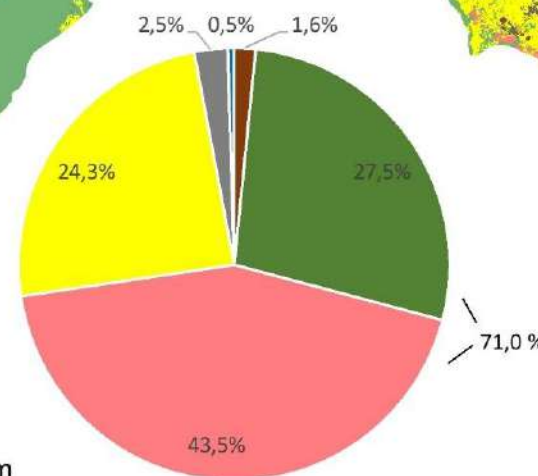
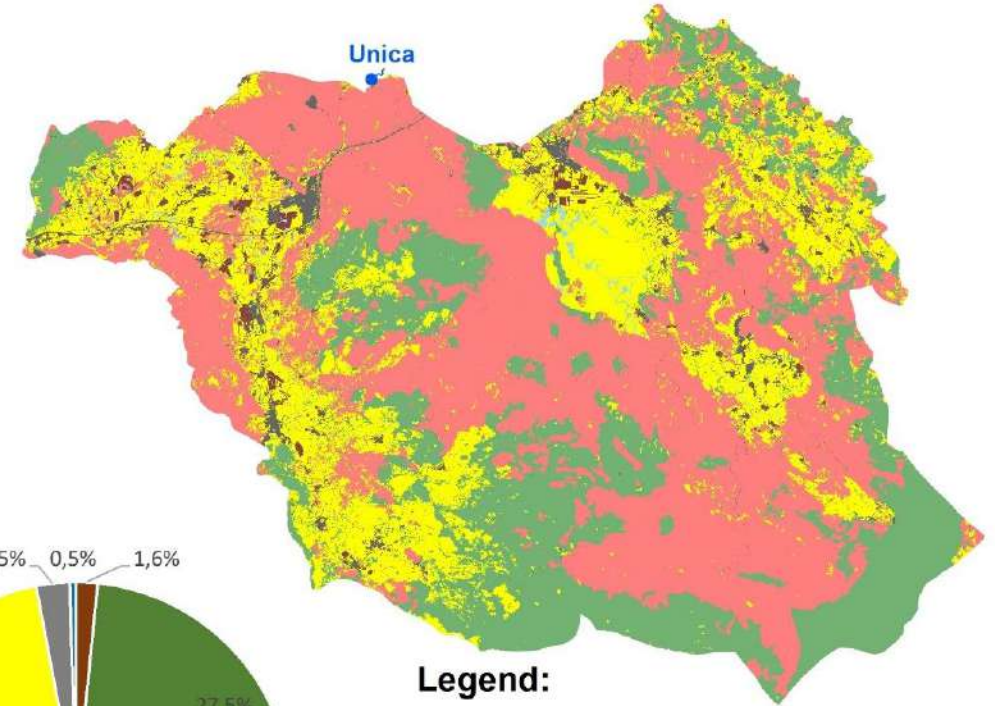


# SPREMEMBA RABE TAL

LAND USE IN THE UNICA CATCHMENT IN 2014



LARGE-SCALE FOREST DISTURBANCES IN 2014-2018



**Legend:**

- karst spring
- large-scale forest disturbances
- fields and gardens
- pastures and meadows
- forest and abandoned agricultural land
- urbanized areas
- water and wetland



Vse dosegljivo spodjeda  
in nosi s sabo, umiva in spira  
zablode časa, zagate dedov,  
zaupanje vnukov, nevero,  
zanos in zasluge in vse umirja  
na pravo mero.

(Pesem o reki, Tone Pavček)

