REPUBLIC OF SLOVENIA | MINISTRY OF THE ENVIRONMENT AND SPATIAL PLANNING

Global Water Partnership Mediterranean

MIO-ECSDE

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Capacity Building Workshop on
"Shared Groundwater Resources Management"

2 – 4 December 2008 / Postojna, Slovenia

MANAGEMENT OF GROUNDWATER BIODIVERSITY

threatened by pollution, water use and climate change

prof. dr. Anton BRANCELJ

National Institute of Biology, Ljubljana

NIB

EUWI MED EU WATER INITIATIVE

GEF

IW | LEARN

UNESCO

SAVA RIVER BASIN COMMISSION

TOPICS

- Definition of subterranean aquifers
- Structure and ecological differences between aquifers
- Fauna and biodiversity – in general
- Specific habitats

- Subterranean fauna in Slovenia & Balkan peninsula
- International activities/projects on GW biodiversity

- Case study of cave Škocjanske jame
- Case study of cave Križna jama

GROUNDWATER AQUIFERS - classification

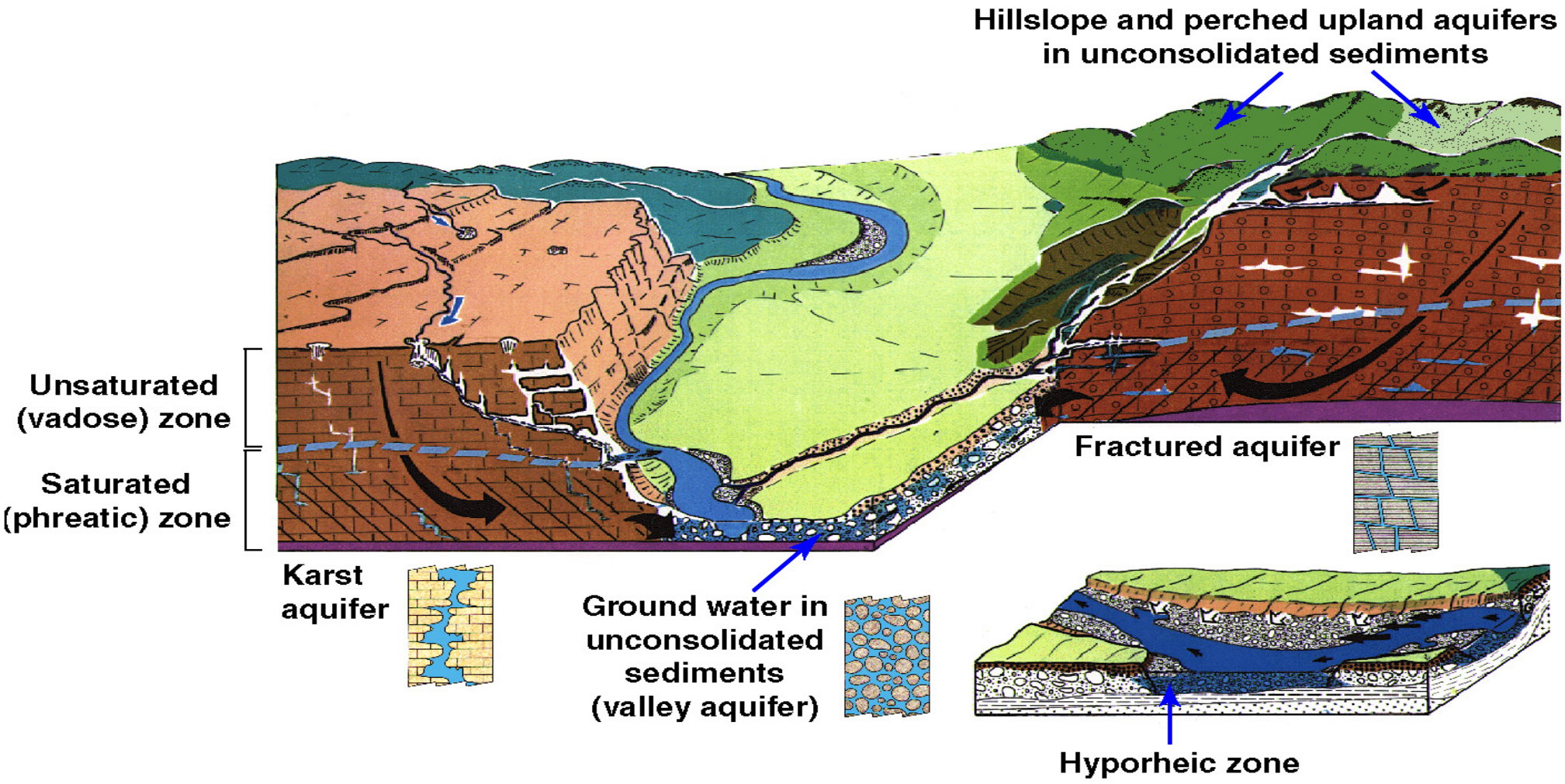
- **Karstic aquifers** (= caves in limestone) - < 8000 SLO



- **Porous aqifers** (= gravel beds & alluvial plains)



CONNECTIONS BETWEEN KARST & POROUS AQUIFERS



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COMMON CHARACTERISTICS

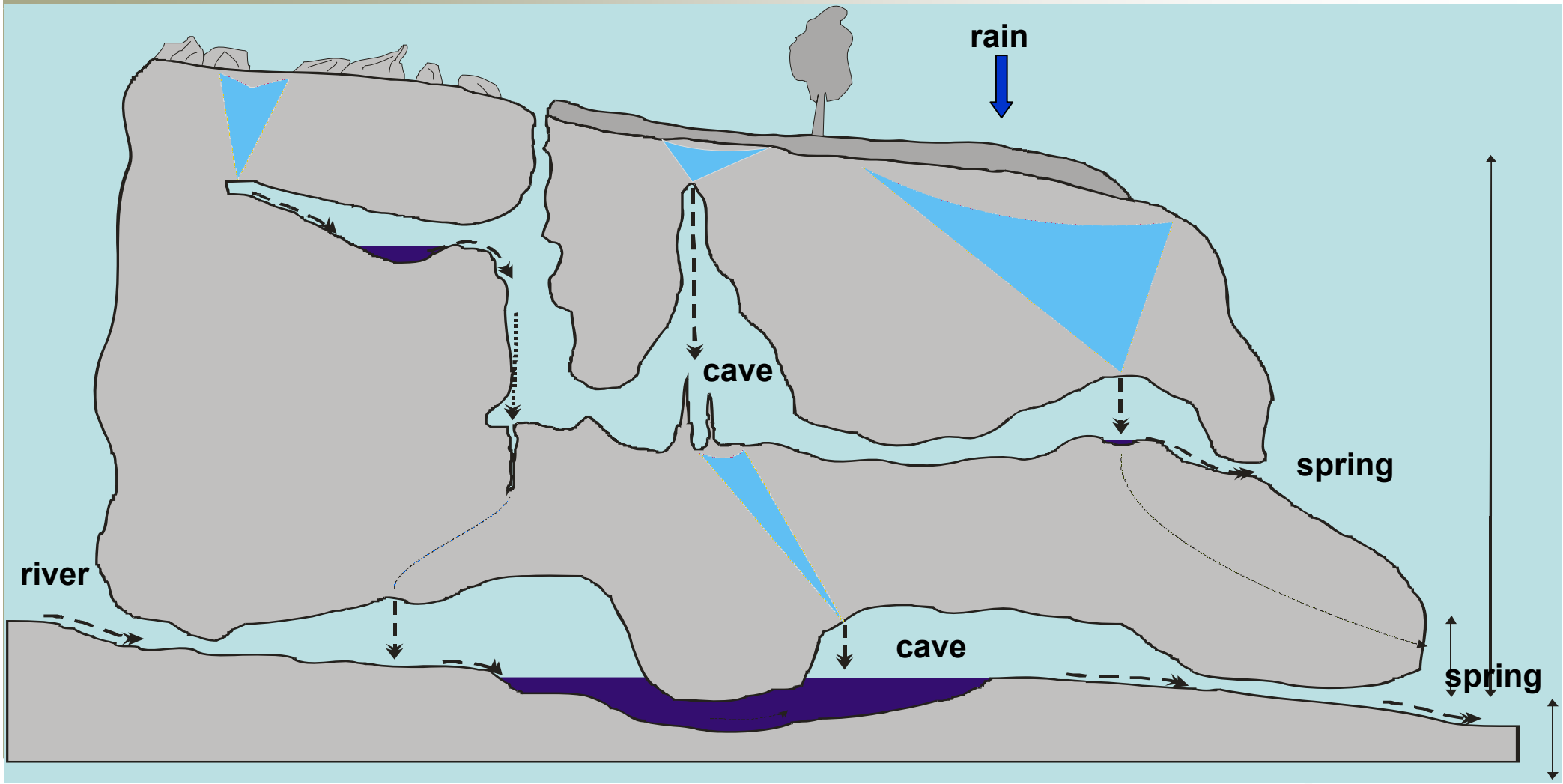
- complete darkness
- dependant on food from surface ecosystems
- connected with surface (precipitation, rivers)
- low oscillations in physical and chemical parameters
- vulnerable (i.e. low self-purification capacity)
- small to large storage capacity
- source for drinking water, irrigation, industry

- **living place of true groundwater animals (stygobionts)**

DIFFERENCES BETWEEN AQUIFERS

- connectivity within systems (low in karst; high in porous)
- distribution (karstic aquifers only on limestone; fissured elsewhere)
- size of space (high in karst; small in porous)
- speed of water movement (m & km in karst; mm in porous)
- different fauna (better studied in karst than in porous aquifers)
- size of animals (mm - dm in karstic; > mm in porous)

CROSS-SECTION OF KARSTIC AQUIFER



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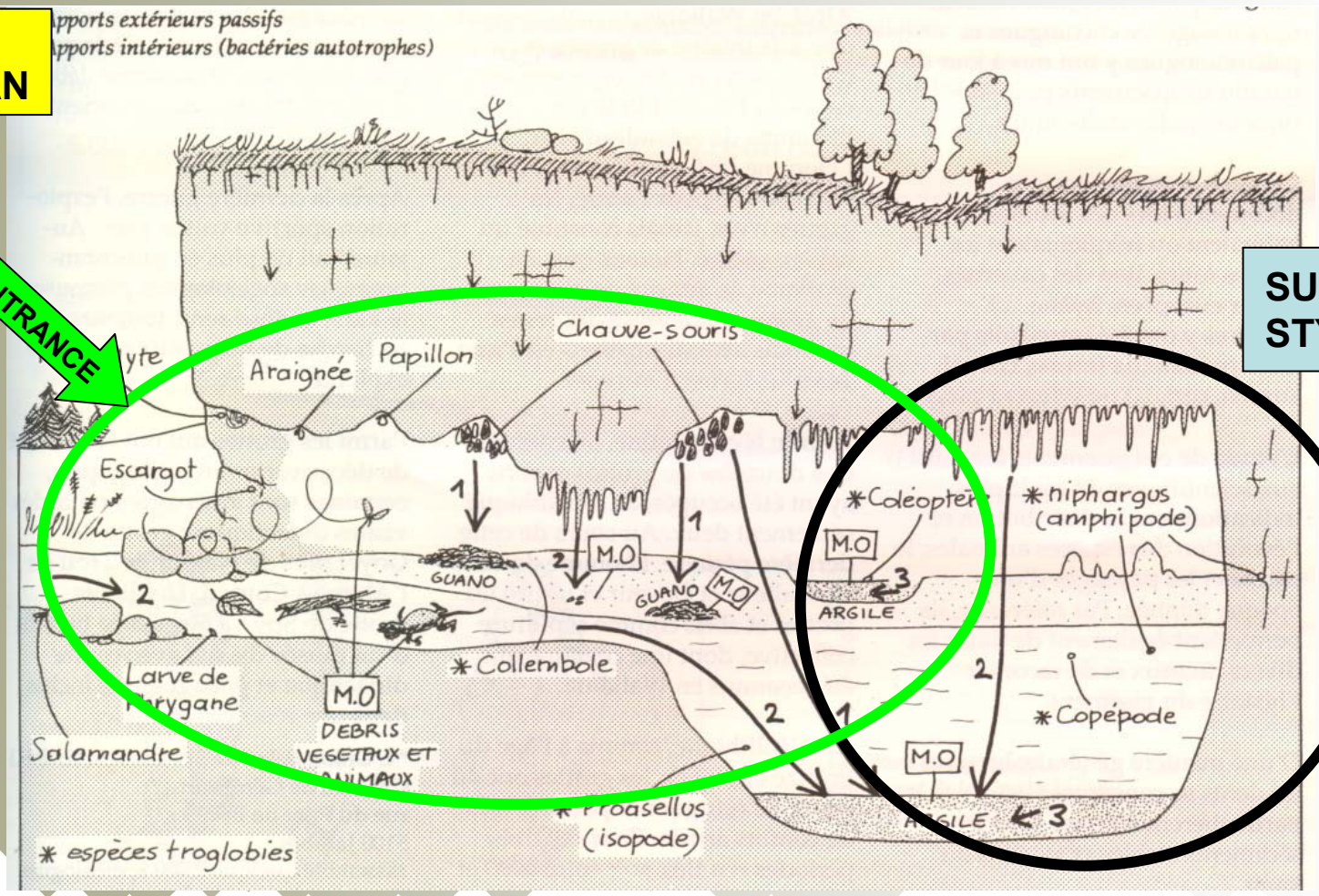
FAUNA IN KARSTIC AQUIFERS

EPIGEAN & SEMI-EPIGEAN



SUBTERRANEAN = STYGOBIONTS

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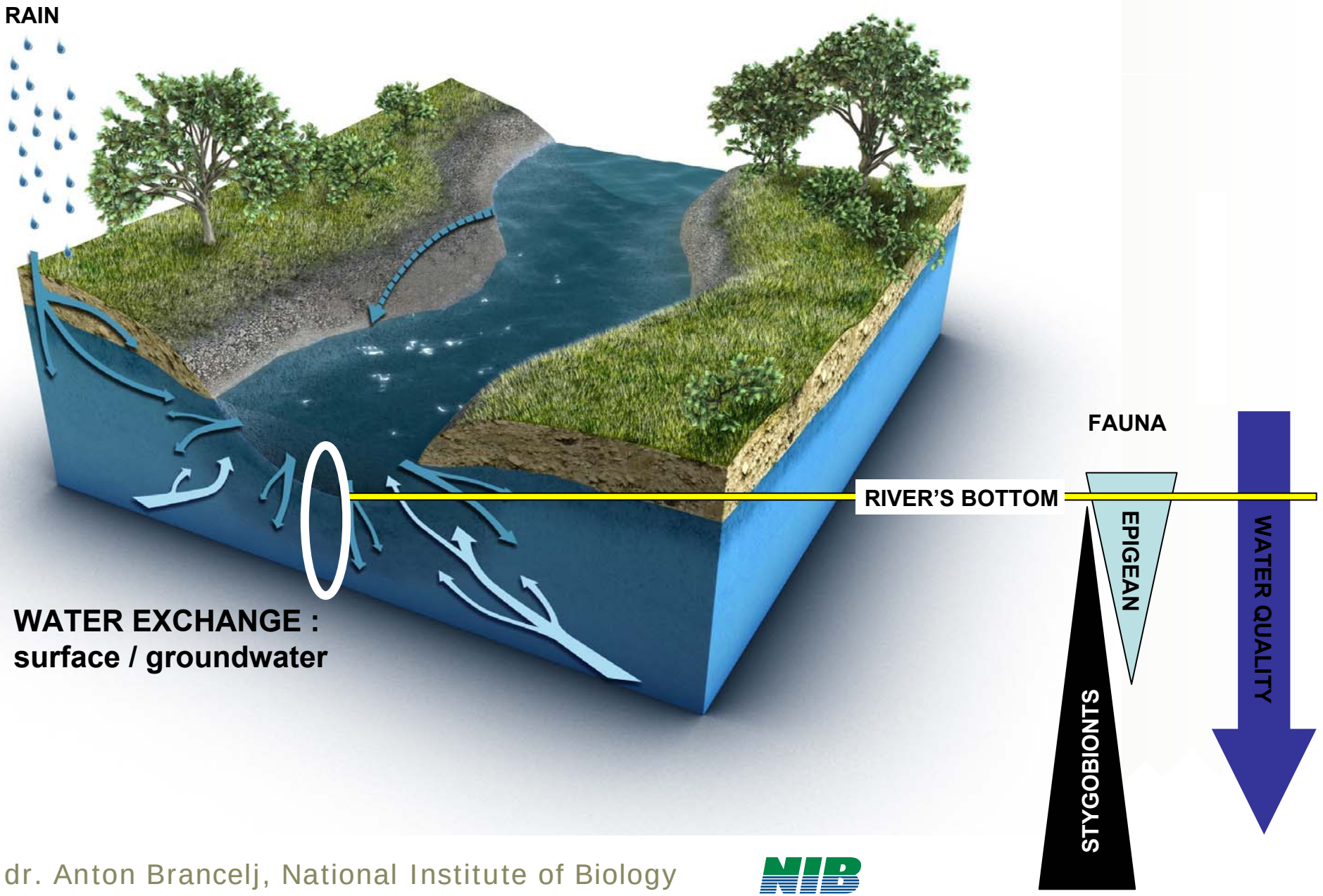
CROSS-SECTION OF POROUS AQUIFER



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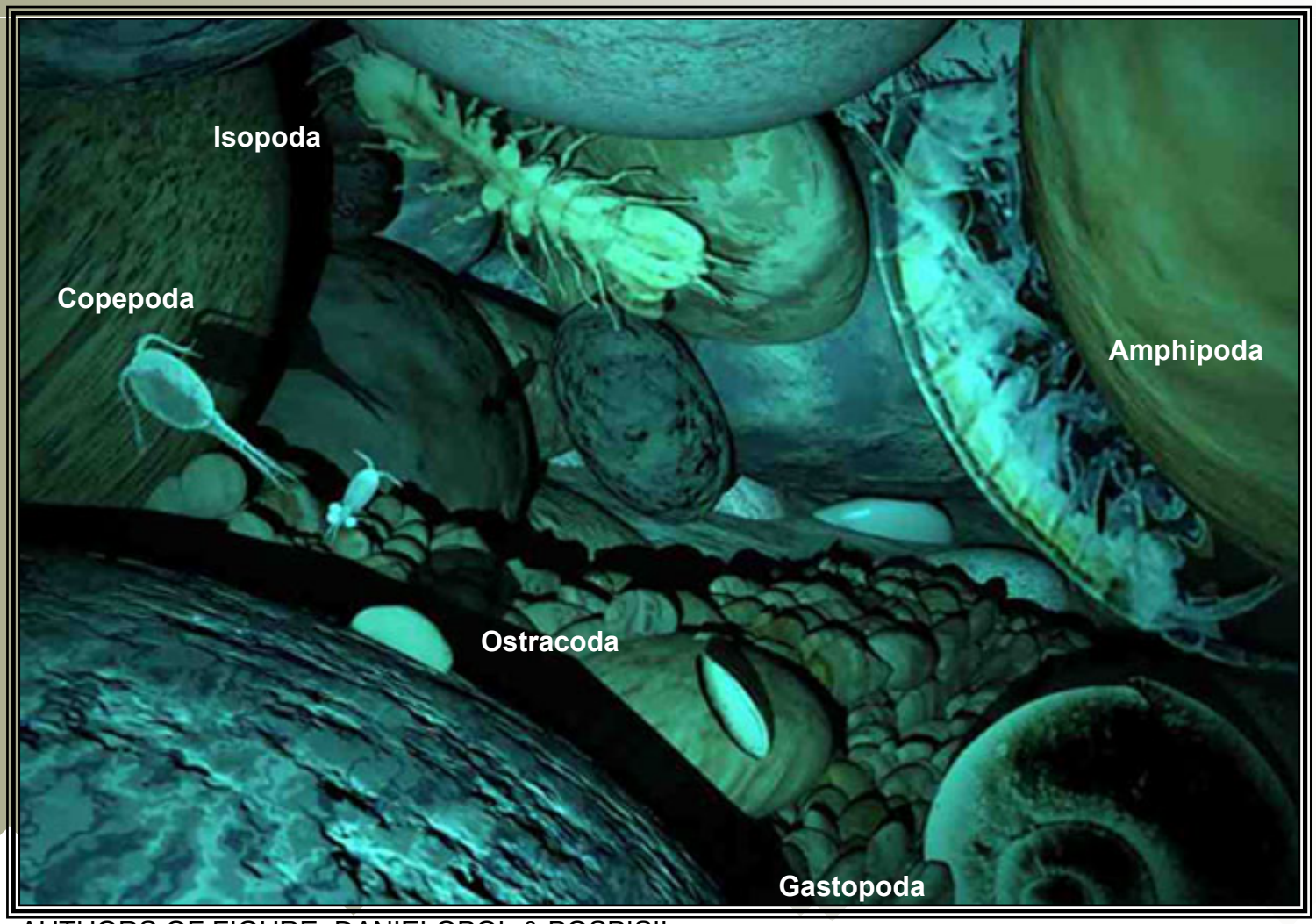
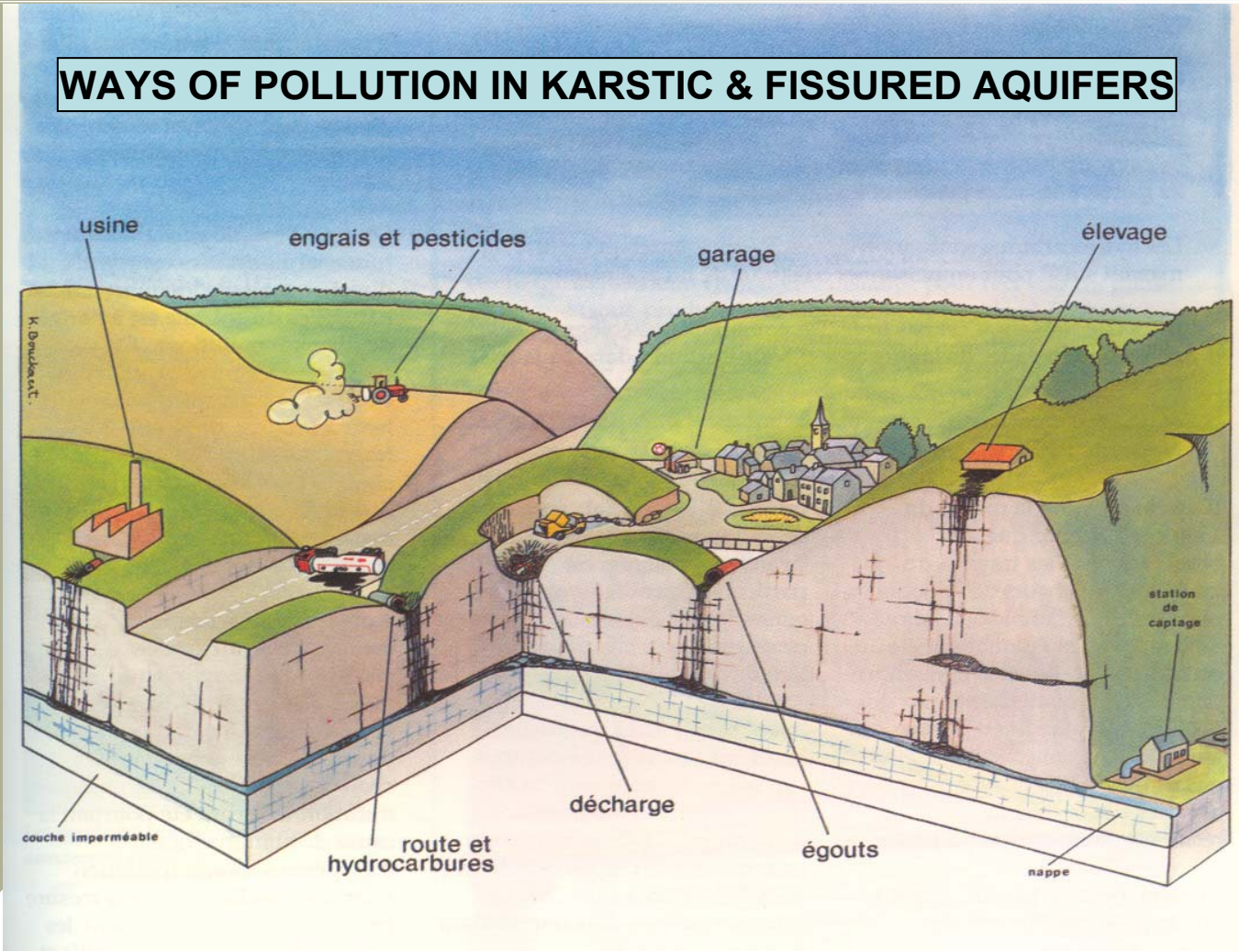
FAUNA IN POROUS AQUIFERS



AUTHORS OF FIGURE: DANIELOPOL & POSPISIL

THREATS ON GROUNDWATER AQUIFERS



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BIODIVERSITY in Water **F**ramework **D**irective

- SURFACE WATER BODIES – “good ecological status”
  - morphology / typology / size of water body
  - ecosystem’s approach - based on composition of fauna and flora
  - reference conditions determined

- GROUNDWATER BODIES – “chemical status”
  - only water quality (chemical) and quantity
  - subterranean fauna not included
  - reference conditions not determined (!?)
  - complete inconsideration of specificity of karstic aquifers

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DEFINITION of BIODIVERSITY

A) number of species in a given space
B) depends on number of specimens and species

EXAMPLE: 100 specimens and 10 species

$H^* = -\sum(ni / N) \log (ni / N)$ – Shannon-Wienner diversity index

AA	BB	CC	DD	EE	FF	GG	HH	KK	LL	
10	10	10	10	10	10	10	10	10	10	= 1.000 (the most UNIFORM)
1	1	1	1	1	1	1	1	1	91	= 0.217 (the most EXTREME)

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GROUNDWATER BIODIVERSITY: GLOBAL SCALE

- Biodiversity in Slovenia: 170 - 200 taxa (approx.)

- Biodiversity in Europe: 1500 - 1600 taxa (approx.)

- Biodiversity in World: 2500 - 3000 taxa (approx.)

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GROUNDWATER BIODIVERSITY: REGIONAL SCALE

DINARIDS & BALKAN (part):

region:	No. of stygo.	Area	No. per 100 km2
Slovenia	170	15 000	1.13
Istra	24	3 600	0.67
Croatia	102	25 500	0.40
Bosnia & Herzegovina	99	51 000	0.19
Serbia	15	33 800	0.04
Montenegro & Kosovo	55	24 500	0.22
Macedonia	100	14 000	0.71

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PECULARITIES OF GROUNDWATER FAUNA

-most of stygobionts are endemic = restricted to small area or single location (!)

- highly endangered – destruction of habitats (pollution, change of water regime)

- some groups very common (with many species) but some very unique (one or few species only)

COMMON *vs*. UNIQUE GROUPS

COMMON GROUPS:
- Amphipoda
- Isopoda
- Copepoda
- Gastropoda

Amphipoda: c. 200 taxa

Isopoda: c. 100 taxa

Copepoda: c. 200 taxa

Gastropoda: c. 200 taxa

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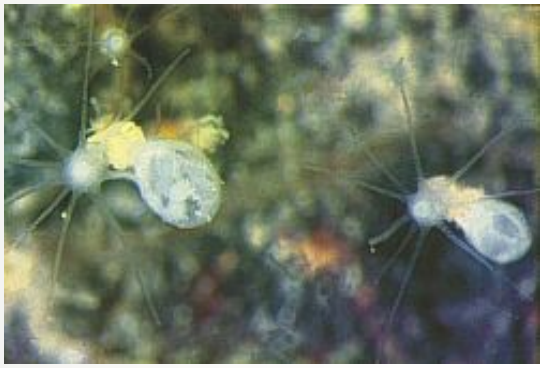
COMMON *vs*. UNIQUE GROUPS

UNIQUE GROUPS (known from the Dinaric region only):

- Porifera – *Eunapius subterraneus*
- Hydrozoa – *Velkovrhia enigmatica*
- Bivalvia – *Congeria kuesteri*
- Polychaeta – *Marifugia cavatica*
- Cladocera – *Alona hercegovinae*
- Amphibia – *Proteus anguinus*

EUNAPIUS SUBTERRANEUS: Jedina slatkovodna podzemna spužva na svijetu živi na području Ogulinsko - Plašćanske krške zaravni

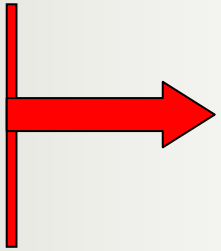
BRANKO JALŽIĆ



CHARACTERISTICS OF STYGO-FAUNA

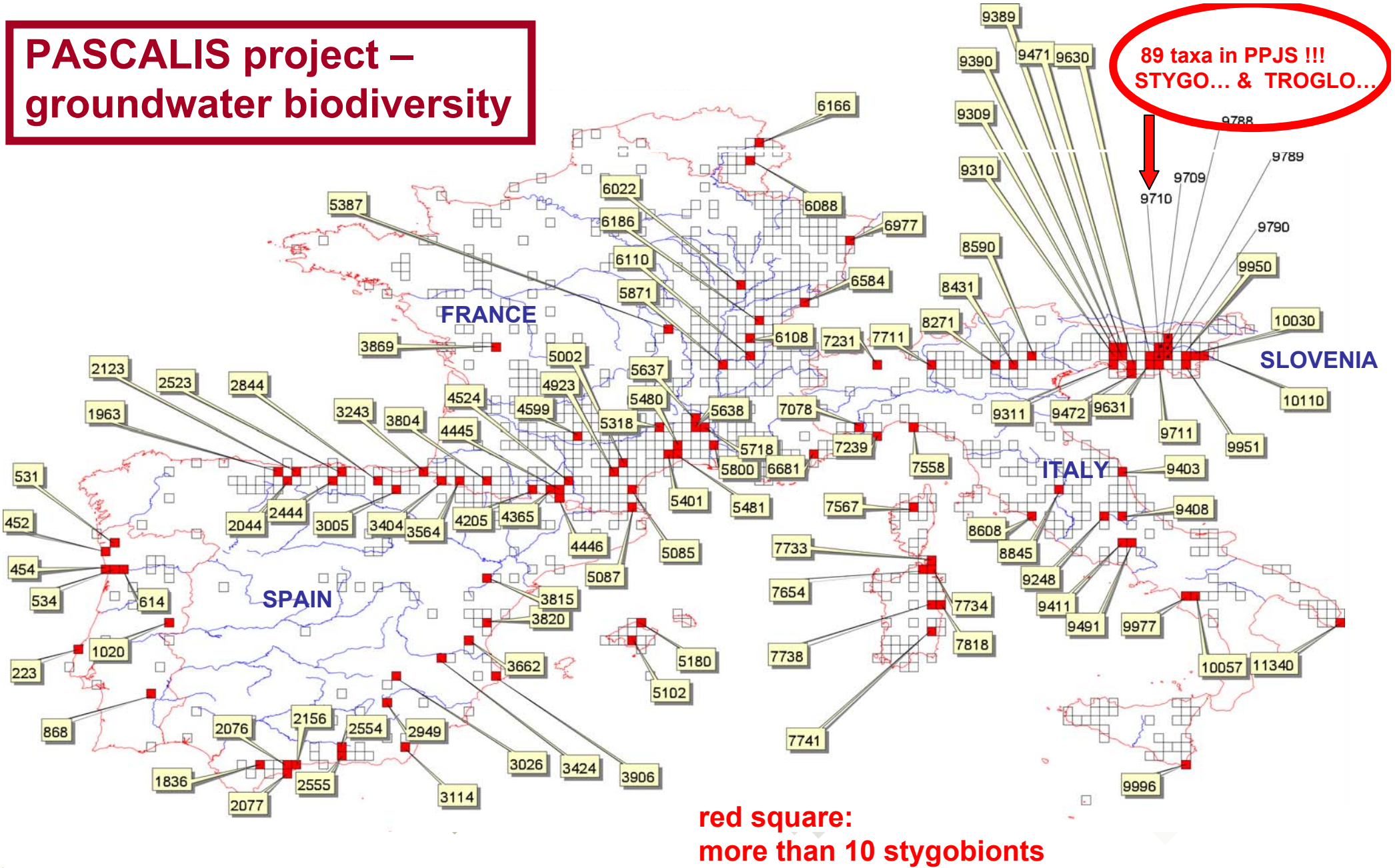
- Small
- Blind
- Pale / white
- Elongated legs and antenules
- Representatives of old fauna

- Slow reproduction
- Few off-springs per clutch
- Endemic
- Not able to compete with epigean fauna



make them vulnerable

PASCALIS project – groundwater biodiversity



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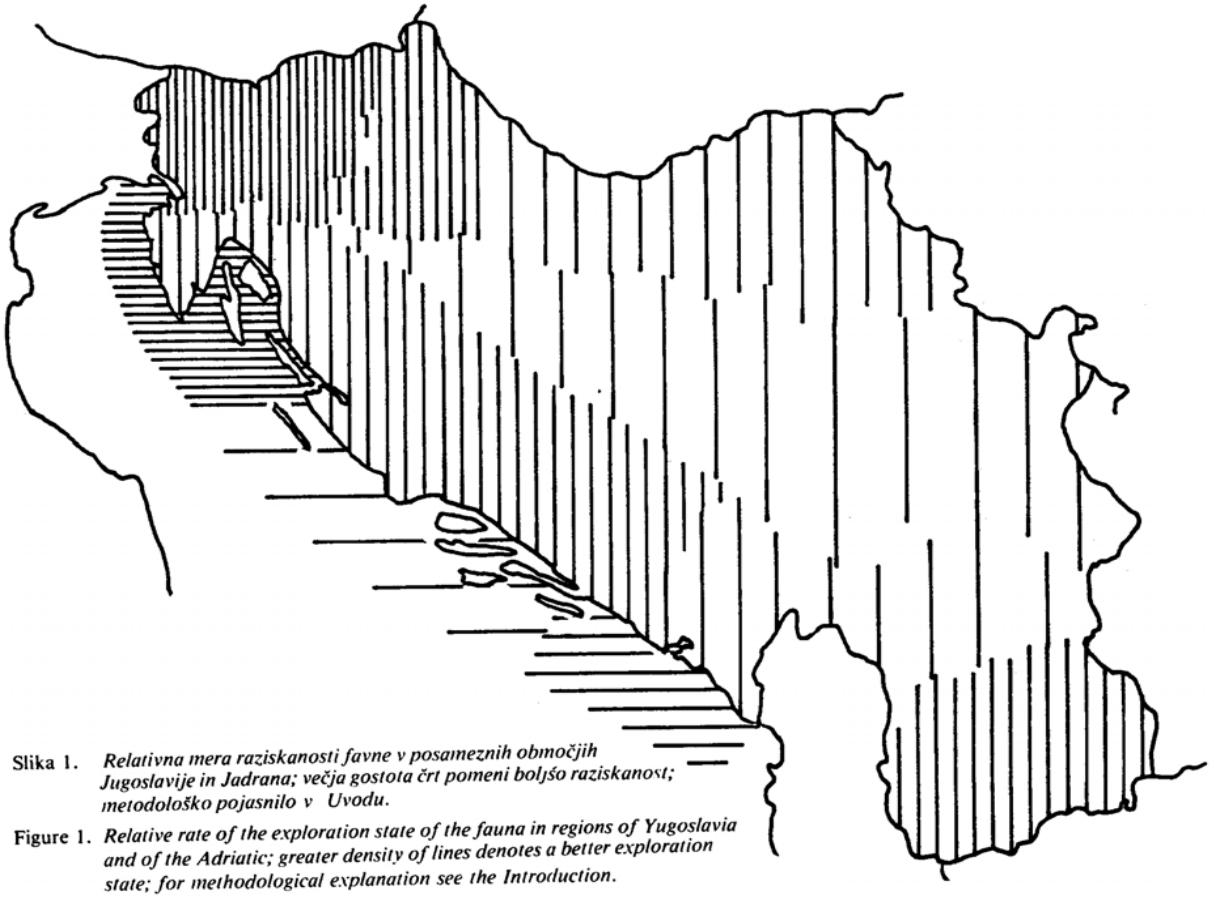
RELATIVE KNOWLEDGE ON GROUNDWATER BIODIVERSITY (data from 1990)



Slika 1. *Relativna mera raziskanosti favne v posameznih območjih Jugoslavije in Jadrana; večja gostota črt pomeni boljšo raziskanost; metodološko pojasnilo v Uvodu.*

Figure 1. *Relative rate of the exploration state of the fauna in regions of Yugoslavia and of the Adriatic; greater density of lines denotes a better exploration state; for methodological explanation see the Introduction.*

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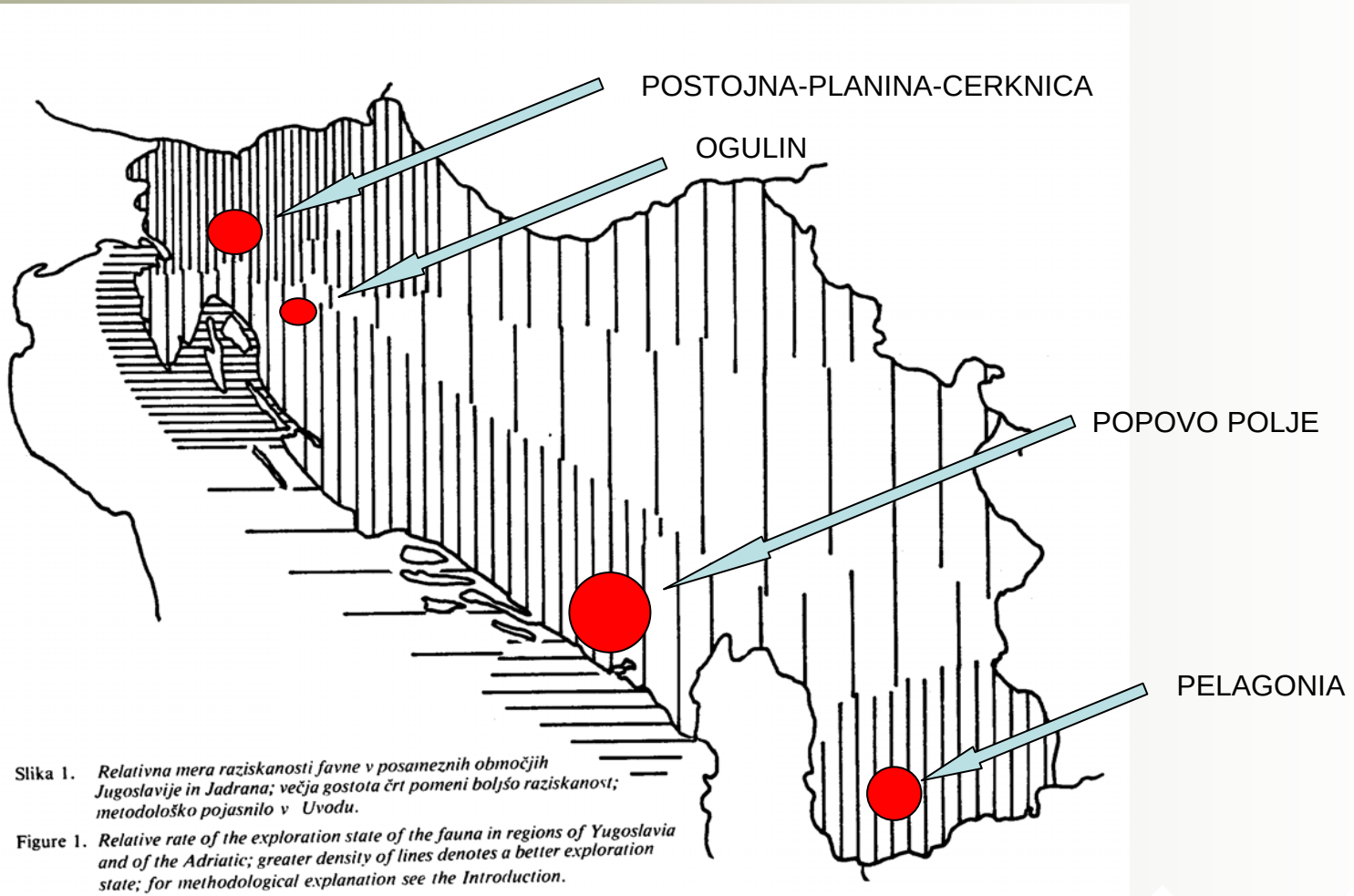
HOT-SPOTS ON GROUNDWATER BIODIVERSITY

(data from 1990)



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UNEXPECTED DISCOVERY – blind *Alonas*

Between 1989 and 1998 three unique and endemic species of blind Cladocera were found in Herzegovina and Slovenia

- *Alona herzegovinae*, Brancelj, 1990 (cave Ljelješnica: H)
- *Alona sketi*, Brancelj, 1992 (cave Osapska jama: SLO)
- *Alona stochi*, Brancelj, 1998 (cave Kompoljska jama: SLO)

UNEXPECTED DISCOVERY – blind *Alonas*

- common opinion on non-existing stygobitic Cladocera

- in fact they are probably relicts from Tertiary

- each species known from one locality only!

- highly vulnerable to pollution = extinction

EPIKARST – specific habitat in the karst

- the first record of epikarst species in 1930 (Kiefer - Škocjanske jame)

- occasionally studied since late 1960' (Rouch, 1968)

- intensively studied after 1999 (several authors; from Slovenia described < 5 species – Copepoda)

- epikarst fauna found also in USA, Brazil, Thailand, ...

- So far: 10 new species from SLO; c. 8 recognised from USA; c. 5 from Brazil; 2 new species from Thailand...

EPIKARST – specific habitat in the karst

- epikarst = few metres thin layer of karst just below the surface

- intensively fractured zone with high capacity of rain-water storage and slow release of it

- very sensitive to pollution and heavily dependant on precipitation (- effect of climate change!)

- rich in specific fauna (stygobionts: Rotatoria, Gastropoda, Copepoda, ….) but not adequately studied

WHERE TO FIND epikarst fauna?

SLOVENIA: LOCATION OF A NEW SPECIES

THAILAND: LOCATION OF A NEW SPECIES

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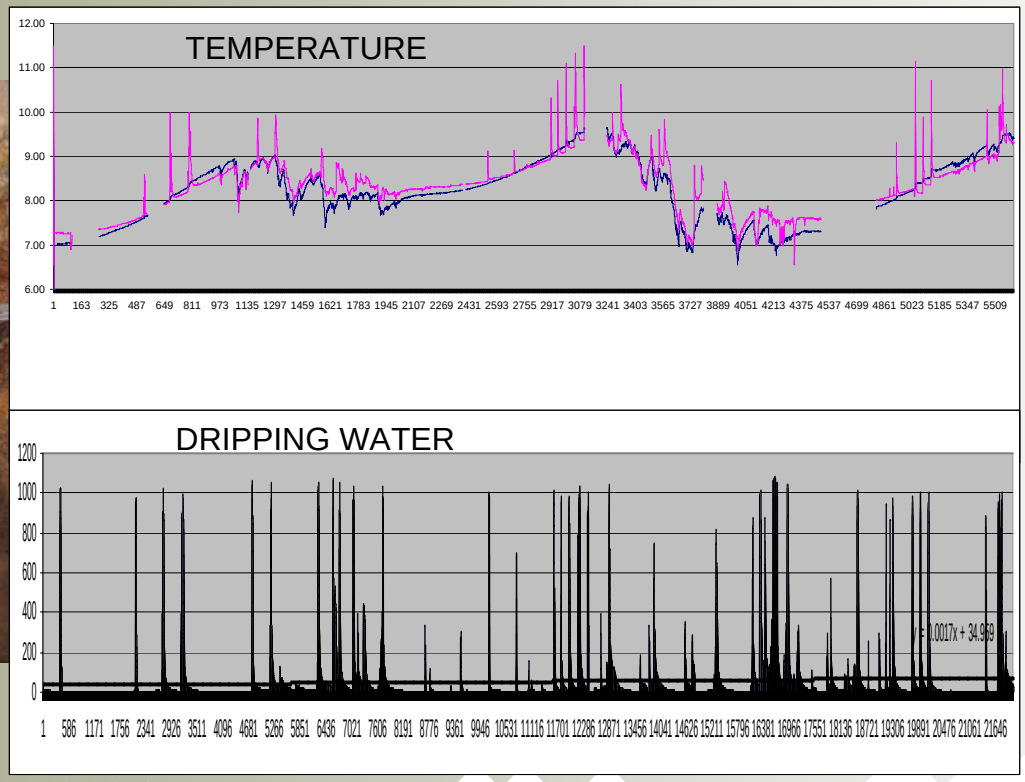
RESEARCH ON EPIKARST FAUNA

- experimental cave : physical and faunistical parameters

(+ 3 new species of Copepoda)



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VALUES OF GROUNDWATER BIODIVERSITY

- natural heritage (of whole mankind)
- national identification (used on stamps, money, ….)
- scientific subject: biology & ecology; paleo-climate; hydrology & geology
- educational importance
- aesthetics values
- turistic atraction (*Proteus anguinus* – "human fish" or cave salamander)
- indicator of water quality and quantity

Considering above mentioned facts:
GROUNDWATER BIODIVERSITY HAS AN ECONOMICAL VALUE!

PROMOTION OF GROUNDWATER FAUNA

in SLOVENIA

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INTERNATIONAL ACTIVITIES

In Europe several national organisations, countries or international associations try to increase activities on research and protection of groundwater fauna

- incl. within WFD

An example:

Biodiversity of surface waters, floodplains and groundwater; Bonn, 29.-30. Oct. 2008

(Bundesministerium fuer Umwelt, Naturschutz und Reaktorsicherheit)

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EPBRS: Research priorities (Brdo, Jan. 2008)

- Survey and inventory biodiversity-rich but poorly known ecosystems including karstic lakes, …, hyporheic zones;

- Understand community dynamics and biogeographic distribution patterns;

- Develop and maintain long-term, regular monitoring in freshwater ecosystems;

- Develop new specific bio-indication tools and base future tools on process-based rather than statistical models;

- Develop methods for defining and gathering reference or baseline conditions;

- Assess the value of biodiversity in small, more-or-less isolated water bodies such as ponds, small lakes, ditches;

PASCALIS project – 4th EU WP

PASCALIS = **P**rotocols for the **AS**sessment and **C**onservation of **A**quatic **L**ife **I**n the **S**ubsurface (2001 – 2004)

Countries: Belgium, France, Slovenia, Spain

Aims: - to collect information on already known groundwater biodiversity (*in participating countries only*)

- to estimate potential groundwater biodiversity based on statistical analyses

- to develope a standard methods for collection / study of groundwater biodiversity

- to establish protocols for assessment and protection of groundwater hot spots in biodiversity

WHY PASCALIS PROJECT?

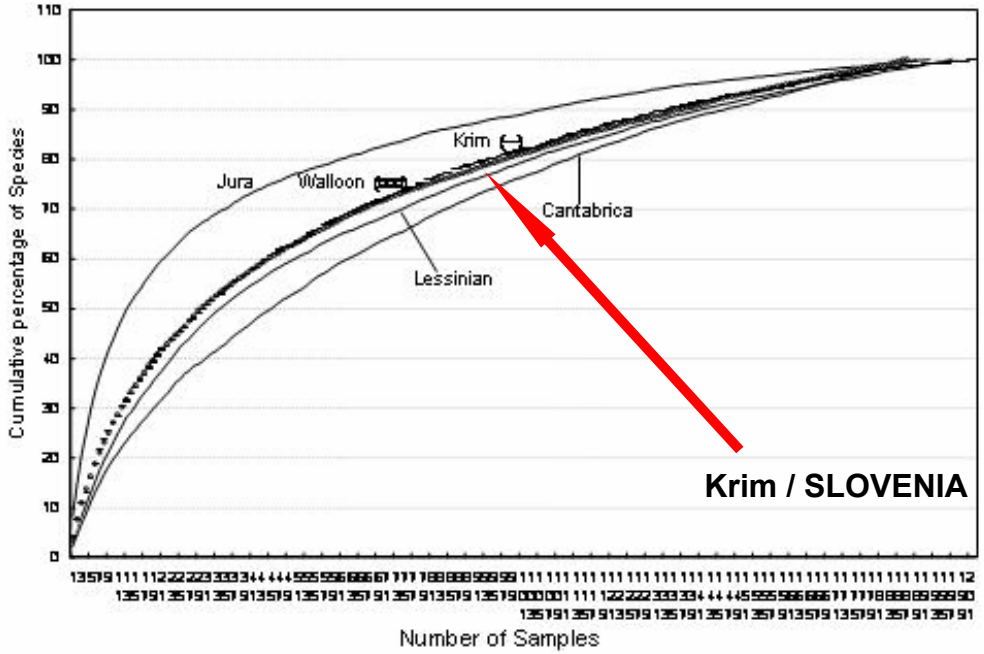
- existing knowledge on groundwater biodiversity was very “patchy” and non-consistent

- however, it indicates high potential of biodiversity

- WFD didn’t include groundwater biodiversity as indicator of ecological status

HIGH GROUNDWATER BIODIVERSITY

SPECIES RICHNESS ACCUMULATION CURVE FOR FIVE REGIONS



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IMPORTANT !!

Known number of stygobionts are not only a result of paleoclimate, geology and ecology but also a result of intensity of research activity in a certain region....

.... **IT IS CORELATED** with a number of specialists (i.e. taxonomists!) for groundwater biodiversity

AT THE MOMENT THERE IS A DEFICIT OF QUALIFIED SCIENTISTS / TAXONOMISTS/ STUDYING GROUNDWATER FAUNA ALL OVER THE WORLD!!!

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VISION:

COMMON AND WELL-RECOGNISED ACTIVITY TO PROTECT GROUNDWATER FAUNA

BASED ON PRINCIPLES OF SUSTAINABLE DEVELOPMENT

WITH NO THREAT OF POLLUTION OR OVER-EXPLOATATION OF GROUNDWATER

(role of climate change?)

ŠKOCJANSKE JAME – story of success

The cave system ŠKOCJANSKE JAME:

river with two names and two faces

REKA (Slovenia) – TIMAVO (Italy)

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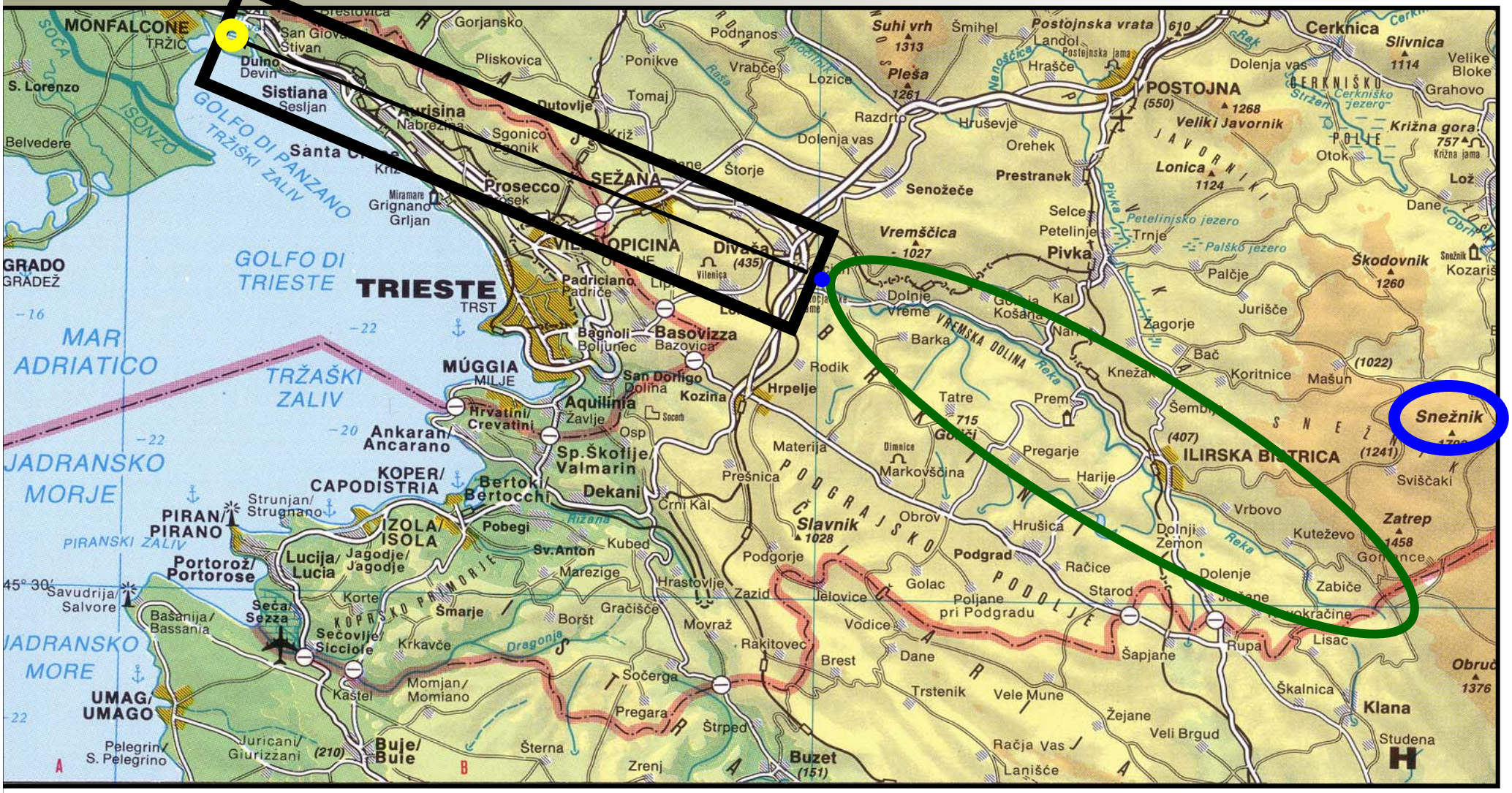
Some facts: - catchment area (epigean part only): 323 square km
- length of the surface river network: 617 km
- spring to source - as crow fly: 110 km



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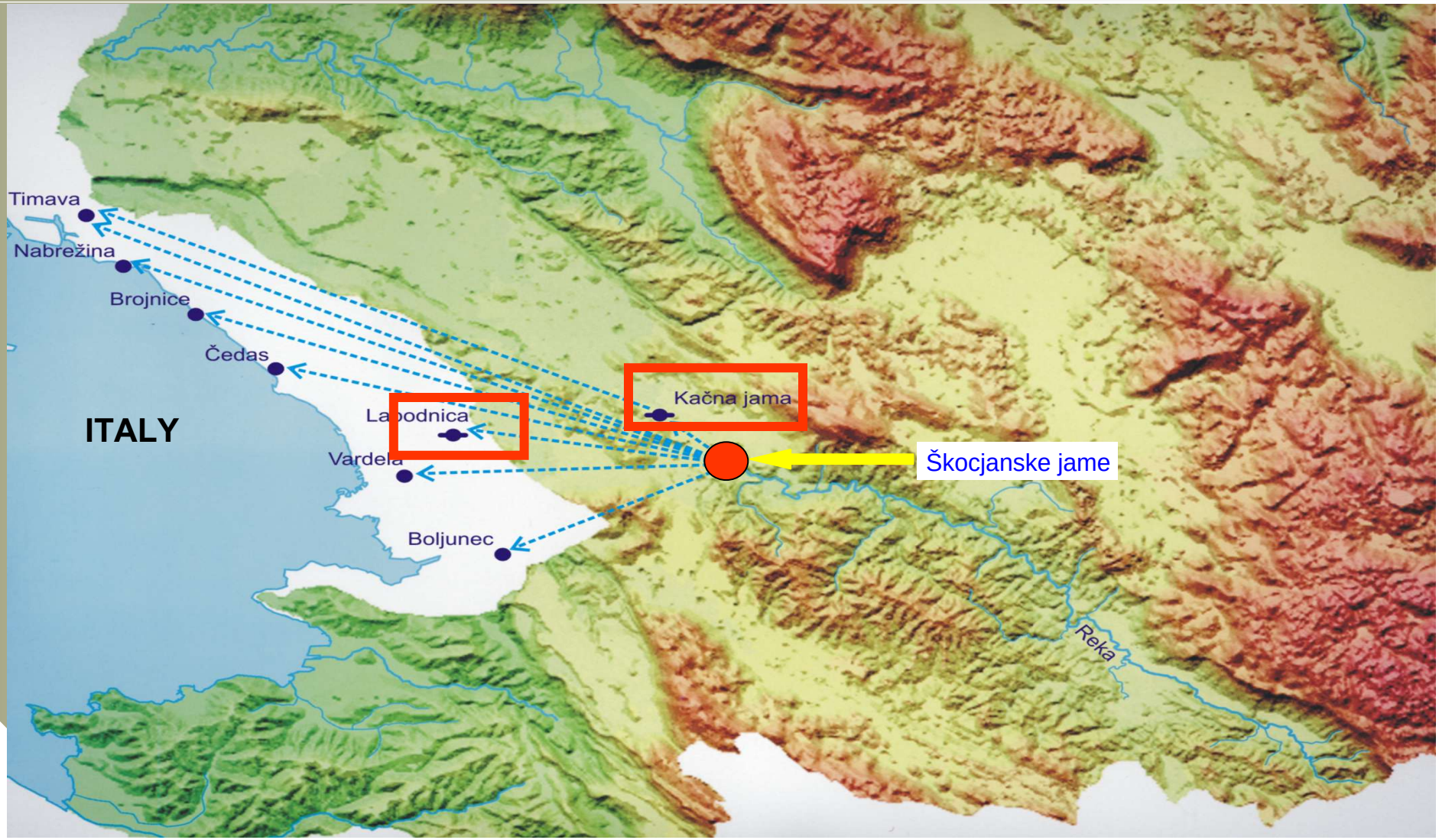
HYDROLOGICAL CONNECTIONS



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HISTORY OF PARK ŠKOCJANSKE JAME

- **UNESCO world (natural) heritage** – since 1986

- **Ramsar site:** Underground Karst Wetland – since 1999

- **Natura 2000** – since 2000

- **M&B (UNESCO):** The Karst Biosphere Reserve - since 2004

Škocjan Caves Park Public Service Agency: established on 27.01.1997

LOCAL POPULATION IS ACTIVELY INVOLVED IN A POLICY OF THE PARK!

BIODIVERSITY IN ŠKOCJANSKE JAME

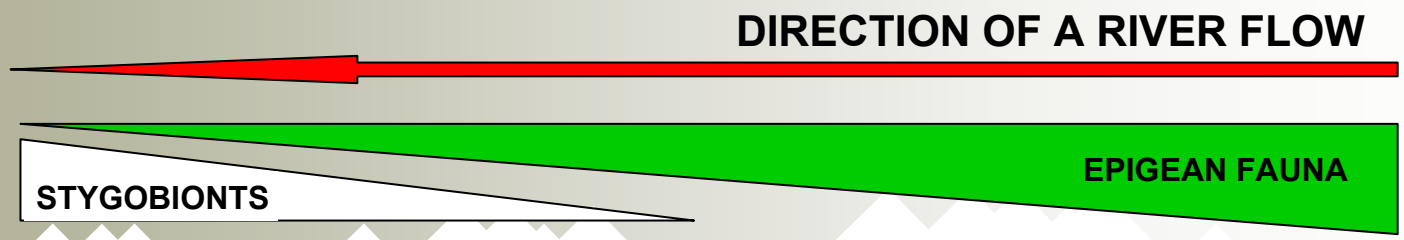
FAUNA IN THE RIVER REKA:

Epigean part:

fauna typical for inland water (dominance of insects' larvae)

Subterranean part:

heavilly polluted in the past (between 1960 -1988)
improving in the last decade (actually since 1991)
stygobiont fauna not very rich



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STYGOFAUNA OF THE RIVER

SOME REPRESENTATIVES OF STYGOBIONTS FROM THE TIMAVO RIVER:

Niphargus timavi – endemic

Marifugia cavatica

Sphaeromides virei

Asellus aquaticus cavernicolus

Troglocaris sp.

POLLUTION PROBLEMS

SURFACE PART OF THE RIVER:

- heavily polluted with industry (TOK) till end of 1980’
- pollution stopped after 1991

SUBTERRANEAN PART:

- heavilly polluted in the past
- fauna in the main channel completely extinct
- some springs in Italy used as souce of drinking water (!)
- after 1991 significant improvement of water quality

STYGOFAUNA OF THE EPIKARST

EPIKARST IN THE ŠKOCJANSKE JAME

- very rich in fauna of Copepoda (15 taxa)

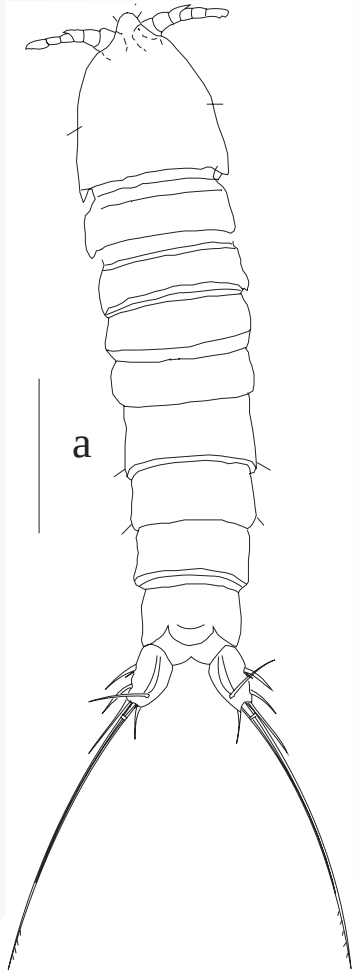
- a lot of endemics

- not directly connected with the river

The first epikarstic species of Copepoda described from the cave Škocjanske jame:

Morariopsis scotenophila (Kiefer, 1930)
Speocyclops infernus (Kiefer, 1930)

Morariopsis scotenophila



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KRIŽNA JAMA - endangerment of groundwater biodiversity






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CAVE WITH 22 LAKES AND RICH FAUNA

Cave Križna jama:

the third Slovenian cave inscribed as a member of International Show Caves Association

- known since 1832; the most important discovery in 1926
- actual length: 8273 m
- 22 lakes with crystal-clear water
- rich in cave fauna (terestrial and aquatic, cca. 45 taxa)
- important location on remains of cave bears

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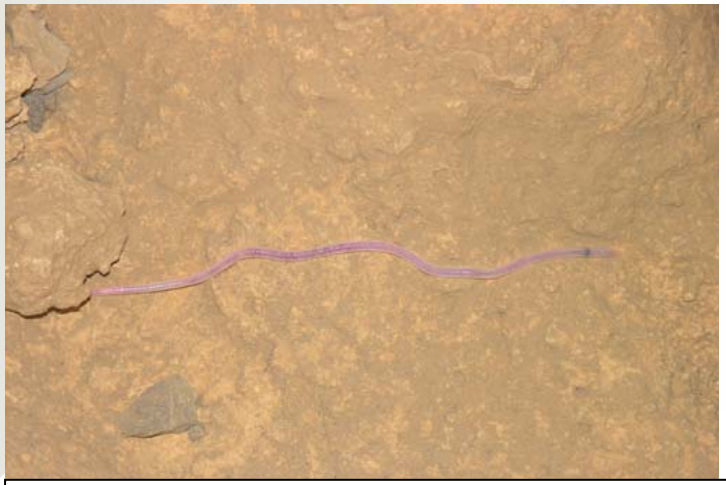
POLLUTION CAUSED BY NEW WWTP

OUTLET FROM WASTE-WATER TREATMENT PLANT

CRYSTAL-CLEAR WATER IN THE MAIN CHANNEL

FOAMS IN THE MAIN CHANNEL - DOWNSTREAM

March 2008



REPRESENTATIVE OF STYGOBIONT (RAIN-WORM)

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NGO SENT A COMPLAINT TO EC TO PROTECT GW BIODIVERSITY

Sep. 2007 – information of DPKJ on preliminary start of WWTP
Oct. 2007 – DPKJ sent protest to ARSO & Minister, media
– reference conditions for water quality analyses (NIB)
– MOP declare DPKJ as NGO with special interest for activities on nature preservation
Dec. 2007 – tracing experiment (IZRK)
Mar. 2008 – WWTP officially started, tracing results
– DPJK sent protest to president of RS, MOP, ARSO,..
Apr. 2008 – protest sent to UNESCO
Jun. 2008 – MOP set temporary ban on WWTP
Jul. 2008 – request from EC to ministry to send additional information on pollution …..

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NOW, WHAT WILL BE THE NEXT STEPS ?

THANK YOU!

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