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Global Water Partnership Mediterranean

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Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Capacity Building Workshop on
"Shared Groundwater Resources Management"

2 – 4 December 2008 / Postojna, Slovenia

The legal framework for the management of karst aquifers in Slovenia - experiences from its application

J. Prestor, J. Urbanc, P. Meglič, J. Šinigoj, K. Hribernik

Geological Survey of Slovenia

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The legal framework for the management of karst aquifers in Slovenia

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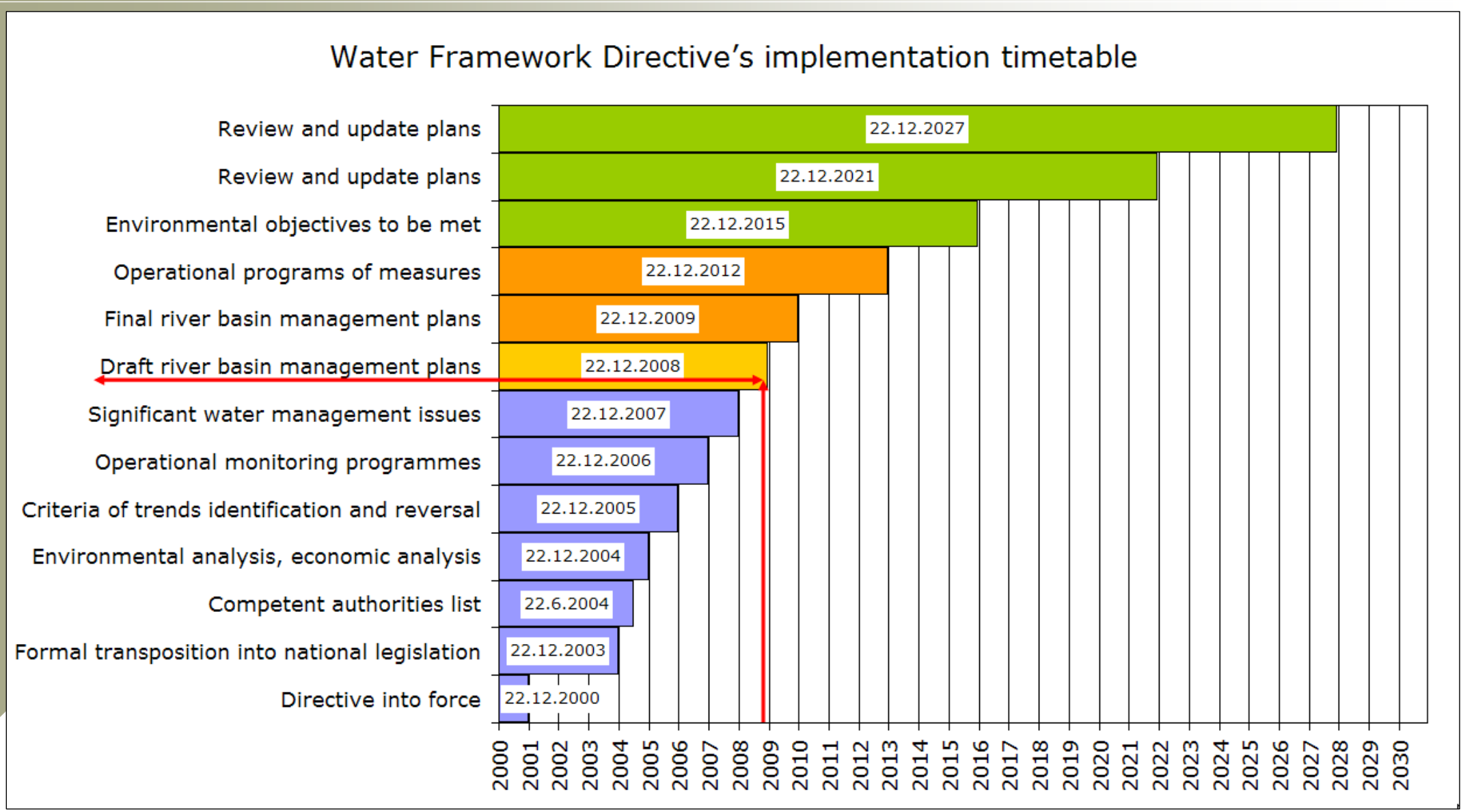
1. Water Framework Directive's implementation timetable



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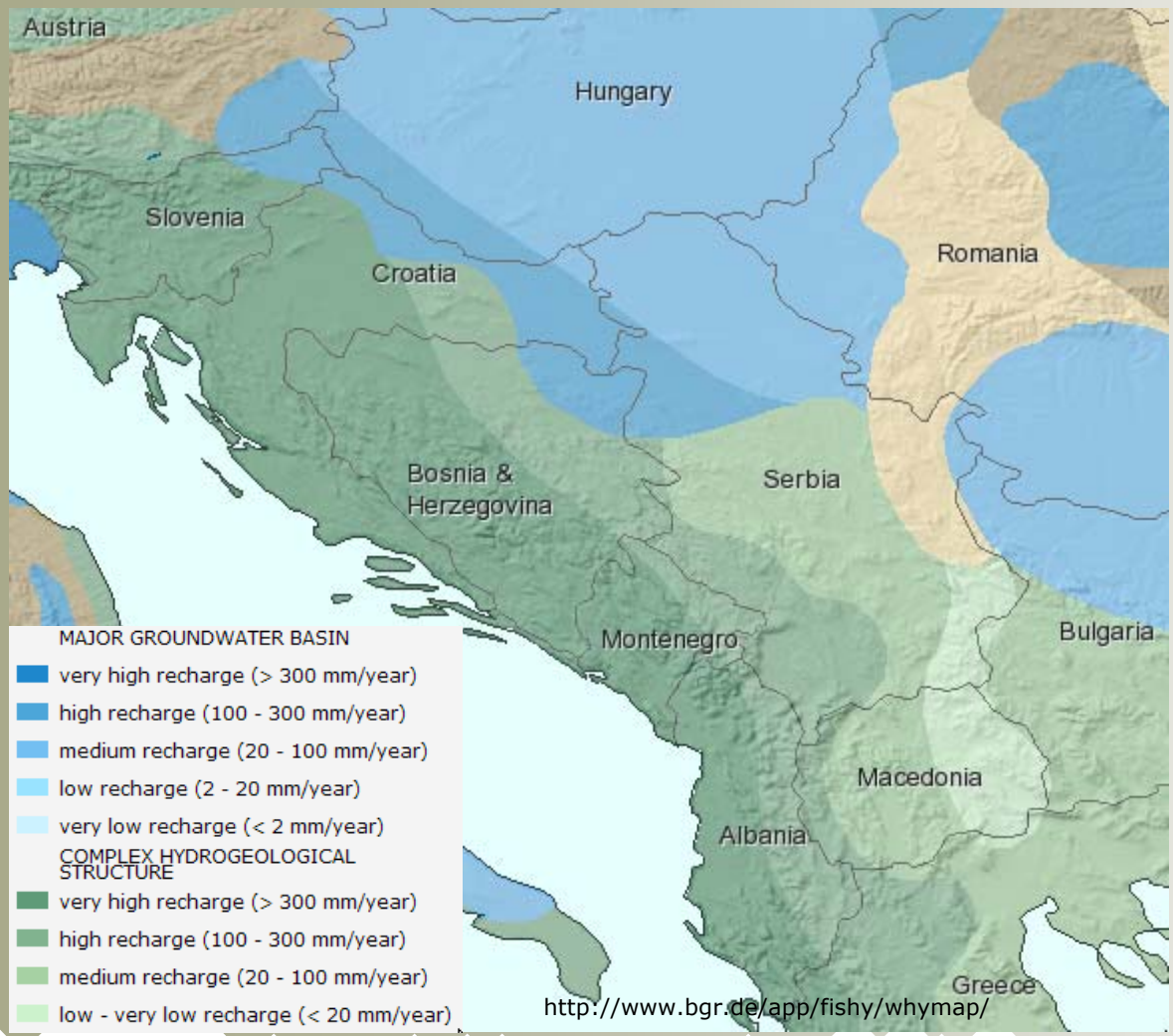
2. Slovene Karst in the Dinaric Karst System



WHYMAP - World-wide Hydrogeological Mapping and Assessment Programme (© 2007, BGR, UNES)

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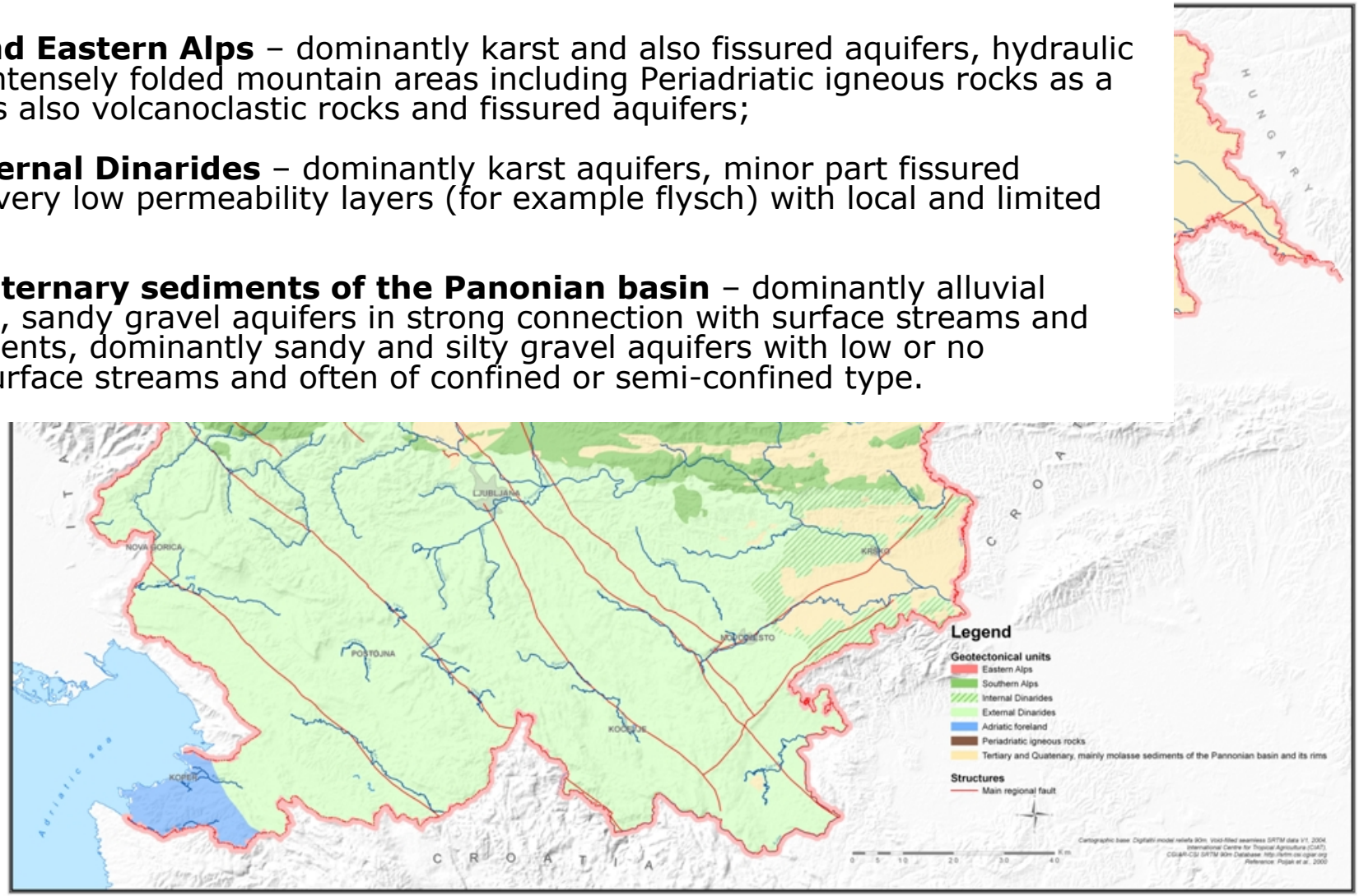
2. Slovene Karst in the Dinaric Karst System

There are three main tectonic units in Slovenia having an important role at the groundwater bodies' delineation:

I. **The Southern and Eastern Alps** – dominantly karst and also fissured aquifers, hydraulic complex system intensely folded mountain areas including Periadriatic igneous rocks as a basement rocks as also volcanoclastic rocks and fissured aquifers;

II. **External and internal Dinarides** – dominantly karst aquifers, minor part fissured aquifers and also very low permeability layers (for example flysch) with local and limited small aquifers;

III. **Tertiary and Quaternary sediments of the Panonian basin** – dominantly alluvial Quaternary gravel, sandy gravel aquifers in strong connection with surface streams and non-alluvial sediments, dominantly sandy and silty gravel aquifers with low or no connection with surface streams and often of confined or semi-confined type.



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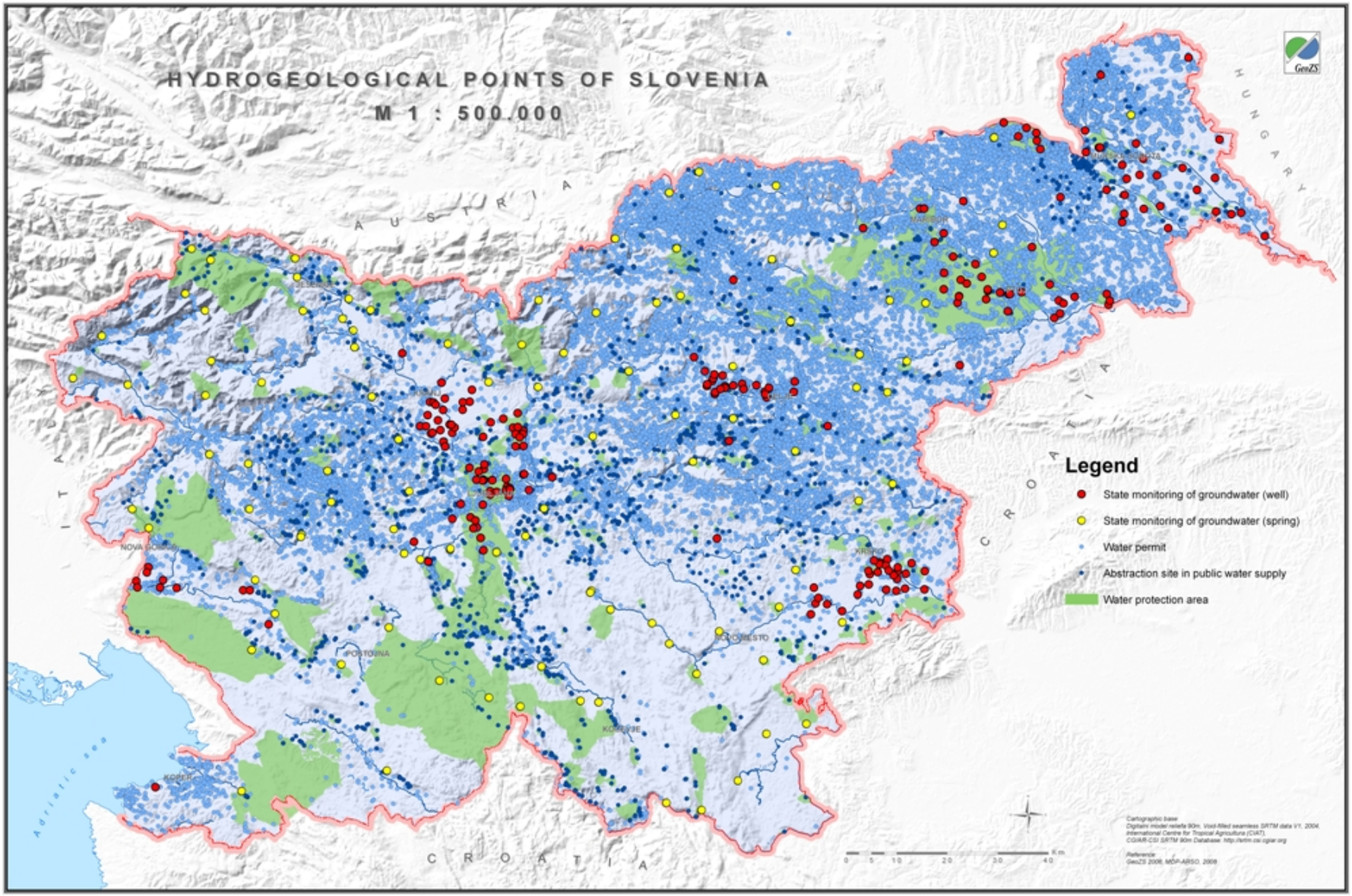
3. Delineation of groundwater bodies, methodology



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3. Delineation of groundwater bodies, methodology

Legal base: WFD (Water Framework Directive, 2000)
Rules on methods for determining water bodies of groundwater (Ur.l.RS, 2003)
Rules of determining water bodies of groundwater (Ur.l.RS, 2005)

Methodology: adapted after: Mise en oeuvre de la DCE identification et délimitation des masses d'eaux souterraines. Guide méthodologique. Document public. BRGM/RP- 52266-FR, janvier 2003

Type of aquifer systems:

(1) Aquifer systems in alluvial sediments

- Specific lithology – non consolidated sediments (coarse gravel, sandy gravel), strong connection with the river – surface water, mostly unconfined;
- permeability: generally strong contrast with bedrock;
- non-significant characteristic but important actual or potential use for drinking water;
- delineation: limits of highly permeable layers or exploitable gravel, sand layers, rivers and junctions with large affluents.

3. Delineation of groundwater bodies, methodology

(2) Aquifer systems in sedimentary rocks and unconsolidated dominantly non-alluvial sediments

- Lithology - intergranular and karst-fissured porosity;
- sedimentary aquifers of regional extension - nonconsolidated or semi-consolidated sediments (mostly younger tertiary layers) or consolidated sediments (also karst and fissured mesosoic and tertiary rocks), may be unconfined and / or confined;
- lateral delineation: catchment basin, half catchment basin, between two rivers;
- delineation in confined zone: 1)lateral = flow line, 2)upstream = boundary of re-covering, 3)downstream = boundary of potential use for drinking water supply (abstractions under technical and economical conditions for drinking water supply).

(3) Aquifer systems in hydraulic complex system adapted to intensely folded mountain zones

- Complex lithology with alternation of aquifers and impermeable layers of very variable size and extension (karst and fissured porosity aquifers of mesosoic and paleozoic age), mountains - intensely folded of younger tectonic movements;
- lateral delineations: great lithology-structural zones, boundaries of large catchment areas, great river interstream - dissymetrical flows.

3. Delineation of groundwater bodies, methodology

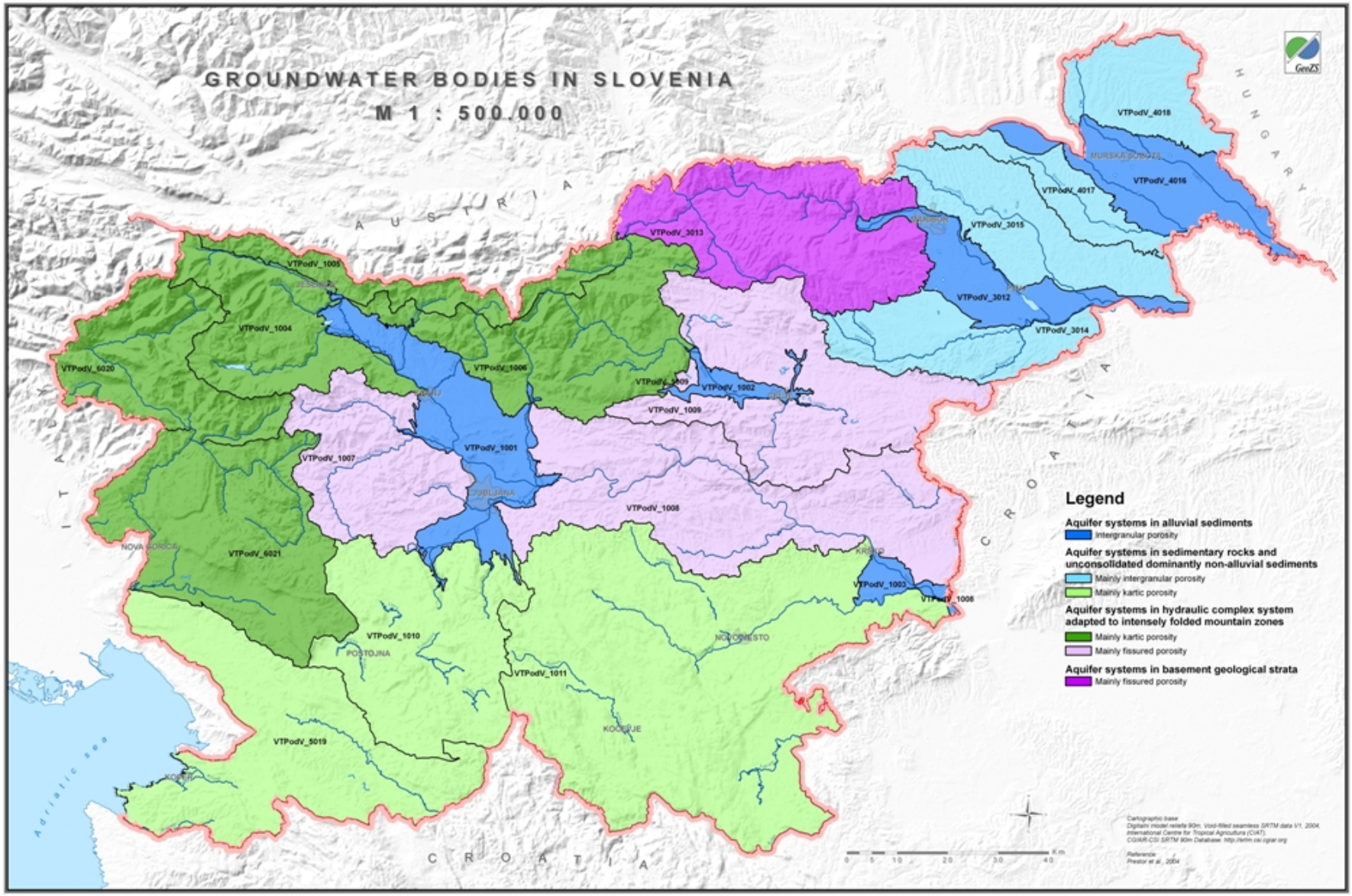
(4) Aquifer systems in basement geological strata

- Identified on the surface by a discontinuous weathering of rocks surrounding a fractured substratum constituting a permeable zone where the permeability is strongly variable (mostly crystaline rocks with fissured porosity and partly intergranular porosity in the weathered part of the layers), surface runoff is significantly greater than the groundwater flow;
- Delineation: according to catchment boundaries of the areas.

(5) Aquifer systems in low permeable strata and local and limited water resources

- Sedimentary formations (generally aquicluds) containing small, local or sporadic aquifers whose boundaries are often not well known (mostly layers of flysch type – tertiary and partly mesosoic age)
- Delineation: corresponds to the limits of the impermeable formation (often regional size) boundaries of the small aquifers are not drawn

3. Delineation of groundwater bodies, methodology – natural conditions



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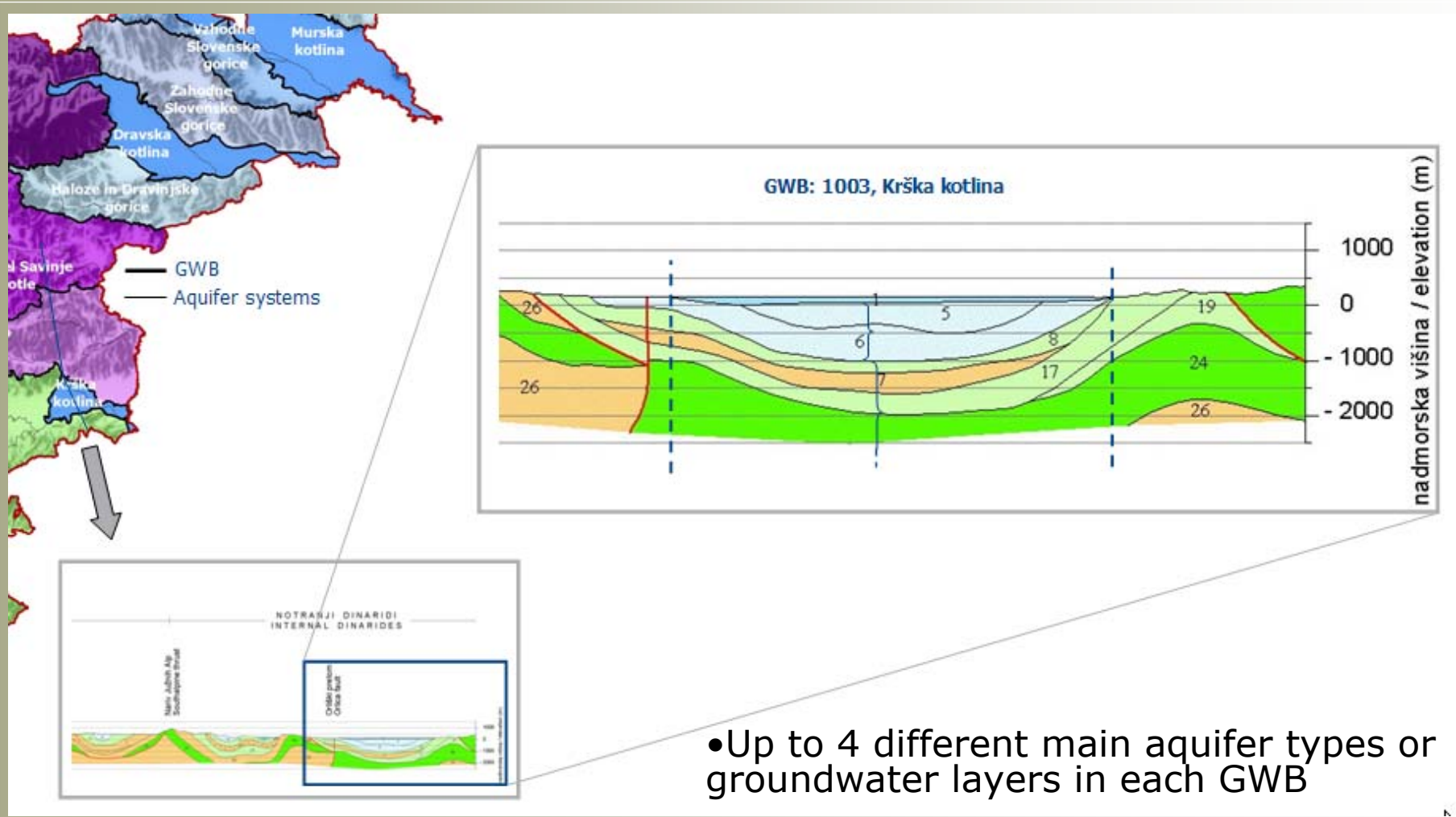
3. Delineation of groundwater bodies, methodology – natural conditions



- Up to 4 different main aquifer types or groundwater layers in each GWB

- Groundwater in the upper overlaying strata is mostly the most important at the delineation

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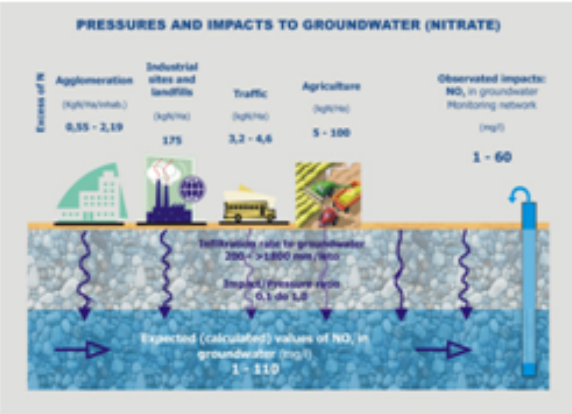
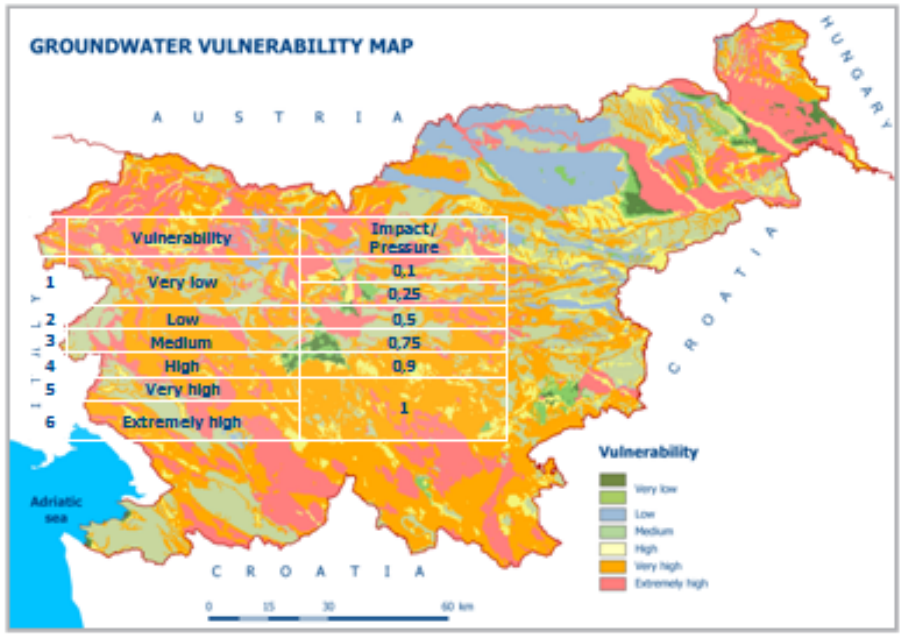
3. Delineation of groundwater bodies, methodology – pressures and impacts

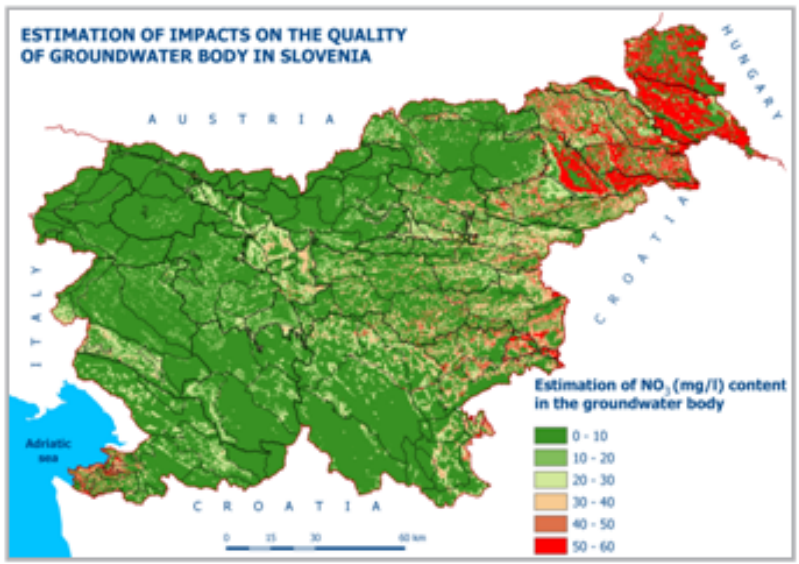
PRESSURES AND IMPACTS

PRESSURES





IMPACTS



Landuse (CorineLandCover 2000) in Slovenia:

- Artificial areas	2,7 %
- Agricultural areas	35 %
- Forest and partially preserved natural areas	61,8 %
- Wetlands	0,1 %
- Surfaces water	0,4 %

Pres

3. Delineation of groundwater bodies, methodology

Final delineation 2004

165 aquifer systems
21 Groundwater bodies

- Average GWB area: 965 km2
- Minimum GWB area: 97 km2
- Maximum GWB area: 3 355 km2

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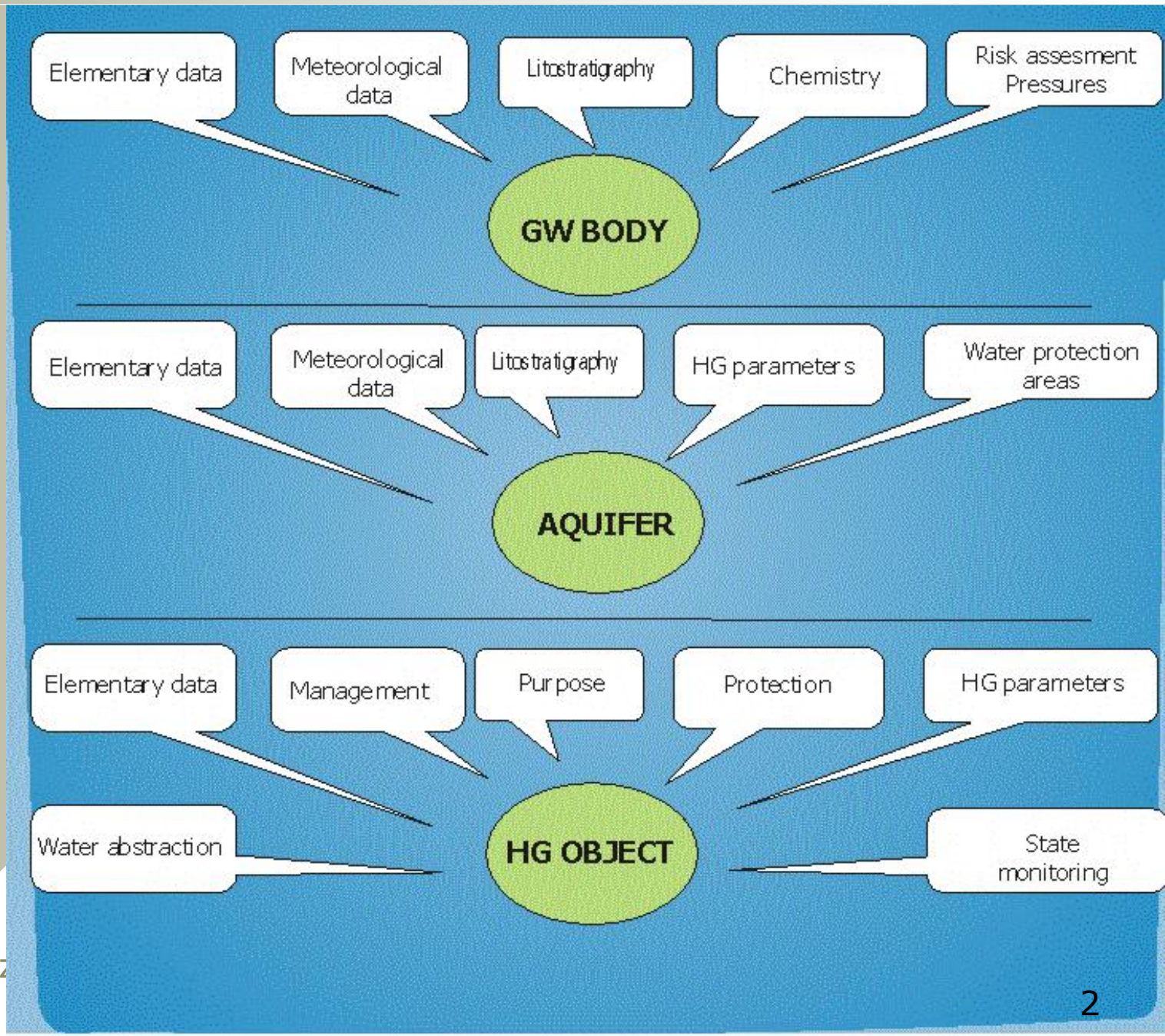
3. Delineation of groundwater bodies, methodology

Information system



Prestor & al., 2008. Geološki z

4. Characteristics of water management from the WFD aspect, with emphasis on karst water

The WFD requires us to assess the status of all groundwater bodies.

This assessment will determine whether their overall status is good or poor.

The overall classification takes into account both the groundwater body's chemical status (in relation to pollution pressures) and its quantitative status (in relation to groundwater abstraction pressures).

Groundwater status objectives set by the WFD rely in part on the protection of, or objectives for, other associated waters and dependent ecosystems.

The objectives for these must be known before groundwater classification can be fully completed.

These associated waters and dependent ecosystems may have different sensitivities to water level and/or pollutants.

4. Characteristics of water management from the WFD aspect, with emphasis on karst water

The essentail classification of groundwater:

- **Saline & other intrusions** - where intrusions caused by abstraction impact on receptors, the groundwater body will be at poor status;
- **Significant diminution of surface water chemistry and ecology** - where groundwater pollution is causing a surface water body to be at less than good status, the groundwater body will be at poor status;
- **Groundwater Dependent Terrestrial Ecosystems (GWDTE)** - where groundwater pollution is causing significant damage to a GWDTE, the groundwater body will be at poor status;
- **Drinking Water Protection** - where groundwater pollution requires an increase in the level of drinking water treatment, the groundwater body will be at poor status;
- **General assessment of groundwater quality** - where there is widespread pollution of a groundwater body it will be at poor status.

5. Main characteristics of karst groundwater bodies - hydraulic

Karst aquifers =

- –dominant channel porosity,
- –in the channel the groundwater flow velocity is higher than in the surrounding rock

Karstified area =

- –Karst phenomena (such as sinkholes, caves, dolines, channels and open fractures) enable fast water-flow through the aquifer

Sinking karst waters =

- -The entire surface water is recharging the groundwater in karst aquifer

What is direct and what indirect input?

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5. Main characteristics of karst groundwater bodies - geochemistry

The next geochemical association (La, Y, Th, Zr, Ti, Nb and Mn) is characteristic for brown carbonate soils, or terra rossa on carbonate platforms.

The main chemical association brings together the high contents of Ni, Cu, Cr, Sc, Fe, V and Mn, distinguishing the areas covered by Pg and K-flysch.

Geochemical association of Pb, Zn, Hg and Cd represents a typical heavy metal association originated either as a consequence of natural erosion of ore-bearing rocks or, again, of mining activity and smelting industry in the past.

Geochemical association Mo, U and V is also characteristic for brown carbonate soils, or terra rossa closely to deep and active faults.

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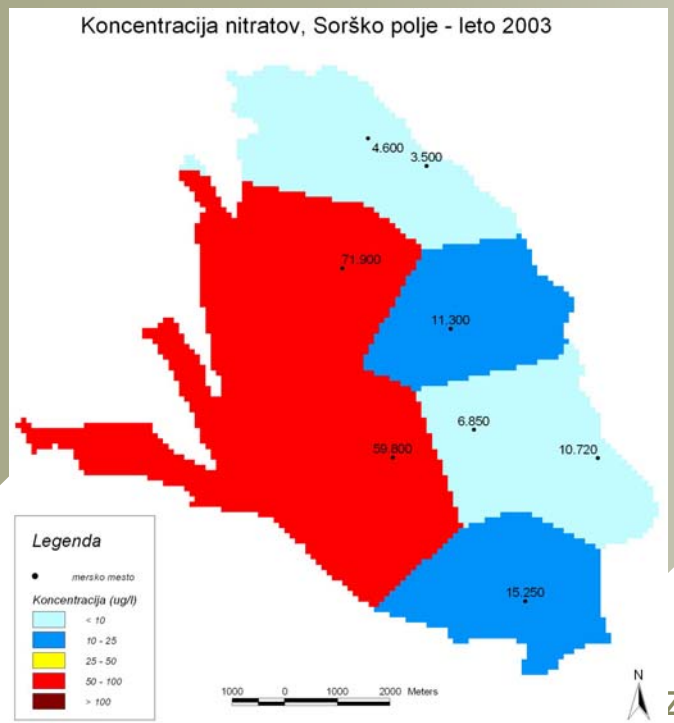
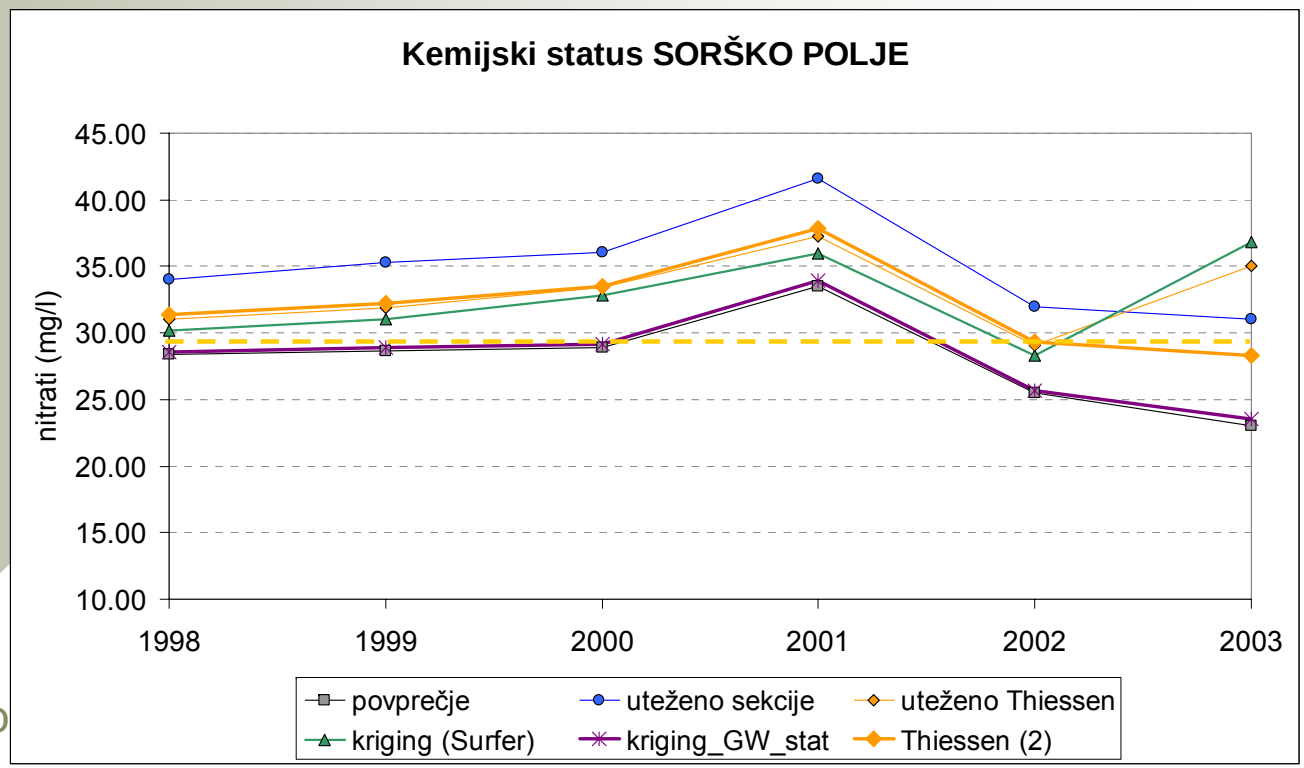
6. Chemical and quantitative status of karst groundwater bodies, methodology

Chemical status - Intergranular aquifers:

Determination of representative grid surfaces with:

statistical interpolation method - **Thiessen polygons**
statistical interpolation method - **Kriging**
the aid of groundwater level map - **Flowpaths**





6. Chemical and quantitative status of karst groundwater bodies, methodology

Chemical status - Karst aquifers:

1) Find internal water divides inside the karst massive and representative areas which belong to individual springs.

2) If water divides can not be defined, representative areas can be determined from the data about discharges in the outflow springs from the karst aquifer system

6. Chemical and quantitative status of karst groundwater bodies, methodology

Quantitative status - Karst aquifers:

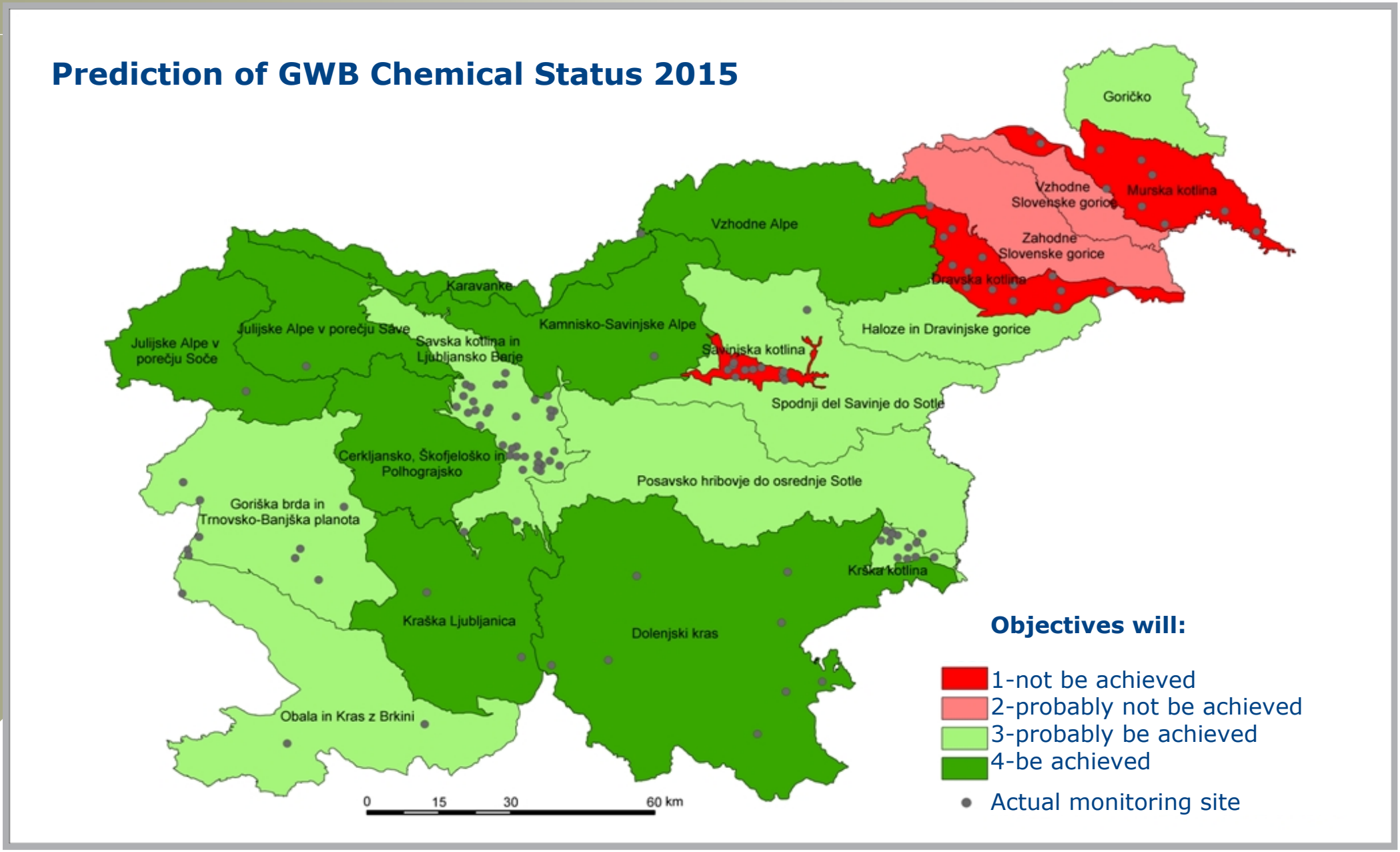
Groundwater bodies within dominantly karst and fissured porosity aquifers

1)Wundt method adapted by ARSO after:

- Deutsche Geologische Gesellschaft: Methoden zu Bestimmung der Grundwasserneubildungsrate.-Arbeitskreis Grundwasserneubildung der Fachsektion Hydrogeologie der Dt. Geol. Ges., Geolog. Jahrbuch Reihe C, Hydrogeologie, Ingenieurgeologie, Heft 19, Hannover, 1977
- Strategiepapier Grundwaserentnahmen, Bundesministerium fuer Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, Dunaj, marec 2004

2) Assessment of yearly renewable resources from infiltration (for example Kennessey method) + correction with exploitability factor

7. Risk of failing to meet the environmental objectives



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8. Protected areas

Main protected areas – regarding groundwater

- Drinking Water Protection Areas
- Groundwater Depended Terrestrial Ecosystems

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8. Protected areas

Drinking Water Protection Areas in Slovenia

DWPA – Aquifers of karst and fissured porosity with significant channel-flow hydrodynamics

Wider area (III.)

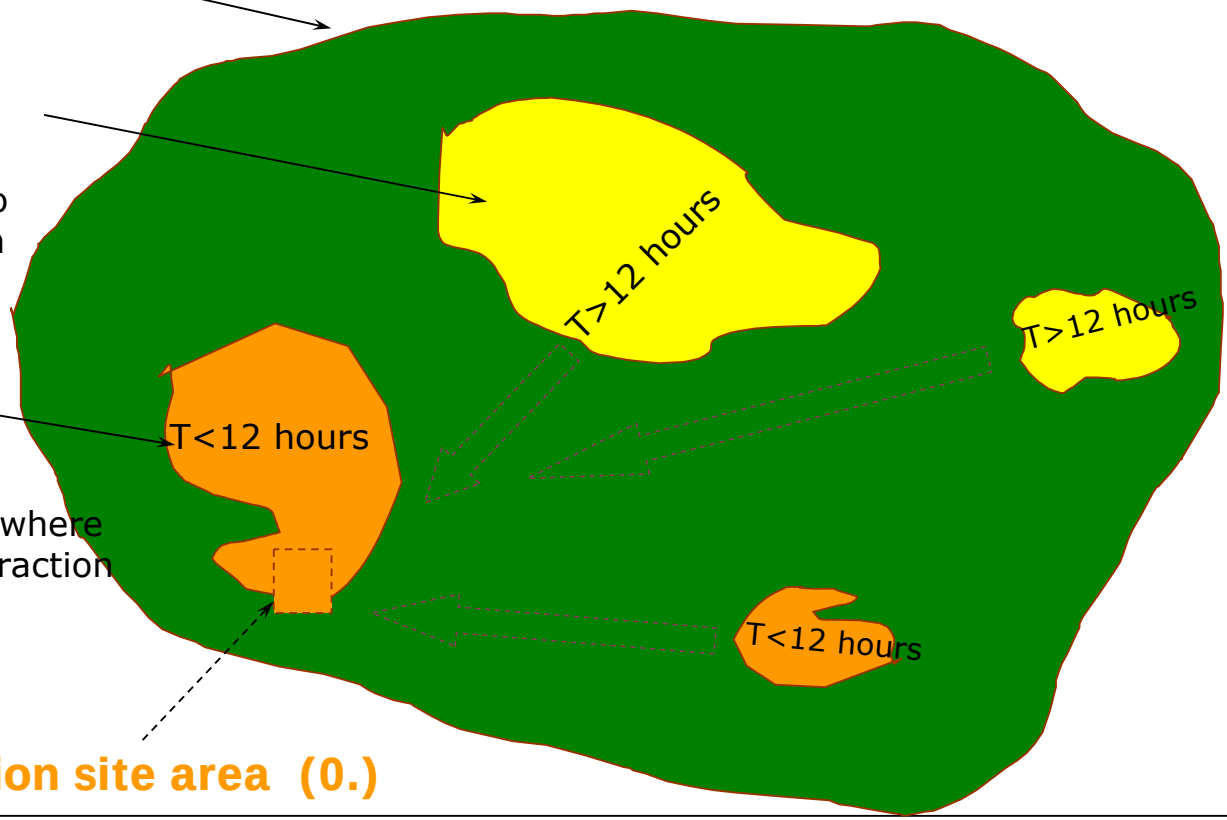
- Groundwater divide

Narrower areas (II.)

- Distinct karstified areas from where the flow travel time (T) to the abstraction site is more than 12 hours.

The narrowest areas (I.)

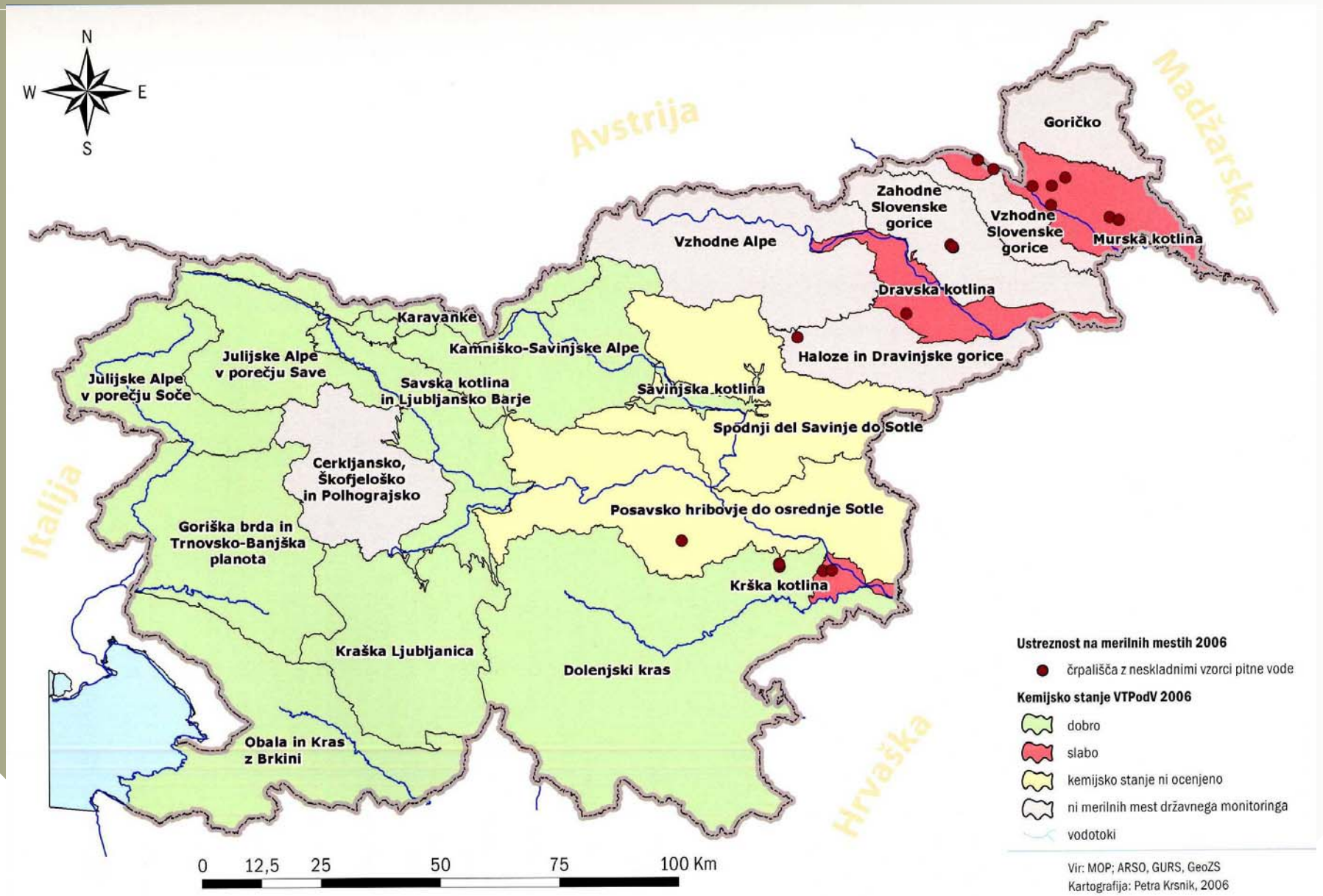
- Distinct karstified areas from where the flow travel time to the abstraction site (T) is less than 12 hours.



Fenced abstraction site area (0.)

1. Rules on **criteria for the designation of a water protection zone** (Ur.l. RS, št. 64/2004, 5/2006)
2. Rules on **construction in water protection zones that may be carried out only pursuant to the water consent** and on the required documentation for obtaining water consent (Ur.l. RS, št. 62/2004)
3. Rules on criteria for **marking a water protection zone** and a bathing water zone (Ur.l. RS, št. 88/2004)

8. Protected areas
Drinking Water Protection Areas



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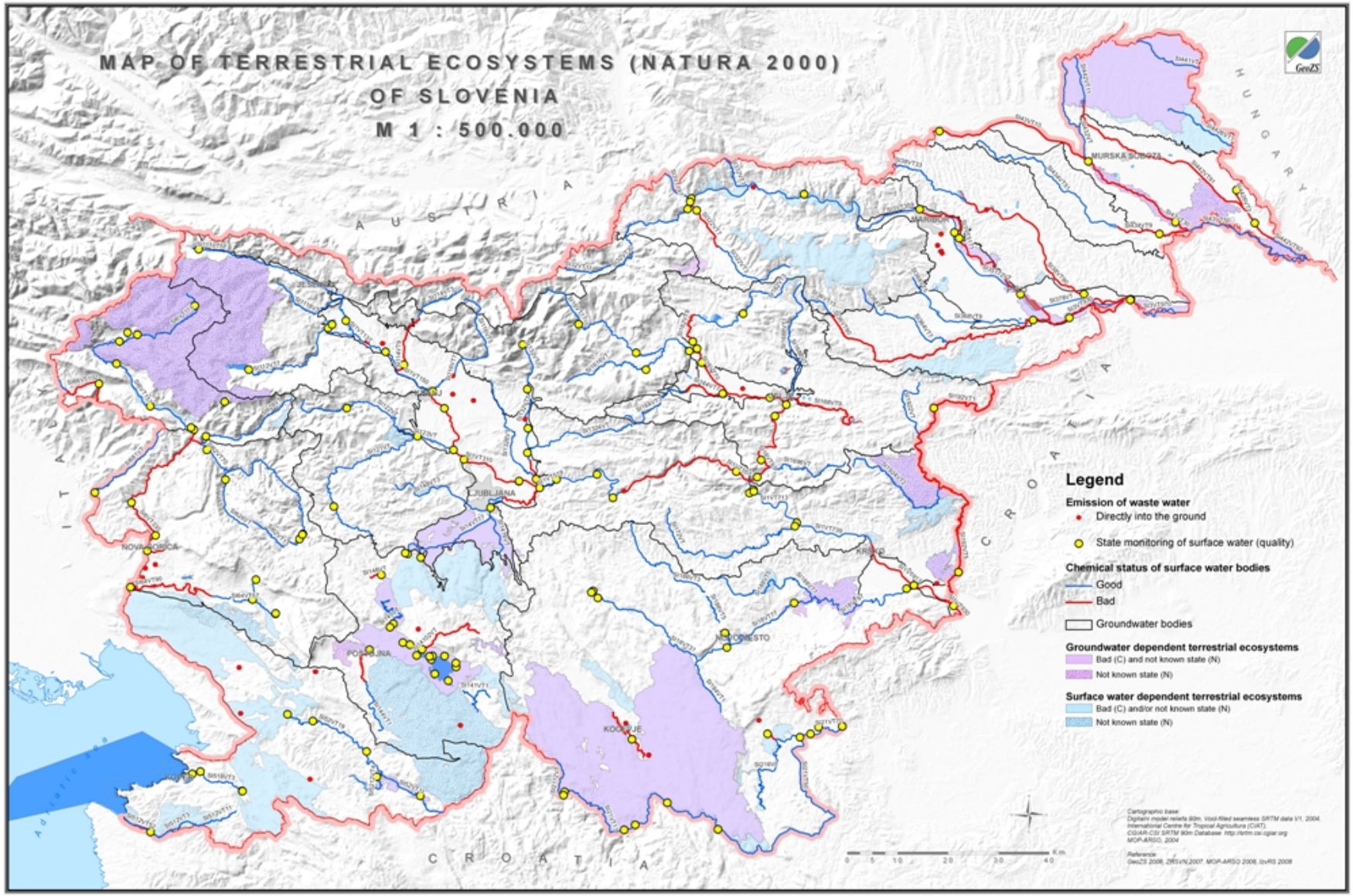
8. Protected areas

Groundwater Depended Terrestrial Ecosystems



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9. Transboundary cooperation

Karst aquifers case study

- The transboundary dinaric karst aquifer system between Croatia and Slovenia – Istria peninsula

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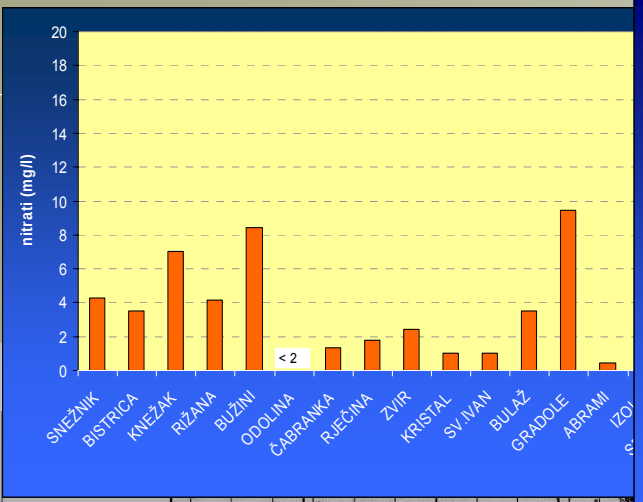
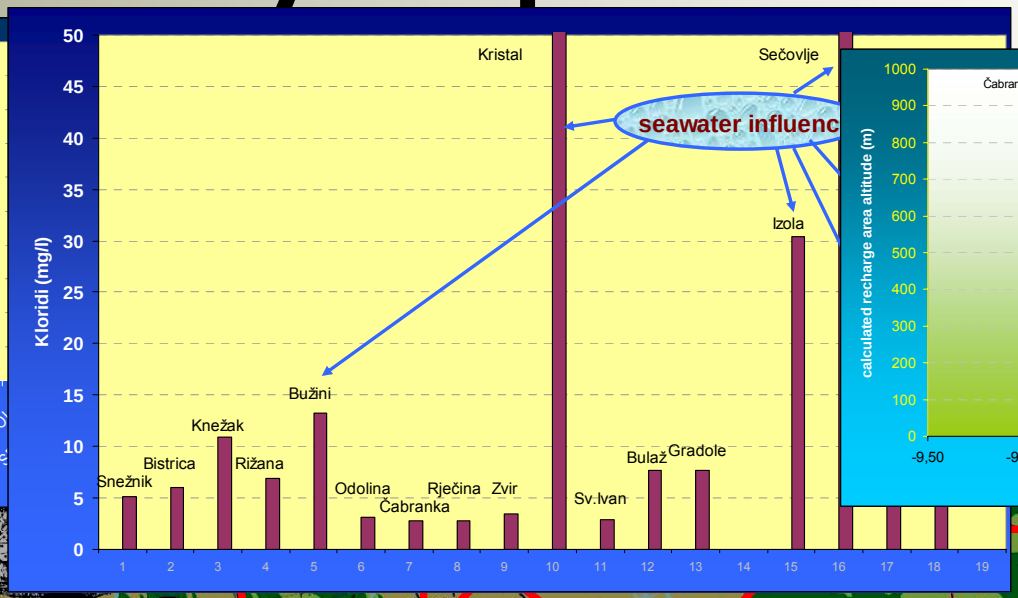
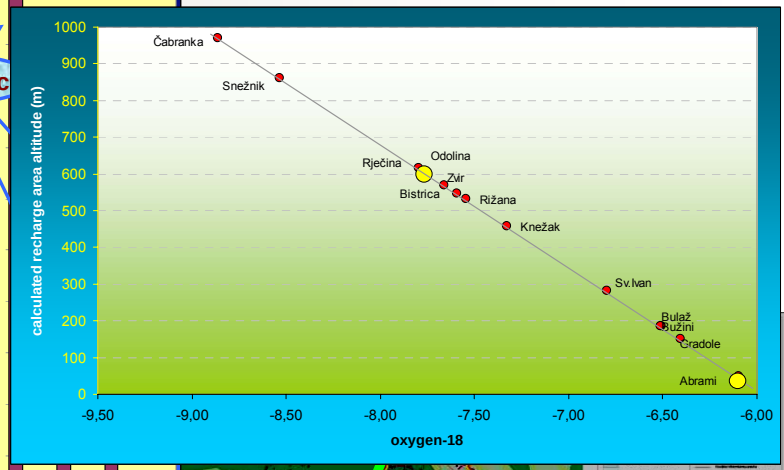
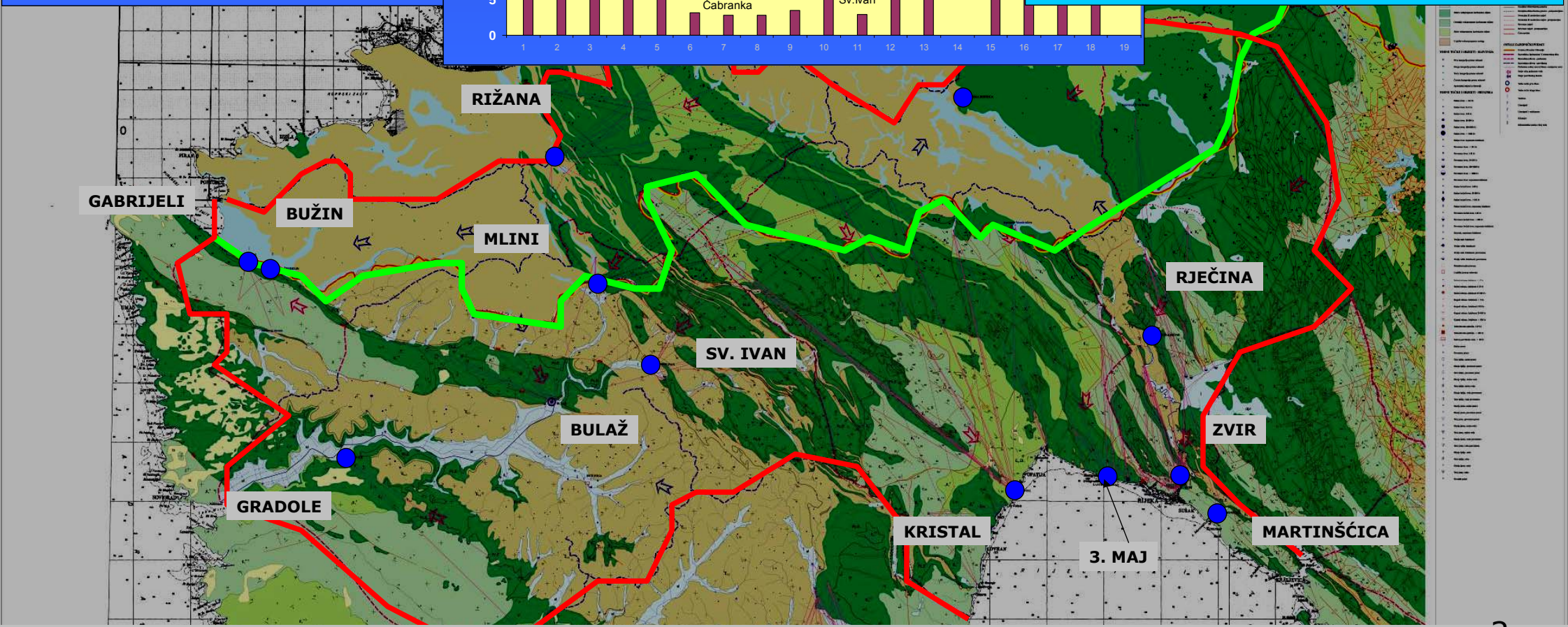
9. Transboundary cooperation



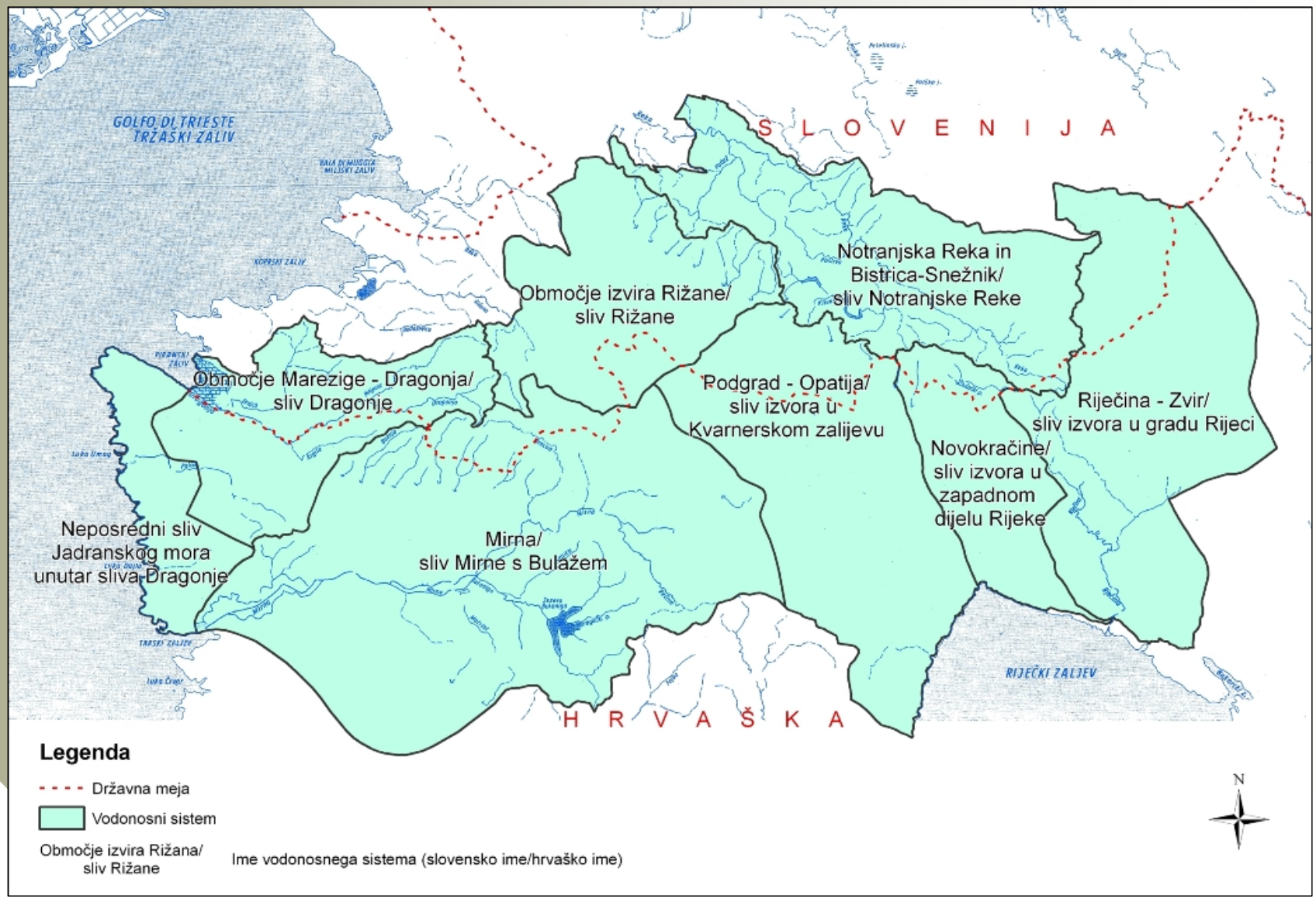






9. Transboundary cooperation

The actual common delineation of transboundary aquifers (Croatia-Slovenia)



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9. Transboundary cooperation

Transboundary aquifers/aquifer systems and Transboundary Groundwater Bodies

Transboundary aquifer/aquifer system:
- is a natural phenomena (with proved or potential cross-border groundwater flow), existing either we have interest or not

Transboundary Groundwater Body:
- is a groundwater (in the transboundary aquifer/aquifer system) that is bilaterally identified and characterized and is the matter of bilaterally agreed process of water management

Thank you for your attention!

- http://kalcedon.geo-zs.si/website/PTGK/viewer.htm
- www.Ewater.eu