United Nations Educational, Scientific and Cultural Organization

Intergovernmental Hydrological Programme

DRIN CORDA

Global Water Partnership Mediterranean

IW LEARN

Session 2
Hydrogeological conceptual model

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UNESCO Technical Webinar - October 2020
Guidelines for Monitoring Strategies in Transboundary Aquifers: Goals, Methods and Tools.
The Case of the DRIN project (ALB-MTN)

Contents

1. Justification

EU-WFD requires a Conceptual Model for the GW monitoring design

European Water Framework Directive (EU-WFD) Guidance Document No. 15 "Guidance on Groundwater Monitoring" (European Commision, 2007)

"the design of a monitoring network should be based on the characterization, assessment of risk and building of a **conceptual model** of the groundwater system, in which the general scheme 'recharge-pathway-discharge' is known"

2. What is a Conceptual Model?

Simplified representation of the hydrogeological system

"It describes and quantifies the relevant geological characteristics, flow conditions, hydrogeochemical and hydrobiological processes, anthropogenic activities and their interactions" (European Commission, 2003).

3. Step-wise methodology

I. Data Collection

- Be representative of the overall state of the groundwater body
- Consider 3D nature of groundwater system
- Consider spatial and temporal variability
- Considered all existing information

II. Harmonization of data

- Harmonization of geological formations nomenclature
- Harmonization of units
- Harmonization of geografical coordinate systems

III. Multidimensional assessment

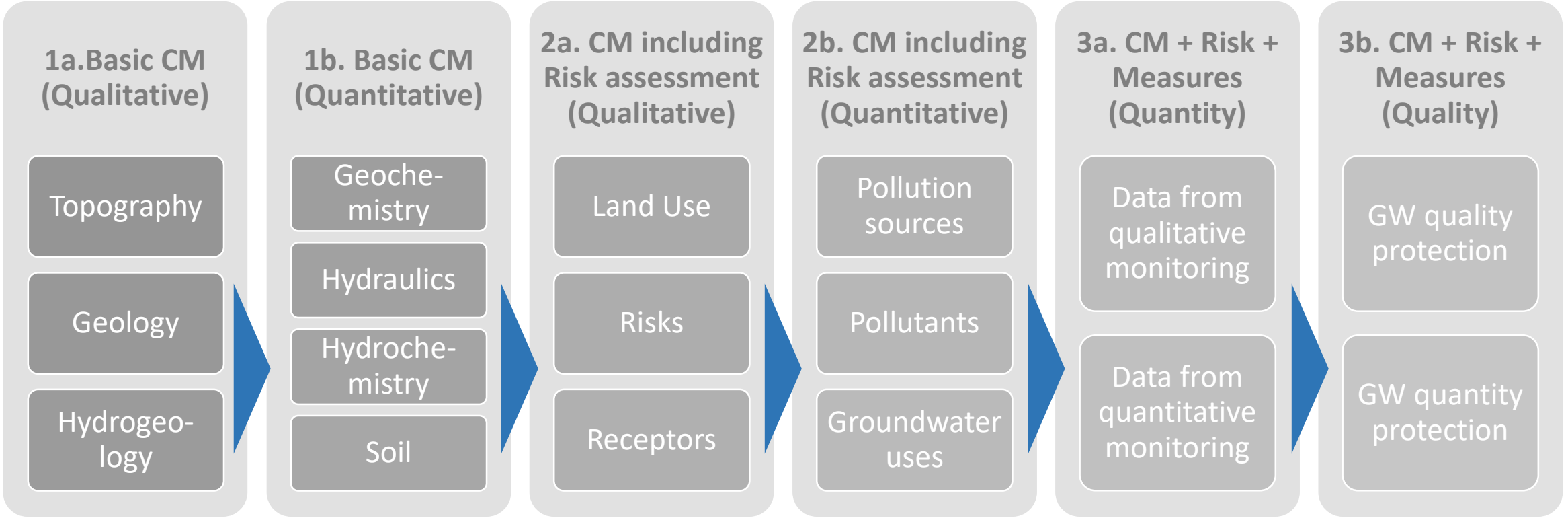
- **Hydrogeological aspects**
  - Geology
  - Hydrogeology
  - Water balance
- **Environmental aspects**
  - Hydrochemistry and groundwater quality
  - Groundwater Dependent ecosystems
  - Landscape and protected areas
- **Socio-economical aspects**
  - Groundwater use
  - Sources of pollution
  - Pressures and Impacts analysis

IV. Definition of Groundwater Bodies

V. Definition of transboundary features

4. Data collection

Stages of complexity based on the EU-WFD Guidelines



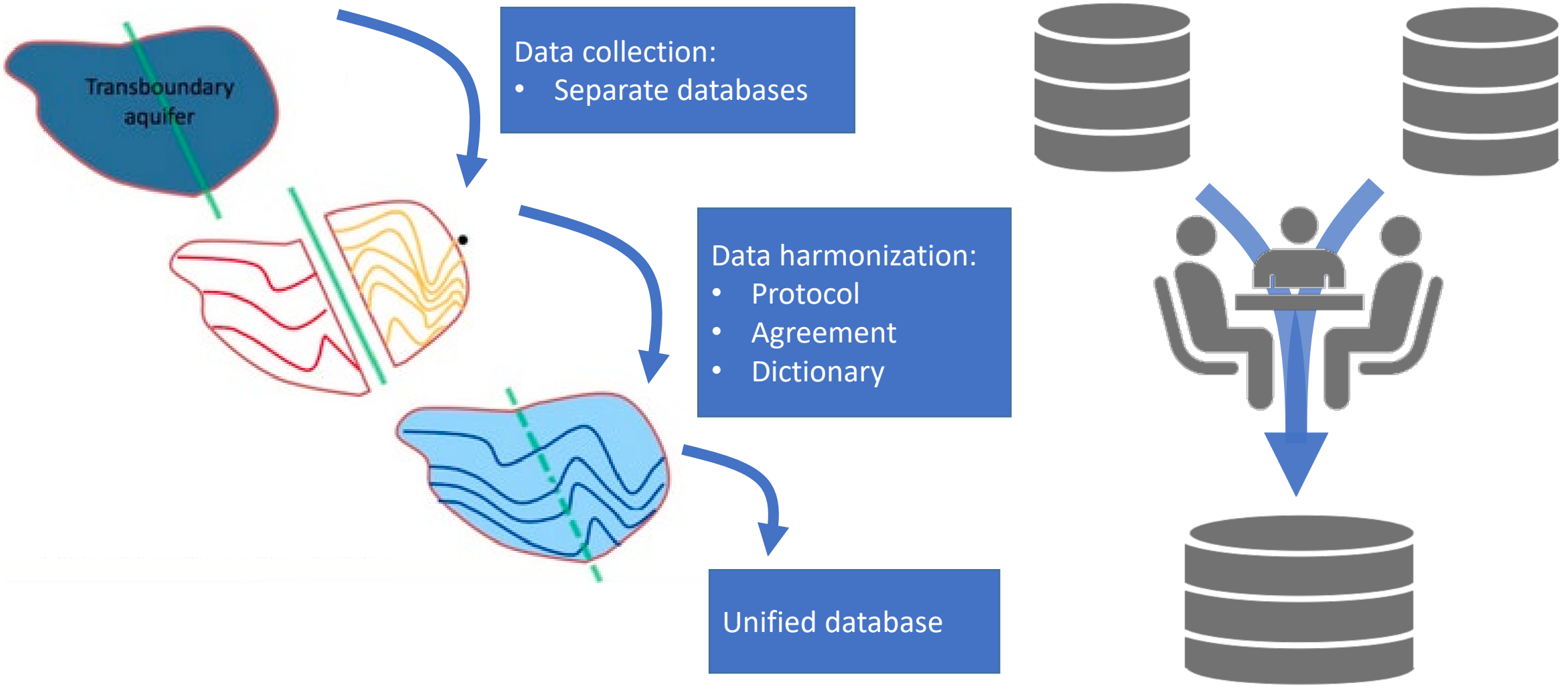
Based on the EU-WFD Guidelines Document 26 on "Risk assessment and the use of Conceptual models for Groundwater"

4. Data collection

Specific data to collect

	Data Needed for the elaboration of hydrogeological conceptual model	Priority (based on EU-WFD requirements)
Topography	Topographic maps	ESSENTIAL
	Detailed Digital Elevation Model	
	Surface waters	ADVISABLE
	Surface water catchment	OPTIONAL
Geology	Geology/Lithology Map	ESSENTIAL
	Tectonics	ESSENTIAL
	Stratigraphy descriptions	ESSENTIAL
	Geophysical data	OPTIONAL
Hydrogeology	Hydrogeological units	ESSENTIAL
	Basic geochemistry	ADVISABLE
	Permeability	ADVISABLE
	Wells inventory	ESSENTIAL
	Groundwater levels time series	ESSENTIAL
	Local uses of groundwater.	ADVISABLE
Climatic	Meteorological data	ADVISABLE
Pollution sources	Inventory of diffuse sources and point sources	ADVISABLE
	Map of flood prone areas	OPTIONAL

5. Data harmonization

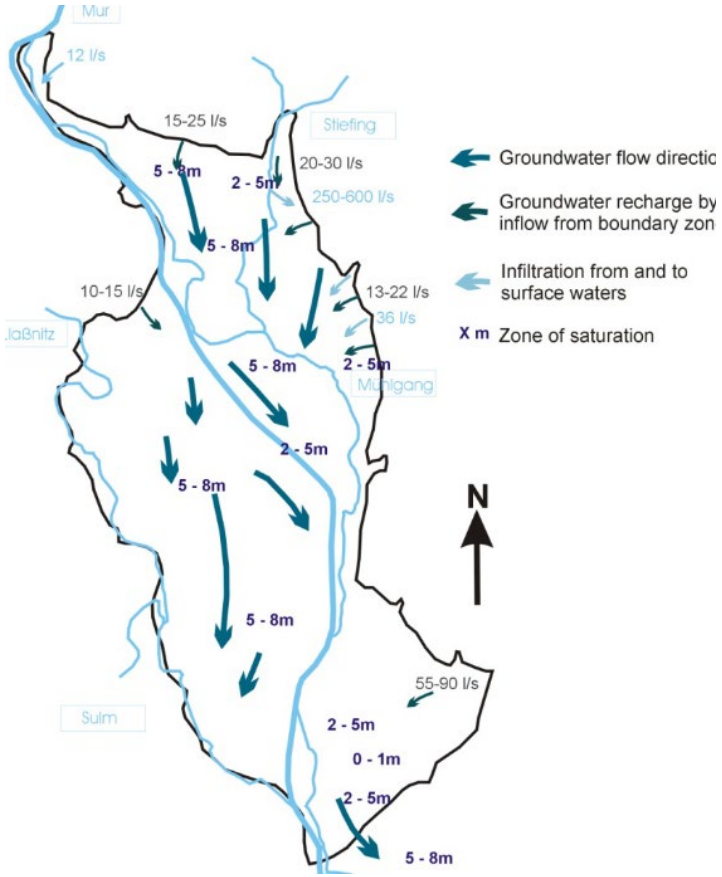


6. Multidimensional assessment

Hydrogeological aspects

How much and How it flows…

- **Maps: geological formations**, **permeable formations**, **confining** conditions, **groundwater heads** and **flow directions**
- **Vertical cross sections: vertical extension** and **recharge-discharge pathways**
- **Time series**: groundwater level and **water balance**



Source: EU commission 2010 after Fank J. et al., 1993

6. Multidimensional assessment

Environmental aspects

What is flowing …

- Piper diagrams (**hydro chemical facies**, groundwaters types, **hydro chemical processes)**
- XY plots (identification of dissolutions, adsorption, cations exchange or redox reactions)
- Maps (**spatial distribution,** hot-spots and spatial trends)
- Time series (**temporal trends** of relevant ions)
- Maps showing location of **groundwater dependent ecosystems**

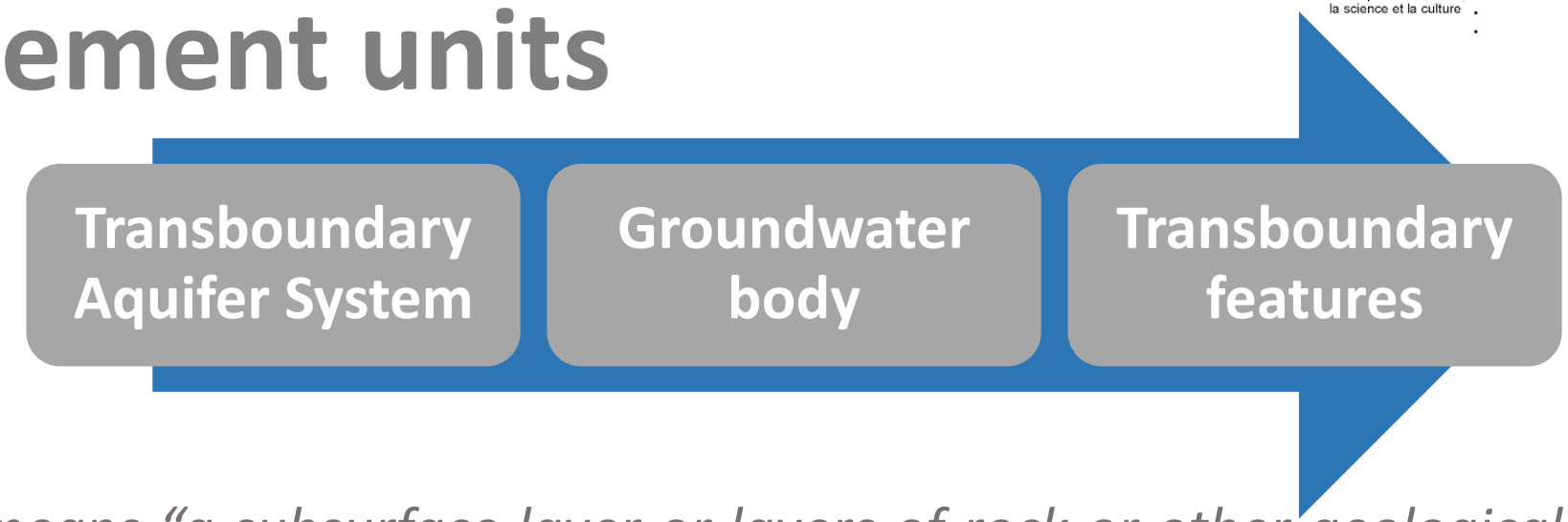
6. Multidimensional assessment

Socio-economical aspects

What is or may be affecting the resource …

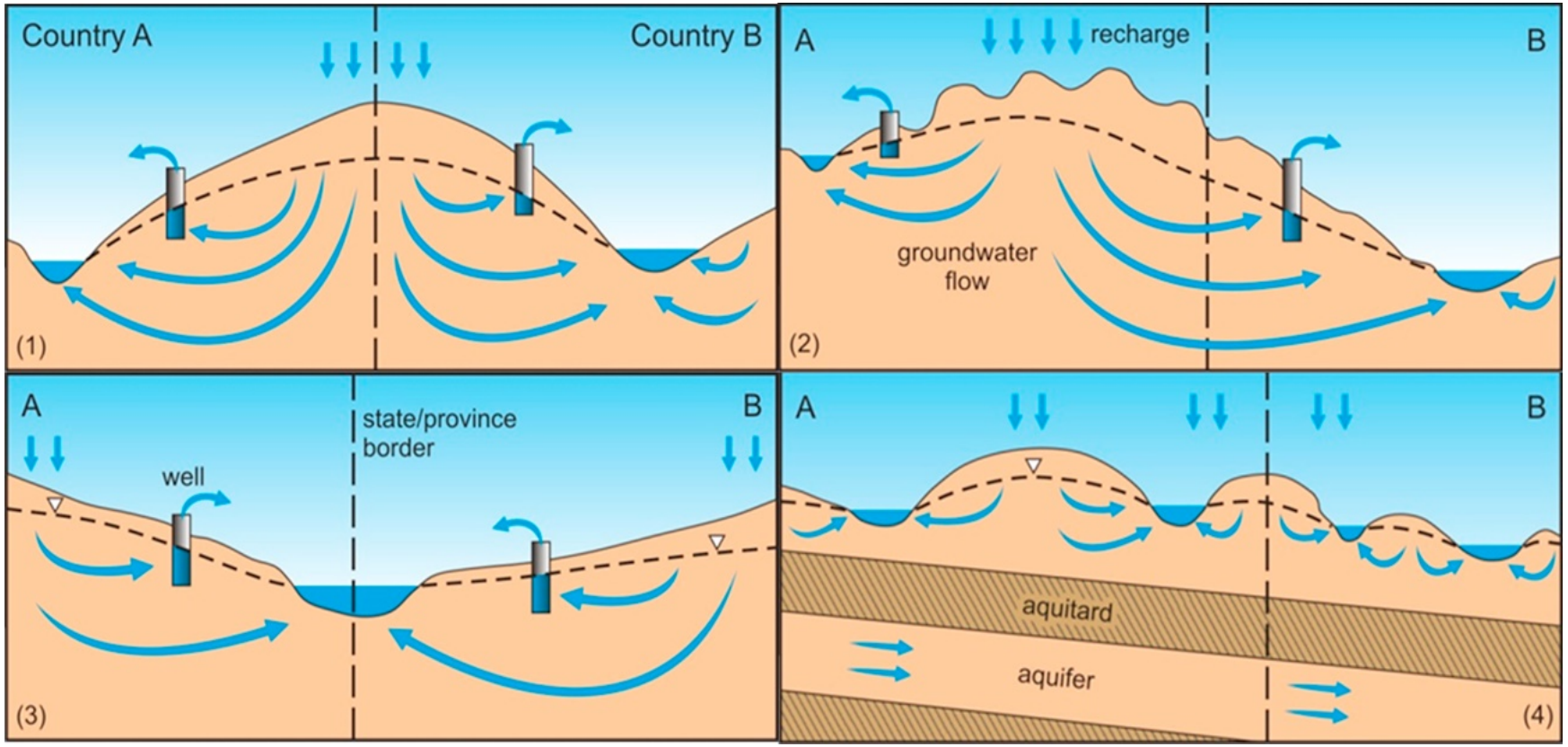
- Table enumerating sources **of diffuse and point pollution** as well as groundwater abstraction actives in each groundwater body or aquifer unit
- Map location **abstraction wells and volumes**
- Map depicting location of major industrial activities, solid waste dump sites, water treatment plants, and land uses.

7. Definition of management units



- ✓ ***Aquifer*** *means "a subsurface layer or layers of rock or other geological strata of sufficient porosity and permeability to allow either a significant flow of groundwater or the abstraction of significant quantities of groundwater"*
- ✓ ***Groundwater body*** *is a "distinct volume of groundwater within an aquifer or aquifers"*
- ✓ ***Transboundary features*** *are all those aspects of a transboundary aquifer or groundwater body, which could require shared management between riparian countries*

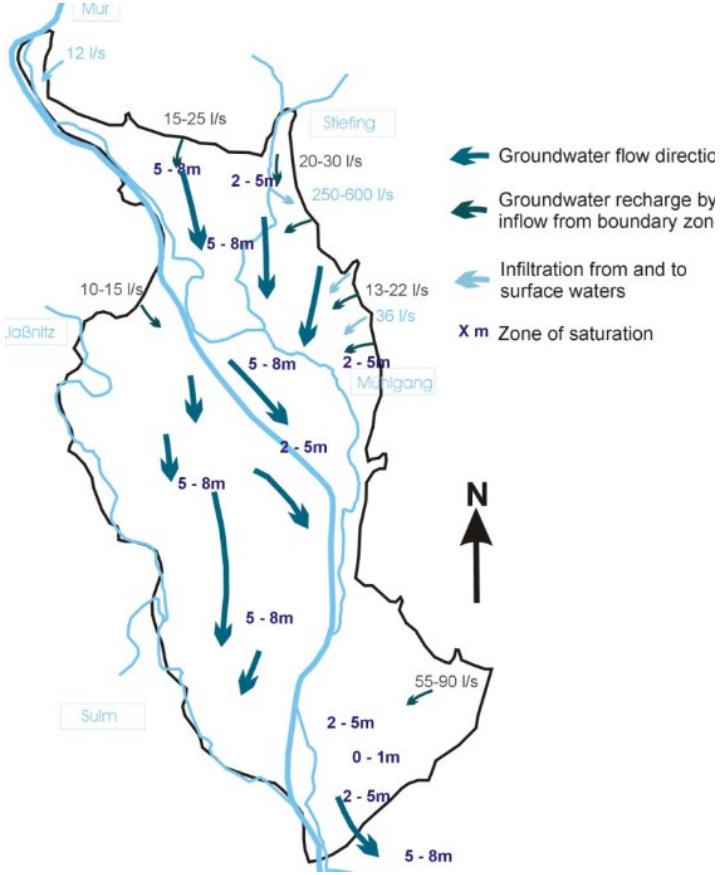
8. Transboundary features



Rivera, A. Journal of Hydrology : Regional Studies Transboundary aquifers along the Canada – USA border : Science , policy and social issues. 4, 623–643 (2015).

9. Reporting

Example of Conceptual Model



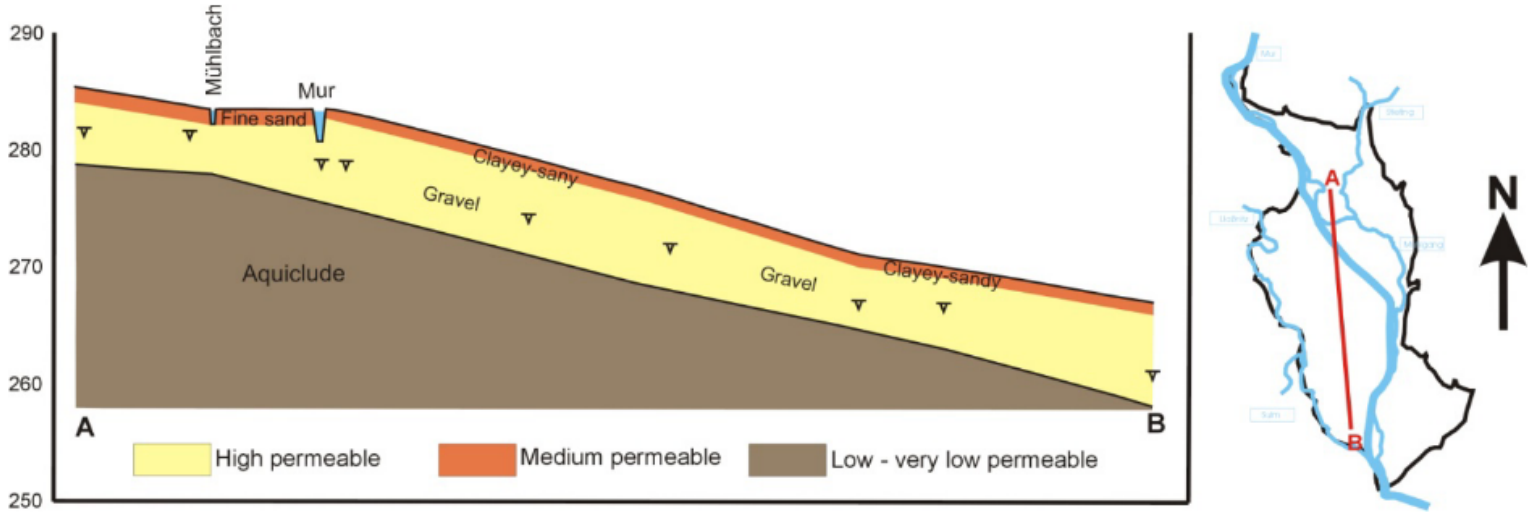
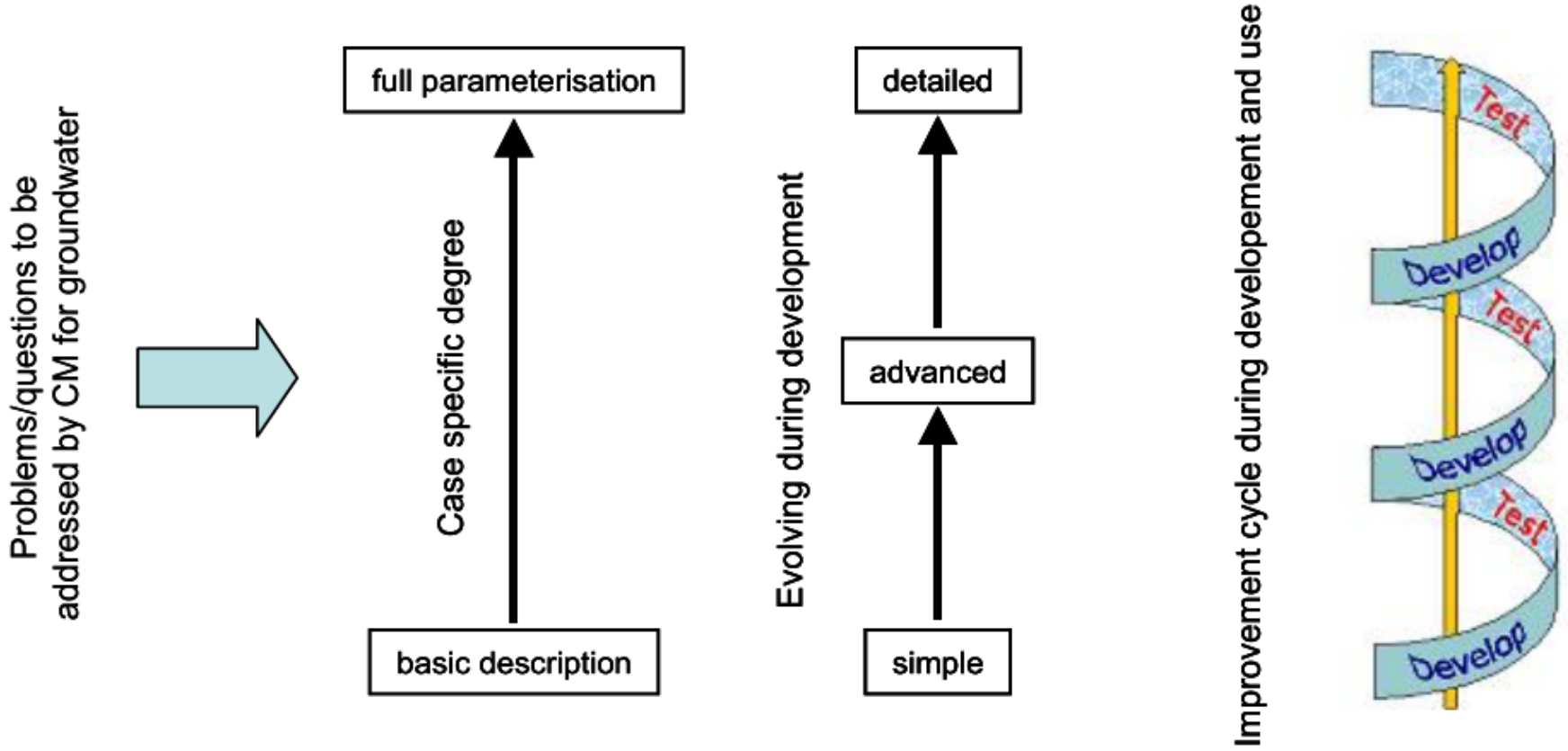


Figure 3: Schematic cross-section through the groundwater body Leibnitzer Feld

Source: EU commission 2010 after Fank J. et al., 1993: Hydrogeology und groundwater model Leibnitzer Feldes (only available in German)

10. Reviewing the conceptual model



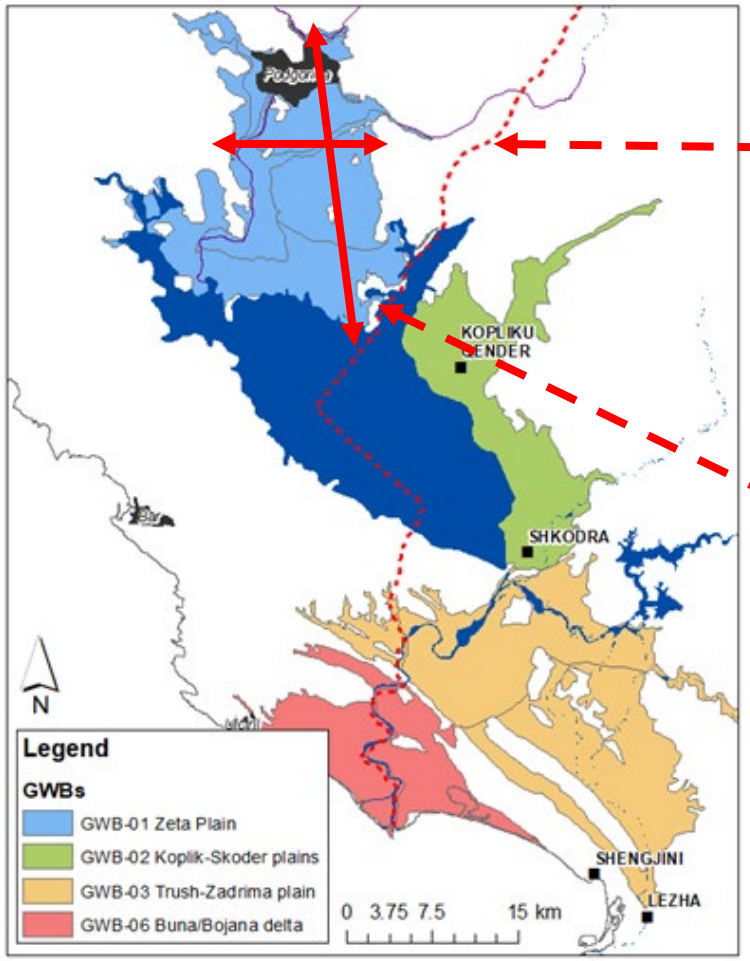
10. Real case

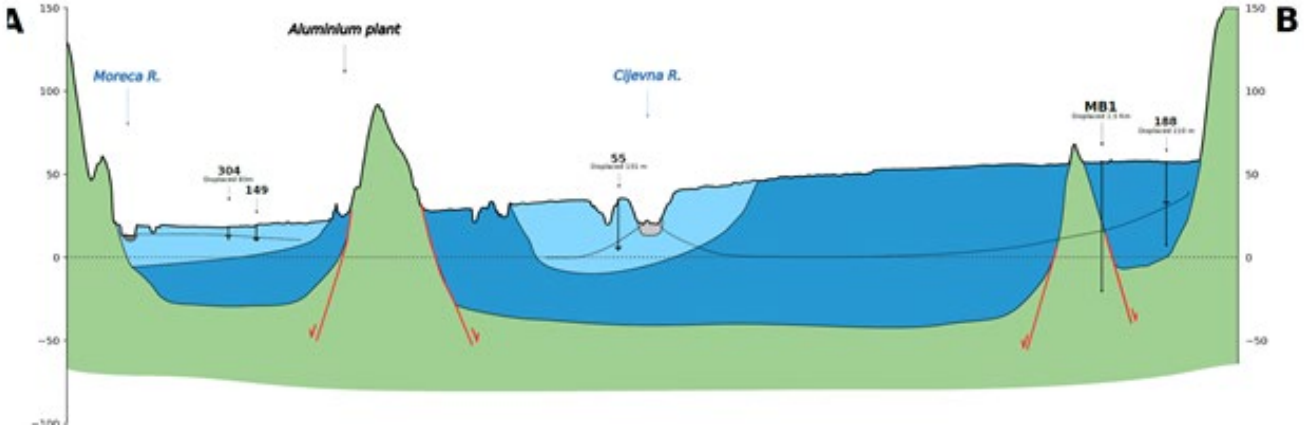
The case of the Skadar/Shkoder - Buna/Bojana transboundary aquifer

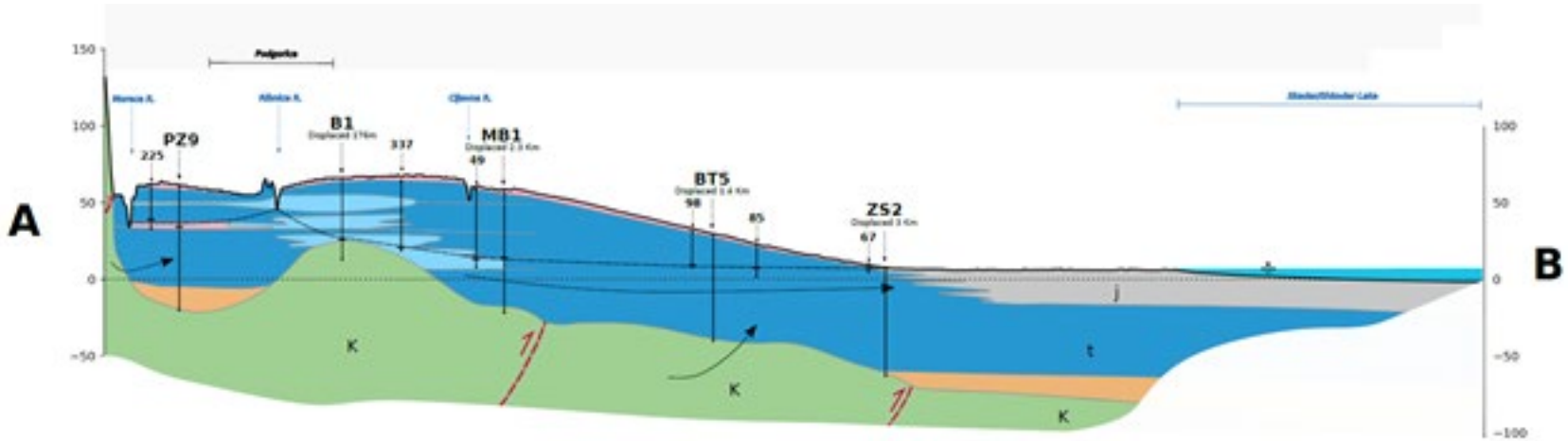
Data collection

	Data Needed for the elaboration of hydrogeological conceptual model	Priority (based on EU-WFD requirements)	MNT	ALB
Topography	Topographic maps	ESSENTIAL	Yes	Yes
	Detailed Digital Elevation Model		Yes	
	Surface waters	ADVISABLE		
	Surface water catchment	OPTIONAL		
Geology	Geology/Lithology Map	ESSENTIAL	Yes	Yes
	Tectonics	ESSENTIAL	Yes	Yes
	Stratigraphy descriptions	ESSENTIAL	Yes	Yes
	Geophysical data	OPTIONAL		
Hydrogeology	Hydrogeological units	ESSENTIAL		Yes
	Basic geochemistry	ADVISABLE	Yes	Yes
	Permeability	ADVISABLE	Yes	Yes
	Wells inventory	ESSENTIAL	Yes	Yes
	Groundwater levels time series	ESSENTIAL	Yes	
	Local uses of groundwater.	ADVISABLE	Yes	Yes
Climatic	Meteorological data	ADVISABLE	Yes	
Pollution sources	Inventory of diffuse sources and point sources	ADVISABLE	Yes	Yes
	Map of flood prone areas	OPTIONAL		Yes

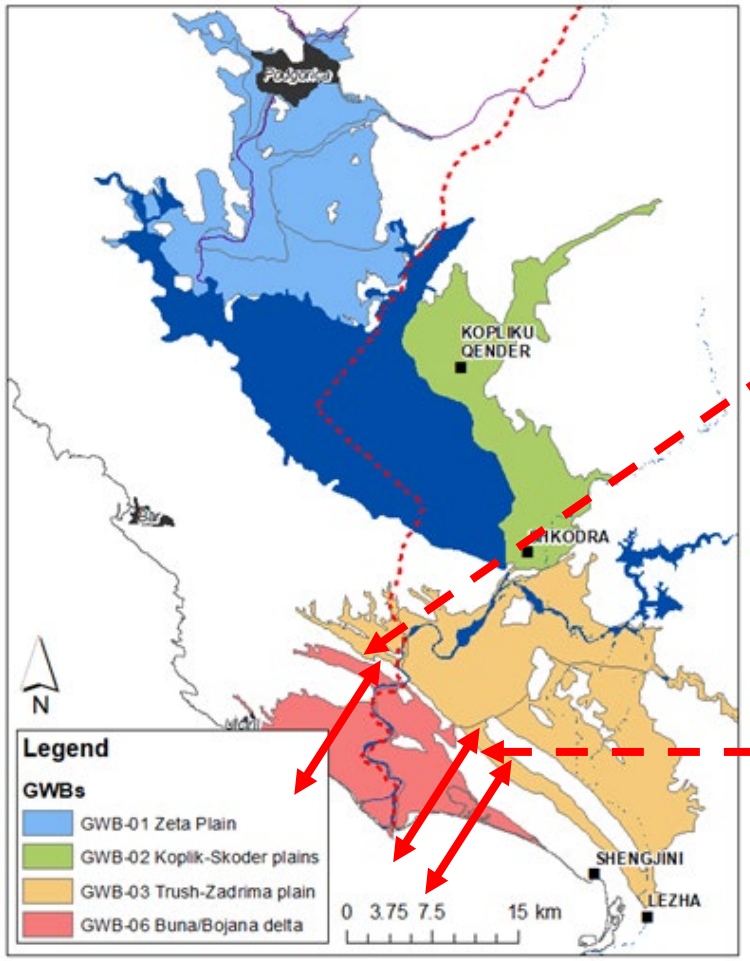
Definition of management units

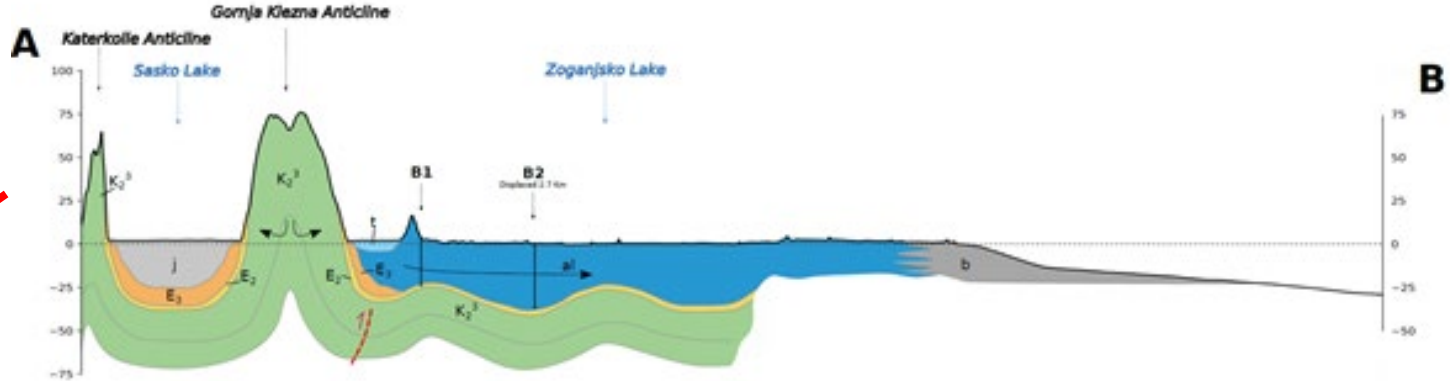


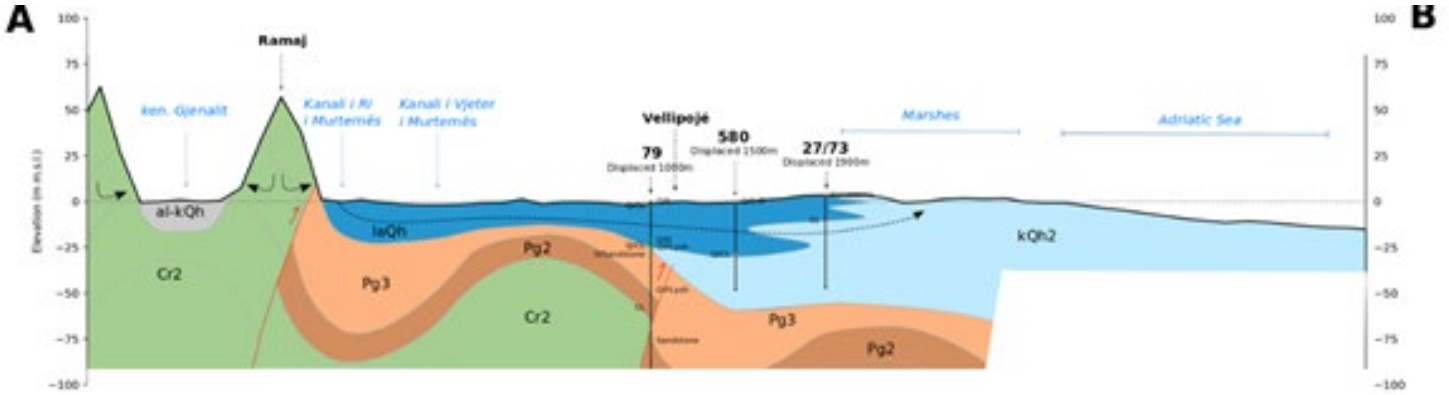




Definition of management units





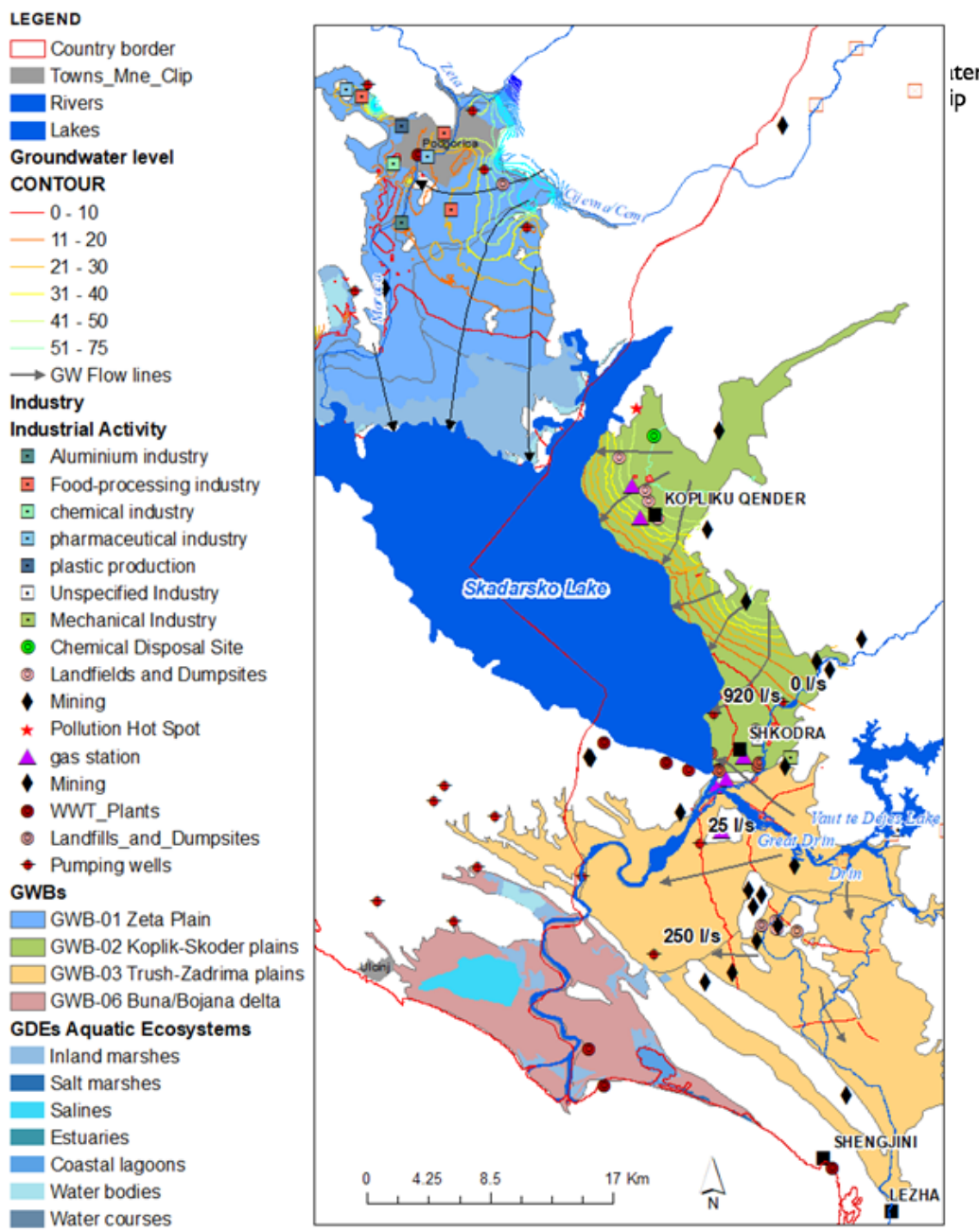


Multidimensional assessment

Hydrological information

Socio-economical information

Environmental information



Further reading

EU_WFD guidance documents:

- European Commission. Common Implementation Strategy for the Water Framework Directive (2000 / 60 / EC). **Groundwater body characterisation**. Framework 9, (2004).
- European Commission. Common Implementation Strategy for the Water Framework Directive. Guidance document No. 26. **GUIDANCE ON RISK ASSESSMENT AND THE USE OF CONCEPTUAL MODELS FOR GROUNDWATER**. (2003).

Other documents:

- Enemark, T., Peeters, L.J.M., Mallants, D., Batelaan, O., Hydrogeological conceptual model building and testing: A review, Journal of Hydrology (2018), doi: https://doi.org/10.1016/j.jhydrol. 2018.12.007
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- Mas-Pla, J. et al. La Directiva marc de l'Aigua a Catalunya. (2006).

Thank you!

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