

Gabcikovo Part of Hydroelectric Power Project and Joint Slovak - Hungarian Monitoring of Environmental Impact



Prepared for

Plenipotentiary of the Slovak Republic
for Construction and Operation of
Gabcikovo-Nagymaros Hydroelectric Power Project
&

Nominanated Monitoring Agent
of the Government of Slovak Republic

**Nagymaros Part
of Hydropower Project**

**Gabcikovo Part
of Hydropower Project**

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Bratislava, SLOVAKIA

Danubian Lowland Aquifer

The main characteristics of Danubian Lowland area :

- **Unique groundwater resources**

- high permeable gravel-sand Quaternary sediments
- thickness of alluvial aquifer more than 300 m
- the aquifer is recharged by water from the Danube river during the whole year
- excellent groundwater quality

- **Unique floodplain ecosystem**

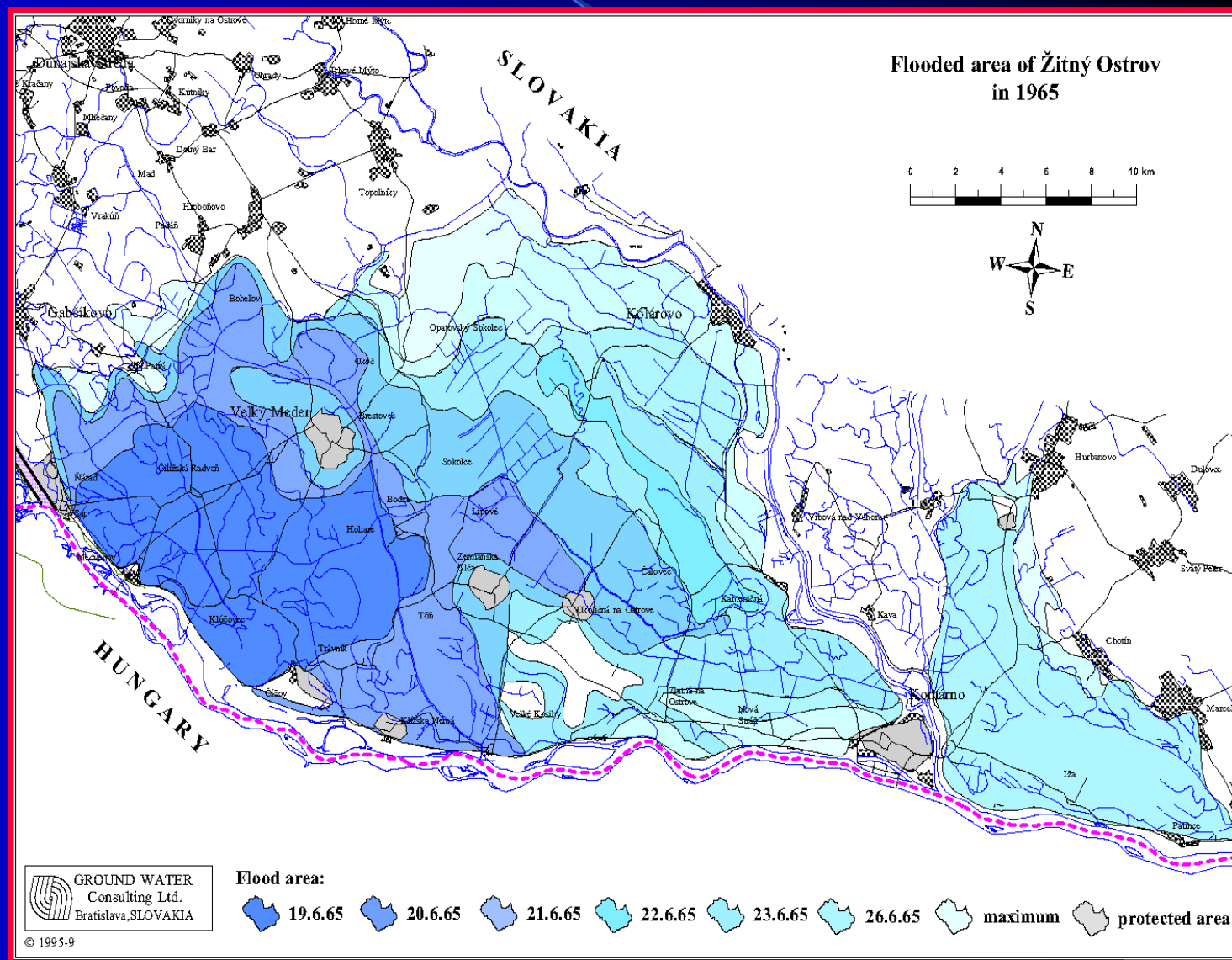
- **Extensive human activities**

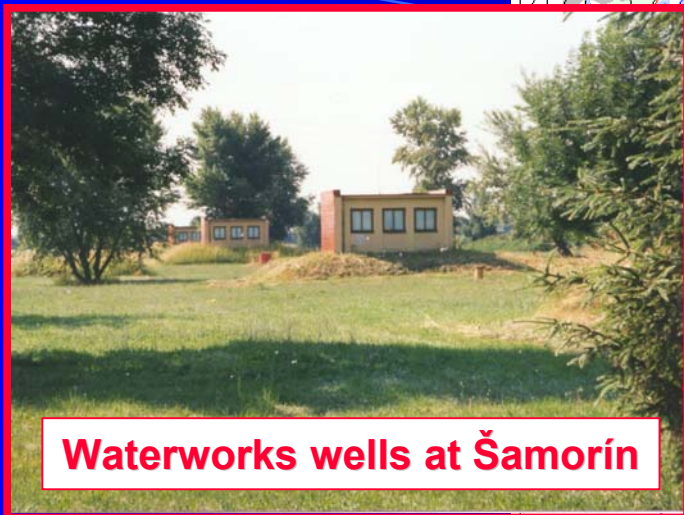
- agriculture, forestry, industry, tourism
- **Gabčíkovo Hydroelectric Power Project**



Objectives of Gabčíkovo-Nagymaros Hydroelectric Power Project

1. Flood Control
2. Navigational Improvements
3. Production of Electrical Energy
4. Positive Environmental Impacts

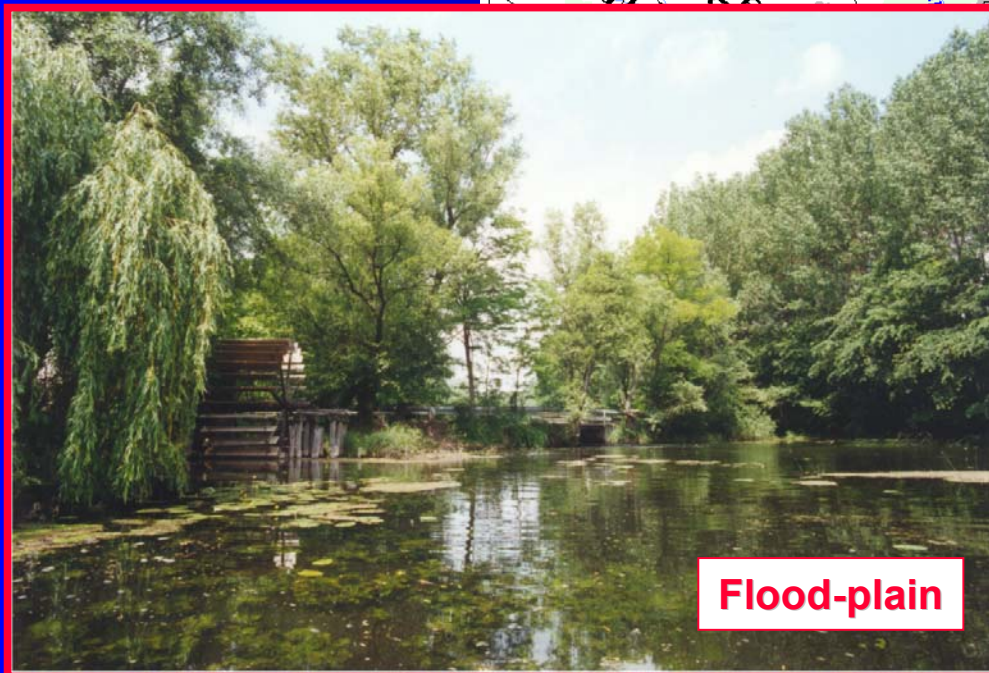




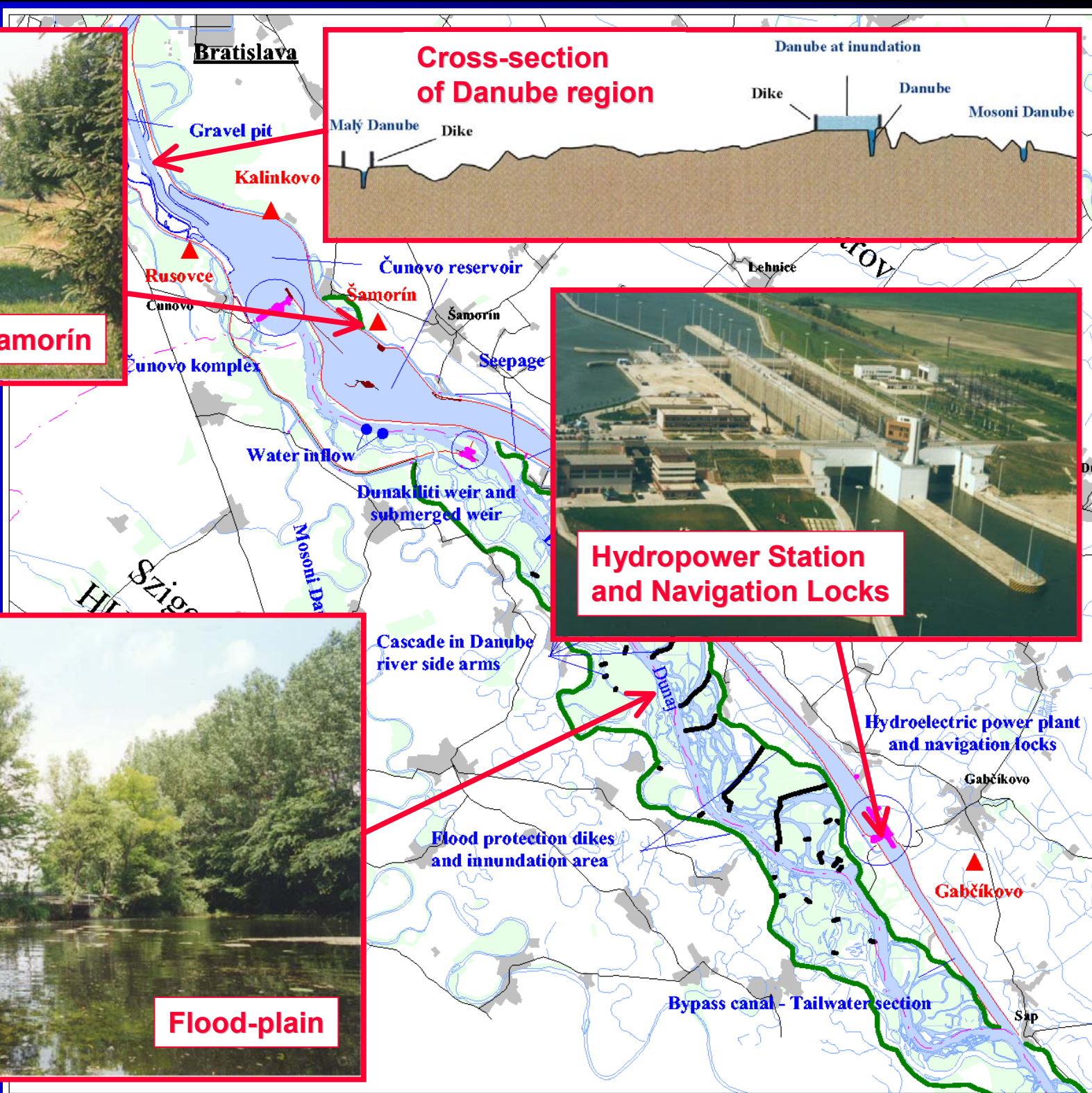
Waterworks wells at Šamorín

Waterworks Capacity:

- Rusovce 2480 l/s
- Kalinkovo 850 l/s
- Šamorín 900 l/s
- Gabčíkovo 1040 l/s



Flood-plain



Hydropower Station and Navigation Locks

Basic Input for Decision Making

Groundwater and Environmental Management in the area is based on :

- **Monitoring**

- surface water and groundwater regime
- surface water and groundwater quality
- quality of river bed sediments
- soil moisture regime in the aeration zone
- biota (flora and fauna) including forestry

- **Data interpretation using numerical modeling**

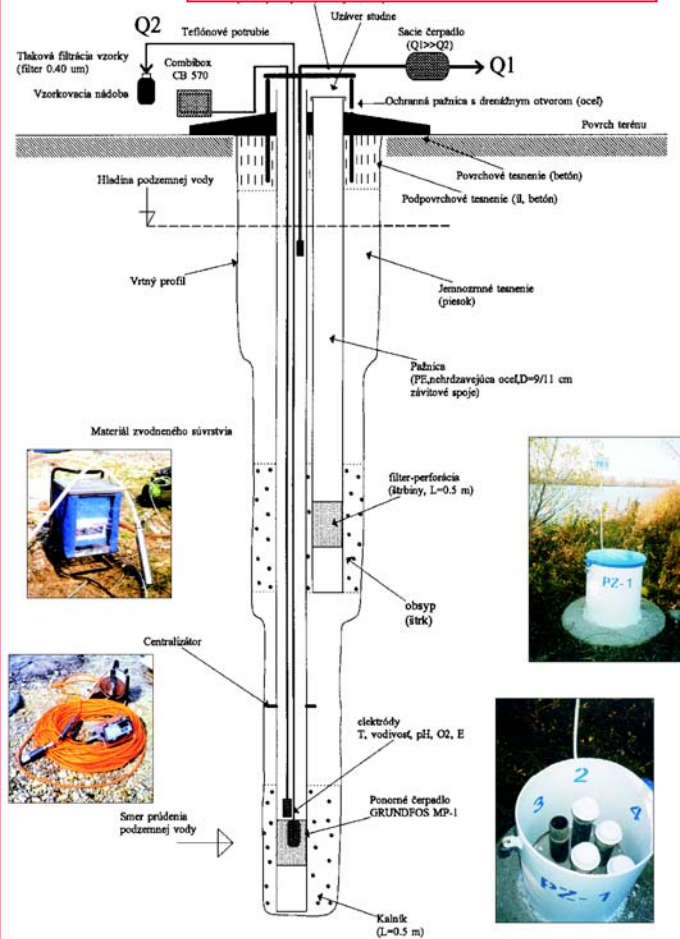
- groundwater flow and quality
- surface water hydrodynamics, sediment transport and quality of water in the river, river branch system, and reservoir
- agricultural modeling, pumping test modeling, etc.

Joint Slovak-Hungarian Monitoring

Agreement between the Government of the Slovak Republic and the Government of Hungary about Certain Temporary Measures and Discharges to the Danube and Mosoni Danube, signed on April 19, 1995:

- Increase of water discharge into the Mosoni Danube and river branches from 20 to 43 m³/s via the Čunovo intake structure
- Increase the discharge into the main Danube downstream from the Čunovo weir to 250-600 m³/s (400 m³/s on average)
- Construct an underwater weir in the main Danube at Dunakiliti to supply Hungarian river branches with water (130 m³/s)
- Collect and exchange environmental monitoring data which are necessary for an analysis of the impact of the mentioned measures (**Joint Slovak-Hungarian Monitoring of Environmental Impacts**)
- Prepare National annual reports and Joint annual reports

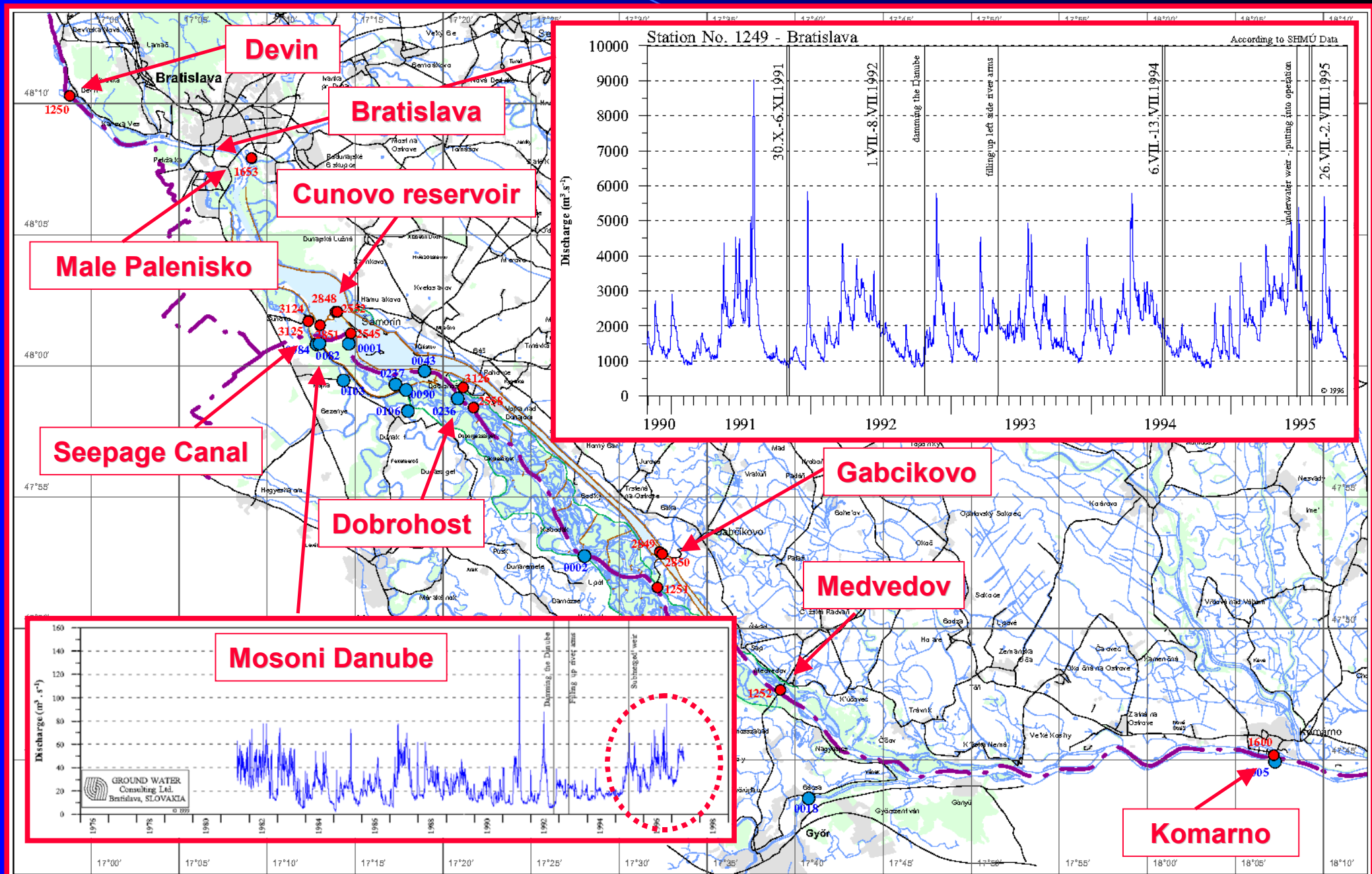
Groundwater quality



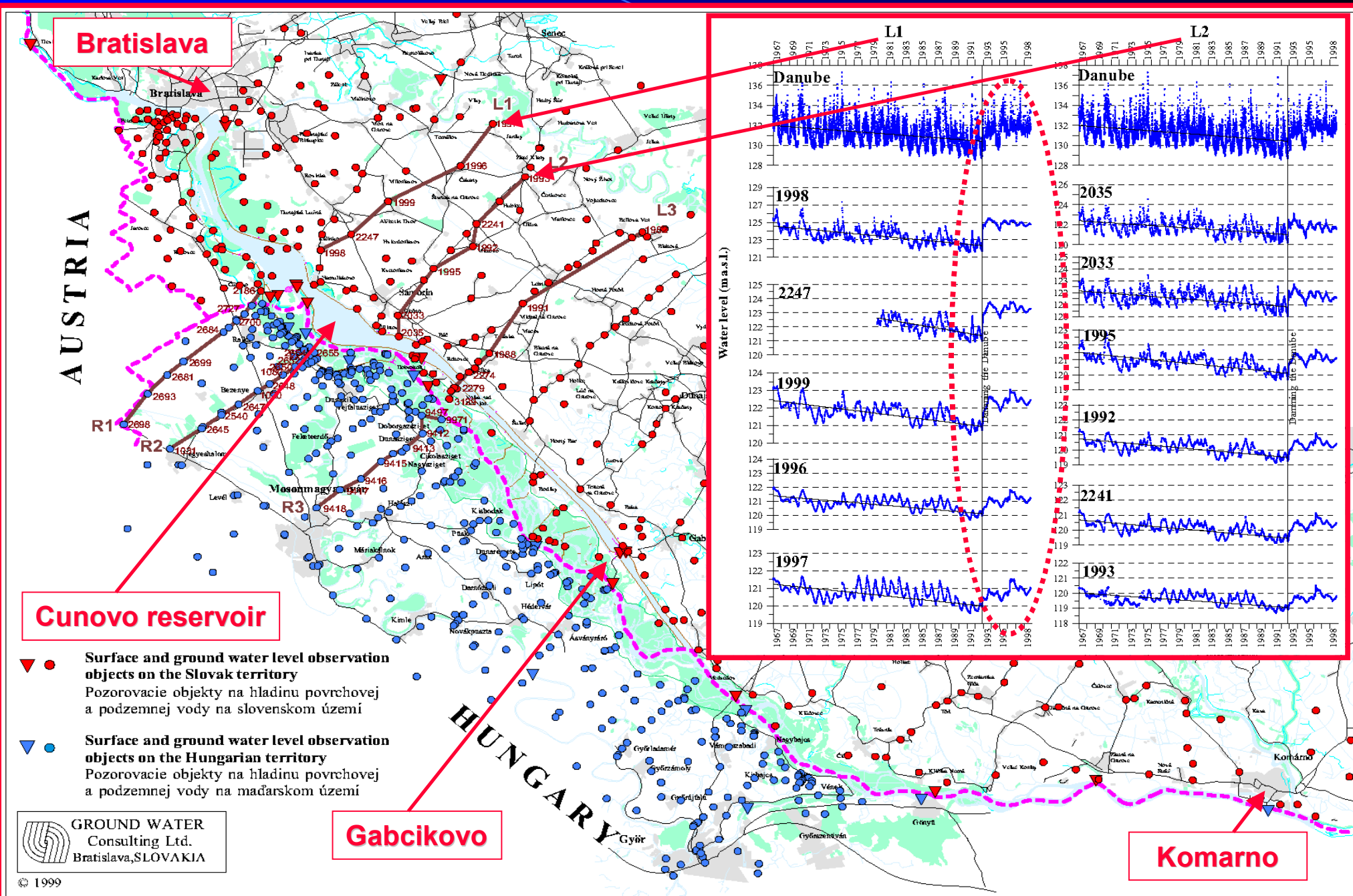
Joint Monitoring



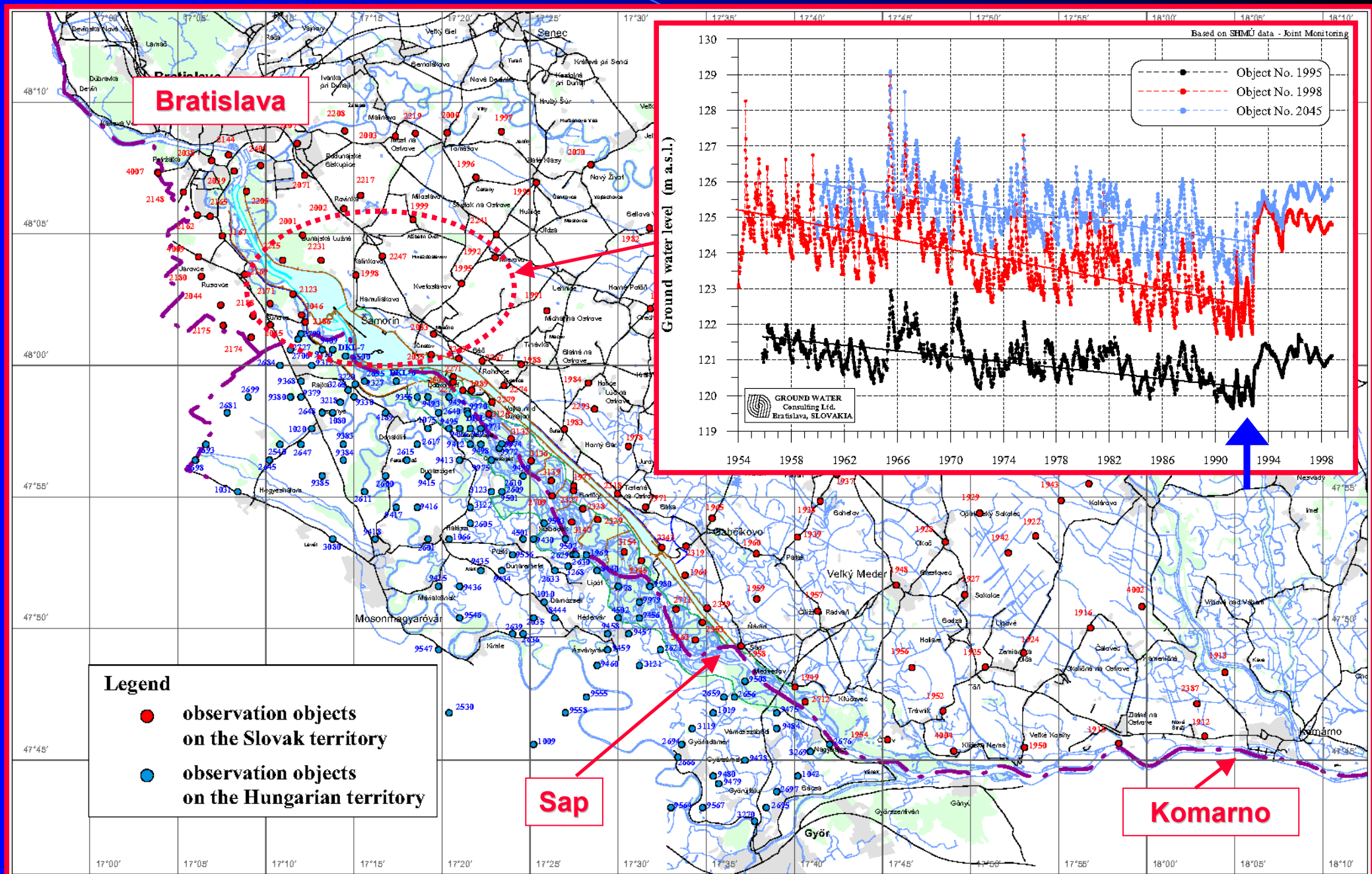
Joint Monitoring – Surface Water Quantity



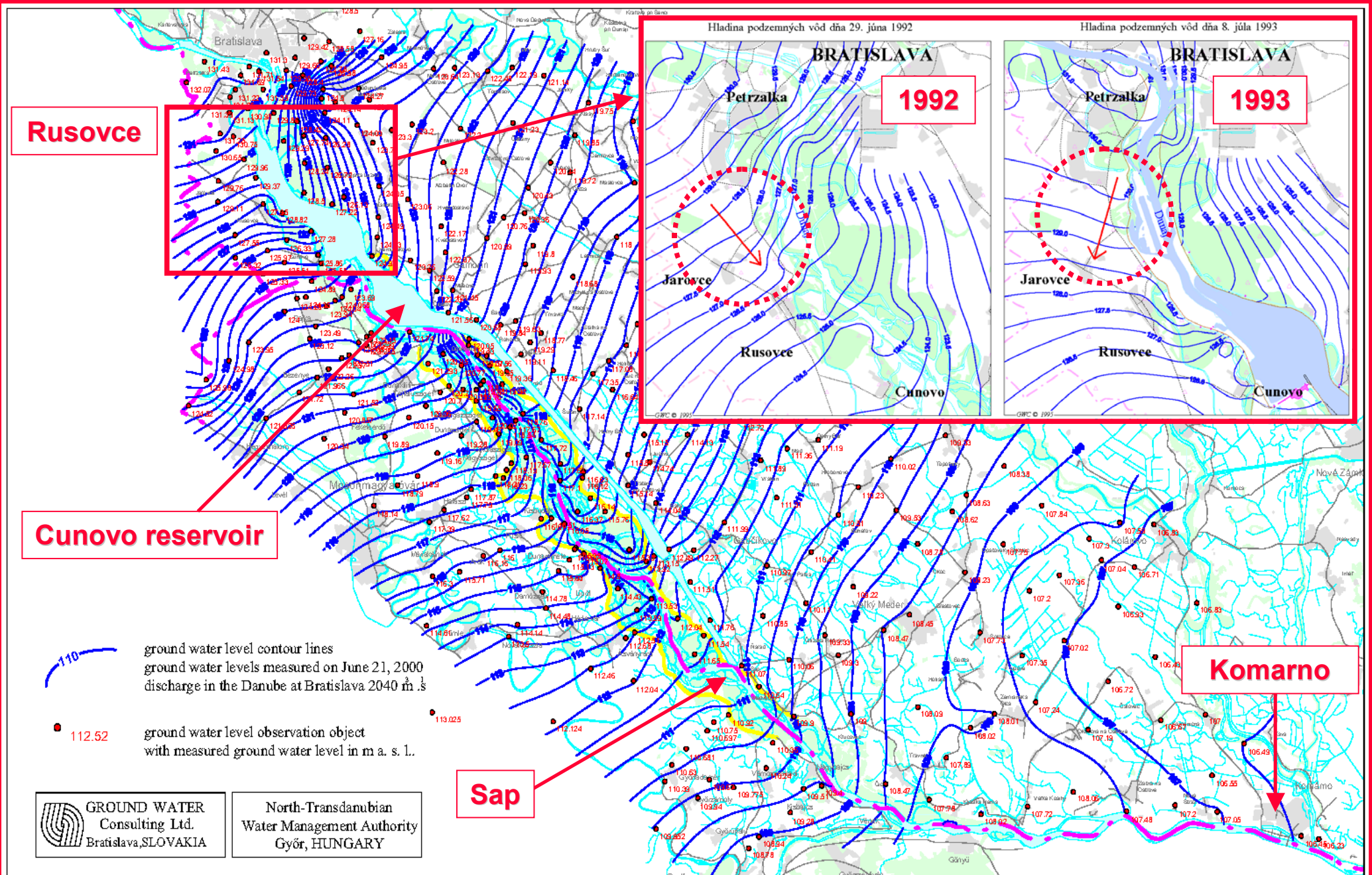
Surface and Ground Water Level Monitoring



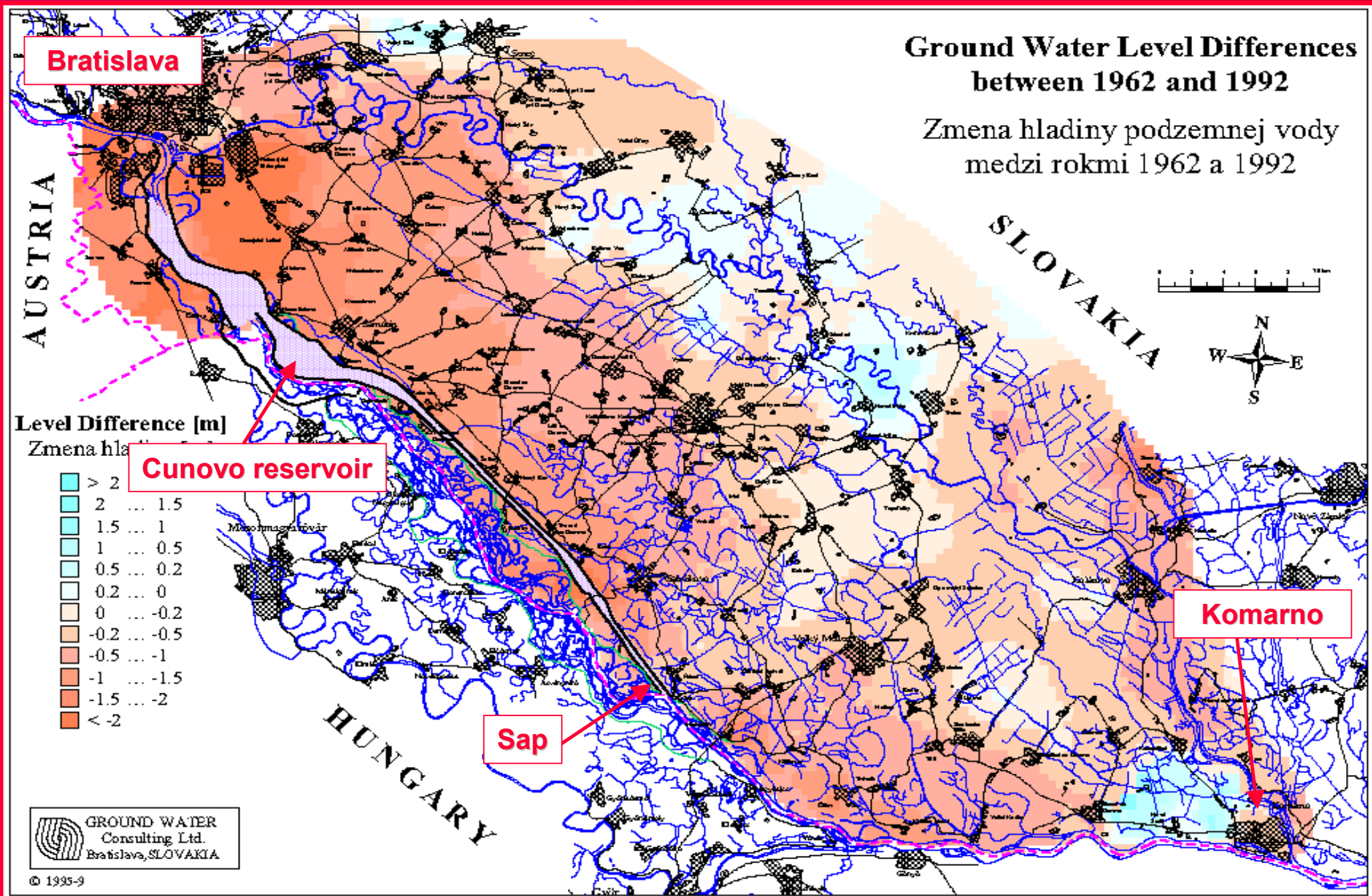
Joint Monitoring – Ground Water Regime



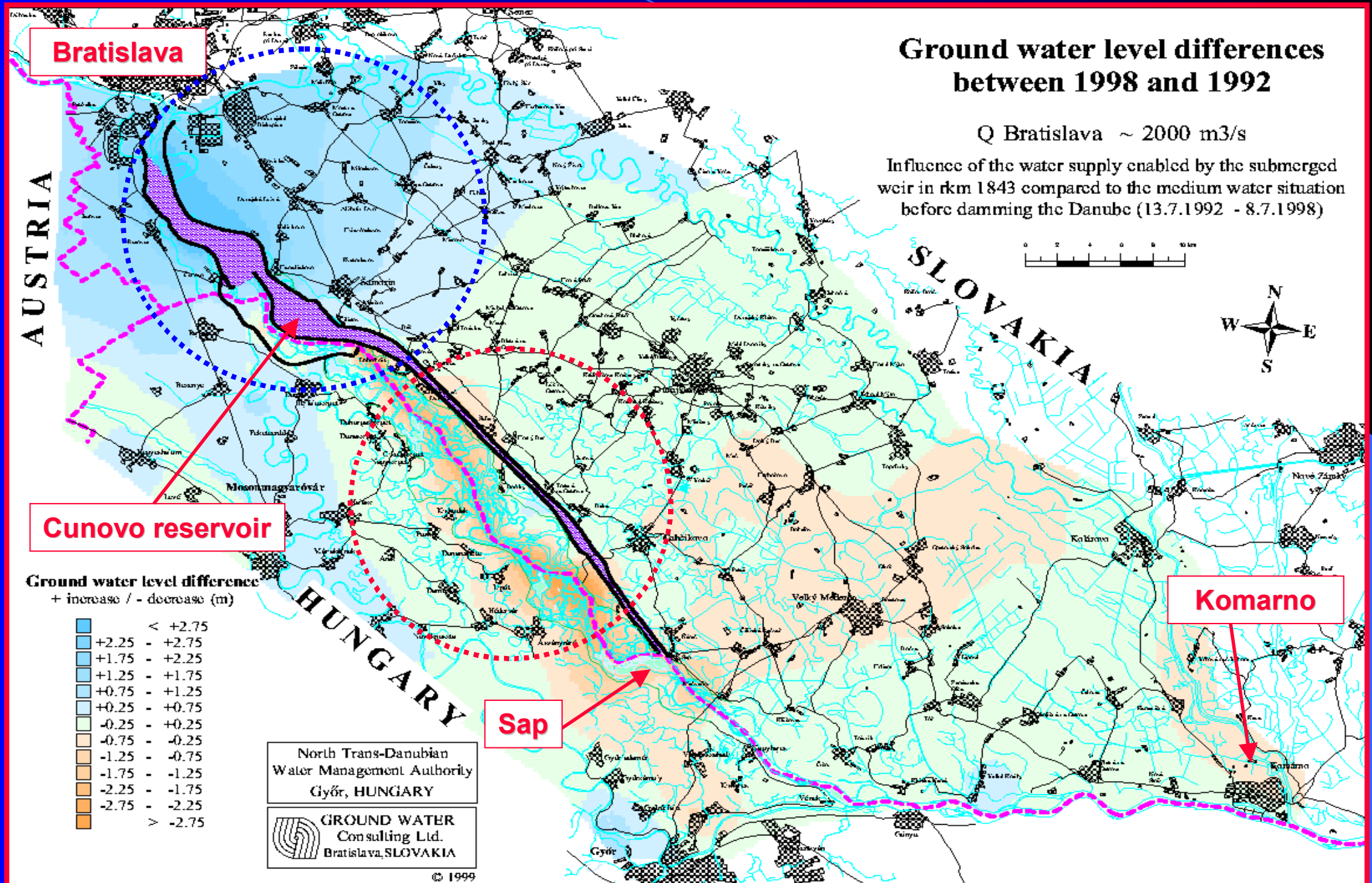
Ground Water Level Contour Lines (2000)



Ground Water Level Differences 1962/1992



Ground Water Level Differences 1992/1998

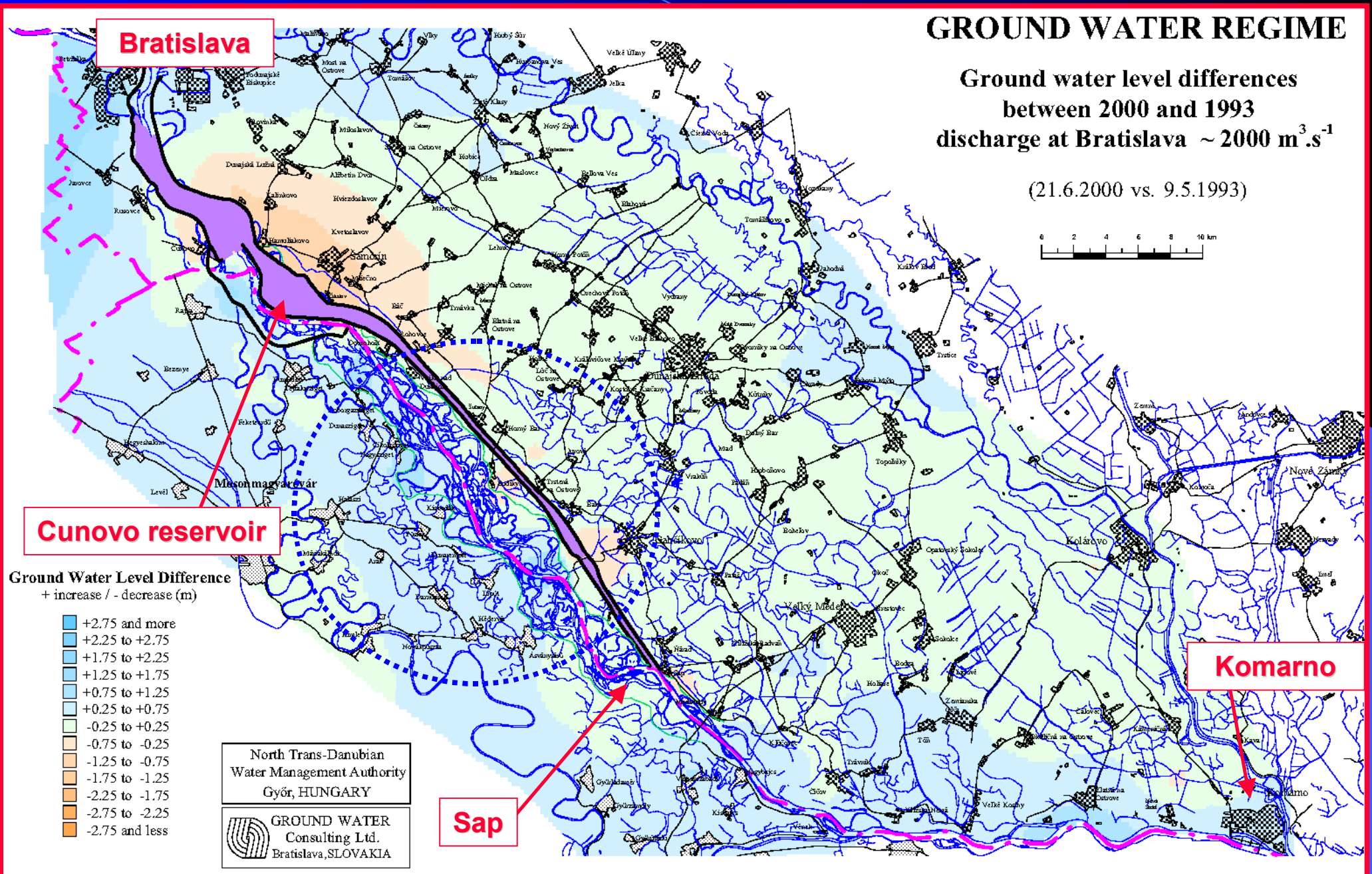


Ground Water Level Differences 1993/2000

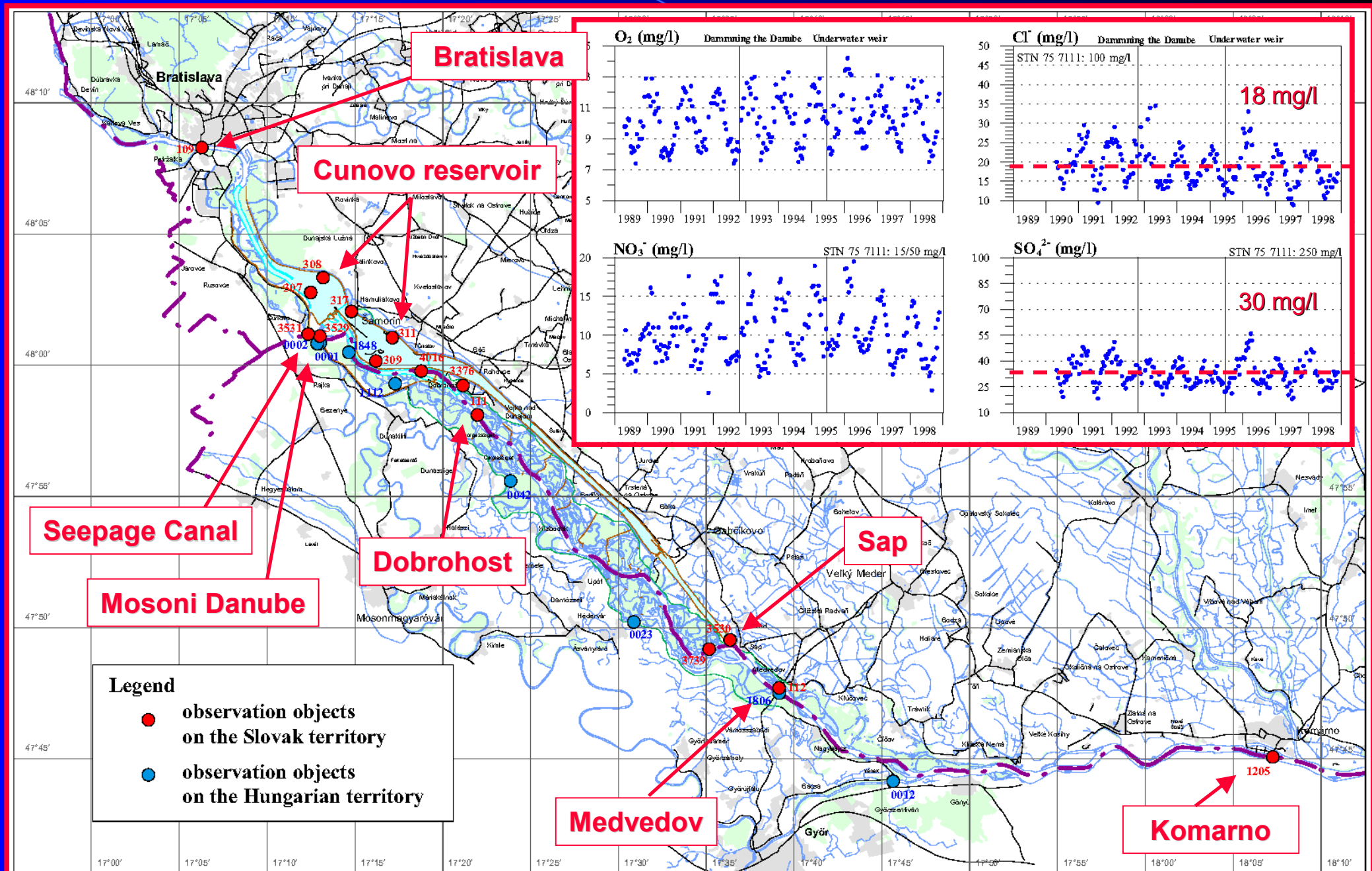
GROUND WATER REGIME

Ground water level differences
between 2000 and 1993
discharge at Bratislava $\sim 2000 \text{ m}^3 \cdot \text{s}^{-1}$

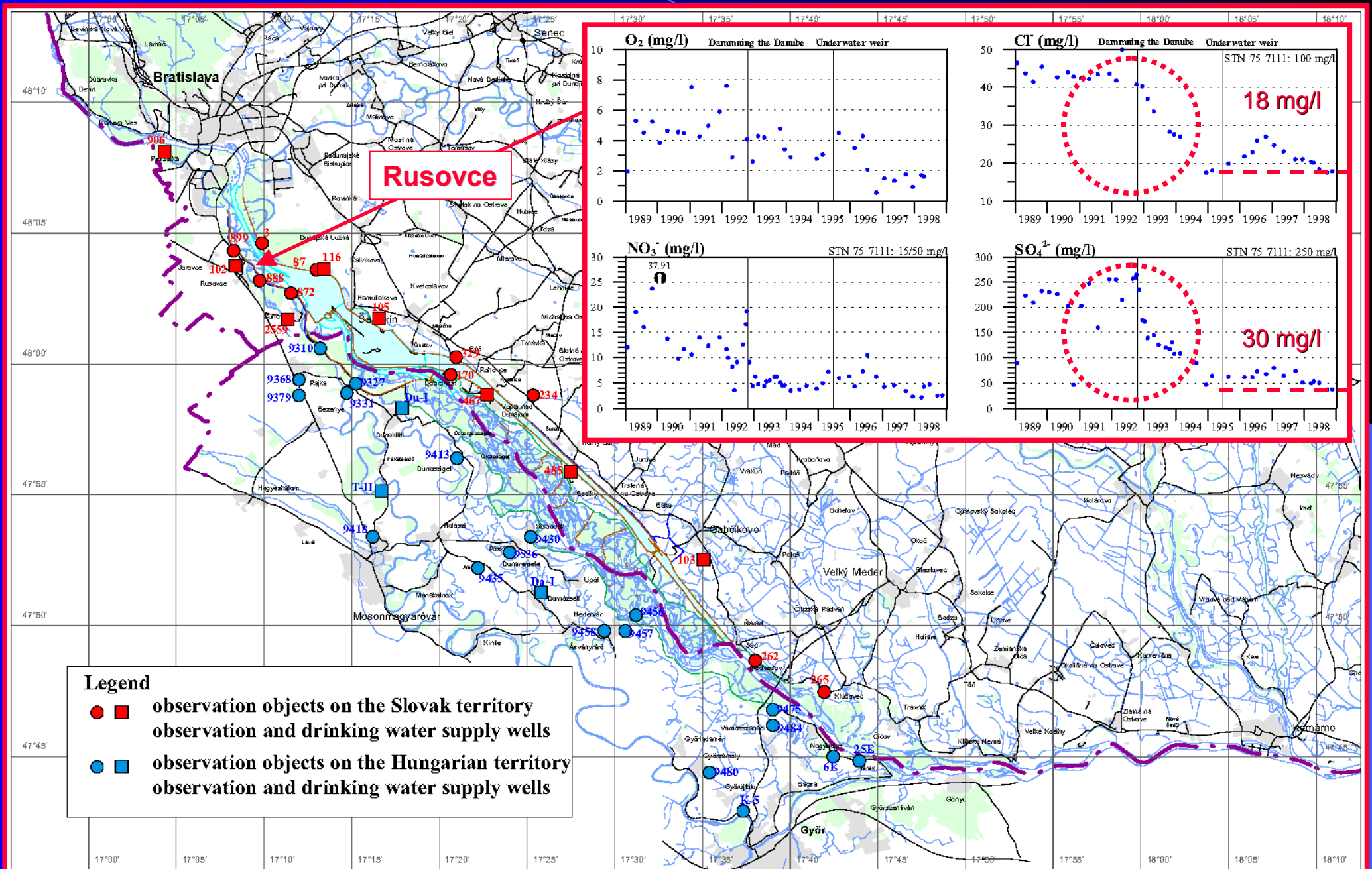
(21.6.2000 vs. 9.5.1993)



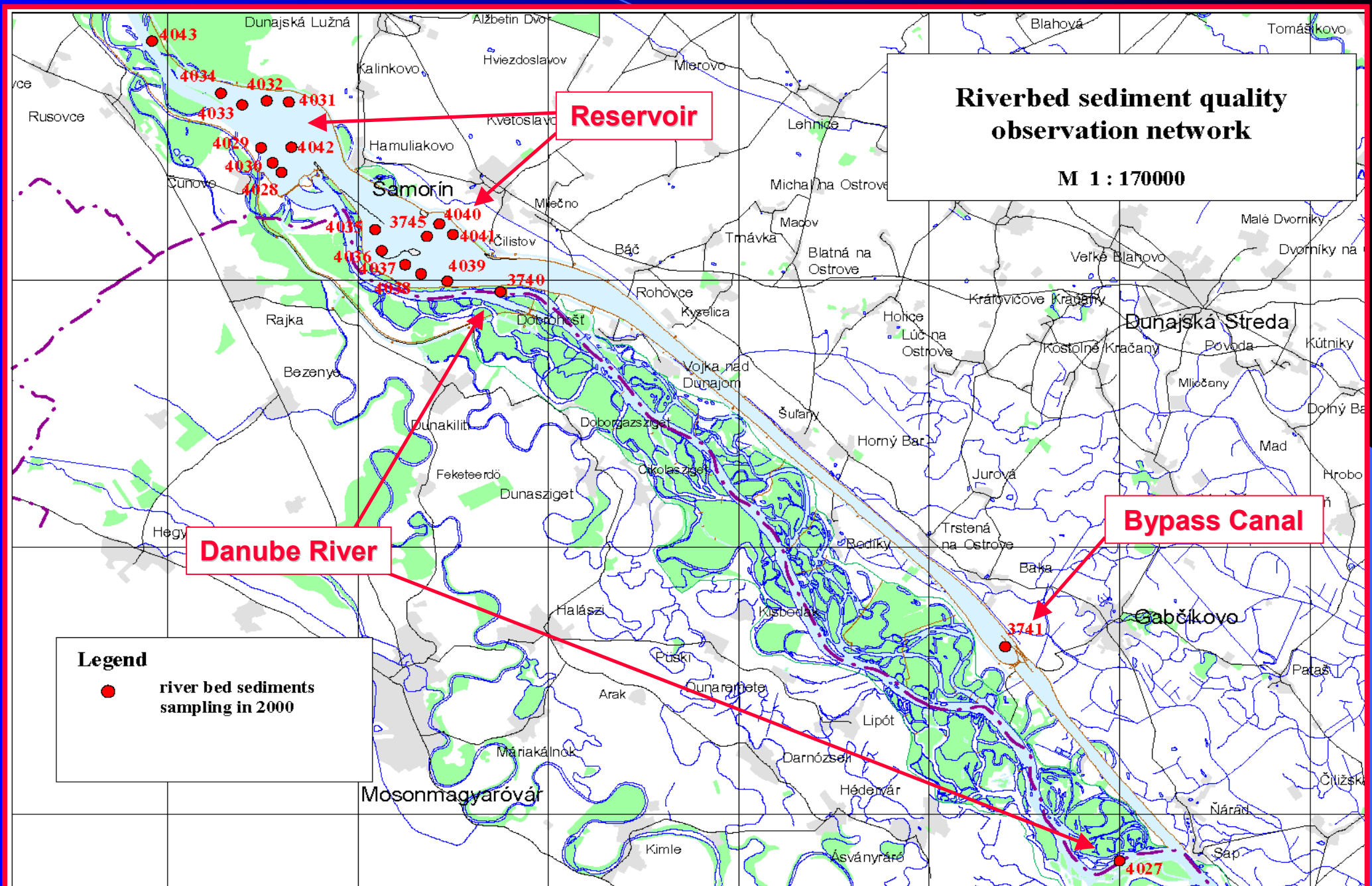
Joint Monitoring – Surface Water Quality



Joint Monitoring – Ground Water Quality

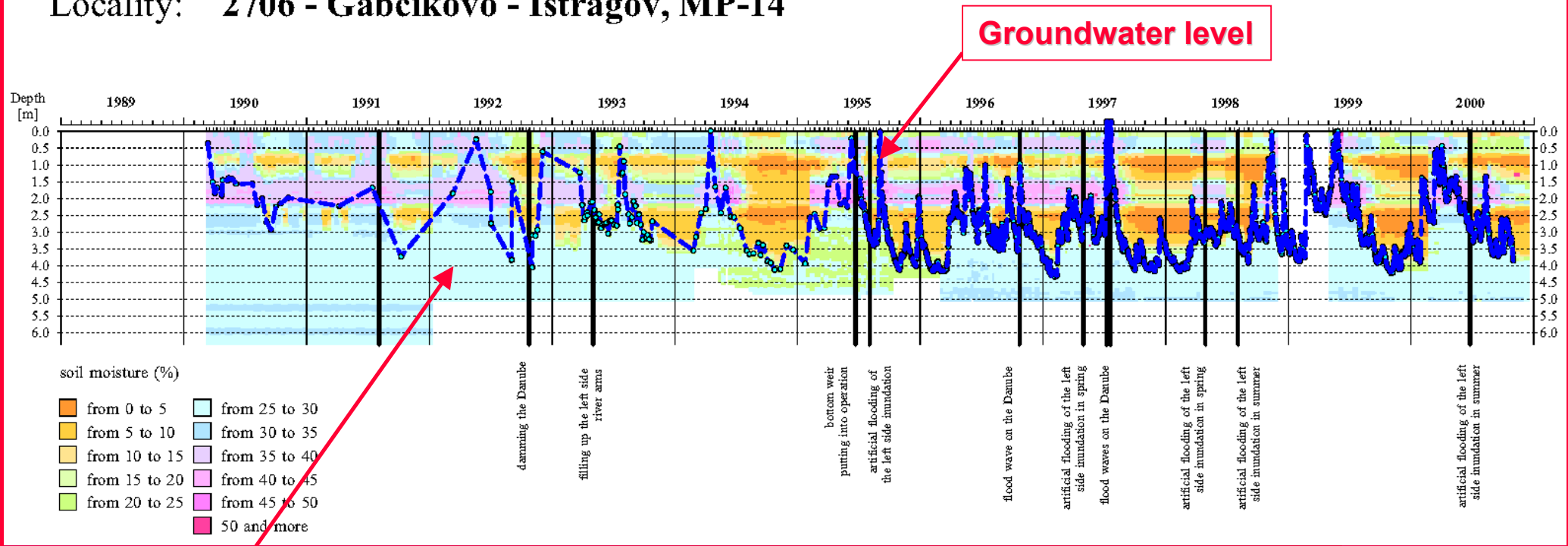


Joint Monitoring – River Bed Sediments

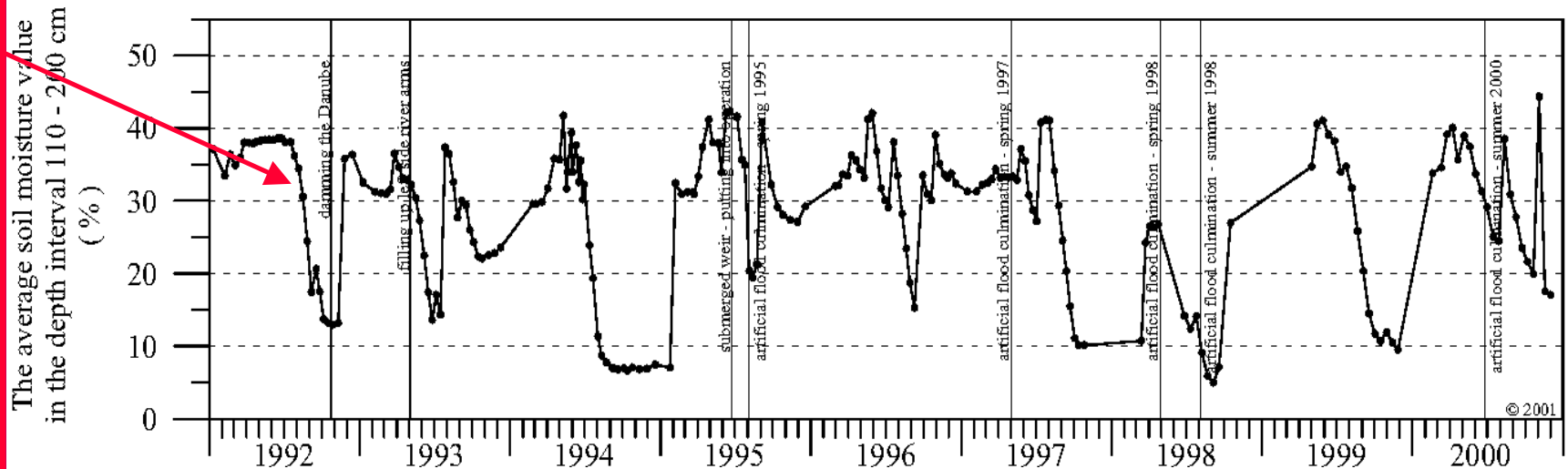


Joint Monitoring – Soil Moisture

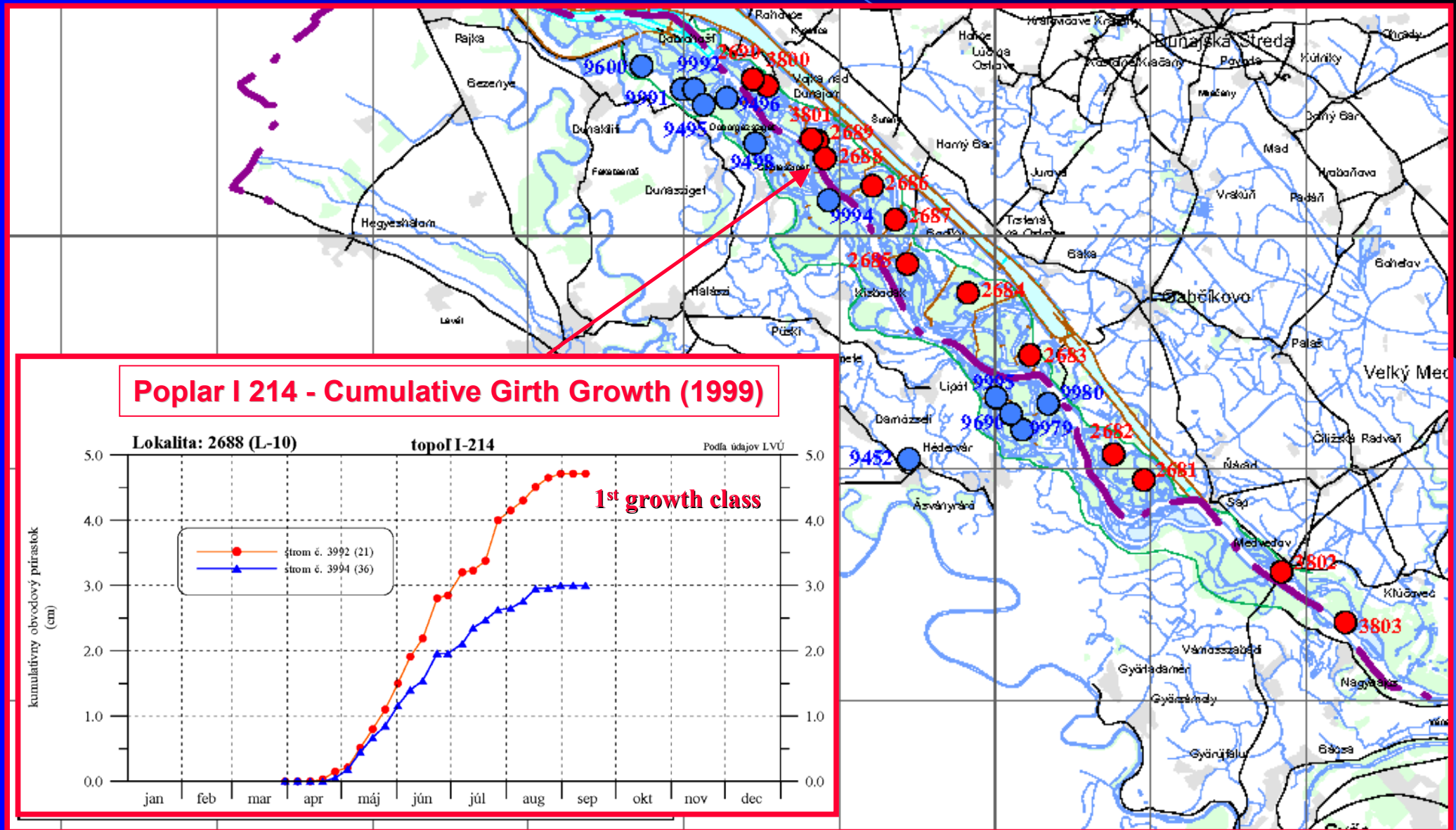
Locality: 2706 - Gabčíkovo - Istragov, MP-14



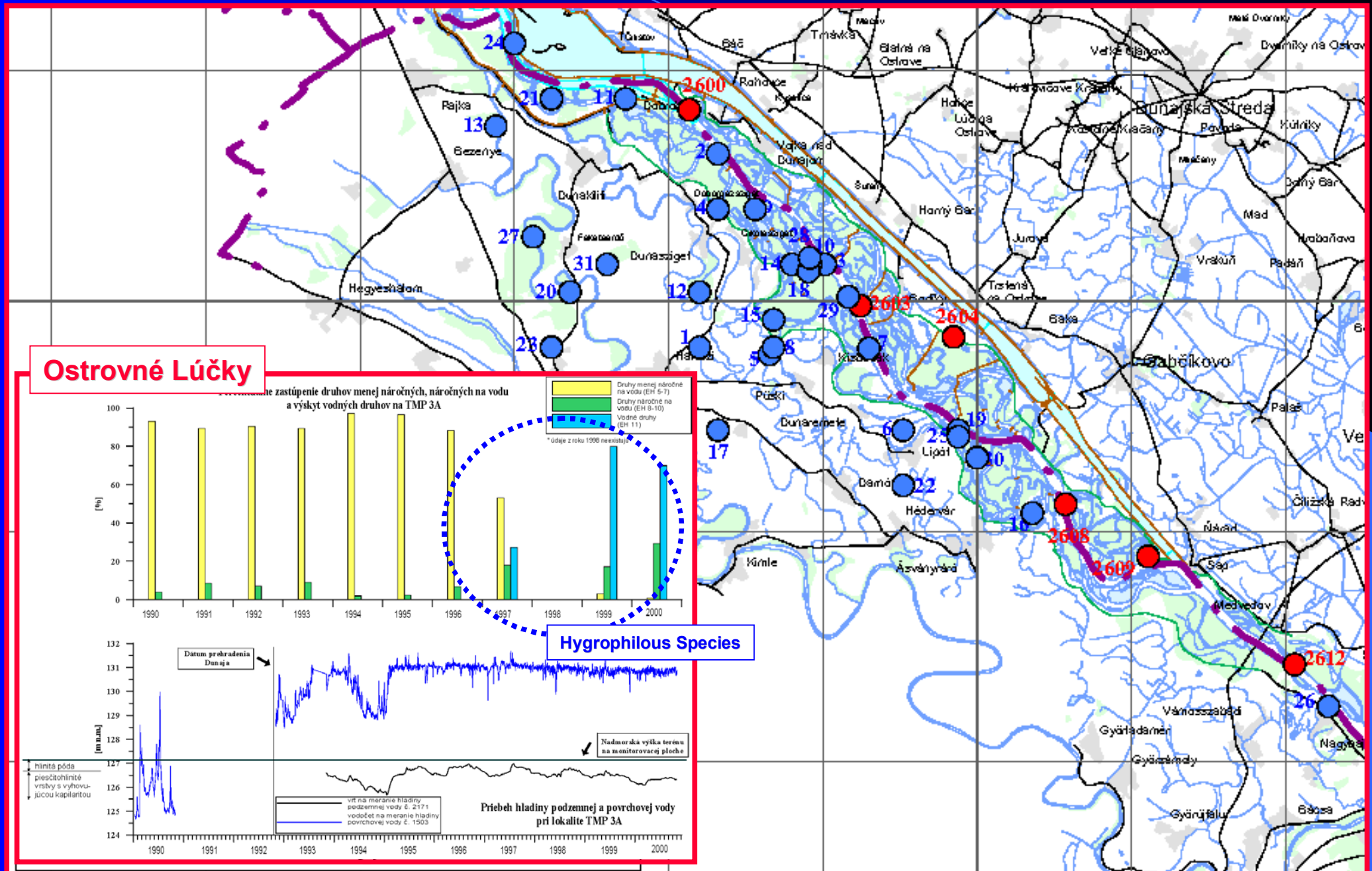
Soil moisture

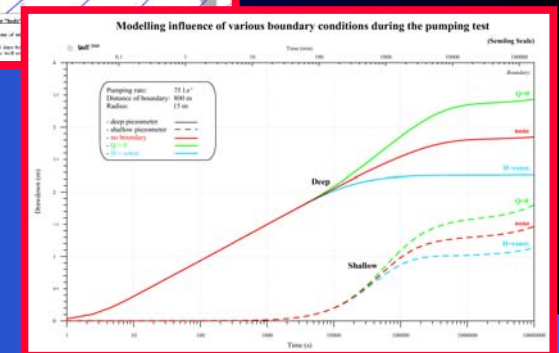
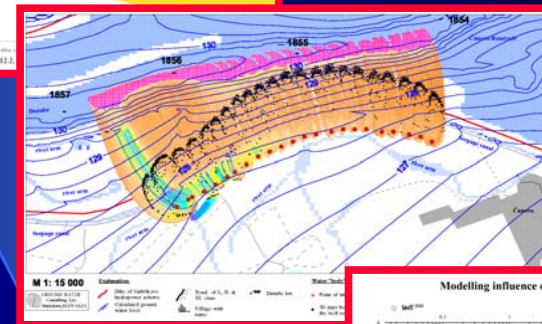
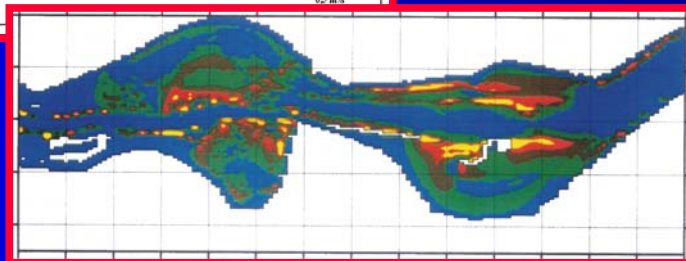
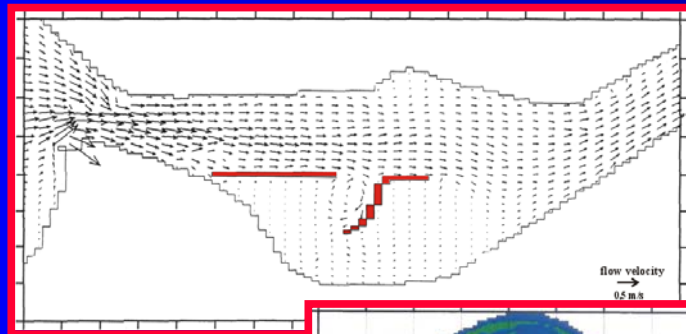
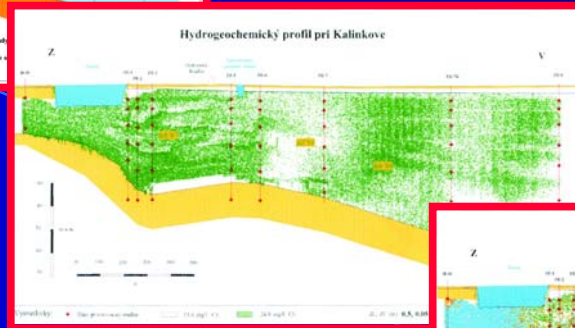


Joint Monitoring – Forest Monitoring



Joint Monitoring – Biological Monitoring





Groundwater Modeling



Modeling examples in Danubian Lowland area :

- **Modeling infiltration from river**
- **Modeling conservative and reactive transport in groundwater**
- **Modeling groundwater flow towards municipal waterworks wells**
- **Modeling surface water hydrodynamics and sediment transport** (Project PHARE EC/WAT/1)
- **Pumping test modeling**

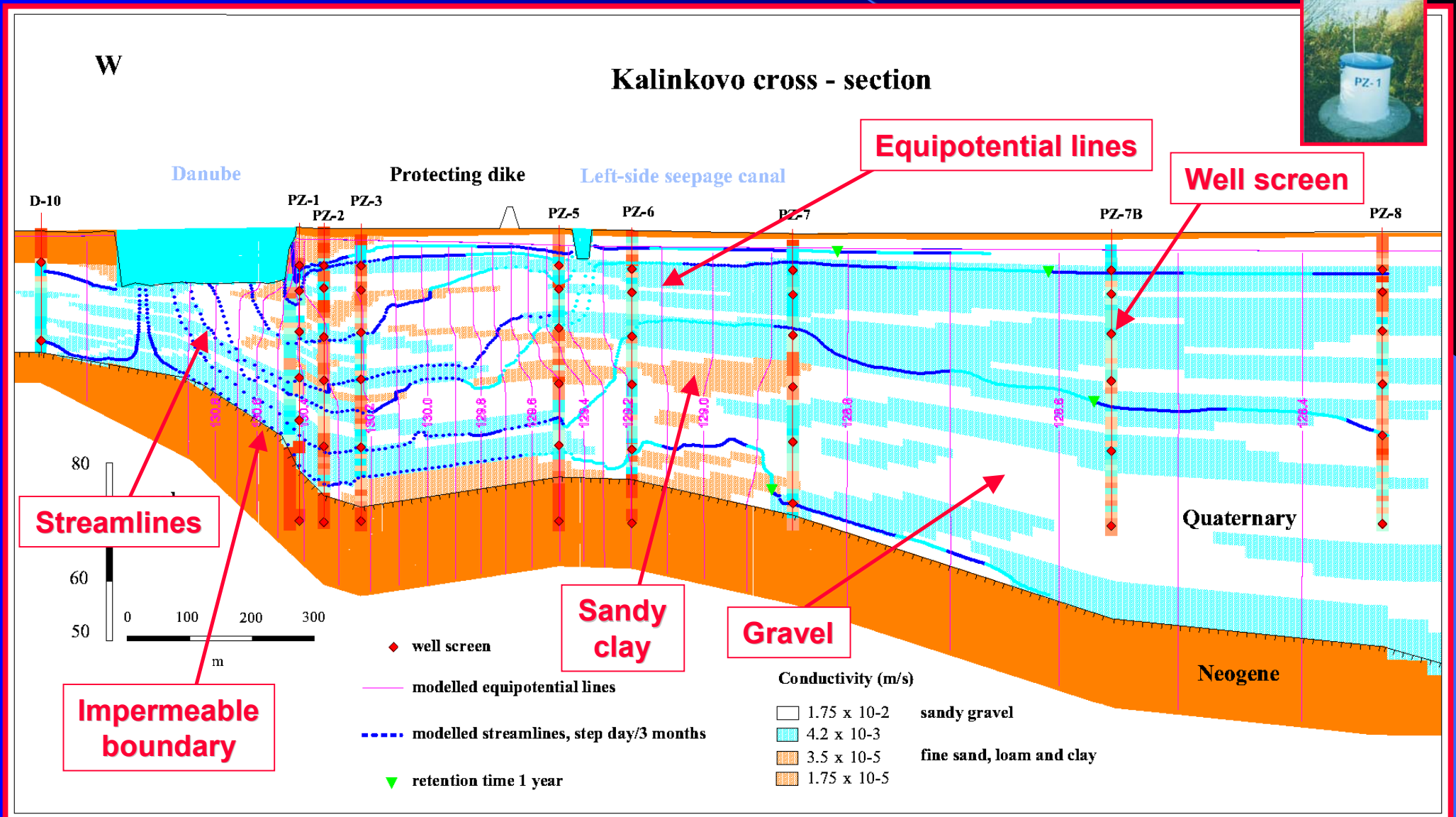
Modeling infiltration from river in vertical profile



Goals of interpretation :

- **Hydrogeological characteristics of aquifer**
- **Boundary conditions**
- **Equipotential lines, streamlines and retention times**
- **Water balance**

Modeling infiltration from river in vertical profile



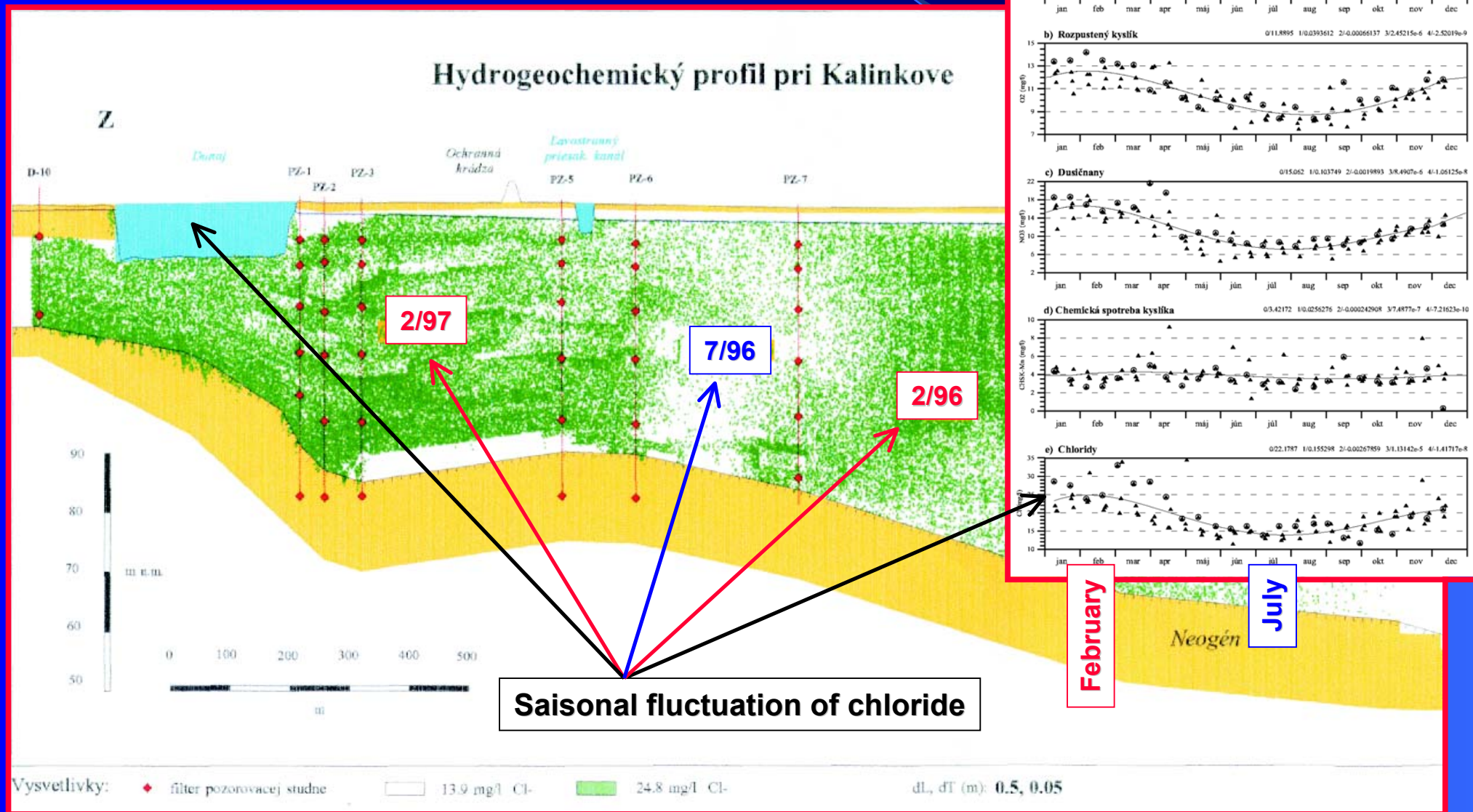
Modeling conservative transport in groundwater



Goals of interpretation :

- **Migration parameters of aquifer**
(dispersivity, active porosity)
- **Changes of groundwater quality caused by seasonal variations of surface water quality**
(e. g. chlorides in Danube river)

Modeling conservative transport in groundwater



Modeling reactive transport in groundwater



Goals of interpretation :

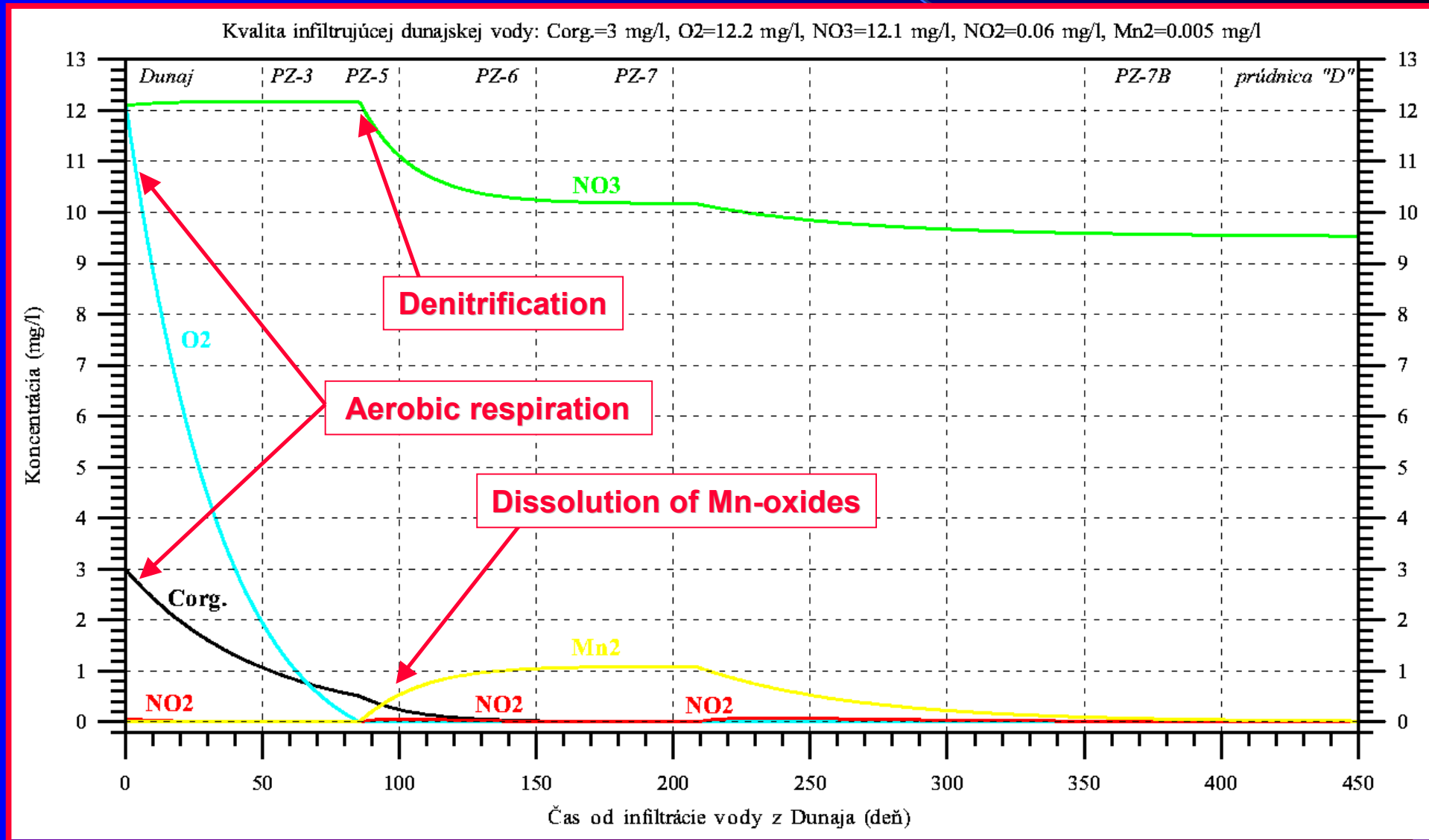
- **Kinetics of microbially mediated redox processes**

(e. g. aerobic respiration, denitrification)

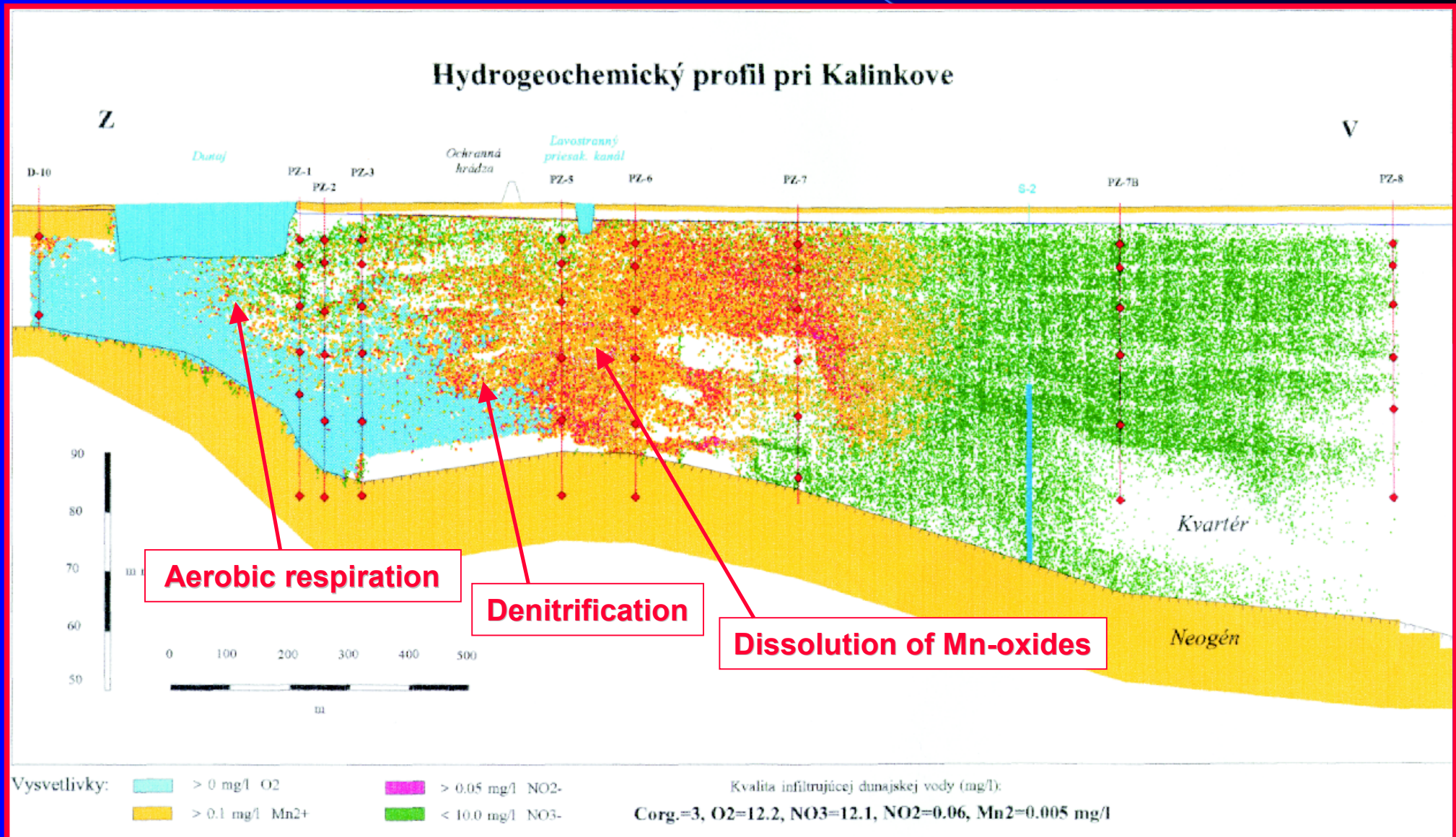
- **Reactivity of aquifer sediments**

(e. g. oxidation of organic carbon,
reductive dissolution of Mn-oxides)

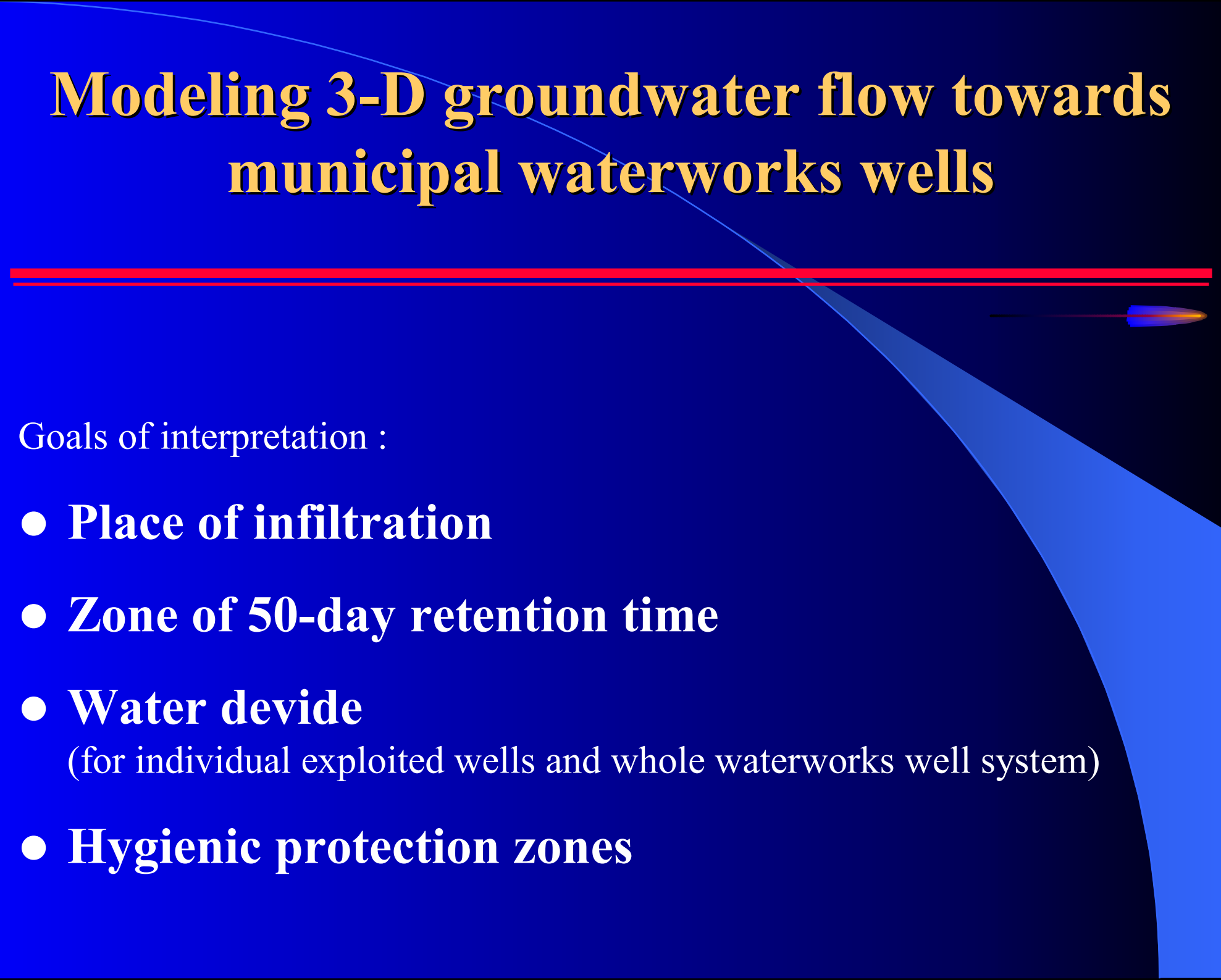
Modeling reactive transport in groundwater



Modeling reactive transport in groundwater



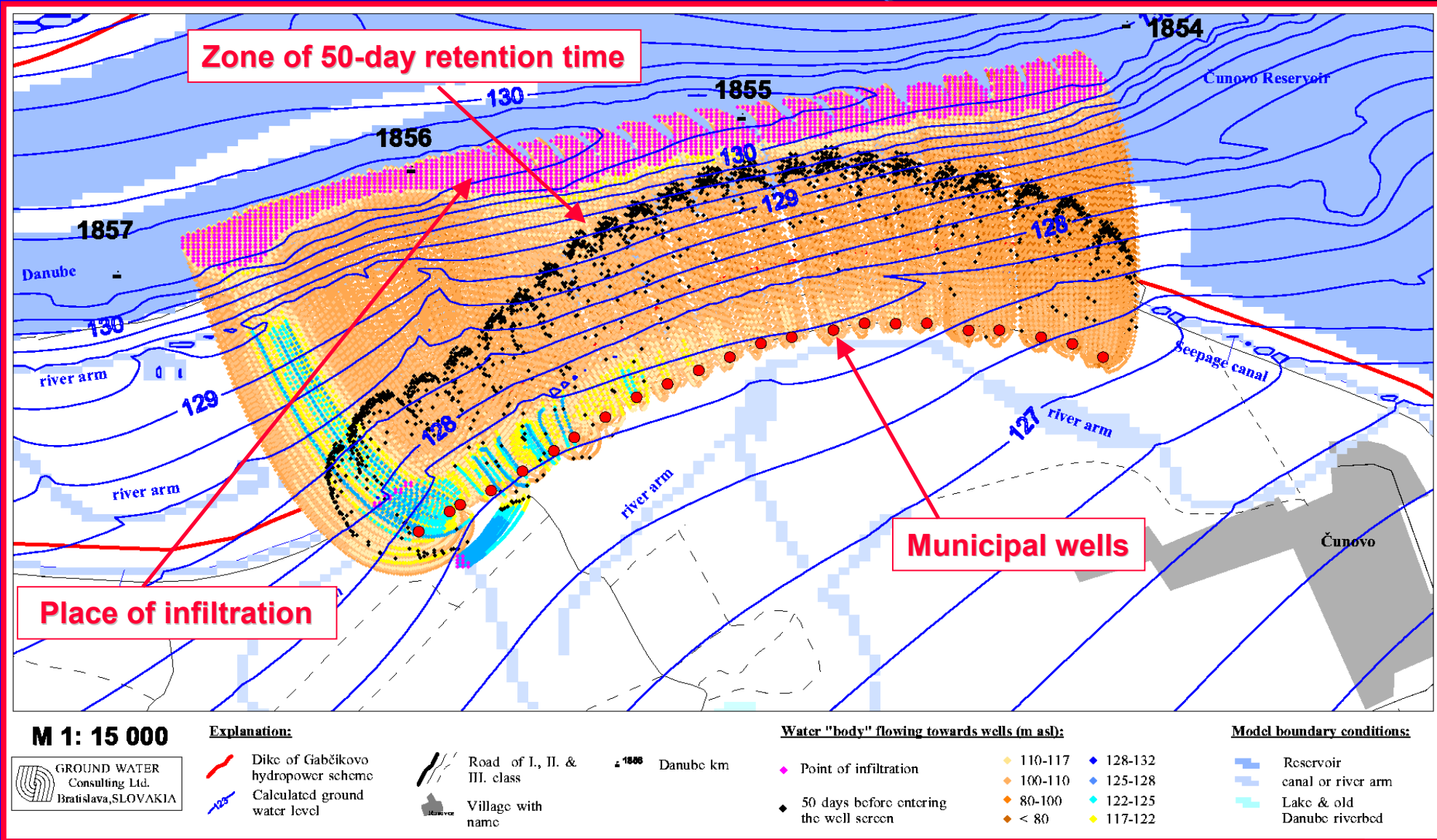
Modeling 3-D groundwater flow towards municipal waterworks wells



Goals of interpretation :

- **Place of infiltration**
- **Zone of 50-day retention time**
- **Water devide**
(for individual exploited wells and whole waterworks well system)
- **Hygienic protection zones**

Modeling 3-D groundwater flow towards municipal waterworks wells



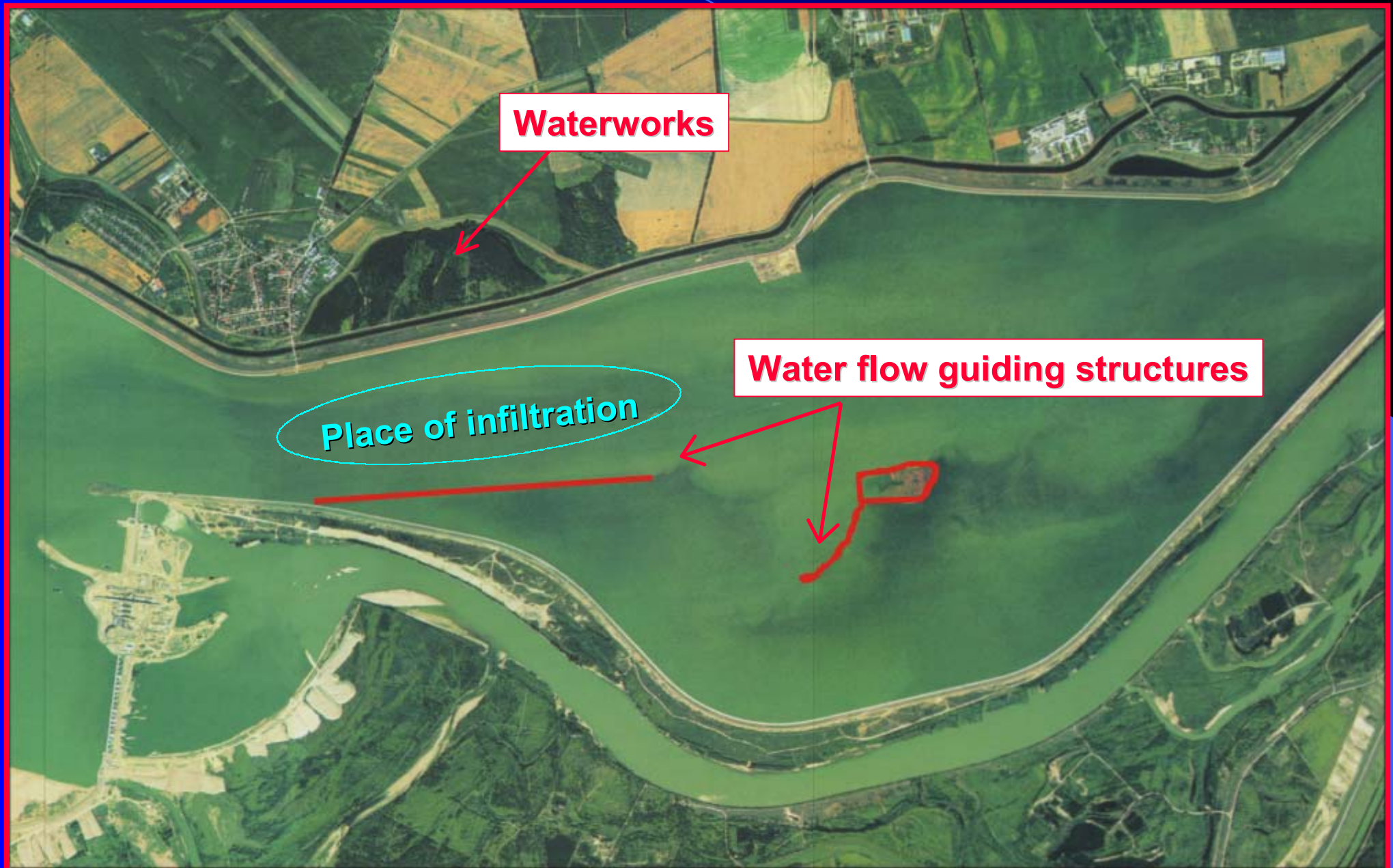
Modeling surface water

(Project PHARE/EC/WAT/1, 1995)

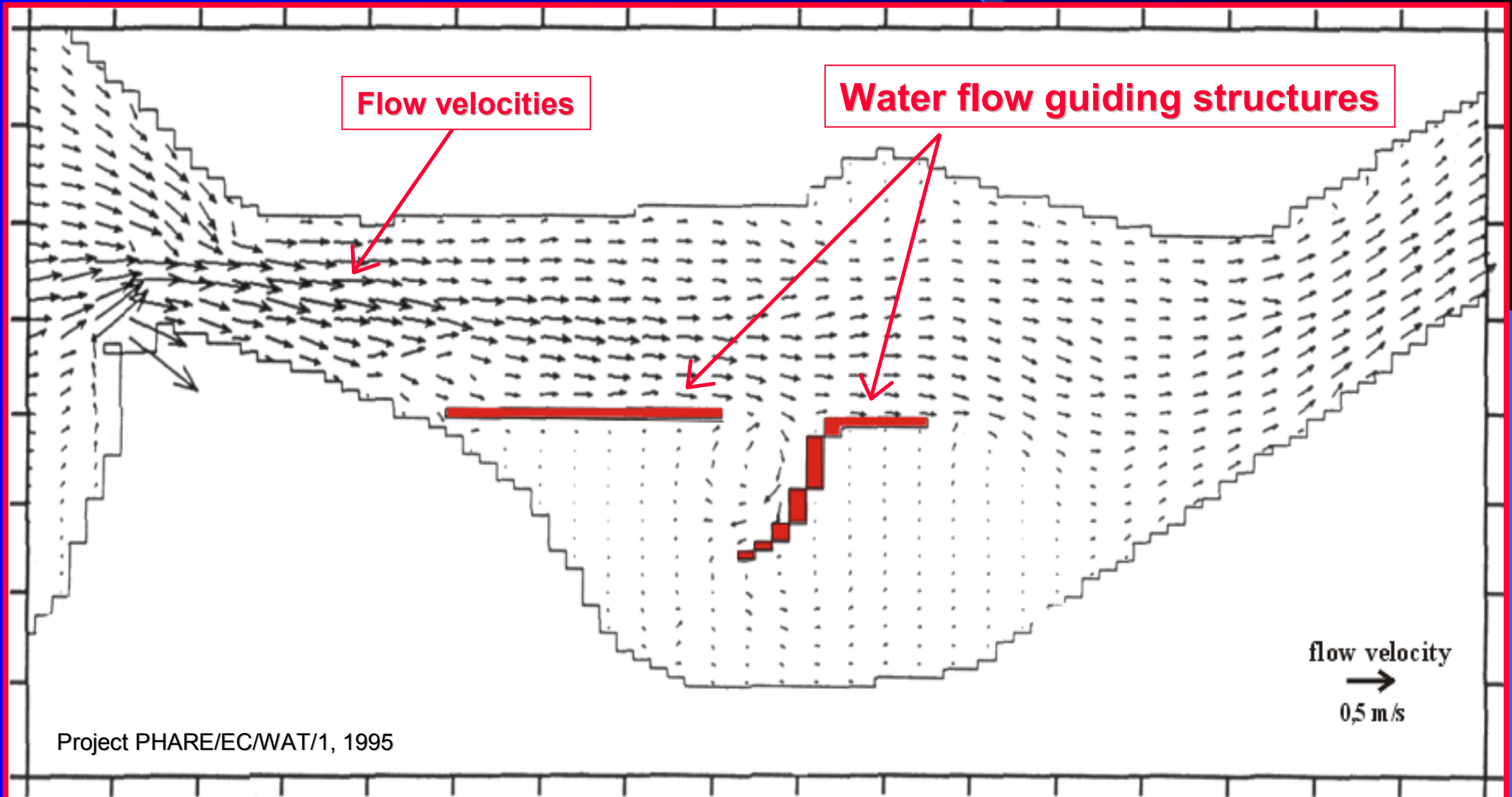
Goals of interpretation :

- **Hydrodynamics**
(surface water flow velocities, depth of water, flooded areas)
- **Sediment transport**
(places of sedimentation and erosion, thickness of river bed deposits)
- **Water flow guiding structures**
- **Surface water quality**

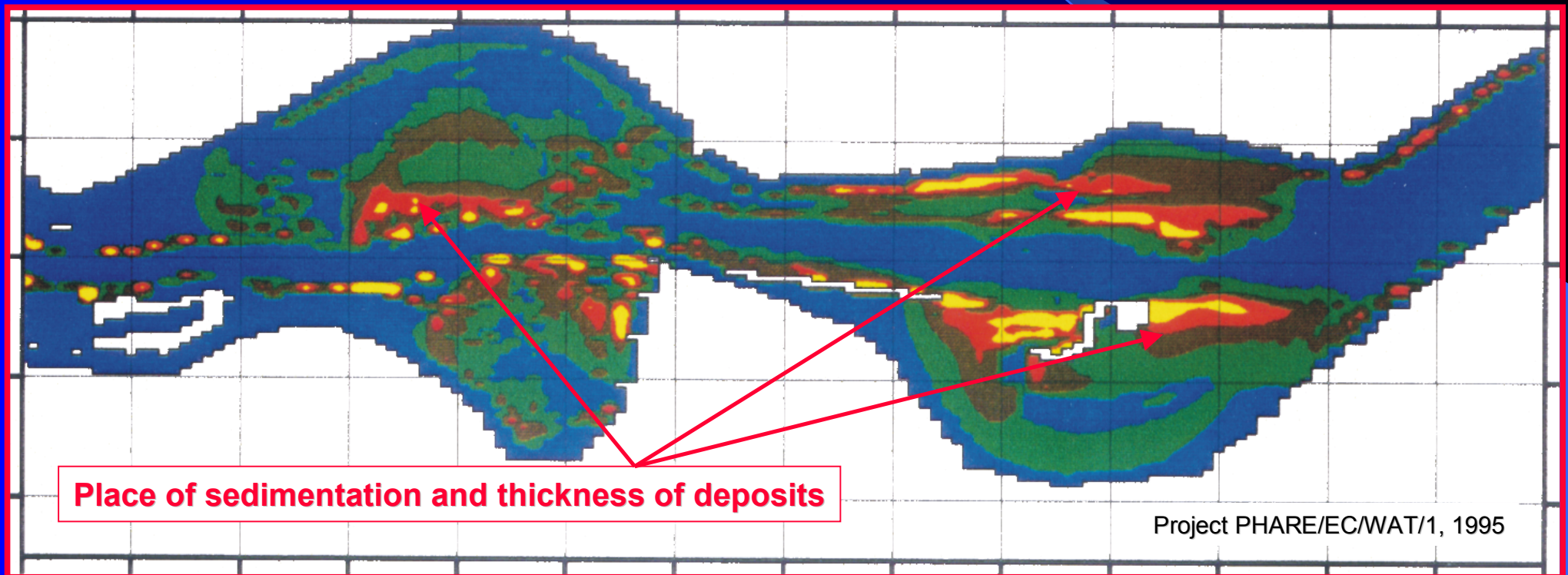
Modeling surface water in the reservoir



Modeling flow velocities in the reservoir



Modeling sediment transport in the reservoir



Pumping test modeling

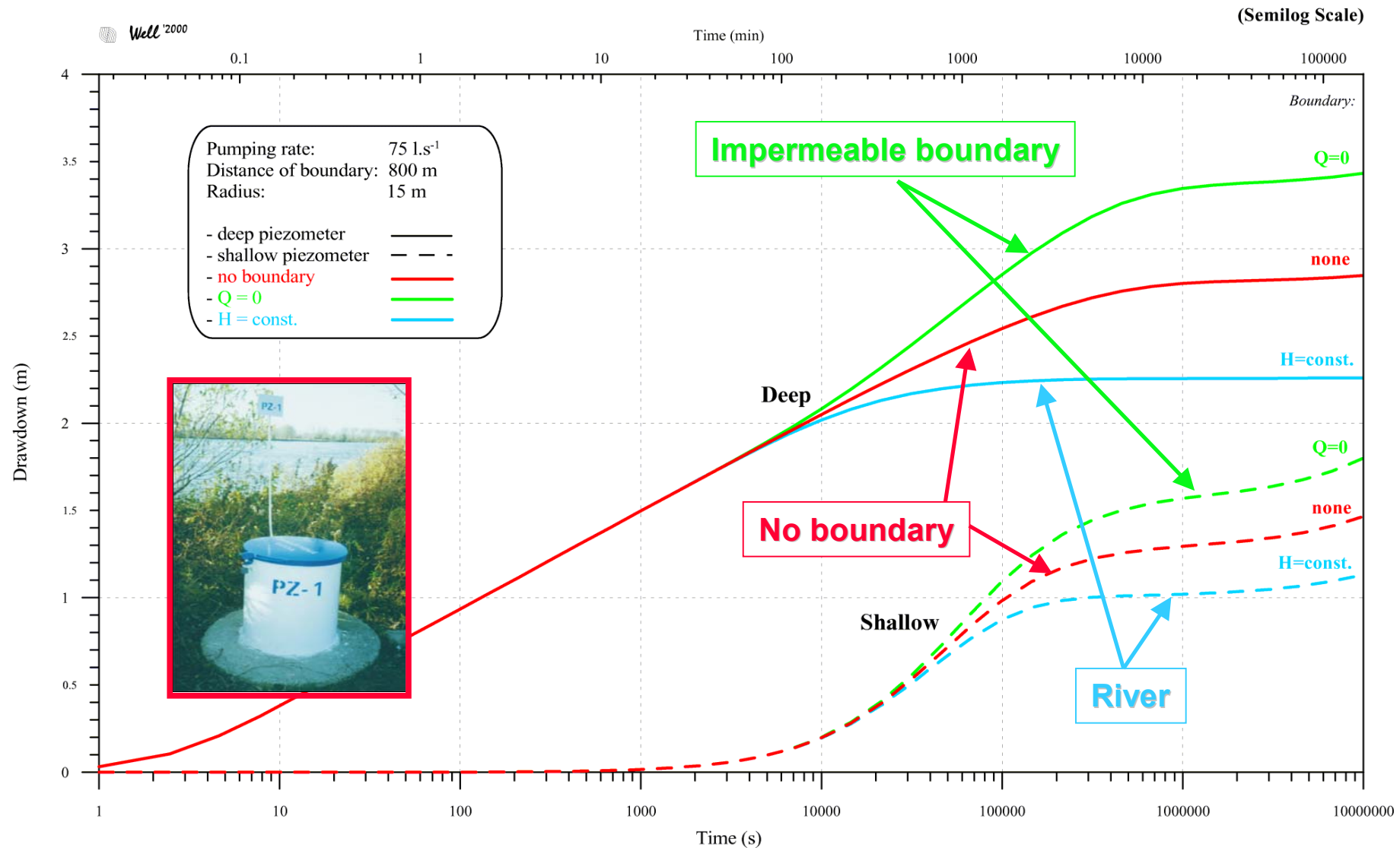


Interpretation of pumping test :

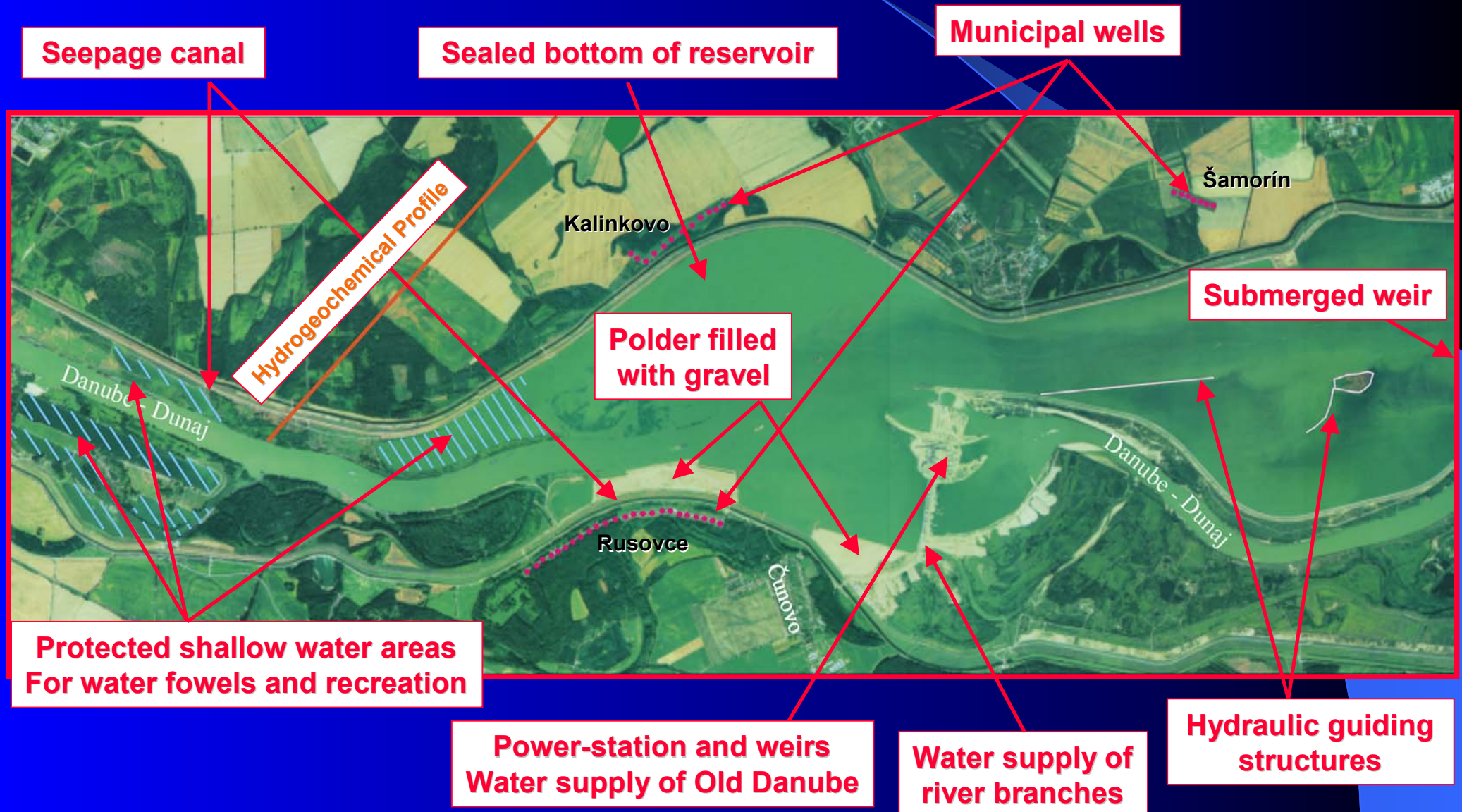
- **Constant or variable pumping rate and drawdown**
- **Hydrogeological characteristics of aquifer**
(non-uniform stratified aquifer under confined, leaky or unconfined conditions)
- **Characteristics of pumping well**
(e. g. radius and depth of well, well loss, position of screen)
- **Influence of precipitation and evapotranspiration**

Pumping test modeling

Modelling influence of various boundary conditions during the pumping test



Examples of water related management

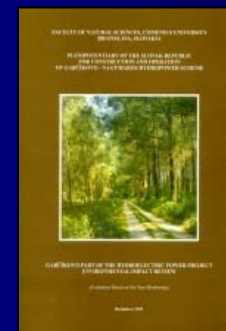
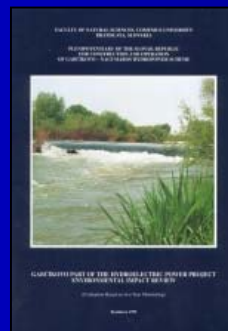


Thank you for your attention .

For more details
see the publications and documents available at :

[WWW . GABCIKOVO . GOV . SK / DOC /](http://WWW.GABCIKOVO.GOV.SK/DOC/)

Publications



Documents

Documents available at WWW.GABCIKOVO.GOV.SK :

- **Treaty between the Hungarian people's republic and Czechoslovak socialist republic concerning the construction and operation of the Gabčíkovo-Nagymaros system of locks (1977)**
- **Judgement of the International Court of Justice (1997)**
- **Agreement between the government of the Slovak Republic and government of the Republic of Hungary concerning certain temporary technical measures and discharges in the Danube and Mosoni branch of the Danube (1995)**
- **Statute on the activities of the Nominated Monitoring Agents**
- **National Annual Report on the Environment Monitoring on the Slovak Territory (1999, 2000)**
- **Joint Annual Report on the Environment Monitoring (1999, 2000)**