UN/ECE Task Force on Monitoring and Assessment
under the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, 1992)

Transboundary Groundwater Karst Aquifer

AGGTELEK – SLOVENSKÝ KRAS

Joint Report No 2 and 3

Final Report

Identification and Review of Water Management Issues
Recommendations for Improvement of monitoring and Assessment Activities

PREFACE

Slovenský kras – Aggtelek: Identification and Review of Water Management Issues is one of the reports of the pilot project programme on the monitoring and assessment of transboundary groundwater under the UN/ECE Water Convention.

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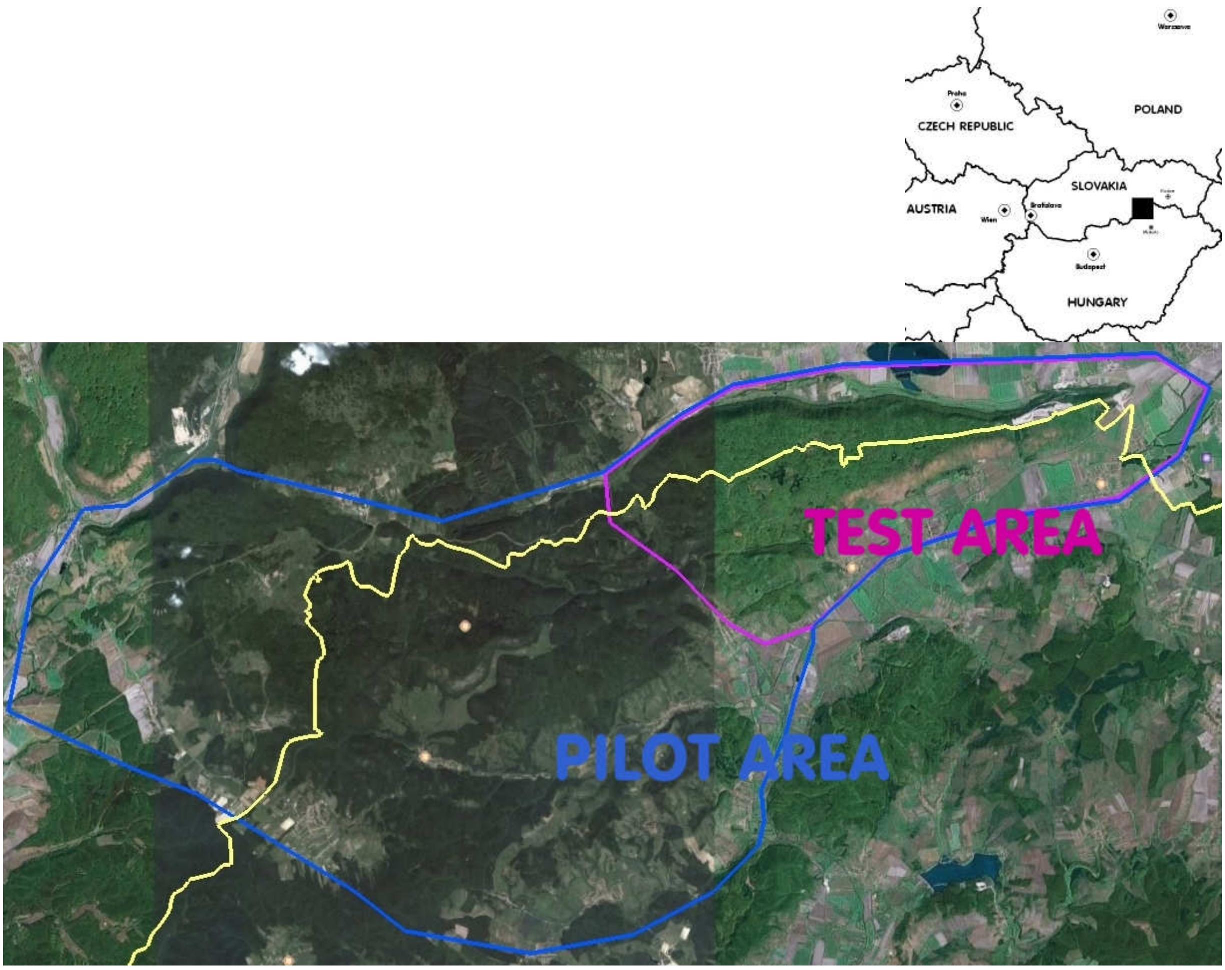

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1. Objectives

The two countries signed the Memorandum of Understanding on the Co-operation in May 2001 (see Annex 1) on the application of the Guidelines on the Monitoring and Assessment of Transboundary Groundwaters elaborated by the Task Force on Monitoring and Assessment under the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki Convention).

The Pilot Project, scheduled to the years 2002-2003, serves the following three purposes in line with the agreement reached by the interested Parties at the starting meeting held in Jósvafõ (Hungary) on 6-8 March 2002.

- introduction of the guidelines on monitoring of transboundary groundwaters, testing the guidelines
- aquifer Aggtelek-Slovenský kras as subsurface water body according to the Water Directive of EU
- vulnerability mapping of the Aggtelek-Slovenský kras area applying the "European Method" elaborated by the EU COST 620 Action

Coming from the above, the results of the project beyond displaying the applicability of the Guidelines on the Monitoring and Assessment of Transboundary Groundwaters in practice, and serving as a basis to the improvement thereof, may be an example of dealing jointly with groundwaters in the Hungarian-Slovakian Joint Commission on Transboundary Waters and they may promote this common activity. Simultaneously both countries have undertaken to participate in the implementation of the tasks coming from the Water Directive of EU, in the framework of the Danube Protection Convention in the catchment area of the River Danube. This will be served by the joint characterisation of the Aggtelek-Slovenský kras in compliance with the EU Water Directive as a groundwater body, and the vulnerability mapping thereof applying the "European Method" elaborated by the EU COST 620. The results achieved here will be built into the activity of the Hungarian-Slovakian Joint Commission on Environmental Protection and Nature Conservation as well.

2. INTRODUCTION

2.1 Pilot projects under the UNECE Water Convention

Identification and Review of Water Management Issues for the Aggtelek – Slovenský kras presents the results of one of the Pilot Projects on Monitoring and Assessment of Transboundary Rivers under the UN/ECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention).

The Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, 1992) include important provisions on the monitoring and assessment of transboundary waters, the assessment of the effectiveness of measures taken to prevent, control and reduce transboundary impact, and the exchange of information on water and effluent monitoring. Other relevant aspects deal with the harmonization of rules for setting up and operating monitoring programme, which includes measurement systems and devices, analytical techniques, data processing and evaluation techniques. Further needs for monitoring arise, because the Convention aims to protect ecosystems, which may be closely connected with groundwaters and the protection of sources of drinking-water supply.

The Water Framework Directive (WFD) 2000/60/EC was adopted by European Union in 2000. It brings forth many new issues and tasks in the water management for the members and future members of the European Union. These developments principally changed the way of thinking about the information that is needed for management of an international river basin and transboundary groundwater.

Monitoring and assessment are also part of the 1999 Protocol on Water and Health to the Convention on the Protection and Use of Transboundary Watercourses and International Lakes. This Protocol contains provisions regarding the establishment of joint or coordinated systems for surveillance and early-warning systems to identify outbreaks or incidents of water-related diseases or significant threats of such outbreaks or incidents (including those resulting from water pollution or extreme weather). It also foresees the development of integrated information systems and databases, the exchange of information and the sharing of technical and legal knowledge and experience.

The Guidelines deal mostly with monitoring and assessment needs that arise from the Convention. As far as possible, monitoring and assessment needs that arise from the Protocol on Water and Health are also considered.

2.2 Guidelines: a recommended approach

An essential element of the Guidelines under the UNECE Water Convention is that the process of monitoring and assessment has to be seen as a chain of activities, where each activity has to be derived in a logica1 way from the former steps. The starting point lies in an analysis of the water management issues and in the specification of the information needs.

Figure 1.1 *Monitoring cycle (UNECE 2000)*

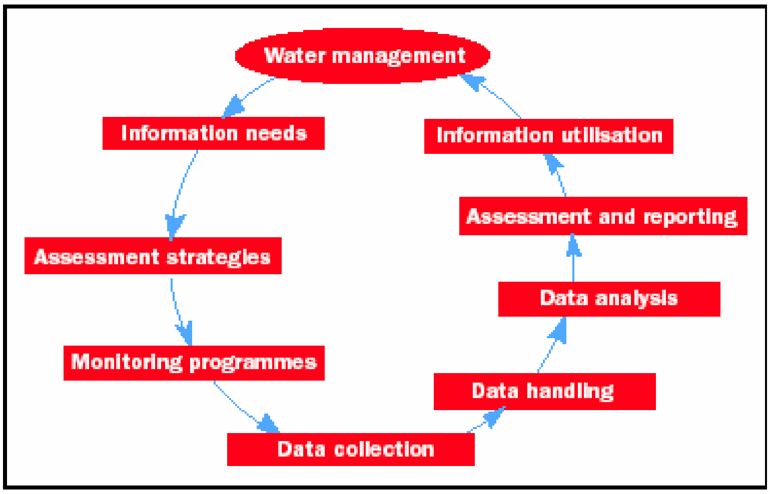
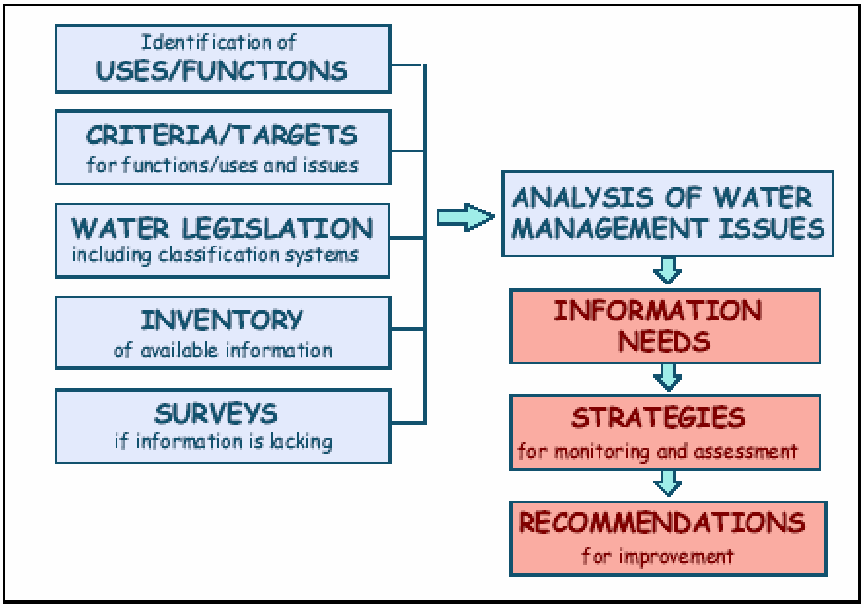


Figure 2.2 provides a roadmap for the analysis of water management issues. One of the basic ideas behind this figure is that it implies a ‘red line’ runs through the analysis. It should be kept in mind that the successive activities strongly relate to each other:

- Uses / functions and issues indicate what information should /should not be inventoried in the inventory.
- The results of the inventory should indicate what information is lacking and what analysis should be included in the surveys.
- The uses and issues indicate on which elements the assessment criteria have to be defined.

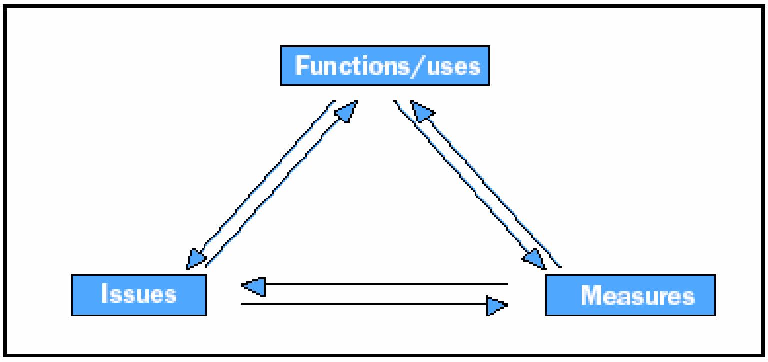
Figure 2.2 *Analysis of water management issuess*



Groundwater management is part of integrated water resources management and protection. The core elements in groundwater management are the functions and uses of the groundwater bodies (aquifers), the problems and pressures (threats) and the impact of measures on the overall functioning of the water body (figure 2.3).

Monitoring that satisfies the information needs should cover these core elements. It should also consider how information is used in the decision making process. Measures can include investigations of the problems and threats, risk analyses, remediation, existing monitoring programme, control of polluting activities or excessive withdrawal.

Figure 2.3 *Core elements of water management*



When establishing transboundary groundwater monitoring strategies, the following need to be identified and jointly agreed:

a) The transboundary aquifer and relations to surface water and associated ecosystems;

b) Specific human uses of transboundary groundwaters;

c) Ecological function of transboundary groundwater resources;

d) Pressures which have an impact on the above-mentioned human uses and on the functioning of ecosystems that is dependent on groundwater (Table 2.1);

e) Quantified, or otherwise clearly defined, management targets which should enable the establishment of restrictions and which can be implemented within a specified time period.

This joint approach allows for the progress achieved by riparian countries to be compared, taking into account the often country- or region-specific context.

Table 1.1 *Function / uses and problems of groundwater system*

Problems	Functions/Uses			
	drinking water	industrial water	agricultural	ecosystems/ nature
Acidification	*	*	*	*
Excess nutrients	*			*
Pollution with hazardous substances	*	*	*	*
Salinization	*	*	*	*
Declining groundwater tables	*	*	*	*

Some functions can also have an adverse impact on other functions, and problems are not necessarily confined to groundwater systems. Clearly, the list of table 2.1 is not exhaustive and can be tailored (or be made more specific) to specific transboundary regions. The specification of the human uses and the ecological functioning, the identification of pressures and problems, and the determination of targets should include both quality and quantity aspects. Human uses of groundwater can be consumptive or non-consumptive. An example of the first use is as a resource for drinking water, industry or irrigation. Non consumptive use can be water table control for construction management and for agricultural purposes, or maintaining a freshwater wedge in coastal zones as a barrier against salt water intrusion.

2.3 Priority settings

The issues and targets of groundwater management should be prioritized - taking into account the Convention and other relevant agreements – at different levels/scales (i.e. ECE region wide, regional and local transboundary level, aquifer level). These prioritized issues determine to a large extent the information needs that will form the basis for monitoring. In the following chapter, methodologies and ways of prioritizing issues and targets will be discussed. Targets accounting for the Convention's objectives can be set for each transboundary aquifer. As with the surface water management, a management unit can be determined for groundwaters. This will be based on conceptual mathematical models and data sets on elements of the water cycle, topographical, pedological and geological information, land use and administrative/legal units. Supply and demand patterns linked to uses should also be included in this characterisation. Targets per unit can be laid down in a strategic action plan which is coordinated by a joint body, set up by the riparian parties, which should also be responsible for priority setting.

2.4 Pilot projects - activities and reports

The pilot project first activity is the establishment of a Memorandum of Understanding between the riparian countries or its responsible ministries on co-operation in the project. Coordination with the transboundary commission is an important aspect. A Pilots Core Group in which the project leaders of the involved countries have participated has had regular meetings since early 2002 to prepare and guide the programme. The pilot project activities are presented below (Table 2.2). For practical reasons the actual pilot projects will end with Recommendations for Improvement, since in order to implement the recommendations, additional decisions and fund raising have to take place.

The project leaders separate the reports by country for the respective activities (Inventory, Legislation, Information Needs, etc.). The results of these activities are summarized in three reports per pilot project, which are issued under the work programme of the UNECE Water Convention:

Table 2.2 *Pilot project activities*

Phase	Activity	Report
Preparatory – Inception	• Prepare and agree Memorandum of Understanding • Prepare funding proposal • Establish project teams and organizational responsibilities • Prepare work plan and inception report	*Report No 1* Inception Report
Preparatory – Analysis of monitoring and assessment needs	• Carry out inventory of basin and establish main water uses and human activities • Review and evaluate existing legislation • Carry out preliminary surveys of water quality and review existing quality data • Make inventories of polluting activities • Identify main water quality and water management issues • Specify information needs accordingly	*Report No 2* Identification and Review of Water Management Issues
Preparatory – Develop recommendations	• Evaluate ability of existing monitoring to meet these needs • Develop strategies for monitoring and assessment • Recommend improvements and prepare cost estimates	*Report No 3* Recommendations for Improvement of Monitoring and Assessment
Implementation	• Redesign monitoring programmes • Implement recommended sampling and analytical methodologies, data handling and data exchange • Procure additional equipment as required • Develop quality assurance programmes • Train required staff at all levels • Make reports on water quality for all stakeholders	Beyond the scope of the pilot projects

- the **Inception report** (including description of the pilot area, MOU, project organization and financial proposal)
- the **Identification and Review of Water Management Issues** for the transboundary groundwater (including the Identification of Functions/Uses and Issues for the transboundary groundwater and the results of Inventories, Evaluation of Legislation, Surveys and Water Management Analysis)
- The **Recommendations for Improvement** (including the Information Needs, the Strategies for Monitoring and Assessment and the Recommendations for Improvement and Cost Estimates).

2.5 Relations between pilot projects and EC Water Framework Directive

There is a close relation between the UN/ECE Water Convention (1992) and the EC Water Framework Directive (2000/60/EC). In 1995, the Water Convention was ratified by the EC (Council Decision 95/308/EC), and in consideration of No. 35 of the EC-WFD, it explicitly states that the WFD has to contribute to the implementation of the Water Convention. Whereas the Water Convention deals with water quality and quantity aspects, the EC-WFD places its main emphasis on water quality; Reduction and control of emissions are the main tools for both the Water Convention and the EC with the ultimate goal of the water systems achieving a good ecological status. Whereas the Water Convention does not provide any timescale, the EC-WFD contains a strict timetable for the number of steps to obtain the desired water quality by the end of 2015. The relation between the Water Convention and the Water Framework Directive is reflected in the Guidelines on Monitoring and Assessment of Transboundary Groundwaters and subsequently in the reports on Identification and Review of Water Management Issues of the various transboundary groundwaters of the pilot projects for implementation of the Guidelines. Operational monitoring is the most important tool in the EC-WFD for obtaining information about the improvement of the status of the quality of the waters as a result of the measures (to be) taken. The Operational Monitoring Programme should be derived from the River Basin Management Plan, which consists of parameters that are indicative of the pressures identified in the water management analysis. A similar approach is found in the Guidelines on Monitoring and Assessment of Transboundary Groundwaters and hence in the reports of the Pilot Projects: the analysis of water management issues as a basis for monitoring and assessment.

The present report on Identification and Review of Water Management Issues and their chapter Recommendations for Improvement can be regarded as the first step in a Transboundary Groundwater Bodies Management Plan. It describes a transboundary groundwater bodies, the functions and uses of the groundwater, the actual status of the quality compared to the requirements of the functions and the main problems and causes following from this comparison and also deals with the information needs, the selection of the indicative parameters and a critical evaluation of the existing monitoring programme in view of their fitness for their purpose.

2.6 The pilot project as part of the international co-operation within the Aggtelek – Slovenský kras groundwater karst body

In May 2001, the Ministry of the Environment and Water of the Hungary and the Ministry of the Environment of the Slovak Republic signed an MOU on co-operation for monitoring and assessment of the Aggtelek – Slovenský kras karst area as a pilot project under the UN/ECE Water Convention.

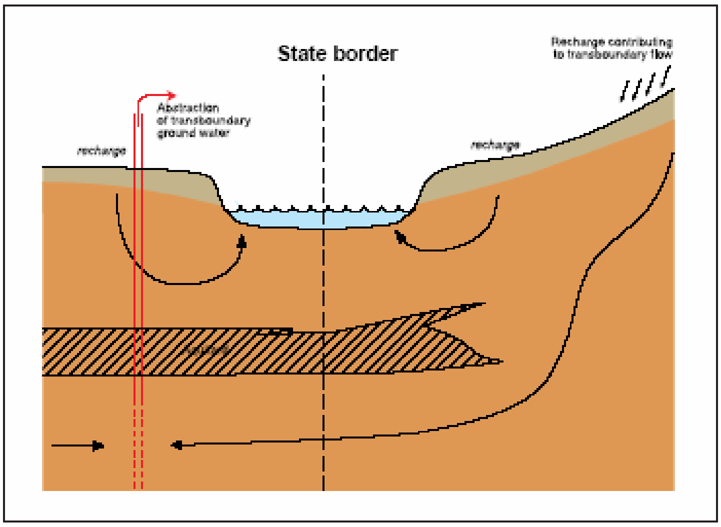
Co-operation between Hungary and Czechoslovakia on water management issues started in 1967 when the Joint Technical Commission between Czechoslovakia and Hungary was established. The first step was a groundwater quantity data changing.

In 1995 the regulations of data changing in Aggtelek – Slovenský kras were endorsed.

In June 1994, the Convention on Protection and Sustainable Use of the Danube River Danube

Convention) was signed, and both countries have CO-operated since 1998 within the framework of the International Commission on Protection of the Danube River (ICPDR). At present, the policy of the ICPDR and of the countries is significantly affected by the EC Water Framework Directive, which is considered the leading policy document in the field of water management.

Figure 2.4 *Transboundary groundwater flow systems*



3. General Characterisation of the Pilot and Test Area of Aggtelek – Slovenský kras Karst Region

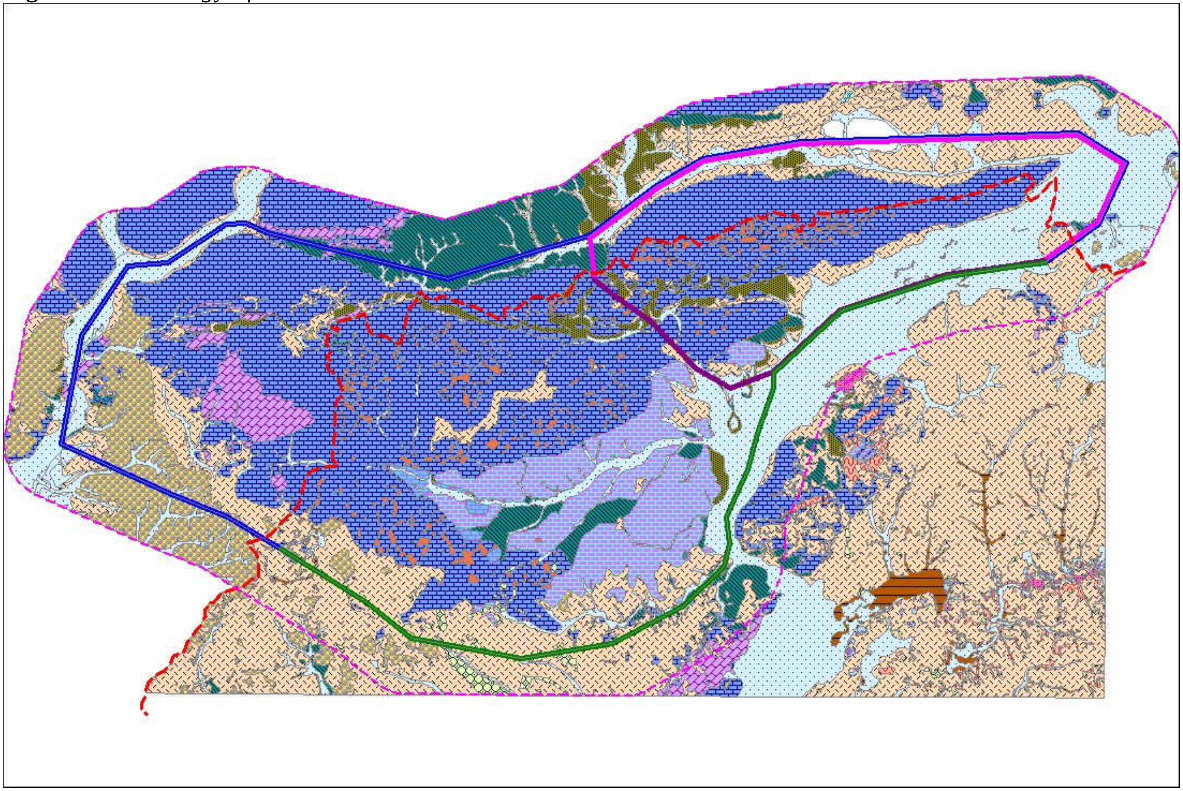
The Aggtelek National Park Biosphere Reserve and the National Park the Slovenský Kras (until 1st March 2002 protected landscape under study – the Biosphere Reserve of the Slovak Karst) run along the Hungary / Slovak state border with over a length of some 57 km.

The National Parks form part of the sub-province of Inner Western Carpathians and of the Slovak Ore Mountain, with minor part belonging to the Lučenec – Košice lowland. The territory proper of protected regions is made up of following sub-units of the Slovak Karst: the Koniar, Plešivec and Silica plateau, Horný Vrch (Upper Hill) and the Zádiel and Jasov Plateau. The borders of the pilot - project interesting area on the Slovak side (see table) can be drawn through the following villages – Dlhá Ves, Ardovo, Plešivec, Vidová, Gombasek, Silica, Silická Jablonica, Hrušov, Jablonov nad Turňou, Hrhov, Včeláre a Dvorníky, on the Hungarian part through Aggtelek, Égerszög, Szinpetri, Szin, Szögliget, Bódvaszilas, Komjáti, Tornanádaska, Hidvégardó, (Dvorníky)

It should be noted that between Dlhá Ves and Égerszög an extended non-karstic area lies, belonging to the karst. This is the catchment area of a number of periodic watercourses, wherefrom the surface runoff is directed towards the karst reservoir and enters it through large sinkholes. This means that any kind of pollution, such as of municipal, agricultural or industrial character may access the karst in a concentrated way without any obstacle or filtration.

On the Figure 3.1, there is the ordinary geological map. With distinguishable the test area:

Figure 3.1 *Geology of the interest area*



Complex geological development of the area of interest resulted also in complex hydrogeological settings. Hydrogeological units in the area are very different according to the character of permeability, character of groundwater circulation; type of groundwater regime, and also in the resulting yield of groundwater sources.

Extension of the area of the Aggtelek Mountains is 202 km2. A 114 km2 area out of this is a karstic plateau built up of middle Triassic limestone and dolomite while 88 km2 is containing impermeable rocks lying in the valleys and in the outskirts of the mountain, consisting of lower-Triassic limestones with snake-stone covered by younger sediments, as well as snakestones and sandstones.

3.1 Slovakia

Quaternary fluvial sediments of the Slaná, Štítnik, Bodva and Turniansky potok streams are considered as important aquifers with intergranular permeability. Hydrogeological unit of the Slovenský kras are Mesozoic rocks.

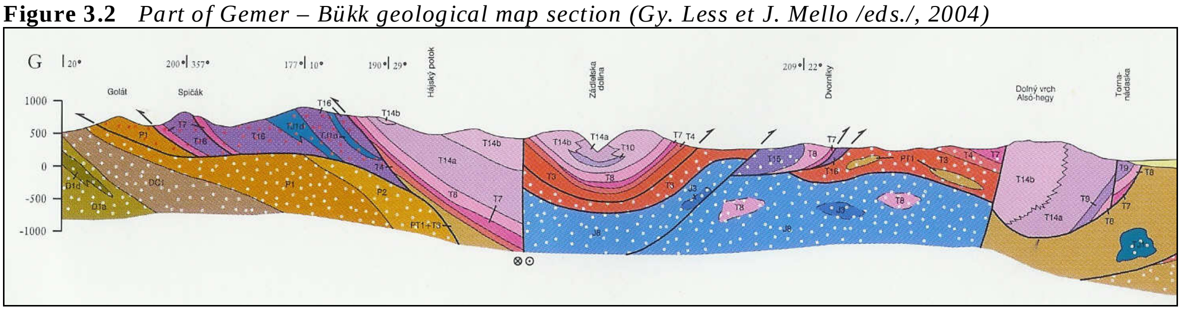
Orvan (1984) described several mechanisms of groundwater drainage (drainage patterns) in the area of Slovenský kras:

1. drainage by springs on the erosion base of the plateau edges (within th pilot area such as
2. combined drainage both by springs and hidden outflow of the system (within the pilot area such as Köszörü)
3. drainage by ascendant springs on regional tectonic faults
4. hidden outflow to the deeper structures within the territory of the Slovenský kras
5. hidden outflow to the deeper structures out of the territory of the Slovenský kras

Within the pilot area we can define major hydrogeological structures, i.e. areas with common recharge, accumulation and drainage:

- **Plešivec - Silická Brezová hydrogeological structure** that occupies southern part of the Plešivecká Planina Plateau and the Triassic karst to south from Silica, ranging from Plešivec on the west up to the Ardovo on the east.
- **Dolný vrch hydrogeological structure** as an eastward continuation of the Plešivec-Silická Brezová hydrogeological structure, separated by the anticlinal elevation of Lower Triassic slates This structure is a northern part of a structure, outcropping also in Hungary
- **Bukový vrch hydrogeological structure**, which is formed only by a smaller outcrop in Slovakia, separated also by Lower Triassic slates from the Plešivec - Silická Brezová hydrogeological structure on the east and Dolný vrch hydrogeological structure on the west
- **Kečovo hydrogeological structure**, defined in space by the line connecting Ardovo, Silica, Silická Brezová, Dlhá Ves and Domica. This structure is only a western part of a larger structure, outcropping mostly in Hungary

Figure 3.2 *Part of Gemer – Bükk geological map section (Gy. Less et J. Mello /eds./, 2004)*



3.2 Hungary

The oldest formation of the area is the upper Permian – early Triassic Perkupa Evaporite Formation, which is on the surface in the Ménes-valley on the west, then from Derenk to Bódvaszilas. Its layers are everywhere below the younger sediments. Between Perkupa and Bódvaszilas in the Bódva-valley it is covered by 10-meter thick Pleistocene fluvial gravel, east of Bódvaszilas it is covered by maximum 150-meter thick Pannonian sediments. The Perkupa Evaporite Formation consists of red fine sand, sandstone, schist, gravelly sandstone, quartzite conglomerate, dolomite and evaporate (gypsum and anhydrite) formed in salty lagoons. Borehole Bsz-7. revealed its thickest sequence about 800 meters, however its 1600-meters thickness in borehole Sz-1. probably is the result of multiple folding. Its overall thickness is 250 m.

The **early Triassic Bódvaszilas Sandstone Formation** continuously settles over the **Perkupa Evaporite Formation**. It is red fine sandstone, its overall thickness is 200 meters and contains Claraia bivalves. It is on the surface south of Busa in the hills of Tilalmas and Ragácsa; on the margins of Bódva-valley; and at Perkupa area.

The early Triassic Színi Marl Formation settles over the Bódvaszilas Sandstone. It is alternate clayly marls and calcareous marl slate. It is 400-meters thick, formed under tidal and open water conditions. It is on the surface around Szín and the southern slopes of Dusa.

The **Szinpetri Limestone Formation** is widespread in the area of Aggtelek Karst. It is 200-250-meters thick, laminated – thin layered and it has dense calcareous veins. It is known from Jósva-valley south of Szín, from Égerszög, and from Szőlősardó. Its thick-layers variant called Jósvafő Limestone Tagozat occurs at Jósvafő, where it is 100-meters thick.

The **middle Triassic, Gutenstein Limestone Form**ation is formed in lagoons below tidal level and without clastic sediments inflow. It is laminated – thin-layered, it has dolomite layers locally. It is on the surface at Acskó-medow – Bába-valley, on the Éles-tető, on the southern slope of Dusa at Szögliget, on the northern slope of Csendes-valley, south of Kecső-valley, and on the margin of Teresztenyei-plateau. It is tectonically elevated at the eastern end of Alsó-hill above the Tapolca-springs.

The **middle Triassic Steinalm Limestone Formation** is platform reef facies. It is known from Aggtelek-plateau southwest of Jósvafő, at Szögliget in smaller areas close to Papkerti -(Csörgő) spring. Its thickness is between 200 and 400 meters.

The middle **Triassic (Ladinian) Nádaska Limestone Formation** and **Reifling Limestone Formation** are formed in open water or inter-platform basins. The Nádaska Limestone is 50 to 120 meters, while the Reifling Limestone is about 50 meters thick. They are on the surface at the eastern end of Alsó-hill next to the Kastély spring, next to Derenk at Kecskekút spring, and on the western side of Ménes-valley. Its best occurrence is next to Szőlőardó, where borehole Szöa-1. logged it.

The **Bódvavölgyi Ofiolite Formation** formed by oceanic rifting between Ladinian and Karnian. The pillow-basalt, gabbro and their weathered form of serpentinite is on the surface in the Bódva-valley south of Szögliget, here it is 200-meters thick. Below the surface it occurs in the Bódva-valley and in the area of Tornakápolna. Its present location is tectonical in the Perkupa Evaporite Formation.

The middle Triassic **Wetterstein Limestone Formation** is the most important formation of the area. Its facies is platform and lagoon. It has 600-meters thickness at Alsó-hill, 1000-meters thickness at Szelcepuszta karstic area, and it is several hundreds of meters thick at the Aggtelek-plateau. It has thick-blocks and it contains remnants of lime-algae, of coralls, and of lime-algae eater gastropods.

The middle to upper Triassic **Derenk Limestone Formation** is sedimentary breccia and it is 50 to 80 meters thick. It is located at the area of Derenk, and in the southern slopes of Alsó-hill between Vidomájpuszta and Bak Antal dolina.

The upper Triassic Halstatt Limestone Formation overlays on the Derenk Limestone Formation. It is red, thick-layered fine limestone. It is covered by the 25-30-meters thick **Zlambach Marl**

Formation, which contains small 2 to 3 centimeter big ammonites. They occur in the area of Derenk at Pasnyag spring and the east-west part of the Haragistya-plateau.

The upper Triassic Szádvárborsai Limestone Formation is 10 to 30 meters thick and it occurs in a few locations at Hargistya and Alsó-hill.

The upper Triassic **Szőlősardó Marl Formation** is known from Szőlősardó and Lepényke, the borehole Szöa-1. revealed it. It is covered by the layers of **Pötchen Limestone Formation**, which is 50 to 100 meters thick, it is limestone containing chert. It is known from the area of Alsó-hill west of Pasnyag spring and around Kopasz vígasz cave.

Younger Mesozoic sediments (Jurassic-Cretaceous) are unknown in the area due to later erosion, as in the Slovakian part of the Karst and in the Rudabánya Mountains the Jurassic deep sea sediments are general.

The subduction – collosion, started in the middle Jurassic, formed nappes in the area of Alsó-hill. At Derenk, Bódvaszilas and Tornanádaska the middle-upper Triassic sediments are tectonically overlay the Wetterstein Formation.

During the next tectonic phase, the younger Triassic layers moved away from their original location over to the Permian – early Triassic evaporite formations, creating a nappe. The layers moved over the ofiolit formations grabbing blocks out of it and folding them into the evaporite sediments. The lower nappe (**Bódvarákó Nappe**) is known from boreholes of the area of Bódvarákó – Szögliget – Perkupa, where below the Permian evaporite formations middle Triassic dolomite layers, containing karst water, situated. The karst water is under pressure and its temperature is 25 °C. Above the Bódvarákó Nappe is the **Komjáti Nappe**, which is evaporite with the infolded ofiolite blocks. It is overlays by the **Szilice Nappe** that contains the full Triassic sediment sequence.

During the Cretaceous compression folded the area creating the syncline-anticline structure with EW axial plane of South Slovakian and Aggtelek Karst Area. This syncline-anticline structure is deformed during a later tectonic phase. Following the formation of syncline-anticline structure the erosion and karstification process started. The karstification process stopped pro tempore during Miocene due to the Miocene sea sedimentation. During the lower Miocene the migration of Rudabánya Mountains and of the upper Triassic blocks at Szőlősardó started toward north and northwest. This migration caused another process creating nappes in the Aggtelek Mountains. At this time, Alsó-hill broke into blocks and the Permian – lower

Triassic evaporite was pushed into the gullies. Meantime, south of the Aggtelek area Oligocene – Miocene sediments deposited, like the **Bretka Conglomerate** and **Putnok (Szécsény) Schlier Formations**. Later, following a pro tem erosion the Pannonian **Edelény Formation** clayly, sandy, lignite layers deposited in the basin areas. The Pliocene, fluvial **Borsodi Gravel Formation** is the sediment of the ancient Sajó River.

Hydrogeologically most significant formations are the karstified and fractured Triassic limestones (for example, Steinalm, Wetterstein, Hallstatt), which built up most than 50 percent of the area. Also hydrogeologically important formations are the aquiclude Permian – Triassic Perkupa Evaporite and Szín Marl and the younger Edelény Clay and Borsod Gravel. They give 40 percent of the sediments. The last 10 percent is the badly karstified, cherty, calcareous-marl sediments like Szinpetri Limestone and Szádvárborsai Limestone.

In the karstified sediments, the dense fissure system is important as significant cave system formed along them, like Baradla-, Béke-, Kossuth-, and Meteor-cave.

Hydrogeological importance of the tectonical elements is that they separate smaller hydrogeological units. Most of the area is open karst; only at certain locations the red clay of the young Pleistocene sediments covers the karst surface.

The thickness of the karstified rocks is between 400 to 1000 meters. South of the Aggtelek Karst, below the young Oligocene sediments a deeper under pressure karst system formed in the Aggtelek-Imola area.

Yearly average precipitation of the area is 661.2 mm, based on 5 station and the average of 70 years. During the last decades precipitation is less, for example it was 574 mm in 1982 (based on 8 measuring station). Most precipitation occurs in June and July (100 mm), and the driest months are February and August, when the average is 15 mm. 2 percent of the precipitation goes to surface flow, and 70 percent of the precipitation evaporates. In average 25 -27 % of the precipitation (min 9% , max 49 %) flows into the karst system through sinkholes and fissures, and after shorter or longer period its flows out at springs. In an open karst system like Baradla or Alsó-cave the velocity of the water is 300m/month. Flow on the karst water level can reach the 3.0 m/day. These data based on tracer tests.

Most of the karst springs are typical flooding karst springs, when the yield at flood reaches hundreds-fold of the yield of base flow. Jósvafő spring yields the most water, average yield is 192 l/s, maximum yield is 7500 l/s. Average yield of the springs is 16 l/s. Most of the spring yields show tidal effect, and two springs show the effect of siphon. Some springs are tidal springs, like Dancza-cave, they work only under flood conditions.

The spring waters are calcium - hydrocarbonate types, TDS is 537.9 – 836.0 mg/l, sodium and potassium are low, 1 – 5 mg/l, in the case of dolomite aquifer magnesium can be as high as 70 mg/l. In numerous springwater sulfate content is higher than average (530 or 800 mg/l) due to the evaporite sediments in their aquifer (Ménes-valley, western part of Alsó-hill).

The temperature of the karst springs is between 8.9 and 27 °C. The temperature has a reciprocal proportion to the elevation of the spring. Water containing warmer component has low tritium content, based on the measurements of VITUKI; 14 C measurements of the water gives the age of water of Melegvíz spring in 1250 years.

4. Uses, Function, monitoring, status of groundwaters

4.1 History of land protection

The area covered by the BR Slovenský kras was officially declared as Protected Landscape Area (PLA) in 1973, from 2002 it is National Park Slovenský kras. The Aggtelek National Park Biosphere Reserve (NP BR) was established in 1978. The official objectives are the protection and recovery of natural resources, and the harmonization of human management, environmental protection and natural beauty, with regard to their multiple scientific, economic, and health functions on both territories. These legal principles are the basis of the protection of rare ecosystems, fauna, flora, and biotic phenomena.

In 1977, the Bureau of the International Coordinating Council of the Man and Biosphere Programme designated the PLA and its prevention zone within the UNESCO‘s international system of Biosphere Reserves.

4.2 Land use

The whole pilot project area lies on the National Parks Slovenský kras and Aggtelek territory, which is attractive due to its natural beauties, diversity of plants and wildlife. The natural conditions of the landscape determine its use. The density of settlement is very uneven, but generally low. Woodlands are the predominant biome of the plateaux: of the total area of the BRs, forests cover 76 %, grasslands and pastures 16 %, and arable land 4 %. Most of the woodlands are coppice stands derived from repeatedly cut broad-leaved trees, and forest plantations cultivated by foresters.

On the plateaux, forestry is predominant, with some agriculture. Settlements and related economic activities are concentrated in the basins and river valleys. The region has an industrial-rural character, and more people are employed in agriculture than industry. The most important industrial activity on Hungarian part is the exploitation of raw materials and accompanying processing, machinery, and metalworking industries The Slovak part of pilot project area is agricultural or forested area with villages, without the industry.

4.3 Use of groundwater

4.3.1 Slovak republic

In the Slovak Karst is water with shallow circulation and unstable yields of springs, flow off the Middle Triassic carbonates at the local erosion level, along the periphery of individual hydrogeological structures. The prevailing part of karst-fissure water has deeper circulation in synclinal structure from carbonates (limestones, in lesser extent dolomites) of the same age. Tectonic zones in carbonates under the Cenozoic filling of the Slaná, Štítnik and Bodva rivers valleys, limited by impermeable basement from shale of the Lower Triassic age, are water-bearing environment. It is possible to use these waters by boreholes situated in the longitudinal or transversal tectonic zones. Mean yield of a single borehole is 25 - 40 $l.s^{-1}$.

The State Water management Balance (SWB) is annually processed of SHMI. In the SWB, part Groundwater, there are detailed analyze of the usable groundwater amounts and withdrawals determinate for each hydrogeological unit of Slovakia. There are defined two base classes of usable groundwater amount;

- *Evaluated* by the Slovak republic Commission of Groundwater Supplies and Sources Classification. The categories A, B, C1 a C2 belong to this class;

- *None evaluated* by the Slovak republic Commission of Groundwater Supplies and Sources Classification. This class involves three categories I, II and III.

Within the pilot area we can define major hydrogeological structures, i.e. areas with common recharge, accumulation and drainage:

- Silica – Silická Brezová
- Kečovská
- Dolný Vrch
- Bukový vrch

In accordance with the Slovak republic Commission of Groundwater Supplies and Sources Classification conclusions there are next usable groundwater amount in C_1 category (drinking water) on the pilot project area:

Table 4.1 *Water abstraction in the Slovenský kras area*

Hydrogeological structure	Usable gw amount in C1 [m^3/year]	Drinking water abstraction [m^3.year]					
		2000	2001	2002	2003	2004	2005
Silická–Silická Brezová	346 896	5 992	6 938	5 677	11 353	16 083	6 938
Kečovská	567 648	83 570	79 155	81 048	105 646	170 925	75 056
Bukovský vrch	252 288	12 930	12 930	11 984	15 137	25 229	11 038
Dolný vrch	725 328	81 048	18 606	18 606	19 552	22 706	17 345

The usable groundwater supply in the whole hydrogeological region MQ 129, named Mesozoic of Central and Eastern part of Slovenský Kras Mtn. was 1282,9 $l.s^{-1}$ according to Slovak State Water management Balance.

4.3.2 Hungary

Table 4.2 *Water abstraction in the Aggtelek area*

	Permitted abstraction		Abstraction per year (m^3)					
	m^3/d	m^3/year	2000	2001	2002	2003	2004	2005
Bódvalenke communal waterworks	9.0	3 285	2 571	1 776	2 194	2 434	1 922	3 431
Komjáti Pasnyag-spring	510.0	186 150	70 295	40 993	52 732	80 574	81 250	78 920
Szögliget Csörgő-spring	88.0	32 120	34 468	22 265	24 240	28 378	28 970	26 917
Varbóc communal waterworks	18.0	6 570	2 759	2 193	2 321	2 615	2 476	2 534
Tornaszentjakab communal waterworks	18.0	6 570	5 383	5 350	5 402	5 775	5 820	6 230
Jósvafő-Aggtelek Babot-well	164.0	59 860	32 908	28 953	27 491	29 171	29 830	32 000
Égerszög communal waterworks	12.0	4 380	3 562	3 161	3 211	3 780	3 415	3 714
Szőlősardó communal waterworks	33.0	12 045	4 235	4 994	5 578	8 264	8 335	7 323
Becskeháza communal waterworks	11.0	4 015	1 610	1 429	1 566	1 510	1 453	1 517

In the „Aggteleki-karszt” area (Water Supply Management Region No. 621), the abstractable dinamic groundwater supply is 0,590 m3/sec, (50 976 m^3/day) defined by the Water Reasorces Reasearch Centre.

4.4 Groundwater quality – monitoring and status

4.4.1 Slovak republic

4.4.1.1Assessment of the Quality of Groundwater

Groundwater quality is monitored on a regular basis by means of state monitoring programme. Systematic groundwater quality monitoring in the Slovak Republic has been performed since 1982. The main objectives of groundwater quality monitoring are:

- to evaluate actual state of groundwater quality in the Slovak Republic
- to define long-term trends of groundwater quality in the Slovak Republic
- to provide details to governmental institutions for decision making processes in the field of groundwater quality protection
- To use mathematical models of water quality and research activities.

Groundwater samples are collected once a year in the autumn. Chemical analyses cover basic and supplementary groups of determinants. A review of determinants is given in Tab. 4.3. The basic group of determinants is analyzed for every sampling site. Determinants from the supplementary group are analyzed for selected sites chosen based mainly on specific local conditions (type of pollution, etc.).

Tab. 4.3: *Groups of determinants*

Basic group of determinants	**Supplementary group of determinants**
pH, standardized conductivity 25°C, conductivity – sampling, temperature of water, air temperature, alkalinity, acidity, dissolved oxygen, oxygen saturation, Eh, color, odor, sediment content	pesticides

natrium, potassium, calcium, magnesium, manganese, iron	PCBs
ammonia ions, nitrates, nitrites, sulfates, chlorides, phosphates, silicates, carbonates, hydrogencarbonates,	aromatic hydrocarbons
COD	chlorinated phenols
forms of CO_2	chlorinated dissolvents
arsenic, aluminium, cadmium, copper , lead, mercury, zinc, chromium, nickel	polyaromatic hydrocarbons
humic substances, nonpolar extractable substances, cyanides, phenol compounds, TOC	halogenated hydrocarbons

The results from monitoring programme are assessed in accordance with Regulation No. 151/2004 Coll. of the Ministry of Health on requirements for drinking water and control of drinking water quality which entered into force on 1 April 2004. The requirements of Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption are fully transposed in this Regulation. The Regulation defines allowable concentrations of chemical substances in groundwater. The evaluation is published in annual report "Groundwater quality in the Slovak republic". Report gives basic information about groundwater quality and main sources of pollution having impact on the water quality.

In the Slovenský Kras area sampling stations is the groundwater quality represented by coloured circles. The circle is divided into four parts, each part of the circle expresses group of determinants Ba, Bb, Bc and Bd in accordance with Regulation No. 151/2004 Coll. (Ba – anorganic determinants, Bb – organic determinants, Bc – disinfectants, Bd – determinants with potential negative effect on drinking water sensory quality). If at least one of determinants in the group exceeds limit value, relevant quarter is red. Exceeded determinant is listed next to this quarter. Green quarter symbolized group of determinants with non-exceeded limit values. If there were no determinants of the group measured, quarter is white.

Degree of contamination is used for presentation purposes. Contamination factor was calculated for each analysed component, which exceeds value permitted by Regulation No. 151/2004 Coll.:

$C_{fi} = C_{ai} / C_{ni} - 1$

C_{ai} - analytical value of i-th component

C_{ni} - value of i-th component permitted by Regulation No. 151/2004 Coll.

C_{fi} - contamination factor of i-th component

Contamination degree of analyzed samples was calculated as follows:

$$C_t = \sum_{i=1}^{n} C_{fi}$$

where $C_{fi} > 0$

C_t - contamination degree of sample

Selection of parameters and value of i-th component permitted by regulation can be modified according to purpose of water quality assessment. Groundwater quality assessment has been done base on contamination degree calculated for groups of determinants:

- All determinants
- Basic determinants
- Heavy metals
- Organic compounds

4.4.1.2Groundwater quality in Slovenský Kras area

List of groundwater quality sampling stations in the area of interest from 1994-2003 is given in Tab. 4.4.

Table 4.4 *List of groundwater sampling stations in Slovenský Kras area*

Name of the station	Number of the station	Start of the observation
Žarnov	108790	1.1.2000
Nová Bodva	500827	1.1.1984
Turnianske Podhradie	500834	1.1.1985
Hrhov-Veľká hlava	139001	1.1.1987
Jabloňov nad Turňou	125890	1.1.1984
Slavec	092390	1.1.1990
Plešivec	090990	1.1.1990
Čoltovo	091090	1.1.1990
Gemerská Panica	291390	1.1.1998

Figure 4.1 *Groundwater Quality and quantity monitoring network in pilot and test areas*

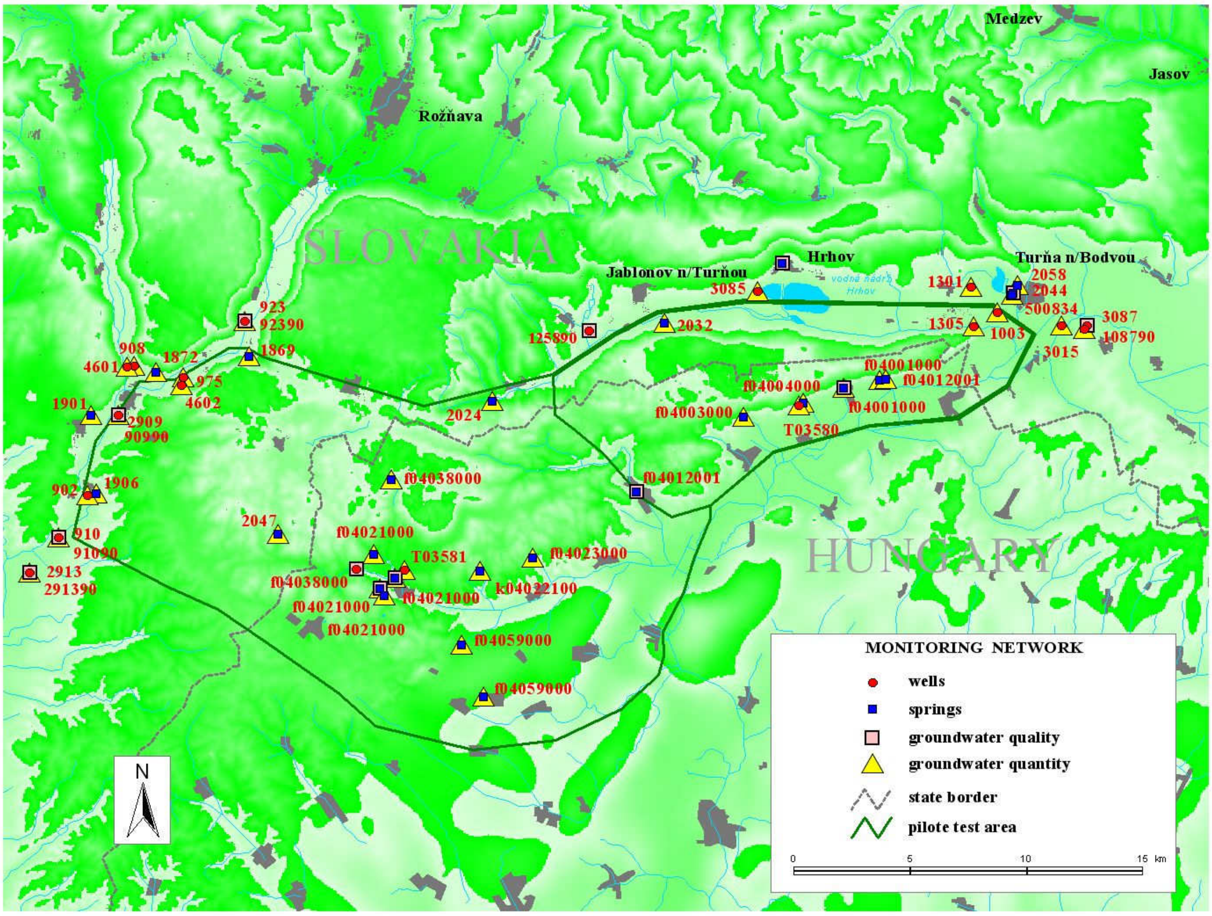
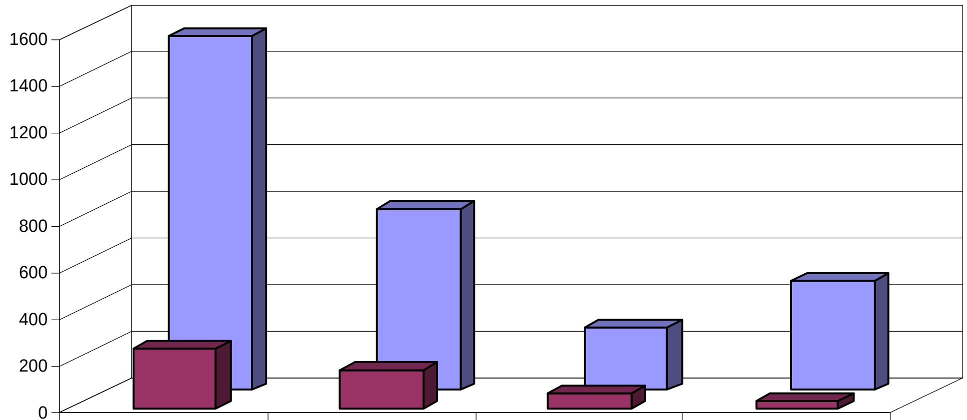


Figure 4.2 *Account of whole group of analyzed determinants*



	All determinands	Basic determinands	Organic compounds	Heavy metals
Number of exceeded	254	162	63	29
Number of samples	1522	780	270	472

If the whole group of analyzed determinants is taken into account, in Fig. 4.2 is shown that 254 from 1522 samples indicate unfit water quality according to Regulation No. 151/2004 Coll. Limit values are the most frequently exceeded by group of basic determinants. Higher concentrations of organic compounds group and heavy metals have been observed only in a few monitoring sites.

More detailed characterisations of groundwater due to the main groups of water quality determinants from 1994-2003 are presented in the following sub-chapters.

4.4.1.2.1 Basic determinants

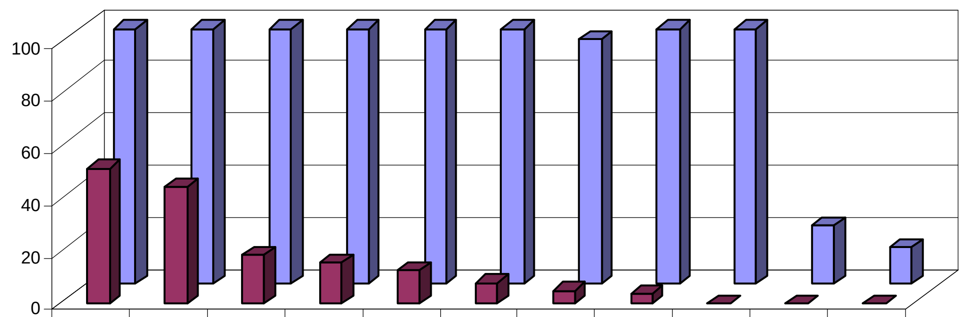
Limit values have been the most frequently exceeded by basic determinants. Number of exceeded determinants in comparison with the Regulation 151/2004 Coll. is shown in Fig. 4.3.

Iron concentrations in groundwater very frequently attain. Iron in groundwater is di- and trivalent. Iron distribution in groundwaters is generally controlled by oxidation-reduction conditions. Lower levels of dissolved oxygen in groundwater cause relatively high concentrations of iron. Concentration of iron exceeded limit value 52 times from the total number 98 analyses for the last 10 years. High iron contents are often associated with increased concentrations of manganese, which has similar geochemical properties.

Manganese is the second of the most exceeded determinants (45 from 98 analyses indicated unfit water quality). Manganese considerably influences organoleptic properties of groundwater, more than iron does. Iron and manganese are determinants indicating anoxic conditions.

The impact of antropogenic pollution on groundwater quality is indicated by exceeded limit values of nitrates, ammonia, chlorides and sporadically nitrites, sulphates and COD. Groundwater quality is determined, besides the primary pollution, by the secondary sources of pollution. Nitrogenious substances from household wastewater, agriculture, animal wastes, and fertilisers pollute groundwaters. Concentrations of nitrogenious substances have decreased during last 10 years, it is mainly caused due to lowering input of agricultural chemicals during this period.

Figure 4.3 ***Number of exceeded limit values of basic determinants***



	total Fe	Mn	NH4	NO3	Chlorides	COD	NO2	SO4	Na	Fluorides	Idle cyanides
number of exceeded	52	45	19	16	13	8	5	4	0	0	0
number of samples	98	98	98	98	98	98	94	98	98	22	14

4.4.1.2.2 Heavy metals

Within the heavy metals group 9 parameters are observed. In period 1994-2003 5 heavy metals exceeded permissible value given by Regulation (Pb, Ni, Al, Cd, As). Number of exceeded determinants in comparison with the Regulation 151/2004 Coll. is shown in Fig. 4.4

4.4.1.2.3 Organic compounds

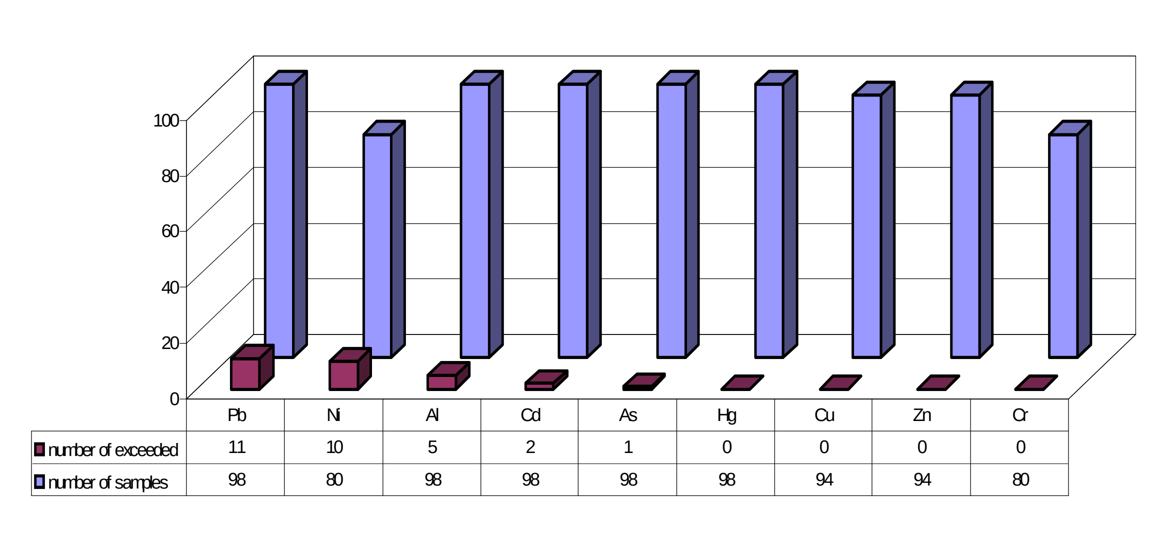
The higher content of lead has been noted the most frequently (11 analyses from 98 were above the limit value). Higher lead concentrations occurred in 4 sampling sites (125890, 139001, 500827, 500834). Local lead anomalies in groundwater are mostly caused by secondary point sources and base-metal sulphide galena-dominated occurrences. However lead concentration was lower than the limit value for the last 5 years.

In comparison with the values given by Regulation 151/2004 Coll. nickel concentration exceeded limit value 10 times (from 80 analyses). Maximum nickel concentration 38 µg/l was measured in sampling station 108790 in 2001. Since 2001 nickel content was not higher than the limit value.

Aluminium, Cadmium and Arsenic occasionally appeared in a few reaches only.

Heavy metals belong to toxic elements with potential carcinogenic effects. It is important to pay attention to protection against pollution because groundwater of this area is the most important source of drinking water.

Figure 4.4 *Number of exceeded limit values of heavy metals*



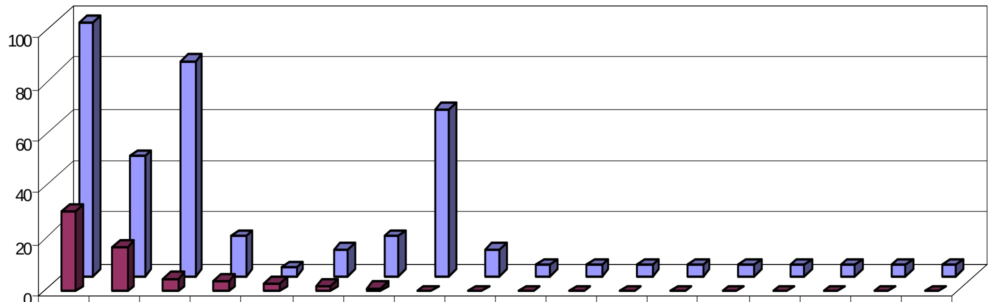
4.4.1.2.4 Organic substances

Organic substances impact on biological and chemical water properties, some of them can have carcinogenic, mutagenic, teratogenic effect, can impact on colour, odour and taste of water.

As seen in Fig.4 5 limit values were the most frequently exceeded by common organic compounds - nonpolar extractable substances (analysed in UV and IR). From 98 analyses the limit value for NES UV was exceeded 31 times in a given period. Occurrence of NES in groundwater can indicate oil pollution as a consequence of industry.

Specific organic compounds have been observed only in 2 selected sampling sites (90990, 91090). Concentrations of specific organic compounds exceeded the limit value given by the Regulation 151/2004 Coll. on rare occasions only. Most analyses were below the detection limit of the analytical method used. In spite of sporadic occurrence it is necessary to protect groundwater. Higher levels of specific organic compounds in groundwater present a potential risk to the environment.

Figure 4. 5 *Number of exceeded limit values of organic substances*



	NES UV	NES IC	Phenol-index	Fluoranthene	Phenanthrene	D 106	Benzo(a)pyrene	Humic subst.	D 103	DDT	Heptachlorine	Hexachlorobenzene	Chlorophorm	Lindane	Methoxychlorine	TCE	1,1,2,2-tetrachloroethane	Tetrachloromethane
number of exceeded	31	17	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0
number of samples	98	46	83	15	3	10	15	64	10	4	4	4	4	4	4	4	4	4

4.4.1.2.5 *Current state of the groundwater quality*

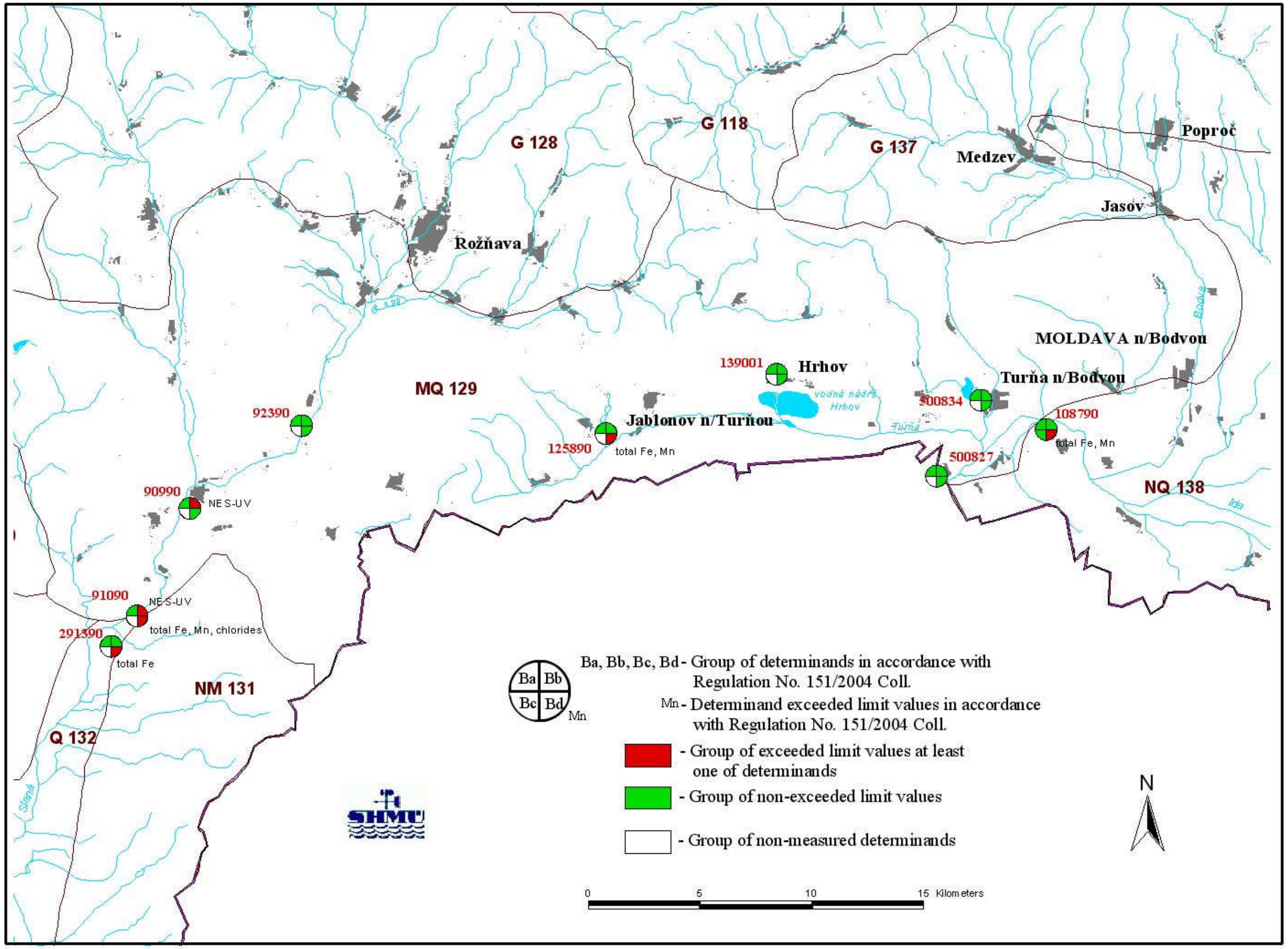
Groundwater quality of this area in 2003 has been monitored in 9 sampling sites (7 piesometric wells of the basic SHMI network and 2 springs). Groundwater samples were taken from the first aquifer in the autumn 2003. Determinants exceeded allowable concentration in comparison with the Regulation 151/2004 Coll. is shown in Tab.4.5. The main water streams are Bodva and Slaná in the Slovenský Kras area. Groundwater quality is determined, besides the quality of natural origin, by the amount of contaminants from diffuse and point sources of pollution. There is impact of Moldava nad Bodvou (point source of pollution – Water and sewerage company Šaca) at the investigated area. The upper part of the Slaná section is polluted by industrial wastewaters (Nižná Slaná, Lubeník, Jelšava, SAD Tesnárka, limekiln in Gombasek, paper-mill in Slavošovce).

Table 4.5 *List of groundwater sampling stations with exceeded determinants*

Name of the station	Number of the station	Start of the observation	Determinants exceeded limit values in 2003
Žarnov	108790	1.1.2000	total Fe, Mn
Nová Bodva	500827	1.1.1984	
Turnianske Podhradie	500834	1.1.1985	
Hrhov-Veľká hlava	139001	1.1.1987	
Jabloňov nad Turňou	125890	1.1.1984	total Fe, Mn
Slavec	092390	1.1.1990	
Plešivec	090990	1.1.1990	NES_{UV}*
Čoltovo	091090	1.1.1990	Mn, total Fe, Cl, NES_{UV}*
Gemerská Panica	291390	1.1.1998	total Fe

*nonpolar extractable substances in

GROUNDWATER QUALITY MONITORING NETWORK IN THE SLOVENSKÝ KRAS AREA



4.4.2 Hungary

4.4.2.1 Information on the present activities of the North Hungary Region Environmental Protection Inspectorate in the field of water protection monitoring, and waste-inspection

In the year 2001 the North Hungary Region Environmental Protection Inspectorate executed its activity according to the tasks and competences defined by the Government Decree No. 211/1997 (XI.26) Korm. and in its area of competence defined in Section VIII, Annex 1 of the Ordinance No. 36/1997 (XII.18) KTM of the Minister of Environmental Protection and Regional Development. In this framework it implements its authority- expert authority- and public authority activities in the field of air-protection, water quality and quantity protection, protection of groundwaters and against the harmful effects of noise and vibration.

4.4.2.1.1 Water quality monitoring

At present 5 sites (4 springs and 1 spring captured as well) are part of the chemical monitoring (Table 4.6). The main characteristics of major components of the monitoring wells and the number of exceeded limit values are shown in tables 4.7 – 4.13. Most components of the monitoring wells are not exceeding the drinking water limits. The pH varies between 6.5 and 8.5, the electric conductivity between 275 and 752 µS/cm, the total hardness between 99 – 282 mg/l,while the alkalinity between 3 – 8.1meq/l. . The NO_3^- is below the drinking water standard (50 mg/l), while the NO_2^- in some cases is slightly above 0.1 which is the limit for karstic waters. The maximums of the NH4+ measurements are much above the drinking water limits (0.2 mg/l for karstic waters), but these data are probably due to improper sampling or sample storing, which is supported by the low median values. The Fe2+ and the Mn2+ are very often above the limits (0.2 and 0.05 mg/l respectively). This is probably due to the fact that the concentrations are very close to the detection limits of the analytical measurements, where the error can be high. Sampling and sample storing can also influence the results. The concentration of Na^+, Cl^- and SO_4^{2-} were always below the drinking water limits. Even the maximum values of the COD measurements were above the limit (3.5 mg/l) almost at each well, but their median values were much below this limit.

Table 4.6 ***List of groundwater sampling stations, which are part to the chemical monitoring in the Aggtelek area, Hungary***

Settlement	Name	Type	Start of the observation
Aggtelek	Babot-well	spring	05.01.1981
Szögliget	Csörgő-spring	spring	03.04.1984
Jósvafő	Jósva-spring	spring	15.01.1985
Tornanádaska	Kastélykert-spring	spring	24.10.1985
Jósvafõ	Nagy-Tohonya-spring	spring	27.11.1985

The time series of the major components of the monitoring wells were also analyzed. The time series can help to detect if there are any trends during the monitoring, and to identify outlier values or laboratory/meteorology changes. At laboratory changes parallel measurements would improve the reliability of data..

Babot-well

The time series of Babot-well (Figure 4.6, Table 4.7) show that the water composition is constant in time. Except of few outliers the data of the main components are within the analytical error. This is reflected in the very close mean and median values. Most of the Fe_2^+ data are below detection limit (<0.01 mg/l). From 1992, neither Fe_2^+ values above detection limit nor NH_4^+ values above the drinking water standard were measured. This can be either due to change in water sampling method, or due to laboratory method change.

Csörgő-spring

Csörgő-spring (Figure 4.7, Table 4.8) is also constant in time. The maximum NO_3^- content is 16.3 mg/l, while the median is 5.3 mg/l. The Fe_2^+ (and partly the NH_4^+) measurements were not carried out at each sampling time, and the measured Fe_2^+ values varies evenly. Values vary between

The concentrations of main components are constant in time for Jósva-spring. 0.01 and 0.1 mg/l.

Nagy-Tohonya-spring (figure 4.8) and Kastélykert-spring (figure 4.7) show also constant concentrations in time. For NH_4^+ slightly higher concentrations were detected after 2001. The data have to be checked during the monitoring. Some small changes in time can be observed in the NO_3^- and Cl concentrations too.

Jósva-spring

The concentrations of main components are constant in time for Jósva-spring (Figure 4.8 Table 4.9). From 1995 the changes in the concentrations of Fe_2^+, NH4+ and COD are higher than before, but except the Fe_2^+, these concentrations are rarely above the drinking water limit.

Kastélykert and Nagy -Tahonya springs

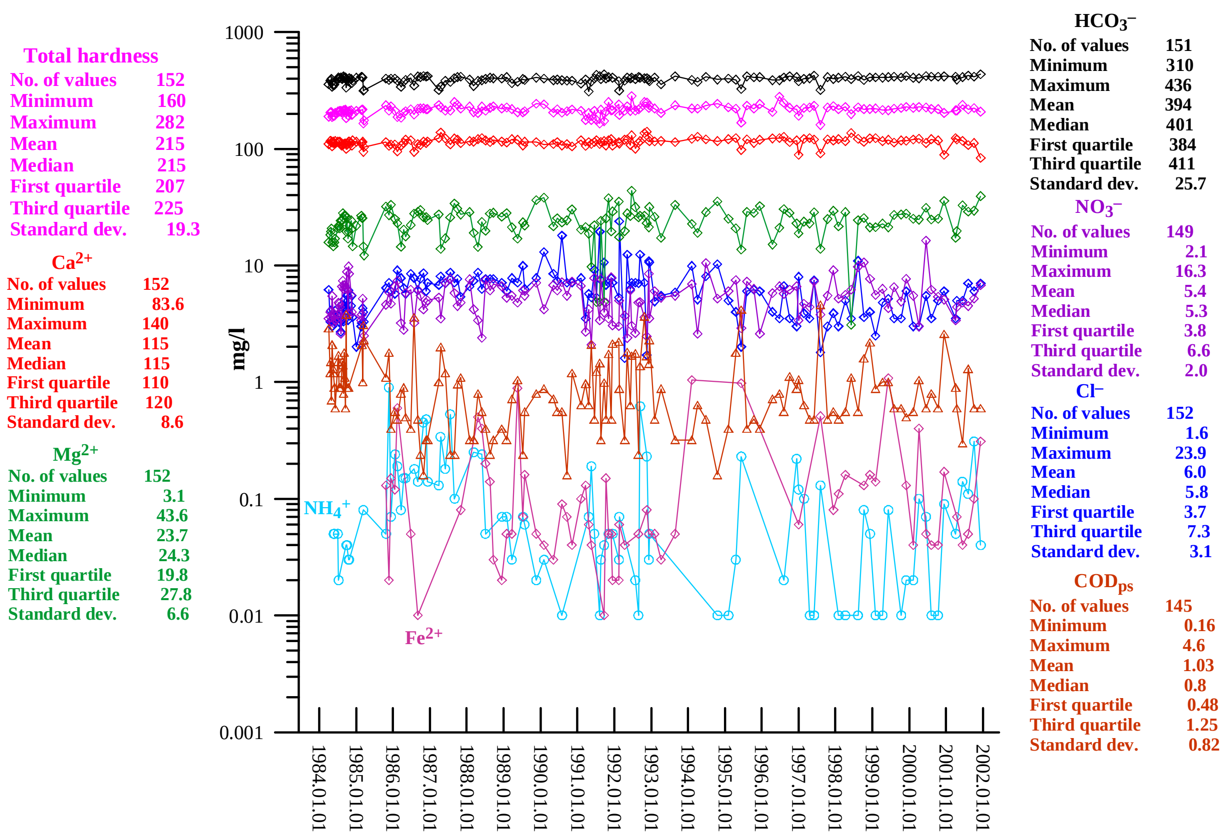
Nagy-Tohonya-spring (Figure 4.10, Table 4.11) and Kastélykert-spring (Figure 4.9, Table 4.10) show also constant concentrations in time. For NH_4^+ slightly higher concentrations were detected after 2001. The data have to be checked during the monitoring. Some small changes in time can be observed in the NO_3^- and in the Cl^- concentrations too.

Babot-well

Table 4.7 *Main characteristics of major components of Babot-well and the number of exceeded limit values*

	pH	EC	Hardness	Alkalinity	Na^+	Fe^{2+}	Mn^{2+}	NH_4^+	Cl^- *	SO_4^{2-}	NO_3^-	NO_2^-	COD
		µS/cm	CaO	meq/l	mg/l	mg/l	Mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	O_2 mg/l
Maximum	*8.0*	*742*	*272*	*8.1*	*12*	*0.07*	*0.02*	*1.09*	*20*	*65.8*	*5.9*	*0.04*	*3.39*
Median	*7.16*	*626*	*217*	*7.2*	*2*	*<0.0*	*<0.0*	*0.12*	*5.4*	*15.1*	*2.5*	*0.009*	*1.0*
No. of exceeded								*28*					
No. of samples	*247*	*240*	*252*	*210*	*138*	*123*	*123*	*138*	*171*	*164*	*213*	*130*	*145*

Figure 4.6 *Time series of major components and their main statistics at Babot-well (f040380007)*

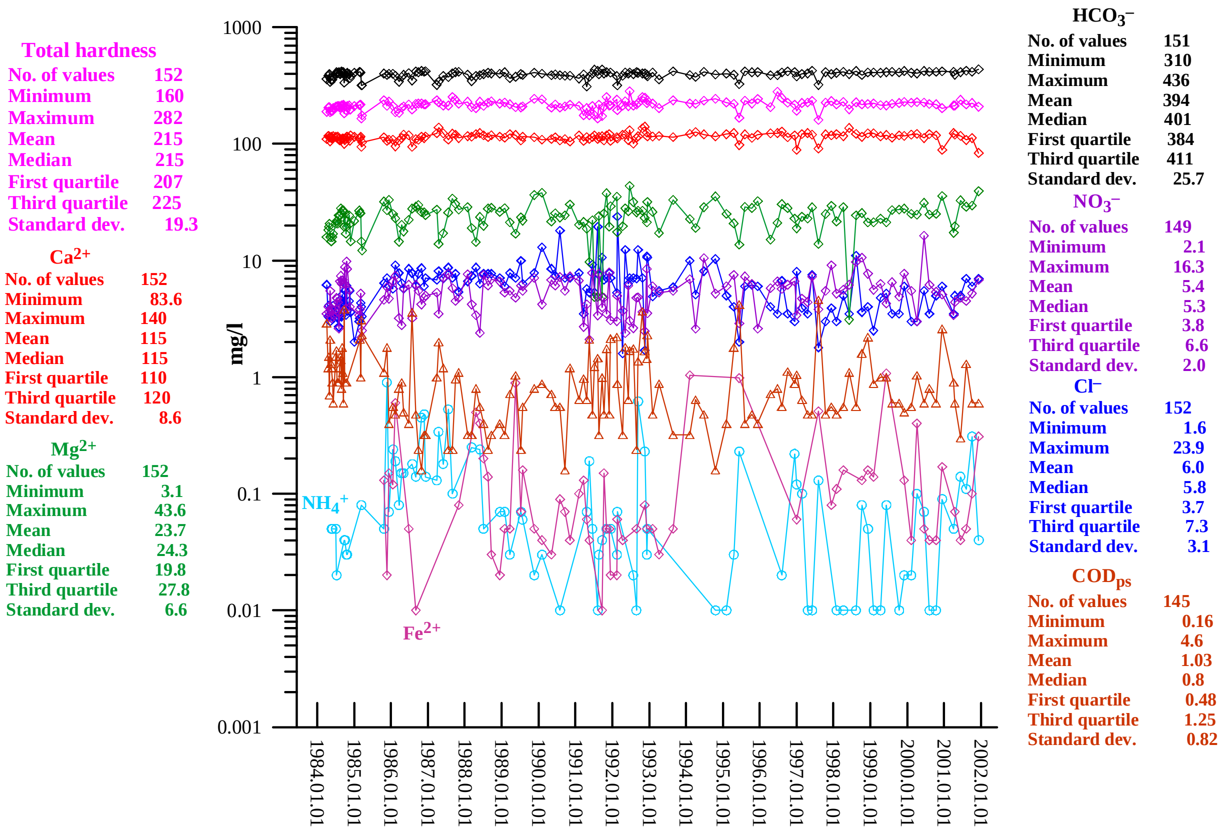


Csörgő-spring

Table 4.8 *Main characteristics of major components of Csörgő-spring and the number of exceeded limit values*

	pH	EC	Hardness	Alkalinity	Na+	Fe2+	Mn2+	NH4+	Cl– *	SO42-	NO3–	NO2–	COD
		µS/cm	CaO mg/l	meq/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	O2 mg/l
Maximum	*8.47*	*752*	*282*	*7.1*	*11*	*1.08*	*0.5*	*0.9*	*23.9*	*106*	*16.3*	*0.1*	*4.6*
Median	*7.31*	*606*	*215*	*6.6*	*4.05*	*0.07*	*0.03*	*0.05*	*5.8*	*57.1*	*5.3*	*0.01*	*0.8*
No. of exceeded						*10*	*13*	*13*					*5*
No. of samples	*152*	*138*	*152*	*151*	*104*	*66*	*42*	*86*	*152*	*133*	*149*	*48*	*145*

Figure 4.7 *Time series of major components and their main statistics at Csörgő-spring (f040120010)*

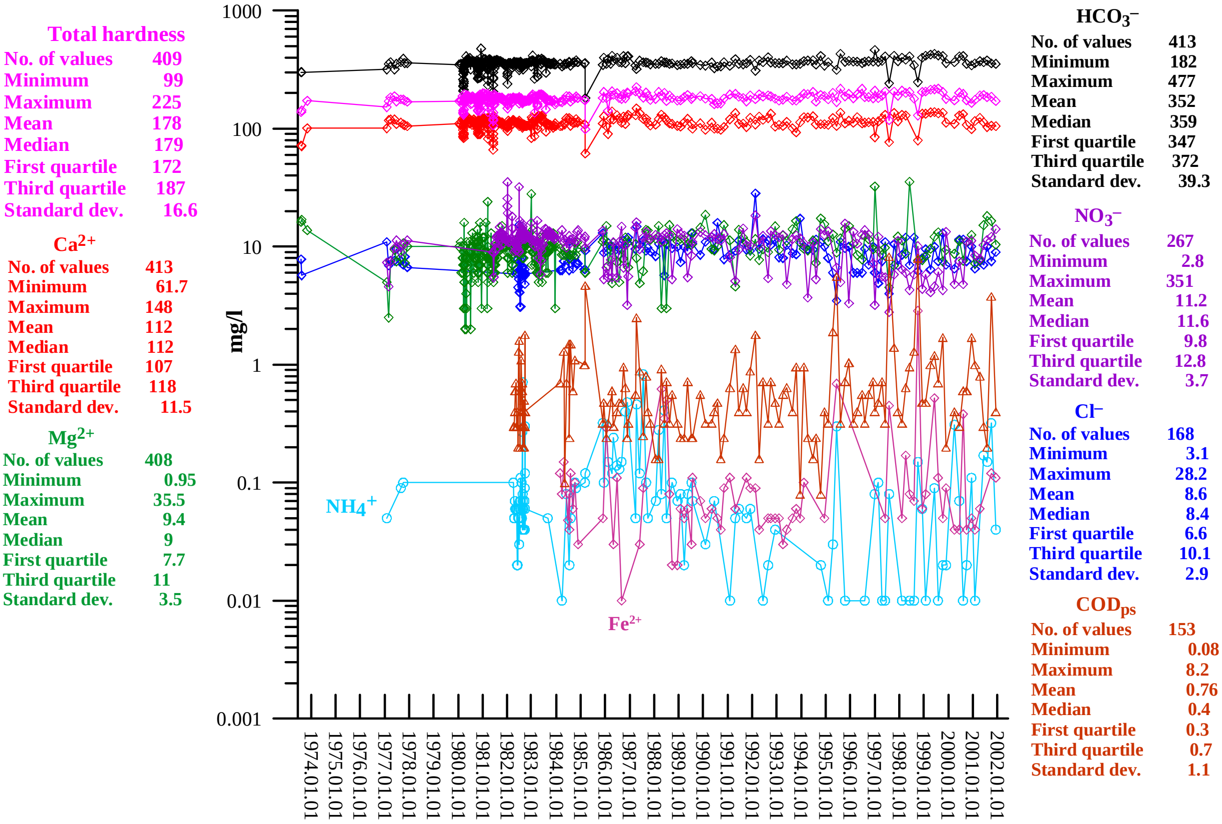


Jósva-spring

Table 4.9 *Main characteristics of major components of Jósfa-spring and the number of exceeded limit values*

	pH	EC	Hardness	Alkalinity	Na+	Fe2+	Mn2+	NH4+	Cl– *	SO42-	NO3–	NO2–	COD
		µS/cm	CaO mg/l	meq/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	O2 mg/l
Maximum	*8.2*	*682*	*225*	*7.8*	*10.2*	*2.86*	*0.36*	*0.83*	*28.2*	*63*	*35.1*	*0.17*	*5*
Median	*7.25*	*533*	*179*	*5.9*	*4*	*0.06*	*0.02*	*0.065*	*8.4*	*25*	*11.6*	*0.01*	*0.6*
No. of exceeded						*9*	*15*	*12*				*2*	*3*
No. of samples	*299*	*420*	*409*	*413*	*129*	*74*	*43*	*118*	*168*	*129*	*267*	*87*	*116*

Figure 4.8 *Time series of major components and their main statistics at Jósfa-spring (f040210004)*

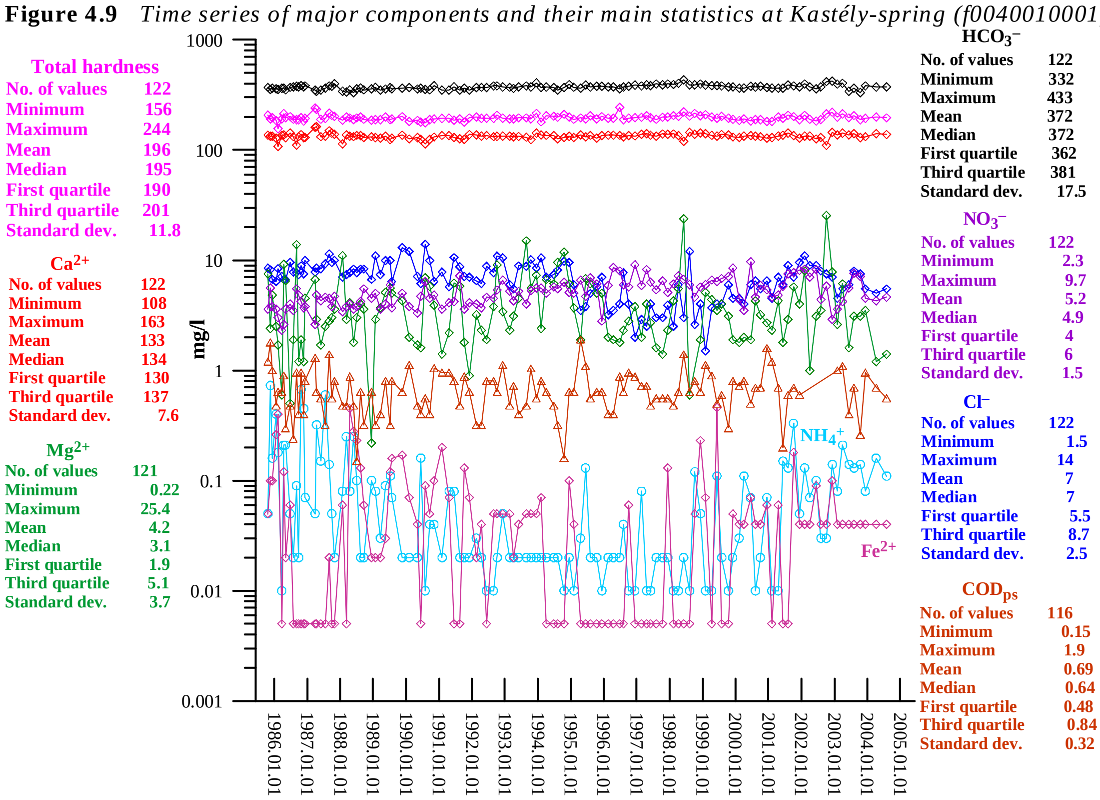


Kastélykert spring

Table 4.10 *Main characteristics of major components of Kastélykert-spring and the number of exceededlimit values*

	pH	EC	Hardness	Alkalinity	Na+	Fe2+	Mn2+	NH4+	Cl– *	SO42-	NO3–	NO2–	COD
		µS/cm	CaO mg/l	meq/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	O2 mg/l
Maximum	*7.96*	*646*	*244*	*7.1*	*9.1*	*0.73*	*0.46*	*0.33*	*14*	*64*	*9.7*	*0.06*	*1.9*
Median	*7.33*	*568*	*195*	*6.1*	*3.8*	*0.03*	*0.04*	*<0.0*	*7.05*	*43.2*	*4.9*	*<0.0*	*0.64*
No. of exceeded						*12*	*7*	*19*					
No. of samples	*122*	*122*	*122*	*122*	*122*	*122*	*122*	*122*	*122*	*119*	*122*	*122*	*116*

Figure 4.9 *Time series of major components and their main statistics at Kastély-spring (f0040010001)*



-Nagy - Tahonya spring

Table 4.11 *Main characteristics of major components of Nagy-Tohonya-spring and the number of exceeded limit values*

	pH	EC	Hardness	Alkalinity	Na+	Fe2+	Mn2+	NH4+	Cl– *	SO42-	NO3–	NO2–	COD
		µS/cm	CaO mg/l	meq/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	O2 mg/l
Maximum	*8.15*	*672*	*247*	*7.4*	*9*	*7.9*	*0.57*	*0.6*	*16*	*69.9*	*13.6*	*0.11*	*5*
Median	*7.27*	*581*	*204*	*6.6*	*3.3*	*0.06*	*0.03*	*0.07*	*5.9*	*39*	*4*	*0.01*	*0.6*
No. of exceeded						*4*	*9*	*10*				*1*	*1*
No. of samples	*274*	*381*	*374*	*376*	*119*	*64*	*44*	*75*	*129*	*127*	*230*	*52*	*116*

Figure 4.10 *Time series of major components and their main statistics at Nagy-Tahonya-spring (f040210002)*

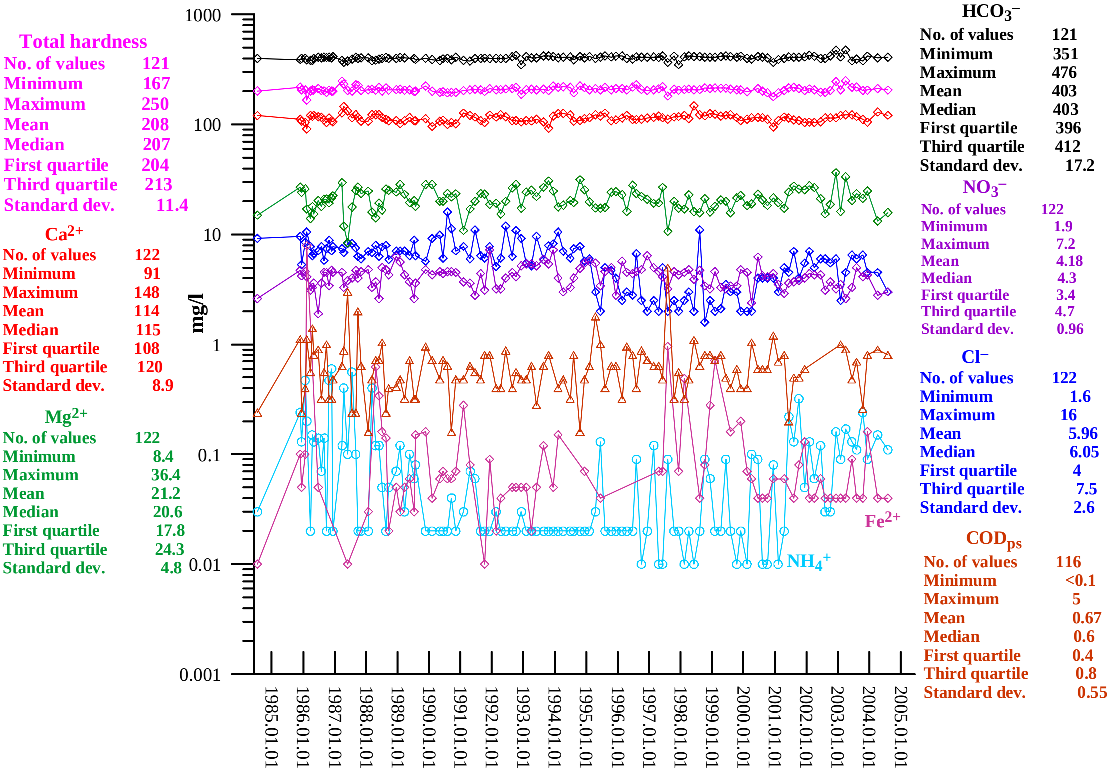


Table 4.12 *Main characterstics of major components of all available samples and the number of exceeded limit values*

	pH	EC	Hardness	Alkalinity	Na+	Fe2+	Mn2+	NH4+	Cl– *	SO42-	NO3–	NO2–	COD
		µS/cm	CaO mg/l	meq/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	O2 mg/l
Maximum	*8.47*	*752*	*282*	*8.1*	*12*	*7.9*	*0.57*	*1.09*	*28.2*	*106*	*35.1*	*0.17*	*5*
Median	*7.27*	*581*	*204*	*6.6*	*3.8*	*0.06*	*0.03*	*0.067*	*5.9*	*39*	*4.9*	*0.01*	*0.64*
No. of exceeded						*35*	*44*	*82*				*3*	*9*
No. of samples	*1094*	*1301*	*1309*	*1272*	*612*	*449*	*374*	*539*	*742*	*672*	*981*	*439*	*675*

Table 4.13 *Main characteristics of major components of all samples and the number of exceeded limit values*

	pH	EC	Hardness	Alkalinity	Na+	Fe2+	Mn2+	NH4+	Cl– *	SO42-	NO3–	NO2–	COD
		µS/cm	CaO mg/l	meq/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	O2 mg/l
Maximum	*9.2*	*2680*	*996*	*10.2*	*124*	*11.5*	*1.24*	*4.2*	*69*	*1650*	*96*	*6*	*14.1*
Median	*7.26*	*578*	*201*	*6.5*	*3.1*	*0.06*	*0.03*	*0.07*	*6.3*	*32.4*	*4.1*	*<0.0*	*0.8*
No. of exceeded		*3*	*7*	*4*		*108*	*136*	*146*		*10*	*3*	*6*	*34*
No. of samples	*2418*	*2670*	*2871*	*2821*	*947*	*516*	*360*	*841*	*1102*	*1102*	*2030*	*567*	*1052*

To check whether the monitoring sites represent the groundwater quality of the studied area, we compared the data (all monitoring samples; Table 4.13) with all the available samples (Table 4.12). In the latter case not all of the samples are from karstic areas, and some of them are found within settlements. So the comparison has to be done with precaution.

The most frequent element which was detected above the drinking water standard is the NH_4^+. 17.4 % of all samples were above this limit, while in the case of the monitoring samples this percentage was 15.2 %.

The other two elements which were very often above the drinking water standard are the Mn and the Fe. Mn: 11.8 % (monitoring samples), 37.8 % (all samples). Fe: 7.8 % (monitoring samples), 20.9 % (all samples).

Outlier values should be controlled during the monitoring.

We can conclude that the monitoring data and the data from other surveys are in good agreement.

4.4.2.1.2 Trace elements

The trace element concentrations of the measured springs are low, which is reflected by their median values mostly below the detection limits. Even the maximum values are not high. They are far below the drinking water standard (201/2001. (X. 25.) Gov. Decree) limits.

Figure 4.14 *Main characteristics of trace elements of all samples and the number of exceeded limit values*

	B	Al	Cr	Ni	Cu	As	Se	Cd	Hg	Pb
	µg/l									
Maximum	*402*	*130*	*17*	*15*	*43.1*	*7*	*2*	*1.1*	*0.9*	*2.99*
Median	*<5*	*<12*	*<5*	*<1*	*2.9*	*<0.5*	*0.17*	*<0.2*	*<0.1*	*<1*
No. of exceeded										
No. of samples	*80*	*67*	*76*	*75*	*76*	*46*	*25*	*39*	*19*	*39*

4.4.2.1.3 Pesticides and organic materials

The monitoring of pesticides/organic materials was not yet started. Few analyses are available from drinking water source protection works and from the survey of chemical status of shallow groundwater carried out in 2004 - 2006 in the frame of a PHARE project.

These data show that the pesticide content of Nagy-Tohonya-spring is above health limit. The metribuzine content of the spring was 0.1 µg/l. No measurements for organic materials were carried out from Nagy-Tohonya-spring. At Csörgő-spring metribuzine, AOX, PAH and TPH, while at Kastélykert-spring AOX, PAH and fenantrene, antracene, fluorantrene, pirene, krizene could be detected, but these data were far below the health limit. There were no measurements from Babot-well and from Jósva-spring.

Metribuzine could be detected in few other springs in the area, too. These springs were the following: Csurgó-spring at Varbóc, and springs of drinking water wells from Szőlősardó and Tornakápolna. At Tornakápolna PAH, TPH and AOX could also be detected in the water.

Eight out of the 11 analysed samples contained pesticides and/or other organics. This fact claims the attention of the importance of the measurements at least at the monitoring sites.

In the summer of 2007, in the frame of the "Environmental state and sustainable management of Hungarian-Slovakian transboundary groundwater bodies (ENWAT)" INTERREG project, two more samples were collected in the area. At Trizs, from Kastély-well no pesticides were detected, while from the brook in the Domica cave (in the Slovakian part of the Aggtelek cave system) 0.01 μg/l atrazine and 0.011 μg/l chlorpyriphos was detected. In the latter case the recharge part of the underground brook is also in Slovakia.

4.5 Groundwater quantity – monitoring and status

4.5.1 Slovak republic

In accordance with springs interception, water exploitation and quality requirements the groundwater represents one of the most economical drinking water resources.

On the Slovak Hydrometeorological Institute (SHMI), there the extensive groundwater quantity monitoring network exists.

By course of monitoring domain (the main parameters are efficiency of springs, groundwater levels and water temperature) the network of Slovakia can be divided into next groups:

- monitoring network of groundwater levels;
- spring efficiency monitoring network.

The actual and long-term evaluation is published in annual report „Groundwater quantity in the Slovak Republic“. The report presents basic information about groundwater gauging sites, maps of their location, the actual measured groundwater values and long-term evaluations. The observations have mostly done weekly (by voluntary observatories). Since 1994 there were installed a large huge of automatic gauges, have also done continually.

The groundwater measurement exists from the year 1967 on pilot project area. Until the 1994, there were monitored 16 springs. Present-day monitoring comprise of only 4 springs and 5 boreholes (list of them see in Table .4.15).

Table 4.15 *Boreholes and springs monitored in the year 2005*

Name/Town	**Name of Source**	**Type of Source**
Slavec	Čierna vyvieračka	spring
Silická Jablonica	Mlynský prameň	spring
Jablon.nad Turňou	Kõsoru	spring
Kečovo	Veľká vyvieračka	spring
Plešivec	975	borehole
Turňa nad Bodva	1003	borehole
Turň.Podhradie	1301	borehole
Turňa nad Bodva	1305	borehole
Hrhov	3085	borehole
Plešivec	4602	borehole

4.5.2 Hungary

4.5.2.1 Information on the tasks of the North Hungary District Water Authority and the hydrological activities thereof

4.5.2.1.1 Tasks of the North Hungary District Water Authority

Among the relation of state tasks to water management defined by Section 2 and 7 of the Act No. LVII of 1995 on Water Management, the National Water Authority and the District Water Authorities implement tasks of the independent central agency and its regional organs, under the direction of the minister in charge of water management. The Government Decree No. 234/1996. (XII.26) identifies the tasks of the District Water Authority.

4.5.2.1.2 *Tasks of the Water Authorities:*

~ execution of the authority power;

~ tasks with relation to the long term plans of water management;

~ international co-operation in water management, implementation of tasks originating from the bilateral agreements on transboundary waters;

~ water resources management;

~ hydrological activities with regard to the quantitative and qualitative assessment of water resources;

~ protection against damages caused by water;

~ with regard to the state-owned waters and hydraulic facilities it maintains, operates and develops:

- the primary hydrometric network and the secondary (operational) networks serving state responsibilities;
- the monitoring systems of the perspective sources of drinking water supply;
- the facilities of flood protection;
- the facilities for the drainage of excess water;
- the hydraulic structures;
- the barrages and the areas of elevated water levels;
- the systems of water distribution and the multipurpose systems;
- The installations of water transfer and supplement serving water resources management.

~ expressing its opinion on the Water Fund, keeping a record of it together with its superintendence;

~ cooperation with the municipalities, with the Public Administration Agencies;

~ Implementation of other tasks originating from the legal regulations in force.

4.5.2.1.3 Hydrological network in the Jósvafõ karst area

4.5.2.1.3.1 Quantity measurements on springs

Recording of water levels – with instrument, type METRA-501 of weekly rotation installed above Thomson-weir – calculation of flow from water level. Measurement of water- and air temperature is done weekly

Table 4.16 *Quantity monitored springs*

Nagytohonya Spring	Lófej- Spring
Kecskekút- Spring	Komlós- Spring
Kastélykert- Spring	Vecsem- Spring
Kopolya- Spring	Kistohonya- Spring
Jósva- Spring	Tapolca- Spring
Pasnyag- Spring	Bolyamér- Spring

- With Thomson-weir, daily reading, calculation of flow with the relevant formula *Teresztenye – Barlang Spring*
- Daily determination of flow with floating in concrete canal *Meleg -Tapolca Spring - Szögliget*

4.5.2.1.3.2 Quantity measurements of brooks in caves

Recording of water levels – with instrument, type METRA-501 of weekly rotation installed above Thomson-weir – calculation of flow from water level. Weekly is done measurement of water- and air temperature *(Styx, Acheron)*.

4.5.2.1.3.3 *Wells for the observation of water levels (PRIMARY STATIONS)*

(In Jósvafõ - recording at every half an hour, in the well, Komjáti - at every two hours). (Komjáti 1, Jósvafõ 2)

4.5.2.1.3.4 *Sinkholes*

Recording of water levels – with instrument, type METRA-501 of weekly rotation installed above Thomson-weir – calculation of flow from water level. Weekly is done measurement of water- and air temperature *(Csernatói, Nagyravaszlyuk)*.

4.5.2.1.3.5 *Precipitation gauges*

Observation of the24 hours amount of precipitation with Hellmann-vessel *(Tornanádaska, Varbóc)*

4.5.2.1.3.6 *Complex meteorological station*

As the time is taking over, the data of the automatic station of the National Meteorological Service were measured *(Jósvafõ)*.

4.5.2.1.3.7 *Primary water quality network*

Jósvafõ		Tornanádaska	- Kastélykert-Spring
- Jósva-Spring		Szögliget	- Csörgõ-Spring
	- Nagytohonya-Spring	Aggtelek-Jósvafõ	- Babot-well

5. VULNERABILITY MAPPING

During the years 2004 and 2005 under mentioned data source papers, maps and charts were realized. Majority of maps are in GIS data source layers form and would be served as a vulnerability map background.

5.1 GIS Background overlies of vulnerability mapping

5.1.1 Inventory of environmental hazards

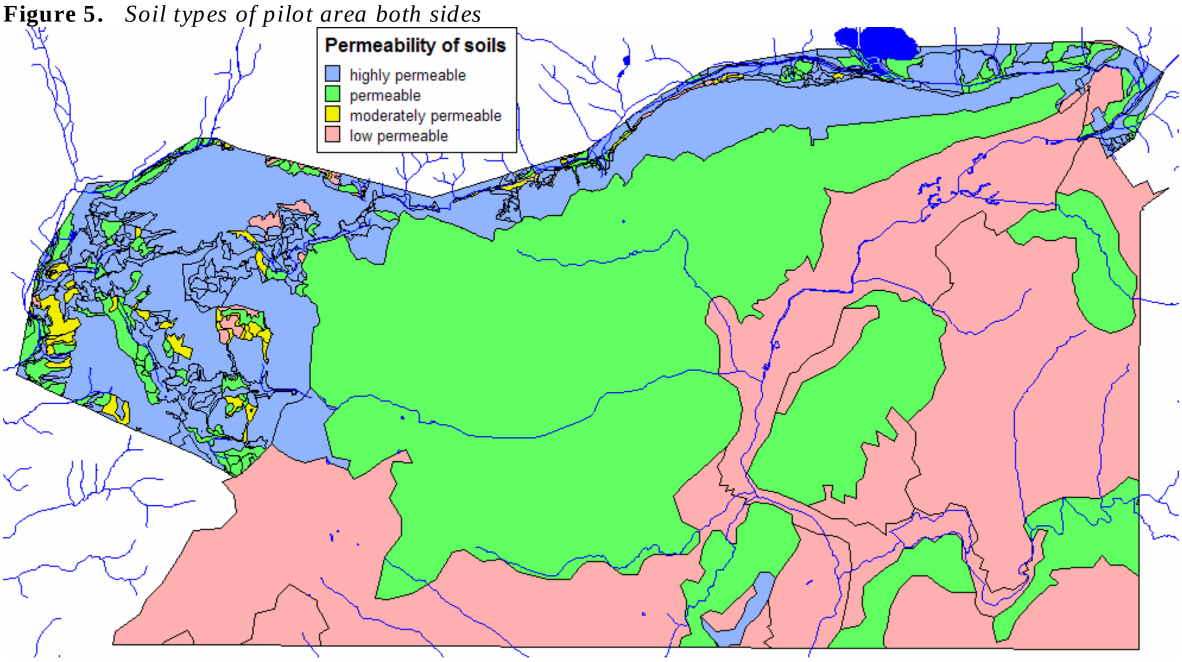
Potential pollution sources with their superficial distributions the mapping was done only on Slovak part of test area – hydrogeological structure Dolný vrch. Variability, seasonality and trends of climatic factors play responsible role at groundwater quality determination. Unequal groundwater expansion is preliminary geological construction consequence. From this reason we can characterize its power to concentrate and originate the groundwater sources. At protection degree valuation of groundwater body before the contaminants affects (environmental hazards) the characteristics of bed and soils are considered.

On the test area, there are following hazards: 23 powered waste dumps, 1 closed dump, 2 stone quarries, cement mill, pebbles treating, hogger, accumulator, scrap material and shaper production, tire service, 13 farmers´ courtyards, 21 graveyards, 5 ponds, road network, railway, pipeline and gasoline.

5.1.2 Natural groundwater protection by soil (soil facilities): soil types, processing of soil skeleton and depth and soil saturated hydraulic conductivity parameter [cm/hr].

From the Figure 4.1 is visible the different way of evaluation of soil permeability in both countries. On the Slovak part, there is in the area of interest, complex evaluation of agricultural soils was performed according to their protective function in water management. Resulting assessment of water management protective function is a synthesis of partial evaluations:

Figure 5. *Soil types of pilot area both sides*



- **Of soil permeability** – qualitative parameter (parameter_i)
- **Of soil retention capability** – qualitative and partially quantitative parameter (parameter_ii)
- **Of organic matter content** – qualitative parameter (parameter_iii)
- **Of sorption complex properties** - qualitative and partially quantitative parameter (parameter_iv)

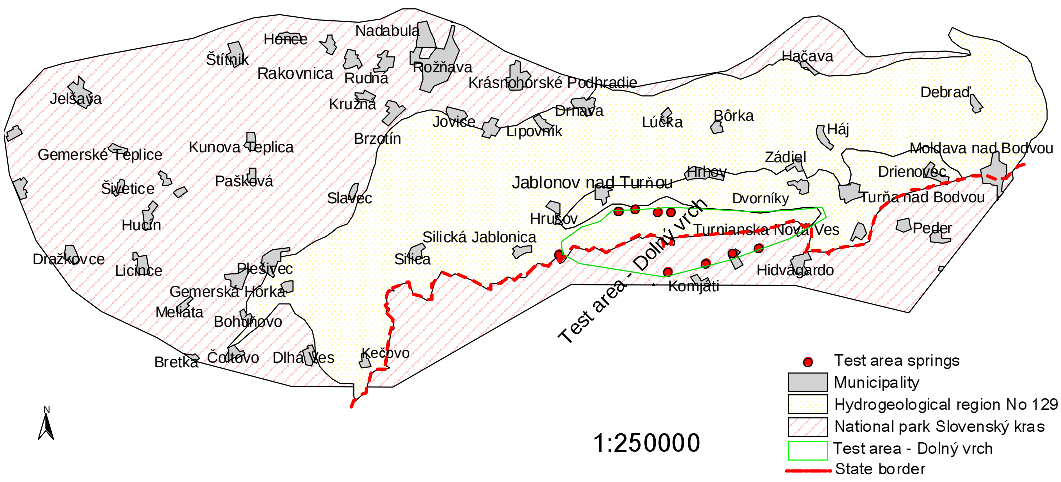
This evaluation is supplemented by the data on ***soil taxonomic unit and subsoils***. Evaluated parameters (as a result of interpretation of basic soil properties) correspond to the recommendations of the European Water Framework Directive 2000/60/EC in the area of groundwater for the evaluation of surface sediments and soils in the frames of groundwater bodies' characterisation

Soil permeability was within the reported territory expressed by the ***parameter of saturated hydraulic conductivity - Ks (cm.hour^{-1}),*** which was calculated for the individual grain size categories by the help of *Rosetta* model and its calibration database. Model *Rosetta* is in hydropedological practice used as a transfer media for the derivation of permeability (hydraulic conductivity) and soil retention from the databases of grain size distribution of soils and supplementary pedophysical properties.

In Hungarian part, there exist only two kinds of soil permeability: permeable and low permeable (see Fig.5.1).

5.1.3 Grounwater flow modeling

Figure 5.2 *Localization of test area*



One of the inputs to vulnerability map assembling is simulated groundwater level. It is result of groundwater flow modeling for hydrogeological structure Dolný vrch in this case. The method of mathematical quasi 3D modeling code TRIWACO (Royal Haskoning, 2002) was used. These programs make possible to obtain the values of the hydrogeological parameters (input of the finite element/difference grid) and outputs of the calculated quantities.

By reason of only particularly groundwater flow of porous rock medium is simulating by the model, it was needs to simulate real conditions. Hydrogeological structure Dolný vrch is encapsulated one. The only structure drainage is the springs situated on both sides of state border.

Than input data for simulation were applied as follows:

- Effective rainfall [md^{-1}]
- Index of permeability [md^{-1}]

- Base of aquifer [m.a.s.l]
- Top of aquifer [m.a.s.l]

The results - e.g. simulated values of groundwater levels were verified by spring discharges.

Springs used for simulation of groundwater levels and flow direction (from Hungary: Vecsem, Pasnyag 1, 2, Kastelykerti, Tapolca and from Slovakia: Jarček, Köszörű 1, 2, Tapolca, Žmaň) , computed groundwater levels and groundwater flow direction are displayed in the next pictures:

Figure 5.3 *Simulatedgroundwater levels*

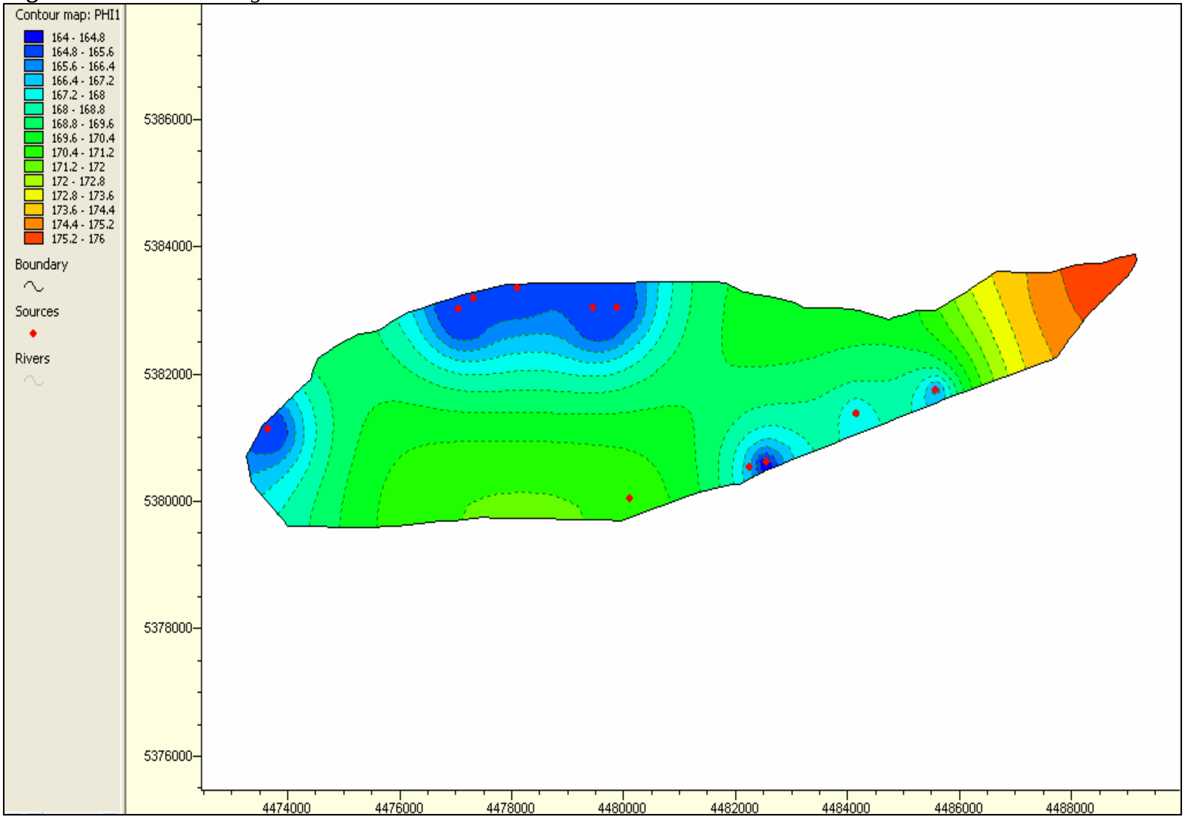
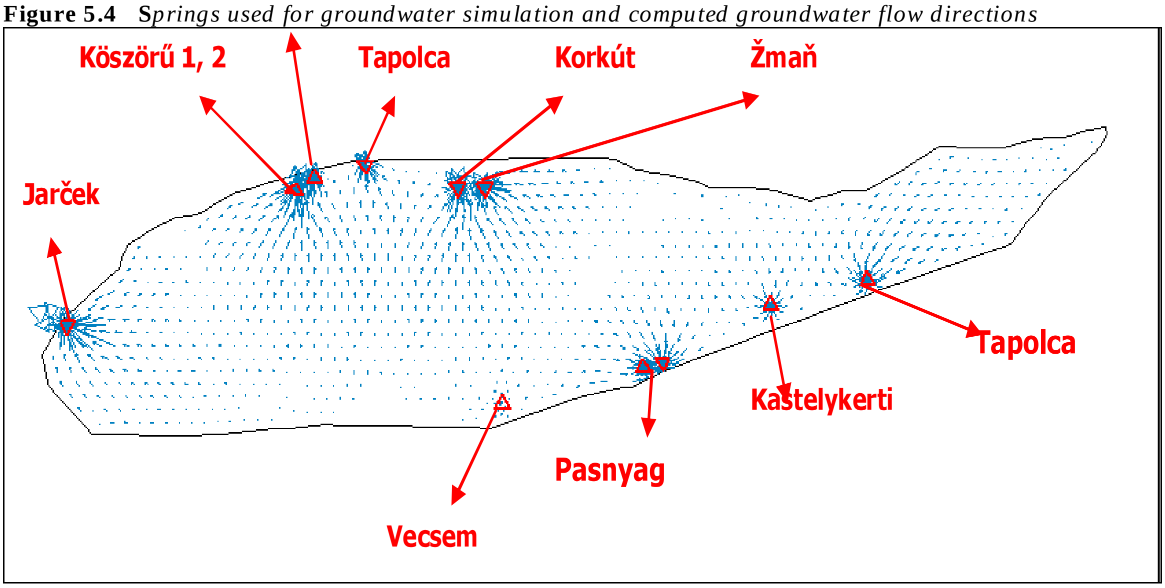


Figure 5.4 *Springs used for groundwater simulation and computed groundwater flow directions*



5.2 Vulnerability

5.2.1 Groundwater Vulnerability Assessment of the Dolný vrch Structure

5.2.1.1 Background of the concept and definitions of vulnerability for groundwater studies

The term ‘vulnerability of groundwater to contamination’ was introduced by Margat (1968). However, the term ‘vulnerability’ is not restricted to groundwater but is used in a wide sense to describe the sensitivity of whatever to any kind of stress, e.g. the vulnerability of global climate to human impacts. As this report deals with the vulnerability of groundwater to contamination, the term is always used in that sense.

The concept of groundwater vulnerability is based on the assumption that the physical environment provides some natural protection to groundwater against human impacts, especially with regard to contaminants entering the subsurface environment (Vrba & Zaporozec 1994). The term „vulnerability to contamination“ has the opposite meaning to the term „natural protection against contamination“ and the terms can be used alternatively. Vrba & Zaporozec (1994) emphasize that vulnerability is a relative, non-measurable and dimensionless property. They suggest distinguishing between intrinsic (natural) and specific vulnerability. The former should only depend on the natural properties of an area, while the latter should additionally take into account the properties of the contaminant. COST 65 (1995) presents an overview on the various definitions of vulnerability that have been proposed until present. Most of them are quite similar. The most recent definitions of groundwater vulnerability were drawn by a group of hydrogeology experts from 17 EU states, grouped in a “COST Action 620” (2004), after long discussions this issue and consequently proposes the following definitions:

- The intrinsic vulnerability of groundwater to contaminants takes into account the geological, hydrological and hydrogeological characteristics of an area, but is independent of the nature of the contaminants and the contamination scenario.
- The specific vulnerability takes into account the properties of a particular contaminant or group of contaminants in addition to the intrinsic vulnerability of the area.

The advantage of such qualitative and descriptive definitions is: that the term ‘vulnerability’ is often intuitively understood, particularly by decision-makers in the planning process.

A quantitative point of view of the concept of groundwater vulnerability – the needs and advantages of a physically based definition

As previously mentioned, vulnerability is often considered as a qualitative, non-measurable notion than as a quantitative property. Up to now, so many methods for vulnerability assessment were developed, relying on counting of rating points for various parameters. This allows for some flexibility in the vulnerability assessment, while providing results, which are easily understood also by non-scientists. However, the lack of a physically based precise definition also has some drawbacks. Vulnerability assessments are often subjective. If different methods are tested in one area, the resulting maps are often different and sometimes contradictory. The results are difficult to compare and, more fundamentally, to validate. Many of groundwater vulnerability maps were contradictory, as they may overestimate or underestimate ranking of some natural features. Consequently, there is a need for an examination of vulnerability concepts from a quantitative point of view, and for the establishment of clearly identified reference criteria for quantification, comparison and validation purposes.

5.2.2 Groundwater vulnerability mapping

Groundwater vulnerability maps were already constructed for many areas, but as various methods of construction were used (DRASTIC, EPIK, REKS), different degrees of groundwater vulnerability in different regions cannot be compared. Also due to different traditions, different datasets available and different approaches used in individual countries, groundwater vulnerability maps often seem to show inconsistencies on the country borders. One of the aims to overcome this is to use common approach based on dataset possibilities connected to the majority of European countries. This was the aim of the COST 620 Action, sponsored by the European Commission that unified many European hydrogeologists to elaborate an interoperable system of groundwater vulnerability evaluation and mapping.

Multilateral project of European Hydrogeologists – COST Action 620 “Vulnerability and risk mapping for the protection of carbonate (karst) aquifers“ – stared its activity in 1997 as a scientific programme supported by the European Commission, with the ambition to elaborate common, generally consistent methodology of groundwater vulnerability assessment in karstic areas. COST action 620 finished in 2003 by final report, and the elaborated product can be called a "European approach" more than a methodology. For groundwater vulnerability assessment according to the "European Approach", an origin-pathway-target conceptual model was used. The possible contamination event is assumed to originate at the land surface. For resource protection, the groundwater surface in the aquifer is the target, for source protection, the spring or well is the target. The pathway consequently consists of the passage through the overlying layers for resource protection, and includes the passage through the aquifer for source protection. The main factors for the vulnerability assessment are the Precipitation regime (**P**), the Overlying layers (**O**), the lateral Concentration of flow (**C**) and the Karst network development (**K**). This approach can be applied not only to the karst rock media, but – taking into account the "flow concentration factor" – also to all kinds of rock environments. Schematic diagram of the origin-pathway-target conceptual model, used for groundwater vulnerability assessment according to the "European Approach", is depicted on Fig. 4.4. Schematic influence of individual vulnerability factors of the "European Approach" (O; C; K; P) is then shown on Fig. 5.5. The possible contamination event is assumed to originate at the land surface. For resource protection, the groundwater surface in the aquifer is the target, for source protection, the spring or well is the target. The pathway consequently consists of the passage through the overlying layers for resource protection, and includes the passage through the aquifer for source protection. The main factors for the vulnerability assessment are the Precipitation regime, the Overlying layers, the lateral Concentration of flow and the Karst network development..

Fig. 5.5 *Schematic diagram of the origin-pathway-target conceptual model used for groundwater vulnerability assessment according to the "European Approach". The possible contamination event is assumed to originate at the land surface. For resource protection, the groundwater surface in the aquifer is the target, for source protection, the spring or well is the target.*

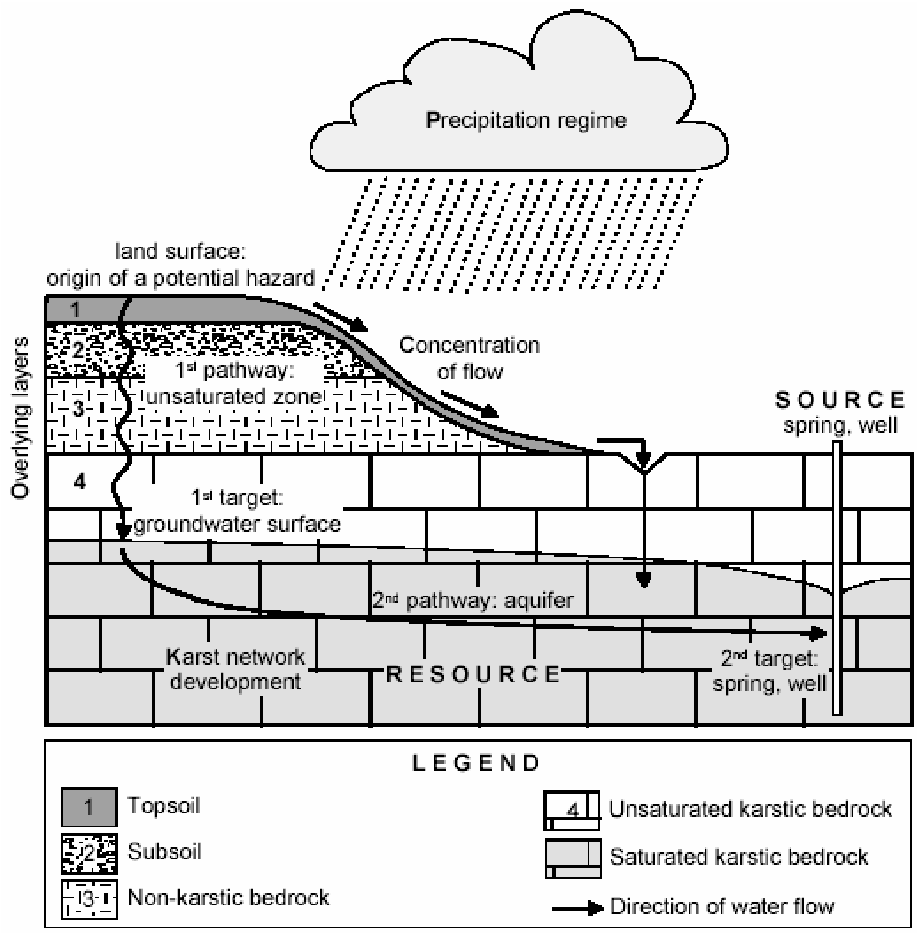
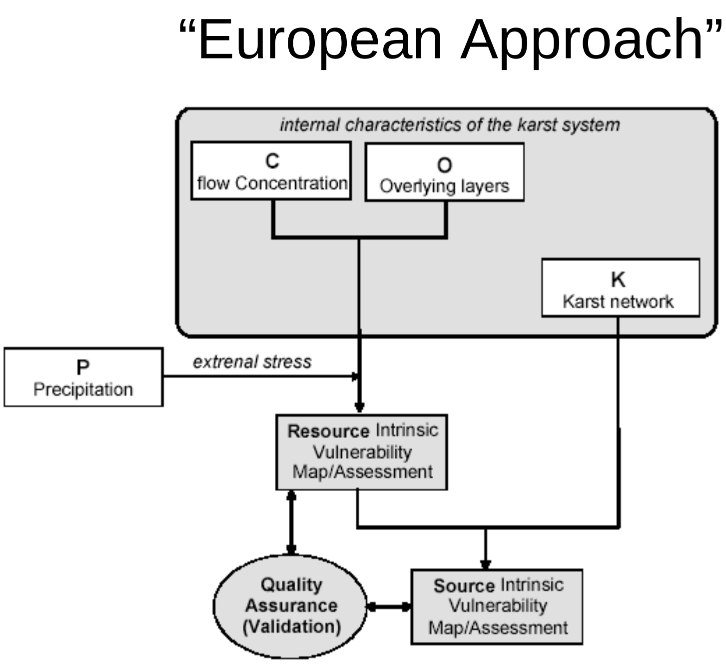


Fig. 5.6 *Schematic influence of individual vulnerability factors of the "European Approach" (O; C; K; P). Groundwater vulnerability assessment is based on an origin-pathway-target conceptual model. The possible contamination event is assumed to originate at the land surface. For resource protection, the groundwater surface in the aquifer is the target, for source protection, the spring or well is the target. The pathway consequently consists of the passage through the overlying layers for resource protection, and includes the passage through the aquifer for source protection. The main factors for the vulnerability assessment are the Precipitation regime, the Overlying layers, the lateral Concentration of flow and the Karst network development.*



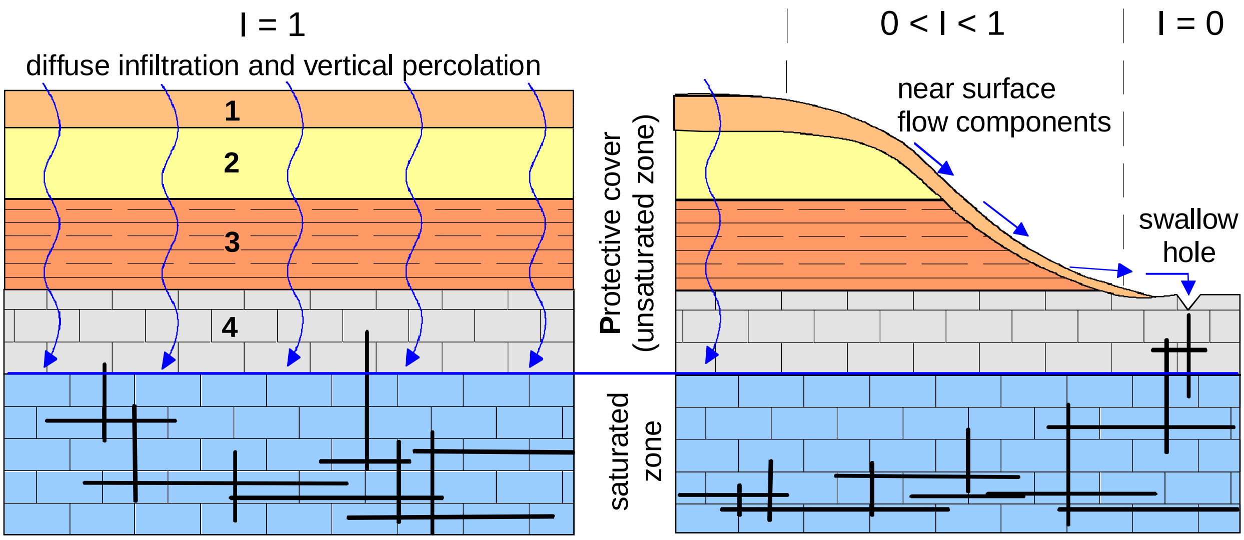
To obtain groundwater vulnerability map of the Dolný vrch / Alsóhegy test area, the equivalent datasets related to the COST 620 "European Approach" were required. From the main original factors for the vulnerability assessment – the Precipitation regime (**P**), the Overlying layers (**O**), the lateral Concentration of flow (**C**) and the Karst network development (**K**) – the first and the last one could be omitted. The precipitation regime (**P**) should be considered mostly in large-scale projects, where substantial differences between precipitation regimes can appear (Mediterranean type / humid type of climatic conditions, e.g.). On an area of several tens of square kilometres, like Dolný vrch / Alsóhegy hydrogeological structure is, the differences between precipitation regime are negligible and this factor can be treated as homogenous for the whole area.

As the aim was to produce an intrinsic groundwater resource vulnerability map, i.e. the vulnerability concept where the target is the groundwater table, the role of different degrees of karstification within the structure is out of interest, as its function starts only in the process of conducting possible pollution less or more quickly towards the groundwater sources. In other words, karst network development (**K**) plays role only in assessing vulnerability of groundwater sources.

The remaining factors, responsible for the final values of groundwater vulnerability – the Overlying layers (**O**) and the lateral Concentration of flow (**C**) – were treated according to datasets available. The major problem was the estimation of the function of overlying layers (**O**) on the places where no real measured information on the level of groundwater table within the Dolný vrch / Alsóhegy hydrogeological structure was available. The only solution was to estimate the unsaturated zone thickness from the results of groundwater modelling process. The description of soil properties and geological settings was relatively available to give the qualitative member of the **O**–factor calculation member.

To assess groundwater vulnerability of Dolný vrch / Alsóhegy, the PI method (Goldscheider et al. 2000) was used. In this method, the overlaying layers factor (**O**) is included in the **P**-factor and **I**-factor is almost identical to the flow concentration (**C**) factor. Moreover, as it was mentioned, the karstification factor **K** can be omitted in resource vulnerability assessment, and having precipitation uniform the selection of two parameters PI method is fairly justifiable. Since the PI method fully conforms to the „European Approach“, the COST 620 group suggests it to be used within its framework.

Fig. 5.7 *Schematic diagram of the applied PI method. The P-factor represents the effectiveness of the protective cover as a function of the thickness and permeability of all the strata between the ground surface and groundwater table (Layers 1 to 4). The I-factor is determined by the degree to which the protective cover is bypassed by surface and near-surface flow.*

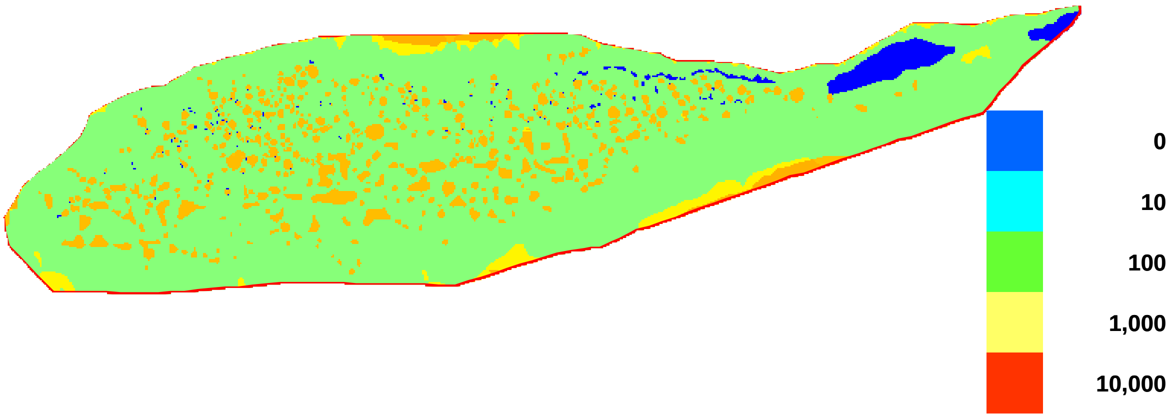


The process of constructing the vulnerability map was divided into three main steps: determination of the P- and I-factors, respectively, and combining the two into the resulting vulnerability map.

In the process of the vulnerability assessment, the P-factor is described by so called protective function P_{ts}. The total protective function P_{ts} is compounded by partial protective functions of topsoil, subsoil and bedrock, multiplied by recharge. The protective function of bedrock itself is the product of its lithology and degree of fracturing.

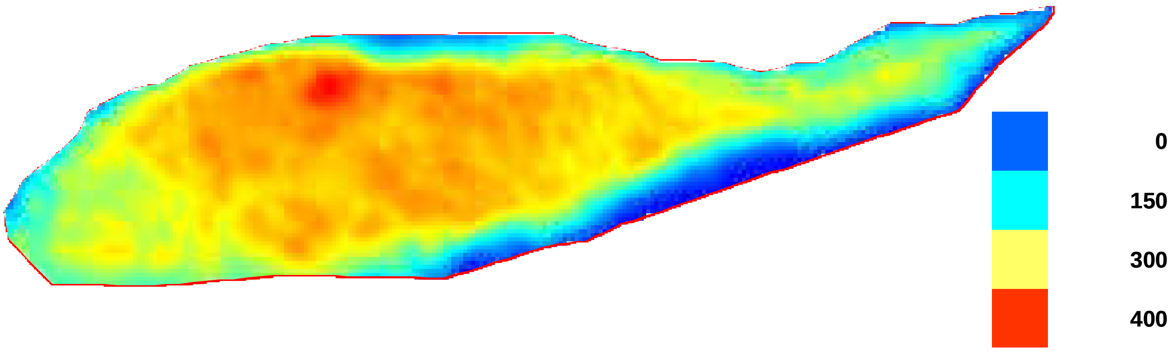
The P-factor was solved individually for topsoil, subsoil and bedrock. Soil maps and CORINE land cover map were used to evaluate the total protective function of topsoil and subsoil (Fig. 5.8)

Fig. 5.8 *Map of the total protective function of topsoil and subsoil.*



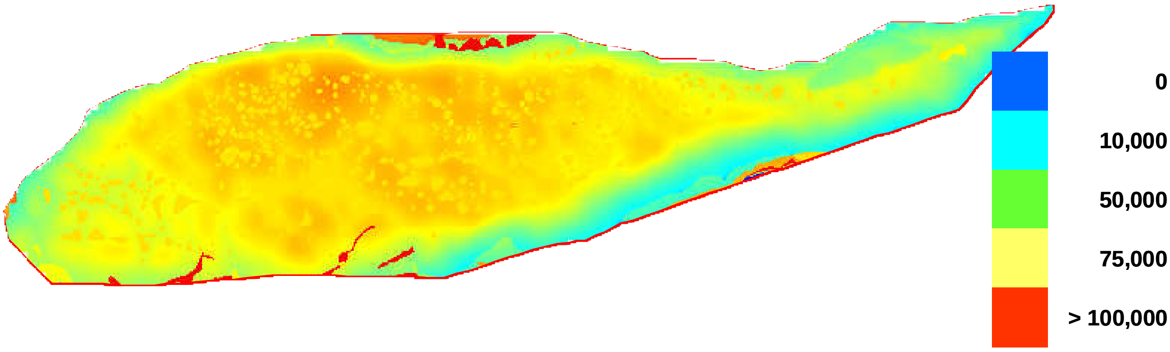
The protective function of bedrock is directly dependent on the thickness of the unsaturated zone and geology. The unsaturated zone thickness was assessed with help of the aforementioned groundwater model, when modeled groundwater table was subtracted from surface elevation (Fig. 5.9).

Fig. 5.9 *Map of the unsaturated zone thickness [m].*



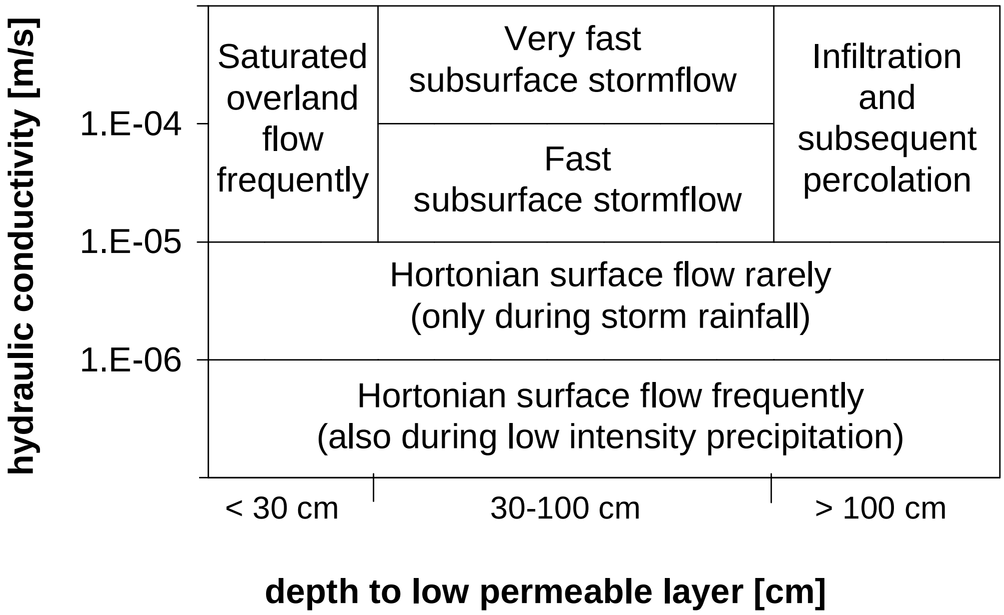
Subsequently this map was combined with geological map that lead to evaluation of the bedrock's protective function. The total protective function P_{ts} was then calculated as a combination of partial scores of topsoil, subsoil and bedrock, multiplied by recharge (Fig. 5.10). The resulting P_{ts} is generally very low due to the enormous thickness of non-saturated limestones.

Fig. 5.10 *Map of the total protective function Pts.*



Next work was dedicated to determination of the I-factor, which is evaluated by estimating direct infiltration relative to surface and lateral near-surface flow. The amount of surface and near-surface flow is directly dependent on rainfall intensity and site properties, with soil properties, slope and vegetation as the controlling factors. The predominant flow processes is a function of saturated hydraulic conductivity and low permeability layers within or below the soil (Goldscheider et al. 2000).

Fig. 5.11 *Determination of the predominant flow process as a function of the saturated hydraulic conductivity and the depth to low permeability layers (Goldscheider et al. 2000).*



The I-factor map was constructed by a procedure recommended by Goldscheider et al. 2000, schematically described on Fig. 5.12.

Fig. 5.12 *The procedure of I-factor evaluation. The process comprises determination of the soil properties (based on soil and geological maps), which combines with slope and land use maps to produce intermediate /'-factor map. The final I-map is created after overlaying the /'-factor map with surface catchment map (Goldscheider et al. 2000).*

1st Step: Determination of the soil properties

Saturated hydraulic conductivity [m/s]		Depth to low permeable layer < 30 cm	30-100 cm	> 100 cm
	$> 10^{-4}$	Type D	Type C	Type A
	10^{-5}-10^{-4}		Type B	
	10^{-6}-10^{-5}	Type E		
	$< 10^{-6}$	Type F		

2nd Step: Determination of the I'-factor

Landuse: Forest			
Soil properties	Slope < 3.5 %	3.5 - 27 %	> 27 %
Type A	1.0	1.0	1.0
Type B	1.0	0.8	0.6
Type C	1.0	0.6	0.4
Type D	0.8	0.6	0.4
Type E	1.0	0.6	0.4
Type F	0.8	0.4	0.2

Landuse: Field/Meadow/Pasture			
Soil properties	Slope < 3.5 %	3.5 - 27 %	> 27 %
Type A	1.0	1.0	0.8
Type B	1.0	0.6	0.4
Type C	1.0	0.4	0.2
Type D	0.6	0.4	0.2
Type E	0.8	0.4	0.2
Type F	0.6	0.2	0.0

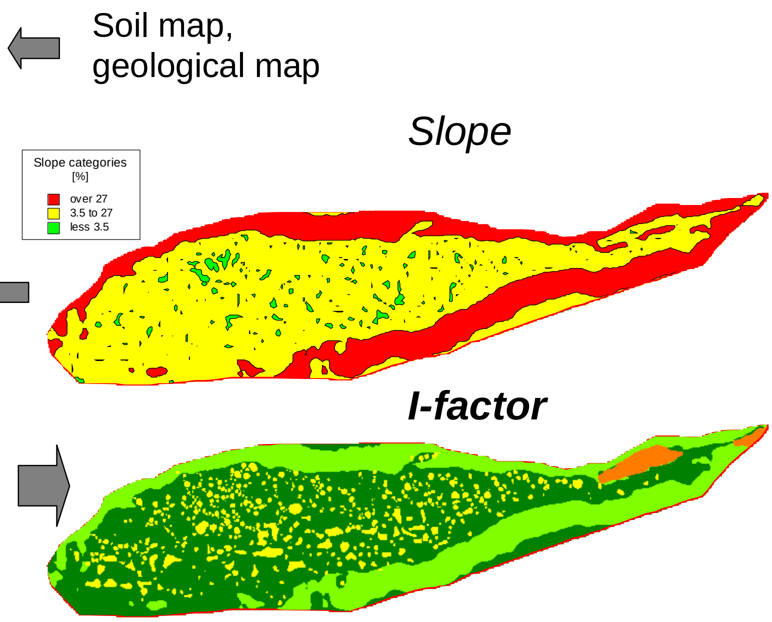
Settlements: I' = 0.8

3d Step: Determination of the I-factor

Surface Catchment Map	I'-factor 0.0	0.2	0.4	0.6	0.8	1.0
swallow hole, sinking stream, 10 m buffer	0.0	0.0	0.0	0.0	0.0	0.0
100 m buffer	0.0	0.2	0.4	0.6	0.8	1.0
catchment of sinking stream	0.2	0.4	0.6	0.8	1.0	1.0
rest of the area	0.4	0.6	0.8	1.0	1.0	1.0

↓

I-map



Finally the P-map was simply overlaid by the I-map, that produced the vulnerability map (Fig. 5.13). The resulting vulnerability score is overwhelmed by the very high protective function of the unsaturated zone. Absence of sinking streams enables the protective function of soils and geological layers to remain high all-over the area.

Figure 5.13 *Groundwater vulnerability map of the Dolný vrch / Alsóhegy test area*

6. SUMMARY OF GROUNDWATER RELATED ENVIRONMENTAL LEGISLATION

6.1 Introduction

Groundwaters are natural resources of outstanding importance in Hungary and Slovakia. More than 97 of drinking water are supplied from groundwaters. Springs and wells fill up the swimming pools in the numerous thermal and medicinal baths. Groundwaters are utilized in the industry and for irrigation as well however to a smaller extent and no extension is justified. Nevertheless the significance of groundwaters is high in terms of natural vegetation and agriculture as well: for the optimal water supply of vegetation an appropriate depth of groundwater table is essential. There are several nature conservation areas of special importance where the wetness migrating upwards from the deeper horizons is providing the sine qua non for special ecosystems. Captured or non-captured natural springs may represent special natural values as well. Spring water or groundwater infiltrating into riverbeds ensure that several small watercourses do not dry up in seasons without precipitation.

Climate changes, human interventions, overuse of the resources and the various pollution sources are causing several problems in groundwater management and protection. In both countries groundwater is owned by the state; at the same time municipalities responsible for water supply, water users, those who perform activities generating pressure on or polluting the environment and after all individual citizens all have their tasks in the preservation of the good quantitative and qualitative status of groundwaters.

Groundwater should be protected not only in itself but also as a part of the system of environmental elements. From this point of view the protection of the geological medium, especially that of soil is of outstanding importance. The legislation takes this into account as one of the firsts in international aspect as well.

The manifold utilization of freshwater resources and among them that of groundwaters without deteriorating their good status is one of the worldwide accepted objectives of sustainable development and is recommended by international organizations. The Water Framework Directive of the European Union confirms this approach as well. The water and environmental legislation regulate the utilization and protection of groundwaters in the same spirit.

Appropriate information is essential for the national environmental, water, geological, public health and educational organizations responsible for groundwaters, as well as for local governments, researchers, consultants, operators, and all citizens in their own domains to share a uniform approach in the utilization and protection of groundwater resources in conformity with the environmental objectives and public welfare.

6.2 Hungarian republic

6.2.1 Major Hungarian legislation concerning groundwater

1/a Definitions of limit values in the Gov. Decree No. 219/2004. (VII. 21.) Korm.

1/b List of pollutants (Annex 1 to the Gov. Decree No. 219/2004. (VII. 21.) Korm.)

1/c Classification of areas sensitive in terms of groundwater status (Annex 2 to the Gov. Decree No. 219/2004. (VII. 21.) Korm.)

1/d Paragraph (1) of Article 5 of Gov. Decree 27/2006. (II.7.) Korm. on the protection of waters again pollution caused by nitrates form agricultural sources

2 Activities having significant effect on groundwaters or on the protection zones of water resources listed in the Annexes of the Government Decree No. 314/2005. (XII. 25.) Korm. on environmental impact assessment and the unified environmental use permits

3. Limit values according to various regulations

4. KvVM Publications in connection with groundwater

Acts

- Act XLVIII of 1993 on Mining Activities
- Act I of 1994 on the publication of the Treaty between the Member States of the European Union and the Republic of Hungary, concerning the accession of the Republic of Hungary to the European Union signed on December 16, 1991 in Brussels
- Act LV of 1994 on Arable Land
- Act UII of 1995 on the General Rules of Environmental Protection
- Act LVII of 1995 on Water Management
- Act UII of 1996 on Nature Conservation in Hungary

- Act UV of 1996 on the Forests and the Protection thereof
- Act XLIII of 2000 on Waste Management
- Act LXXXIX of 2003 on the Environmental Pressure Fee

Government Decrees

- Government Decree No. 38/1995 (IV. 5.) Korm. on the Public Drinking Water Supply and Public Sewerage
- Government Decree No. 72/1996 (Y. 22.) Korm. on implementation of authority powers in water management
- Government Decree No. 123/1997 (VII.18.) Korm. on the protection of the actual and perspective sources and the engineering facilities of drinking water supply
- Government Decree No. 132/1997. (VII.24.) Korm. on the tasks in connection with the elimination of accidental water pollution
- Government Decree No.203/1998. (XII. 19.) Korm. on the execution of the Act XLVIII of 1993 on mining activities
- Government Decree No. 74/2000. (V.31.) Korm. on the announcement of the Convention on the Protection and Sustainable Use of the Danube River done in Sofia on the 29th June 1994
- Government Decree No. 239/2000 (XII: 23.) Korm. on the rights and obligations linked to the utilisation of pit pools.
- Government Decree No. 50/2001 (IV. 3.) Korm. on the rules of use and handling of waste waters and sludge in agriculture
- Government Decree No. 201/2001 (X. 25.) Korm. on the quality requirements of drinking water and the order of supervision thereof
- Government Decree No. 219/2004. (VII. 21.) Korm. on the protection of groundwater
- Government Decree No. 220/2004. (VII. 21.) Korm. on the protection of surface water quality
- Government Decree No. 221/2004. (VII. 21.) Korm. on certain rules of river basin management
- The Government Decree No. 314/2005. (XII. 25.) Korm. on environmental impact assessment and the unified environmental use permits

- Government Decree No. 27/2006. (II. 7.) Korm. on the protection of waters against pollution caused by nitrates of agricultural sources

Decrees of ministers

- Decree No. 18/1992 (VII. 4.) KHVM of the Minister of Transport, Communication and Water Management on the requirements of the operation of public water facilities
- Decree No. 18/1996 (VI. 13.) KHVM of the Minister of Transport, Communication and Water Management on the application for a water permit and the annexes thereof
- Joint Decree No. 4/1997. (III.5) IKIM-KTM-KHVM of the Minister of Industry and Commerce, Minister of Environmental Protection and Regional Development and the Minister of Transport, Communication and Water Management on the set of data originating from geological explorations to be transmitted to the Hungarian Geological Service, and on the order of communication thereof
- Decree No. 29/1997 /IV. 30) FM of the Minister of Agriculture on the execution of the Act on the Protection of Forests
- Decree No. 22/1998. (XI.6.) KHVM of the Minister of Transport, Communication and Water Management on the hydrographical activities of the water organisation
- Decree No. 11/1999 (III.11.) KHVM of the Minister of Transport, Communication and Water Management on the appropriation of the Water Earmarked Financial Facility
- Decree No. 43/1999 (XII.26.) KHVM of the Minister of Transport, Communication and Water Management on the calculation of water resources fee
- Decree No. 74/1999 (XII. 25.) EüM of the Minister of Public Health on the natural medicinal factors
- Joint Decree No. 10/2000 (VI. 2.) KöM-EüM-FVM-KHVM of the Minister of Environment, Minister of Public Health, Minister of Agriculture and Regional Development and the Minister of Transport, Communication and Water Management on the limit values required to the quality protection of groundwater and the geological media
- Decree 21/2002. (IV. 25.) KöViM of the Minister of Transport and Water Management on the operation of public water supplies
- Decree 27/2004. (XII. 25.) KvVM of the Minister of Environment and Water on classification of settlements located in sensitive areas in terms of groundwater status

- Decree 28/2004. (XII. 25.) KvVM of the Minister of Environment and Water on the limit values of water pollutants and certain rules of the application thereof
- Decree 30/2004. (XII. 30.) KvVM of the Minister of Environment and Water on rules for the investigation of groundwaters
- Joint Decree 65/2004. (IV. 24.) FVM-EszCsM-GKM on the rules of bottling and marketing of natural mineral water, spring water, drinking water, drinking waters with enriched mineral content and flavoured water
- Decree 14/2005. (III. 28.) KvVM of the Minister of Environment and Water on the rules of screening investigations to be carried out in the course of remedial site investigation
- Decree 27/2005. (XII. 6.) KvVM of the Minister of Environment and Water on the detailed rules of the control of used and waste water emissions

Instructions, Directives

- Joint Instruction No. 8001/2000 (Kö. Vi. Ért. 5.) KöViM-KöM of the Minister of Transport and Water Management and the Minister of Environment on the perspective sources of drinking; water supply
- Instruction No. 8001/2002 (K. Ért. 2.) KöM of the Minister of Environment on the modification of the Instruction No. 8001/2002 (K. Ért. 6.) publishing the data-sheet specified by the Government Decree No. 33/2000 (III. 17.) Korm.
- Instruction No. 8001/2005 (MK 138.) KvVM of the Minister of Environment and Water on the register of open karsts in external areas
- Instruction No. 8/1970 (V. E. 6.) OVH of the National Water Authority on the publication of the operational regulations of geothermal wells (geothermal installations)
- Directive No. 2/1971 (V.18.) OVH of the National Water Authority on the obligatory periodical instrument testing and maintenance of geothermal wells

In addition to the WFD the following two directives are of outstanding importance terms of groundwater protection:

- the so-called Groundwater Protection Directive (80/68/EEC).

- (Its Hungarian adaptation is the Government Decree No. 219/2004. (VII. 21.) Korm. on the protection of groundwater); and
- the so called Nitrate Directive (96/676/EEC) (The Hungarian adaptation is the Government No. 27/2006. (II. 07) Korm.).

The Council Directive 80/68/EEC deals with the protection of groundwater against pollution caused by certain dangerous substances. It classifies dangerous substances into List I and List II depending on the level of danger caused by the relevant substances.

6.3 Slovak republic

6.3.1 Major Slovak legislation concerning groundwater

Act No. 364/2004 Coll. on Water Sources, changing and amending some laws (Water Act). The new Water Act (entered into force on July 1st 2004) relates to all forms of water bodies, water protection, rights to waters and their recording, water constructions and rights and duties to plots directly connected with waters. Legal institutions, that have a long-term tradition in Slovakia and are connected with water handling, are included in the new Water Act.

Regulation of the Ministry of Environment No. 221/2005 Coll., which provides details about survey of occurrence and state of surface water and groundwater assessment, about monitoring, water balance.

Regulation of the Ministry of Environment No. 151/2004 Coll. on Drinking Water Requirements and Drinking Water Quality Control. Regulation defines allowable concentrations of chemical substances in drinking water.

Regulation of the Ministry of Environment No. 442/2002 Coll. on water-supply and public sewerage system, in accordance with Act No. 276/ 2001 Coll. about changes and completing of. Network branches control.

Regulation of the Ministry of Agricultural No. 392/2004 Coll., which provides Agricultural activities program in, assigned vulnerably regions.

Governmental order No. 617/2004 Coll., which provides the sensitive areas and vulnerable areas.

7. THE WATER MANAGEMENT ANALYSIS IN VIEW OF THE EC- WATER FRAMEWORK DIRECTIVE

The Water Framework Directive of EU (Directive of the European Parliament and of the Council 2000/60/EC of 23 October 2000 establishing a framework for community action in the field protection of water.

The objective of the Directive is to establish a framework for the protection of waters, among them for the protection of groundwaters, which a. o.

"Prevents further deterioration and protects and enhances the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic environment";

"Promotes sustainable water use based on a long-term protection of available water resources";

"Aims at enhanced protection and improvement of the aquatic environment inter alias through specific measures for the progressive reduction of discharges, emissions and losses of priority substances and the cessation or phasing-out of discharges, emissions and losses of the priority hazardous substances';

"Ensures the progressive reduction of pollution of groundwater and prevents its further pollution".

The Directive applies basically the river basin approach. However it should be taken into account that the borders of river basins (catchment areas) are adjusted to surface waters, so they do not coincide completely with those of groundwaters, and that the national borders (among them the borders of EU) are frequently crossing the natural catchment areas. The Directive lays emphasis on the control of transboundary groundwater resources as well.

The Directive prescribes the setting of environmental objectives relating to groundwaters as well. The main issue is to maintain the balance of withdrawal and recharge and to prevent or reverse the deterioration of the qualitative status of groundwaters:

- In terms of quantity groundwater is in good status if changes water level changes of anthropogenic origin do not cause alterations in surface waters influencing terrestrial ecosystems and when they do not cause changes in the flow direction thus leading to the deterioration of water quality,

- Groundwater is in good chemical status if the concentrations of pollutants do not exceed limit values on quality applicable under the relevant Community legislation and they do not result in any significant damage to terrestrial ecosystems directly or indirectly (through associated surface waters) dependent on groundwaters and if no spreading of any pollution can be demonstrated.

To the implementation of the environmental objectives the Directive prescribes deadlines to be strictly kept, which may be postponed to a limited extent only. The aim is the "good" chemical and ecological status of surface waters and the "good" quantitative and chemical status of groundwater waters.

The provisions should not be considered violated if they could not be implemented because of unforeseen or exceptional circumstances like droughts in connection with groundwater levels. Impacts should be investigated also in these cases and all possible measures should be taken to restore the original status.

The Directive regulates the monitoring of water status, among those that of groundwater as well. Observations have to be extended over all groundwaters, however monitoring frequency should be increased where the achievement of environmental objectives is doubtful and near the state borders. The primary objective is to provide information for the evaluation of the long-term changes brought about by natural processes and/or anthropogenic activities. The Directive calls for the monitoring in the form of periodic surveys, systematic observations at specific sites and special tests under exceptional circumstances.

The Directive prescribes to register the protected areas (among them those serving the protection of groundwaters) furthermore the identification of all bodies of water used or intended to use for the abstraction of water intended for human consumption providing more than 10 m3 a day or serving the water supply of more than 50 persons. Water bodies providing more than 100 m3 a day has to be monitored.

The Directive prescribes the characterisation of river basins (including also groundwaters). More detailed characterisation is required where the establishment of good status may be difficult. River Basin Management Plans should be prepared and reviewed regularly providing the ways of how to achieve the environmental objectives and the necessary measures. States have to report these and the results to the European Union at regular intervals.

The Directive orders the elaboration of action programme in order to mitigate pressures on and the pollution of waters. With certain exceptions the Directive prohibits all activities involving the direct discharge of polluting substances into groundwaters.

The Directive contains numerous other provisions as well. The implementation of the provisions and measures should be summed up in the River Basin Management Plans covering the area of a river basin and/or the relevant countries. The plans have to be revised every six years.

In both countries the harmonization of the Directive and the implementation of the provisions should be completed by the same deadlines as in the old member-states of the EU. A basic requirement of the implementation of the Directive is the implementation of other directives referred to in the Directive.

ICPDR

The 'International Commission for the Protection of the Danube River (ICPDR)' is an international organization consisting of 13 Contracting Parties and the European Union. Since its establishment in 1998, it has grown into one of the largest and most active international bodies engaged in river basin management in Europe. Its activities relate not only to the Danube River, but also to the tributaries and ground water resources of the entire Danube River Basin. The ultimate goal of the ICPDR is to implement the 'Danube River Protection Convention'. Its mission is to promote and coordinate sustainable and equitable water management, including conservation, and the improvement and rational use of waters for the benefit of the Danube River Basin countries and their people. The ICPDR pursues its mission by making recommendations for the improvement of water quality, developing mechanisms for flood and accident control, agreeing on standards for emissions and by assuring that these measures are reflected in national legislation.

The ICPDR is supported by a Secretariat based in the Vienna International Centre in Vienna, Austria. In 2000, the ICPDR was nominated as the platform for coordinating the development of a 'Danube River Basin Management Plan ' to meet the requirements of the 'EU Water Framework Directive', the main goal of which is to ensure that all EU waters achieve 'good status' by 2015.

ICPDR Tisza Group

At the first ministerial meeting of the ICPDR in 2004, representatives of the five Tisza countries – Ukraine, Romania, Slovakia, Hungary and Serbia -- signed a Memorandum of Understanding `*Towards a River Basin Management Plan for the Tisza river supporting sustainable development of the region*` and agreed to prepare a River Basin Management Plan for the Tisza Sub-river Basin by the end of 2009. As a 'sub-basin' of the Danube River Basin, the Tisza countries are not legally required by the EU to prepare such a plan. However, the EU does encourage detailed programes and management plans for sub-basins. In this way, the development of the 'Tisza River Basin Management Plan' represents a model and pilot project for Europe, especially as it integrates issues related to water quality (e.g. pollution) and water quantity (e.g. floods). The 'Tisza Group' was also created in 2004 to prepare and coordinate all activities related to the preparation of the Tisza River Basin Management Plan. The Tisza Group serves as a platform for strengthening coordination and information exchange among relevant international, regional and national bodies and projects in the Tisza River Basin

Both countries provided Country and ICPDR reports, which are concerned with groundwater status and water managements of country. Development of the Tisza Analysis Report and contribution to the preparation of the Tisza River Basin Management Plan: in the frame of this work package three parts of the analysis report will be prepared (1) Characterization, (2) Water Quality report and the (3) Cross cutting issues. The report will be coordinated via the Tisza Report meetings where the country representatives will be present together with the ICPDR experts and project management and will discuss the report elements. To outline the future steps for the preparation of the Tisza River Basin Management Plan workshop will be organized where the key water management issues for the Tisza River will be discussed.

The Pilot project was been presented on the ICPDR platform.

8. RECOMMENDATION FOR IMPROVEMENT OF MONITORING AND ASSESSMENT

- To extend the common area for the whole groundwater body
- To enlarge the number of the monitored parameters, monitoring of priority substances relevant
- To increase the sampling frequency (4 times a year in a karst area)
- To adapt the timing of pesticides monitoring to the time of their application
- To supplement the monitoring network with monitoring objects catching pollution from the potential point sources of pollution based on the results of the detailed characterisation of the groundwater bodies within the river basin management planning process (WFD)
- To establish monitoring sites on the permanent water courses upstream of the swallow holes (quantity and quality)
- To monitor the groundwater-dependent ecosystems
- To create and maintain a common database on groundwater in the transboundary groundwater body
- To perform joint trace experiments to verify groundwater flow directions
- To maintain and extend groundwater quantity monitoring (spring discharges and groundwater levels especially within karstic structures), with higher frequency (daily measurements at least) and including water temperature data
- To establish and maintain regular groundwater data exchange

9. CONCLUSION

- Such bilateral projects are very useful as different institutions are involved (ministries, hydrometeorological institutes, geological surveys, regional authorities, national parks, environmental protection institutions...)
- Learn definition of the objectives (beyond UN ECE groundwater guidelines) covering the relevant issues such as WFD, vulnerability mapping, risk assessment
- The personal connections, meetings and workshops are essential and cannot be replaced by electronic corresponding
- Common fieldwork are even more recommended
- Outputs of pan-European projects and activities create a good platform for bilateral cooperation
- For the project, to be time-effective, financial support is inevitable
- The most valuable result of such a project is that proper groundwater management can be achieved by using the outputs of the monitoring
- Within the WFD demands the cooperation on transboundary groundwater bodies on status assessment and on environmental objectives and preferably on programme of measures, the cooperation should be extended on every transboundary groundwater body. While this cooperation is managed within the bilateral commission, projects on special problems or tasks are highly recommended (e.g. ENWAT project, thermal spa projects).
- Ongoing INTERREG IIIA project (ENWAT) with similar topic was started in June (September) 2006 on both countries geological surveys (MAFI and ŠGÚDŠ)
- Bilateral projects not only under the EC, but also under Transboundary committee are recommended

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11. ANNEXES

MEMORANDUM OF UNDERSTANDING

ON THE COMMON PARTICIPATION IN THE PILOT PROJECT

FOR THE IMPLEMENTATION OF GUIDELINES ON MONITORING AND ASSESSMENT

IN THE AGGTELEK KARST - SLOVENSKY KRAS AQUIFER

In the framework of the Hungarian-Slovakian Joint Commission on Transboundary Waters there are three subcommittees organized accordingly to the common watersheds (Danube, Tisa / Tisza, Ipeľ / Ipoly) and one for the Water Quality. Moreover there are two expert groups, one for hydrology and one for financial matters. There are regulations both for water quality and quantity data exchange, for flood situations and for the prevention of accidental pollution too.

Within the UN/ECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki 1992), both countries are participating in the Working Group on Monitoring and Assessment. Based on a Memorandum of Understanding a pilot project has been executed since 1996 on the Ipeľ/Ipoly River to test the „Guidelines on Water Quality Monitoring and Assessment of Transboundary Rivers “. The experiences gained from that pilot project have been used in the revision of the above mentioned Guidelines in 1999.

This time both Parties agree to participate in a common pilot project in the Aggtelek Karst - Slovenský Kras aquifer for the implementation of the „Guidelines on Monitoring and Assessment of Transboundary Groundwaters “endorsed by the Meeting of the Parties to the Convention in The Hague, The Netherlands, 23-25 March 2000.

The Aggtelek Karst - Slovenský Kras is a hydrogeological unit divided by the state border between Republic of Hungary and the Slovak Republic. It has been identified by both countries as a common aquifer in the Inventory of Transboundary Groundwaters (compiled in 1999).

The Aggtelek Karst – Slovenský Kras provides groundwater resources of good quality in both countries. The caves of the area are part of the World Heritage Program. While the cooperation on expert level has a long history between the two countries´ scientific institutions, a well - based water resource management in both countries requires liable data from the aquifer as one unit. This goal is to be served by the implementation of the „Guidelines on Monitoring and Assessment of Transboundary Groundwaters “

As the implementation of the Guidelines needs more workload than present regulations, the parties are requiring some financial and scientific support by possible donors too.

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Representative	Representative
of the Government of the Republic	of the Government of the Slovak
of Hungary	Republic

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