Development of ground water regime in the area of the Gabčíkovo Hydroelectric Power Project

IGOR MUCHA, DALIBOR RODÁK, ZOLTÁN HLAVATÝ, ĽUBOMÍR BANSKÝ and KATARÍNA KUČÁROVÁ

GROUND WATER Consulting Ltd., Kolískova 1, 84105 Bratislava, Slovak Republic

Abstract. The interpretation of ground water level and soil moisture changes is, the basis for interpreting biological monitoring and further environmental impact assessment. Interpretation of ground water regime changes can support correct discussion not only of environmental questions but also discussion about political elements. A decrease of the ground water level means changes into the more dry biocoenoses. An increase of ground water level means changes into the more wet biocoenoses. If the criterion is accepted that wet biocoenoses are more valuable, more original and more native in the Danube flood-plain area, that they support higher biodiversity and higher genetic diversity, than it is easy to define areas with negative and positive changes. Changes in ground water levels have an identification role in environmental impact assessment.

The long-term decrease of ground water level negatively influencing natural environment in pre-dam conditions was evident over a large part of the territory. At present, continuous water supply into river branches is guaranteed, areas covered with water are enlarged, water quality in river branches is dramatically improved. The major impact of the Project is the general increase of ground water levels, mainly on the area previously influenced by the long-term ground water decrease, to a position known approximately 30 years ago.

Key words: ground water flow, quality, regime, monitoring, management; Gabčíkovo-Nagymaros Project, ecological aspects, opinions. (11 figs)

Introduction

The impact of Gabčíkovo hydropower structures and realised hydro-technical measures on environment is progressed via changes in the hydrological regime of surface and ground water, through the moisture changes in the zone of aeration, which include the soil horizon with roots, and subsequently through the changes in flora and fauna. The goal of the monitoring is not only to estimate changes after putting the Project and hydraulic measures into operation, but mainly to observe, evaluate, and manage the water regime in such a way that processes lead to improving of the environmental conditions. Hydropower structures have many technical means for managing the surface and ground water regime and thus also large possibilities to influence positively the environment (Fig. 1.).

The impact on biota occurs through changes in ground water level and changes in the soil moisture conditions of the zone of aeration. If there is an increase in ground water level due to the construction of hydropower structures, than there is also an increase of moisture in the zone of aeration, or occasionally the moisture may remain unchanged at some depths, but there is in no case a decrease in the moisture caused by the engineering works. Reciprocally the same is valid. If there is a decrease in the ground water level, then there is also a decrease in the soil moisture, or occasionally the moisture may remain unchanged at some depths, but there is in no case an increase in the moisture caused by the engineering works. Monitoring of surface and ground water level changes is decisive for interpreting of biota monitoring data and further for environmental impact assessment. (Fig. 2.).

Gabčíkovo part of the project

Project Gabčíkovo-Nagymaros was not only a joint investment project for the production of energy, but it was designed to serve other objectives as well: the improvement of the navigability of the Danube, flood control and regulation of ice-discharge, and the protection of the natural environment [Judgement, 1997]. As a result of earlier constructions along the Rhine and the Danube, The project has benefited from the experiences encountered during earlier similar constructions along the Rhine and the Danube in relation to the effect of such projects on the environment. Independent experts of the Commission of the European Communities, on November 23, 1992 in their working group report stated: "In the past, the measures taken for navigation constrained the possibilities for the development of the Danube and the flood-plain area. Assuming that navigation will no longer use the main river over a length of 40 km, a unique situation has arisen. Supported by technical measures, the river and flood-plain can develop more naturally".

European Communities tripartite fact-finding mission (October 31, 1992) stated, that "not using the system would have led to considerable financial losses, and that it could have given rise to serious problems for the environment".

Fig. 1. Gabčíkovo part of the Project, technical means for managing surface and ground water regime.

Water management tools

Based on research since 1953, various measures were proposed and realised. Some proposals were realised in the reservoir and in the river arm system of the flood-plain area, with the goal of improving the surface and ground water quality and minimising eventual adverse effects, to improve ecological conditions, living and hygiene conditions, to support regional development. Project has saved the inundation area with its river branches and ecotopes and includes a wide variety of tools for surface and ground water management (Fig. 1.)

Due to the construction of the by pass canal outside of the inundation area, it was anticipated that the natural water regime and discharge in the Danube would change between the Dunakiliti weir and the confluence at Sap. In the old Danube river bed, underwater weirs were designed to maintain the water level at a level corresponding to

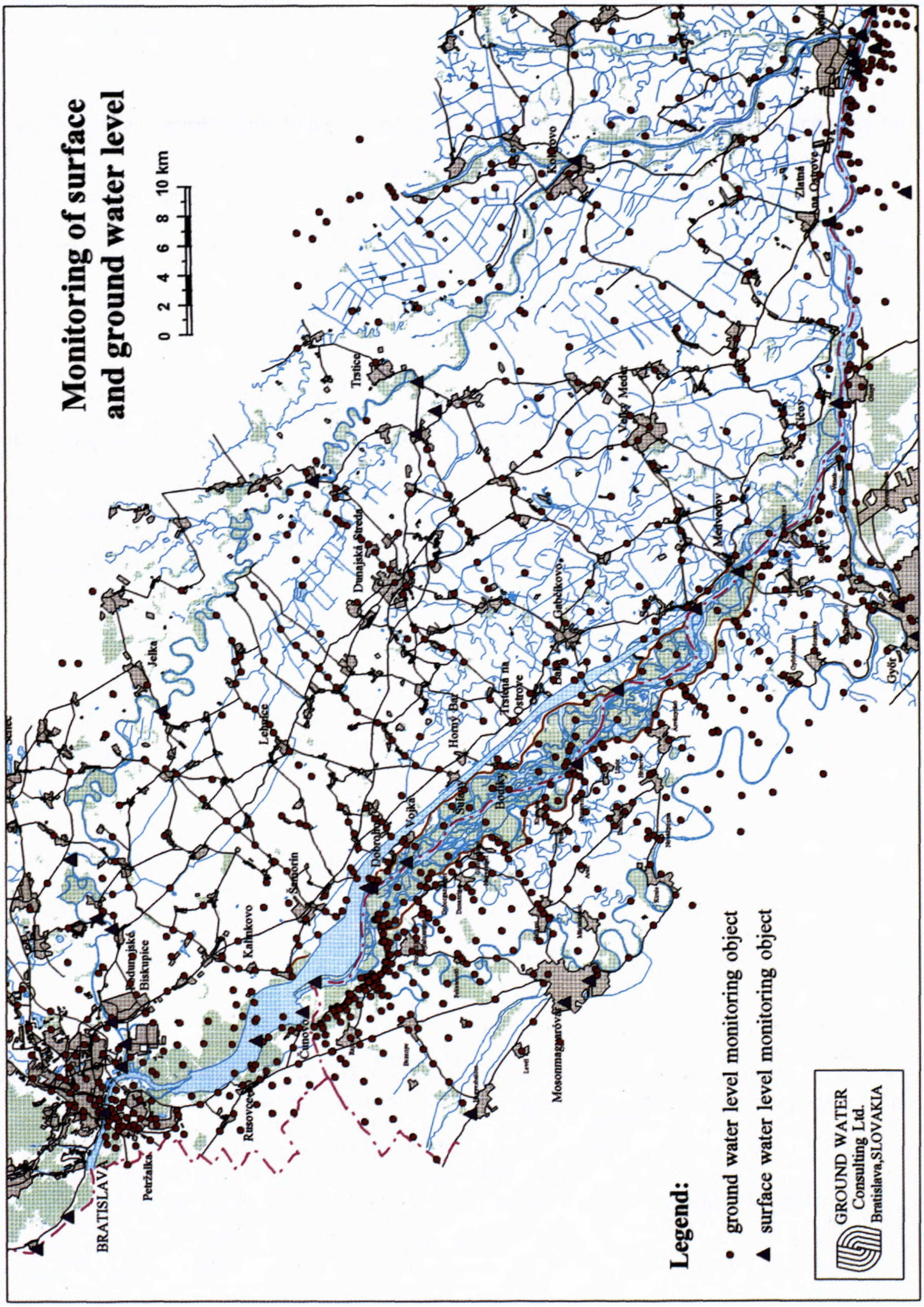

Fig. 2. Monitoring of surface and ground water level.

the low natural water level in the Danube pre-dam conditions. The Danube branches, in both Slovak and Hungarian areas, were adjusted by cascades at several places to maintain optimal water levels to ensure their revitalisation. A continuous water supply into the river branches, similar to natural conditions, was ensured by the construction of intake structures, at Dunakiliti weir on the Hungarian side, and at Dobrohošť on the Slovak side (Fig. 1).

Danube, ground water and geology

The Alpine - Carpathian geological system is a part of the mountainous system of the European Alpides, formed between the Lower Cretaceous and the Neogene times.

The Gabčíkovo project is in the central part of an intra-mountain depression, called in Slovakia the Podunajská nížina (Danubian Lowland). The Danube basin is filled by Late Tertiary and Quaternary fluvial and lacustrine sediments. The thickness of the Danube gravel aquifer ranges from a few metres at Bratislava up to 462 m near Gabčíkovo and goes back to a few metres downstream Sap in the direction towards Komárno.

The important factors in the creation of the aquifer were the existence of the granite threshold between the Alps and the Carpathians in the area of Bratislava and the predominantly andesite hard rocks downstream between Štúrovo/ Estergom and Nagymaros. These are the upstream and downstream geological boundaries and hydrological barriers. Hard rock boundaries and tectonic subsidence of the basin determined the surface slope, Danube water flow velocities and subsequently the development of the so-called Danube Inland Delta, an alluvial fan below the granite threshold at Bratislava, with its typical original morphology, i. e. branching of the Danube´s changing river meanders, coarse sediment accumulation, change in gradient etc. This large alluvial fan represents a highly permeable and extensive aquifer capable of carrying high volumes of ground water. Water from the Danube infiltrates into the fan sediments and flows downward as ground water through the Danubian Lowland nearly in parallel with the Danube River. In the downstream part the river has a small slope, deposits are more fine grained and generally less permeable. Here the ground water flows back into the Danube river via its own river arms, the Danube tributaries and drainage canals (Fig. 3).

Granite and andesite thresholds and the place where the alluvial fan ends, and the river have their slope and speed suddenly dropped (decrease of river gradient from 40 to 10 cm per kilometre) are important places from the point of changes of natural conditions. At this places there have been proposed to situate hydropower projects known as Wolfsthal, Nagymaros, and Gabčíkovo, respectively (Fig. 3.)

Ground water level

Pre-dam development

Before the multiple impoundment in the upper Danube catchment areas, and the embankment and endikement in Austria, Slovakia, and Hungary, the Danube was still a free flowing braided river with a wide flood-plain that extended far beyond the present dikes. Flow velocities may also have been much lover. With the past endikements, especially during the last century, flood peaks became steeper and higher. The original zoning in vegetation toward higher ground and associated forests was largely 'diked' out of the system. Most of the higher, no longer flooded soils behind the dikes, were converted into agricultural lands. The area in between the dikes were consequently flooded more often and river arms flushed and scoured more intensively. Free meandering was limited by the construction of dikes. Interconnections between the river and its branches were limited. The main flow was concentrated in to previously a single river branch, later known as the main Danube. The interaction with the side arms so created became limited. According to the experts of the Commission of the European Communities, (November 23, 1992), flow in almost all river arms existed 17 days per year.

Such activities resulted in the following long term changes:

- Greater water depth and much higher flow velocities in the Danube, mainly in the navigation channel, increased erosion.
- Decrease in the bed-load transport via granite threshold, decrease of river sedimentation and increase of riverbed erosion.
- Disconnection of river branches and side arms with the main river bed and their drying out.
- General decrease of water levels in the Danube.
- General decrease of ground water levels and changes in the ground water flow.

The long-term considerable decrease of ground water level which occurred in the last 30 years (before putting the Gabčíkovo part of the Project into operation) is evident mainly in the upper part of the Danubian Lowland, close to Bratislava (Fig. 4.). The decrease of ground water level over a long time had already negatively influenced natural conditions, mainly in the flood-plain area, and in general had negatively influenced agriculture, forestry and ground water resources.

Present situation

At present continuos water supply into the river branches on both sides of the Danube is guaranteed, areas covered with water are enlarged, and water quality in the river arms is dramatically improved. Conditions in the river branches resemble conditions in the 60's, before heavy fortification of the Danube river banks. Flood-plain area on the Slovak territory, the area between the Danube and protective dikes, was artificially flooded few times since putting the Project into operation according to proposals based on biological monitoring. The major impact of the Project is the general increase of ground water levels, mainly on the area previously influenced by the long term ground water decrease (Fig. 5.). The Joint Slovak-Hungarian monitoring supports the expectation, that after constructing shallow underwater weirs in the Danube a

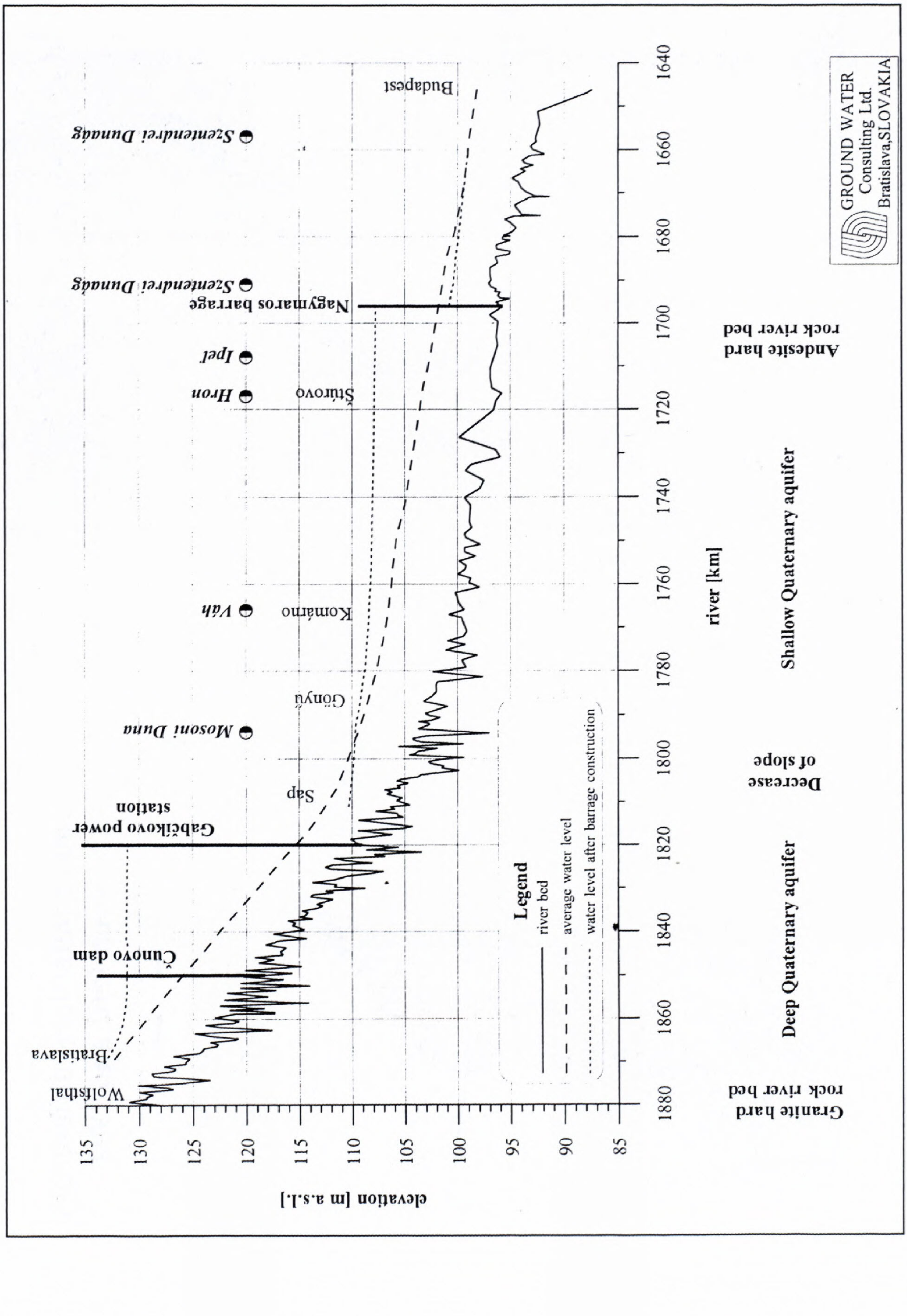

Fig. 3. Longitudinal cross-section of the Danube

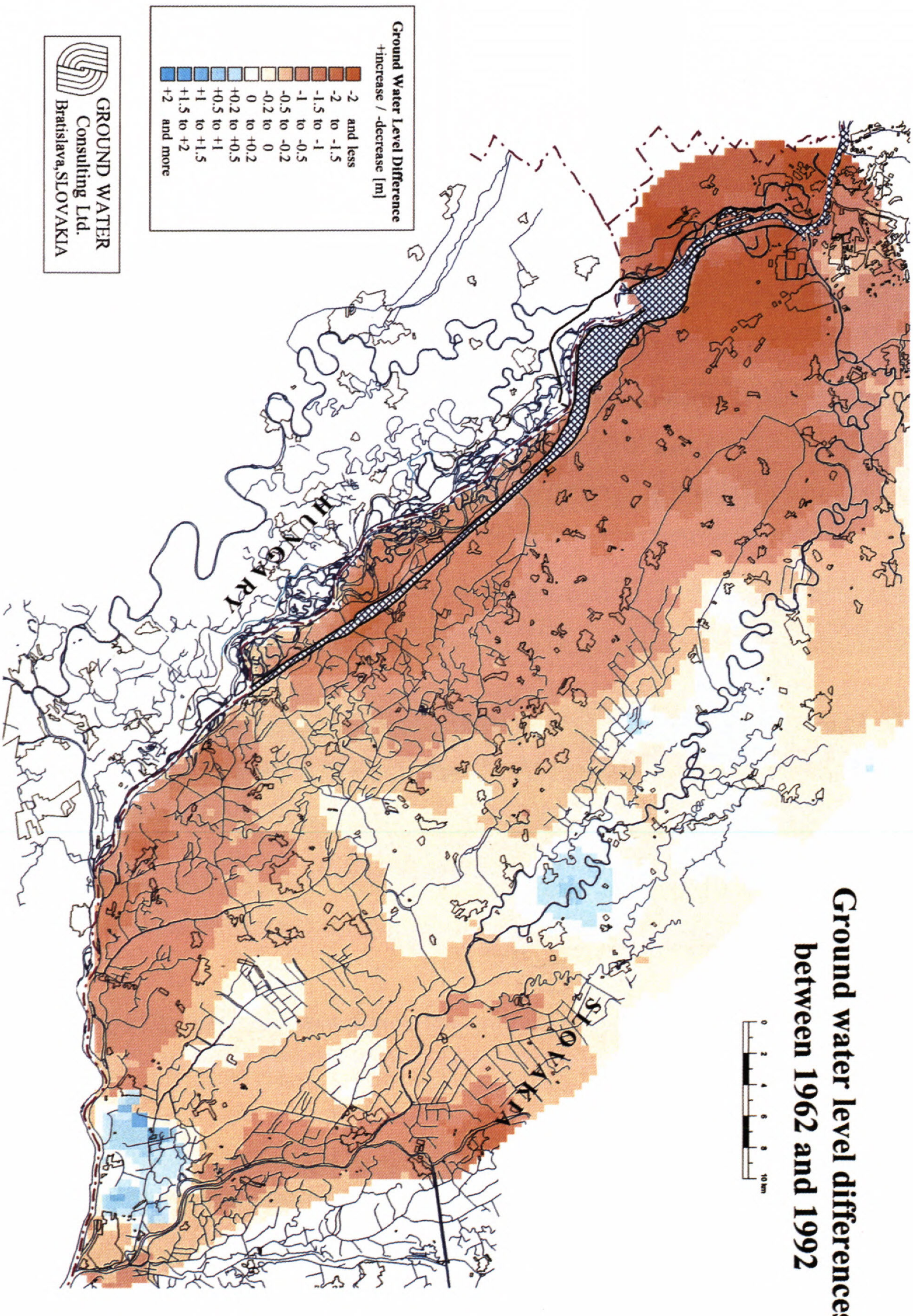

Fig. 4. Decrease of ground water level in the last 30 years before putting Gabčíkovo into operation

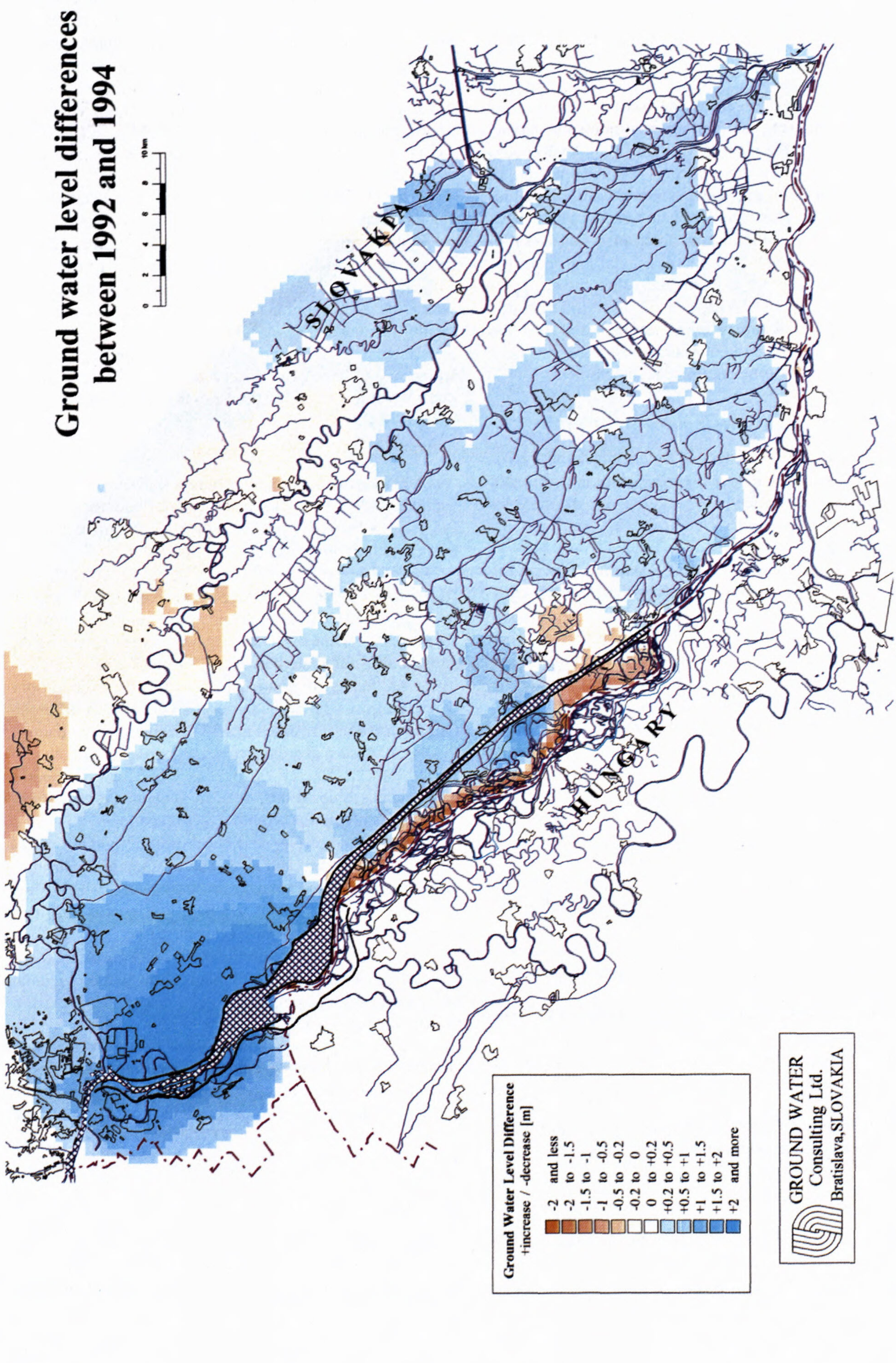

Fig. 5. Increase of ground water level after putting Gabčíkovo structures into operation, 1992-1994

positive impact on ground water will occur also in the strip adjacent to the main Danube. In general, the trend towards the re-establishment of the situation known some 20 - 30 years ago on the prevailing part of the territory is being confirmed.

The interpretation of ground water level and soil moisture changes is, therefore, the basis for interpreting biological monitoring and further environmental impact assessment. A decrease of the ground water level means changes into the more dry biocoenoses. An increase of ground water level means changes into the more wet biocoenoses. For this reason soil moisture changes have been studied (Fig. 6). If the criterion is accepted that wet biocoenoses are more valuable, more original and more native in the Danube flood-plain area, that they support higher biodiversity and higher genetic diversity, than it is very easy to define areas with negative and positive changes. Changes in ground water levels have an identification role in environmental impact assessment.

Water quality

Water quality is characterised by chemical and hydrobiological composition. Apart from natural processes water quality is influenced by pollution, for example by nitrates, sulphates, organic chemicals etc. from agriculture, industry.

Because the ground water of the Danubian Lowland is recharged from the Danube, water quality and the river bottom sediments have the most important role. Reduction and oxidation processes are the most important processes for ground water quality. Redox reaction may often control the water quality and the migration of toxic organic and inorganic wastes in the river sediments, in the aquifer and in the ground water. The main goal is therefore to save and to improve the aerobic conditions, mainly in the area used for water supply. The main factors supporting good ground water quality are:

- fluctuation of the ground water level in gravel and sandy horizons, without water-logging of soil, and without standing surface water in polders,
- the high content of oxygen, the low content of organic carbon and the moderate content of nitrates in the Danube water,
- the low content of organic carbon and the moderate content of nitrates in the river bed sediments and their high permeability,
- the low seepage of organic carbon and chemicals from the soil horizon, good possibility for soil aeration,
- relatively very low organic and inorganic pollution of the river, recent river sediments and at the aquifer terrain surface,
- high velocities of the Danube water during infiltration through river bed sediments.

Danube water quality

The Danube between Bratislava and Komárno has a favourable oxygen conditions with slight increase of dissolved oxygen balancing according to temperature around the values of saturation. No significant changes occurred after putting the hydropower scheme into operation, Fig. 7.

The values of COD(Mn) - chemical oxygen demand and BOD_5 - biochemical oxygen demand characterise the content of organic substances, which act as reductants in the oxidation-reduction processes in the water. For example during the river water infiltration values BOD_5 are approximately 60 to 70 % of the COD(Mn) values. There exists a long term decrease of values BOD_5 and COD (Mn) in the Danube (Fig. 7).

Content of nitrates (NO_3) is optimal in the Danube and fluctuates about 12 mg/l (Fig. 7).

Concentrations of heavy metals are low, and correspond to the natural background conditions in the river (Fig. 7). The content of organic micro-pollutants is in the Danube water low, only sporadically exceeding the drinking water quality standards. The Danube water is of excellent quality as a water recharging aquifer and no significant changes in water quality have been observed after putting the Gabčíkovo structures of the project into the operation.

The Danube sediments

The general content of organic carbon in river bed sediments deposited from suspended load ranges from 0.5 % to 3 %. An average content of organic carbon in these dried sediment samples is about 2 %.

In the suspended load in the Danube at Bratislava [Kelnárová, 1991] an average content of organic carbon in the dry matter is 7.2 %. Thus in the sediments from the suspended load in the Danube an average content of organic matter fluctuate between 2 % and 7.2 %. The quality of sediments originated from bed-load (in conditions when the flow velocity is larger than 0.3 m/s) is different. Organic carbon decreases nearly to zero, average content of clay particles decreases to zero, specific diameter of settled particles increases to 2 mm, conductivity coefficient increases up to 0.02 m/s. In general river bed sediments are suitable for ground water recharge.

In general, the river bed is permeable, content of organic carbon is low, and river bed is suitable for infiltration of river water, mainly in the places where flow velocities are higher than 0.3 m/s, and coarse sedimentation and at least temporary erosion exists.

The data collected during the geochemical field investigation of flood-plain sediments show that no regional pollution of organic contaminants or heavy metals exist in the flood plain area. The relatively high contents for Ni, Cu and Fe might be explained by higher background contents. A significant portion of metals in sediments is associated with non-reactive minerals. Iron forms in the aquifer oxidising conditions limonite coats on particle surface (well visible on gravel) and increases the overall sorption capacity of sediments.

Measures to ensure ground water quality

Bottom infiltration, responsible for the resulting quality of ground water, is influenced by the bottom sediments and the flow velocity of infiltrating water. Following vari-

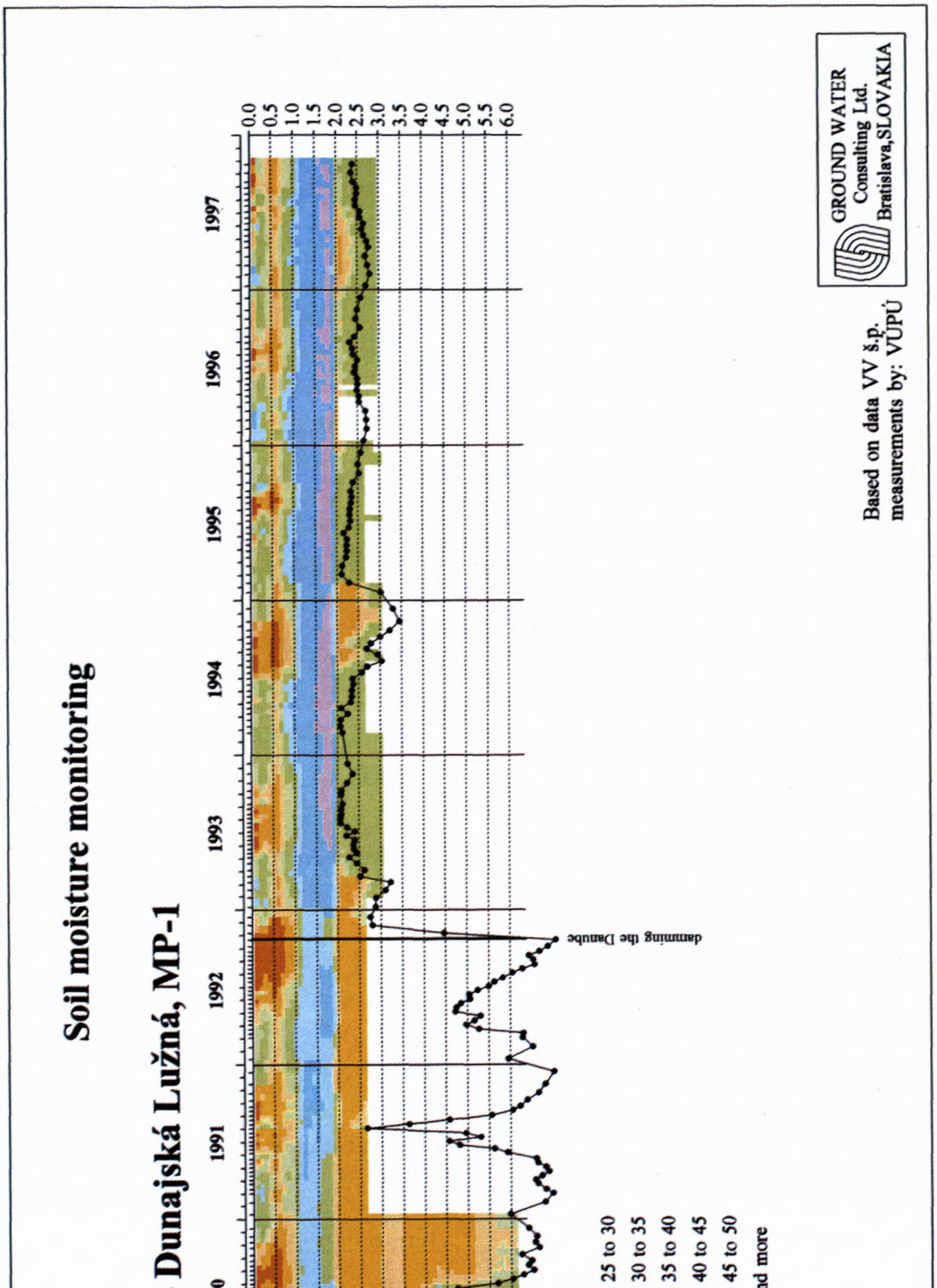

Fig. 6. Example of soil moisture changes – upper part of the Žitný ostrov area.

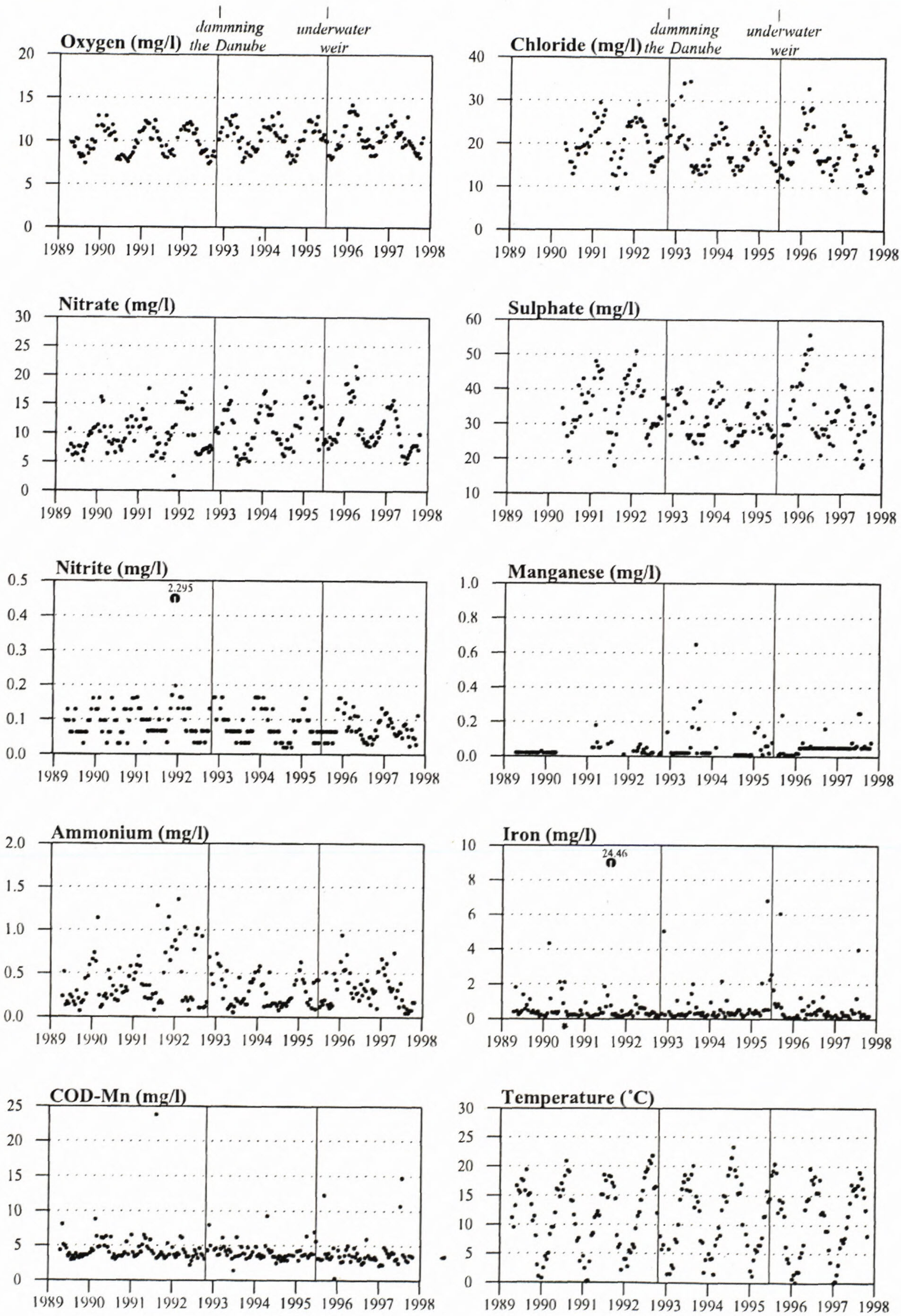

Fig. 7. Danube water quality at profile Komárno.

ants may occur by the river and reservoir bottom and bank infiltration [Mucha, Paulíková et al. 1992]:

- Bottom erosion and sedimentation are in long-term equilibrium, they alternate according to the Danube discharge. Water quality after infiltration corresponds to oxidising conditions and the ground water is of drinking water quality. Bottom permeability remains relatively high and suitable for infiltration.
- Settled organic matter is smaller than the amount of organic matter oxidised by the oxygen, dissolved in the infiltrating water. The water quality after infiltration is good. Bottom permeability may gradually decrease to some limiting value.
- Settled organic matter is larger than the amount of oxygen matter, oxidised by the oxygen, dissolved in the infiltrating water. Water quality after infiltration is after some time not adequate. The river bottom is progressively clogged and quantity of infiltrating water gradually decreases.

The basic principles to ensure ground water quality after putting the Gabčíkovo part of the project into operation were as follows:

1. Ensure the water quality in the Danube and the reservoir, high content of oxygen and a low content of organic carbon.

2. Ensure good infiltration possibilities from the Danube, good permeability of the reservoir and river bottom, and a minimal loss of oxygen during infiltration.

3. Ensure minimal infiltration of water from places with unsuitable water quality and places with higher settling of organic matter rich sediments.

4. Hinder infiltration from places with stagnant water and exclude such areas from the front of water works [Maier, 1991].

The Danube water in Bratislava has favourable water quality from the point of ground water recharge. Nutrients are not an inhibitor of eutrophication. Eutrophication could be the main additional and temporary source of the organic carbon in water and in the settled sediments. In summer the only inhibitor of eutrophication is the turbidity of water, the turbulence and velocity of the water flow.

The main measures used to ensure the ground water quality were as follow:

1. Two hydraulic structures in the downstream part of Čunovo reservoir have been constructed (Fig. 1.).

The goal of the linear one is to ensure high enough flow velocities in front of the waterworks at Šamorín to maintain high reservoir bed permeability at places where ground water recharge (in front of waterworks' wells) takes place, to maintain changes in sedimentation and erosion to hinder settling of finer sediments, and to ensure low losses of oxygen during infiltration of water via sediments. At the same time this structure enforced sedimentation at places where sedimentation is harmless and advantageous from the point of seepage of water towards the Old Danube.

The second S-shaped hydraulic structure ensure turbulent and partially rotational flow and ensure the mixing of water.

Hydraulic structures in the reservoir are ensuring high enough velocities at chosen places, differences in flow velocities and sedimentation conditions, partially rotational flow in the downstream part of the reservoir and larger turbulence of the flow. Hydraulic structures are active only if the water flow velocity is significant. Therefore water management regime should ensure high enough flow velocities. Possibility for at least partial erosion of fine particles in the previous river corridor is created by the Čunovo weir.

2. To ensure high flow velocities, variability in flow velocities, and thus good infiltration possibilities into the aquifer from the Danube. The Danube between Bratislava down to Ostrovné lúčky flows between the old river banks and further downstream continues to Čunovo weir in the old deep river bed.

3. To ensure minimal infiltration of water from places with unsuitable Danube water quality and places with higher settling of fine sediments in front of waterworks Kalinkovo the adjacent part of the reservoir bottom was sealed.

4. To hinder infiltration from places with stagnant water and to exclude such areas from the front of the water works at Rusovce-Ostrovné lúčky-Mokraď the polder area was filled with the gravel.

Ground water quality

In situ measurements, sampling and chemical analyses of ground water are carried out on selected observation wells and municipal water supply wells. In general, the municipal water supply wells are considered as the source of the most reliable information about ground water quality (Fig. 8).

The most important parameters regularly measured have been chosen to demonstrate the general ground water quality (municipal wells on the right side of the Danube at Rusovce and on the left side of the Danube at Kalinkovo, Fig. 9, 10).

The importance of the territory on the right-hand side of the Danube for ground water resources, is stressed by the existence of the high capacity waterworks Rusovce - Ostrovné lúčky - Mokraď, and the local waterworks for the villages Rusovce and Čunovo (Fig. 1, 11).

The waterworks Rusovce - Ostrovné lúčky - Mokraď is situated parallel to the Čunovo reservoir. The waterworks utilises ground water recharged by water infiltration from the Danube. The system consists of 23 wells situated at a distance of about 120 m from the seepage canal, and 500 - 600 m from the Danube, at the present reservoir. The distance between the individual wells is 100 m. The capacity of the locality Rusovce - Ostrovné lúčky ranges between 800 and 1200 l/s. The total capacity of the whole waterworks after putting the hydroelectric power structures into operation, together with the newly built wells in the locality of Mokraď, equals 2480 l/s [Hauskrecht, Polčan, 1995].

The territory of the waterworks consists of the Danube Quaternary high permeable gravel-sand sediments. Their

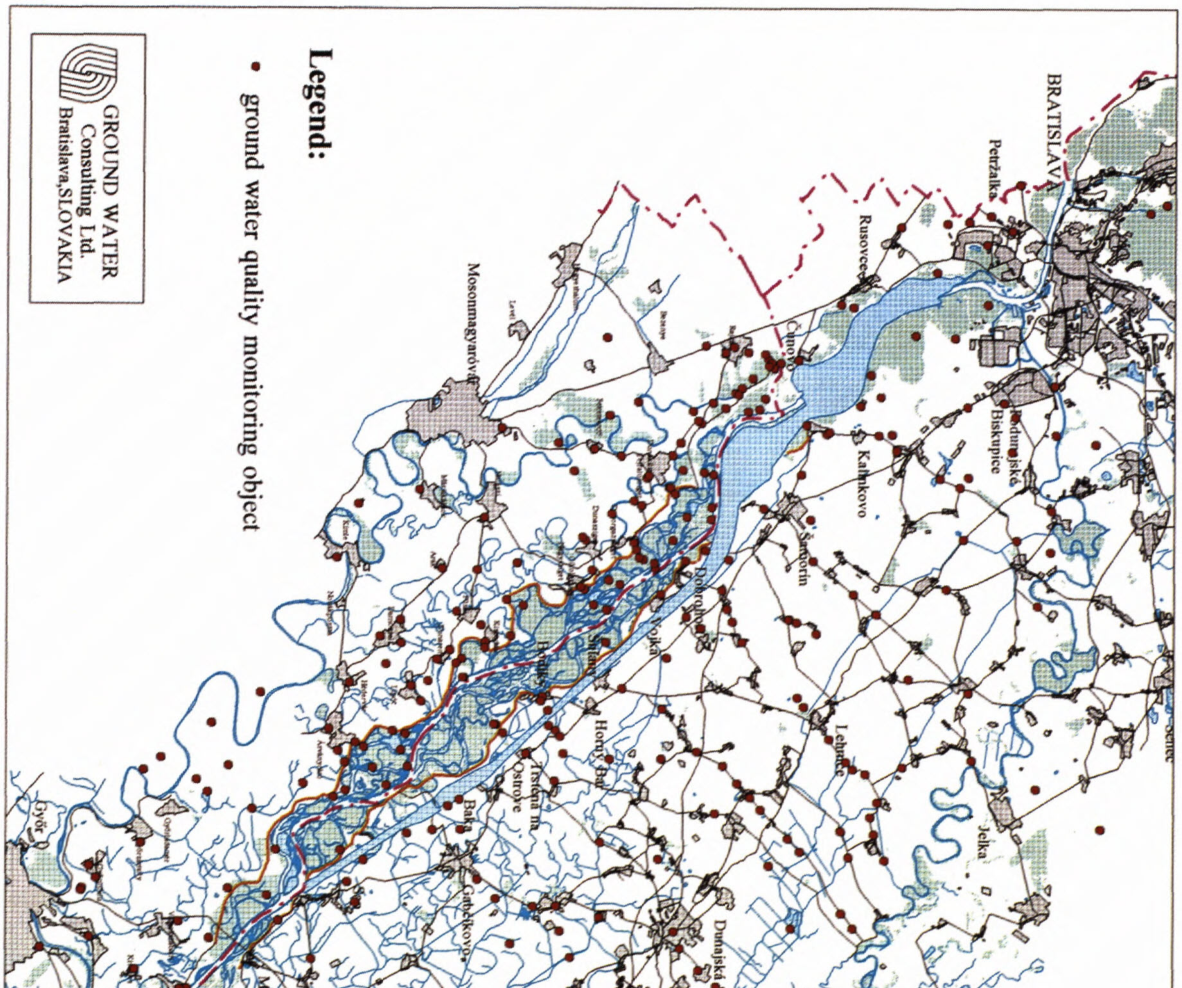

Fig. 8. Ground water quality observation wells.

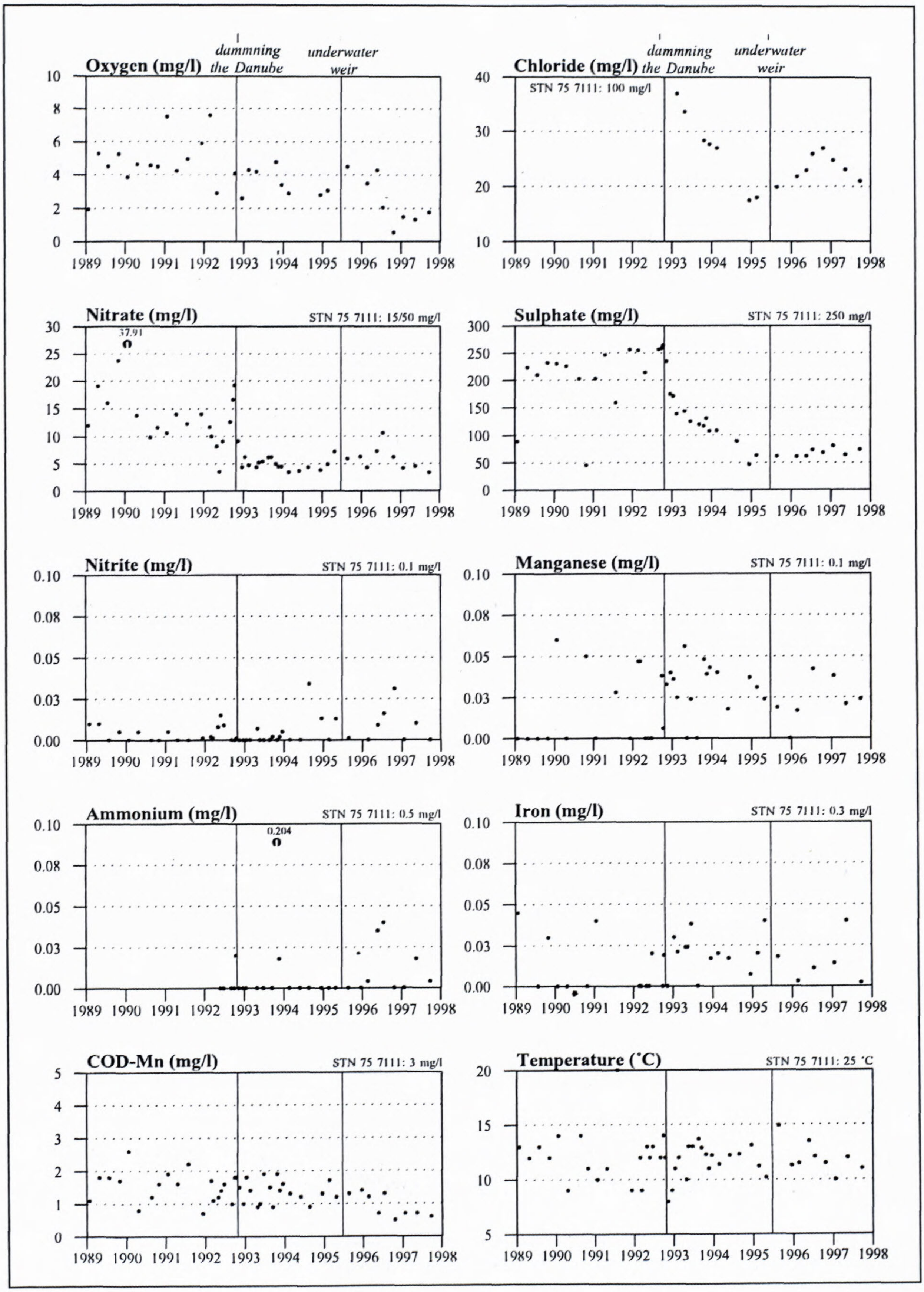

Fig. 9. Ground water quality at profile Rusovce

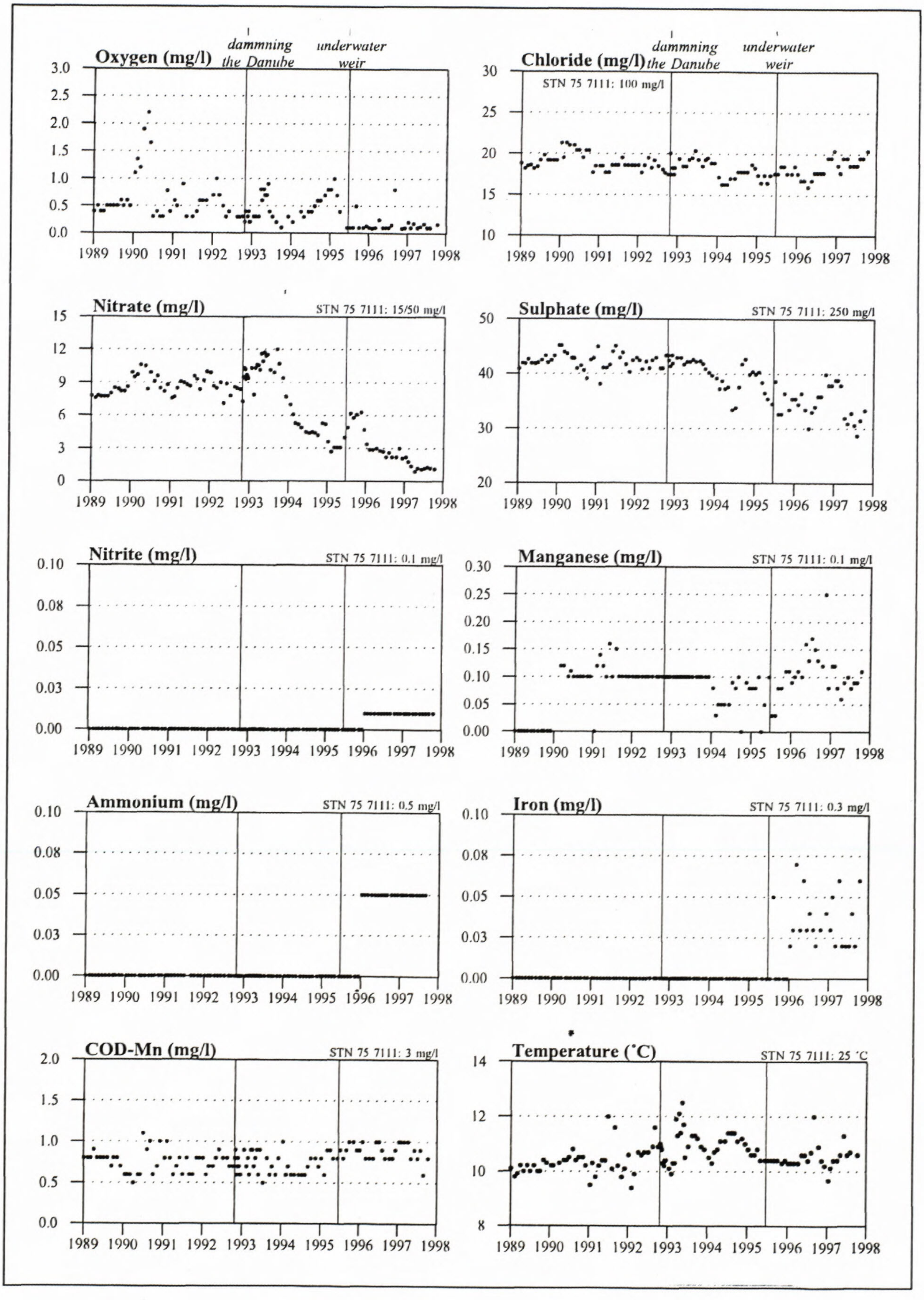

Fig. 10. Ground water quality at profile Kalinkovo

thickness in the upper part of the area (Rusovce - Ostrovné lúčky) is 50 - 60 m, and in the lower part of the area (Mokraď) 60 - 80 m.

Before damming the Danube the area of waterworks was partially drained by the Danube itself and by the pumping of water from wells. Continuous decrease of the ground water level, and large extension of the cone of depression negatively affected waterworks water quality [Hauskrecht, Polčan, 1995]. Another long-term forwarding process of the river bed erosion downstream of Bratislava caused a decrease in the amount of infiltrated water from the Danube [Mucha, Paulíková, al., 1992, Rodák, Banský, 1995]. Under these conditions ground water flow transported contaminants from Petržalka city and the Austrian territory towards the water supply wells. From the waterworks standpoint, the shift of the ground water watershed inland as far as Čunovo, was regarded as negative [Hauskrecht, Polčan, 1995].

The increase of the water level in the Čunovo reservoir caused a radical change in the ground water level and ground water flow (Fig. 11). At present the ground water flows from the Danube toward the system of wells of the Waterworks Rusovce - Ostrovné lúčky - Mokraď, and further inland, towards Hungarian territory. The decrease of chlorides and sulphates is regarded as a dominant and very positive change in the area with respect to the ground water quality (Fig.9.).

At present there are three large-capacity waterworks on the left side of the Danube. Waterworks Kalinkovo consist of 10 wells with filter parts at a depth interval between 40 to 80 m. Ground water recharge from the Danube river existed at all water level stages. Impoundment of water in the Čunovo reservoir caused an significant increase of ground water level in the wide adjacent area.

Water quality from the Kalinkovo waterworks is systematically monitored since setting the water wells into operation in 1972. Course of changes in water quality from well S-4 situated in the middle of the well system and closest to the Danube is shown (Fig. 10). The most visible changes are characterising oxidation-reduction processes. The presence of chemicals including water pollution was not detected. According to microbiological and biological criteria, ground water from the wells is permanently of drinking water quality.

Lessons to be learned

The long lasting dispute about the Gabčíkovo - Nagymaros Project, bears tragic testimony of economic, ecological and political losses which in fact have been paid and will be paid by the people and the nature in this part of Europe. Just from this reason it is necessary to look behind all marketable slogans dragging the realities in such disputes.

Slovakia was asked (and is still asked by some groups) to restore this section of the Danube to the situation as it existed prior to putting the Gabčíkovo structures into operation. In other words, to abandon entirely these works and to render useless this huge investment. This would mean emptying the reservoir and the bypass canal, and leaving the sites as unused masses of concrete and equipment – a long ugly scar on the landscape of Slovakia, and in addition, a decrease of ground water level with all the negative consequences known from the pre-dam conditions. There is hardly the opinion to return this area to a green "cow pasture", as suggested. It was also painted an extremely muddled picture of the Project, portrayed as a massive waste of scare resources, designed solely to meet the ideological objectives, a "dinosaur" from "a previous age". The reality is completely different. High-ranking political personalities, heading the Hungarian and Slovak expert groups, signed the "Framework Agreement..." document (27. Feb. 1998), and agreed that the Project shall provide for example the following changes:

- The principal works of the Gabčíkovo part of the Project shall include in addition the Čunovo (Variant C) installations.
- Hungary may create reservoir in its territory, as national investment. The functions of the Čunovo installations and the environment shall not be adversely affected.
- There shall be either a new schedule of construction of the Nagymaros part of the Project or the replacement of the Nagymaros part of the Project by Pilismarot part of Project (8 km upstream Nagymaros), with the technical parameters as close as possible to those of the Nagymaros part of the Project.

The "Framework Agreement" stated that the Project shall improve conditions for international navigation in the whole sector of the Danube between Bratislava and Budapest, in accordance with requirements deriving from the recent creation of the Trans-European waterway between the North Sea and the Black Sea. The "Framework Agreement" provided additional environmental protection, for example, jointly agreed methodology for environmental impact assessment shall be worked out and used, existing and potential sources of pollution shall be jointly identified, and agreed measures adopted, there shall be a joint environmental monitoring system developed using methodology of the existing joint monitoring system established by the Agreement of 19 April 1995, operation of the project structures shall be optimised according to the monitoring results, etc.

It was expected, as confirmed at time by both Prime Ministers, that the draft Agreement would be approved and signed by them. To the regret of Slovakia this has not happened. For its part, the Government of Slovakia approved the draft Framework Agreement and announced its willingness to put it into effect. Hungary postponed its approval and, upon the accession of its new Government following the May 1998 elections, it has proceeded to disavow the draft Framework Agreement and now further delays implementing the Judgment. Moreover, Hungary acts as if the Treaty 1977 is suspended (in effect indefinitely) and has no current operative effect. And this in spite of the fact, written in the Judgment, "it is of cardinal importance that the Court has found that the 1977 Treaty is still in force and consequently governs the relationship between Parties. That relationship is also determined by the rules of other relevant conventions to which the two

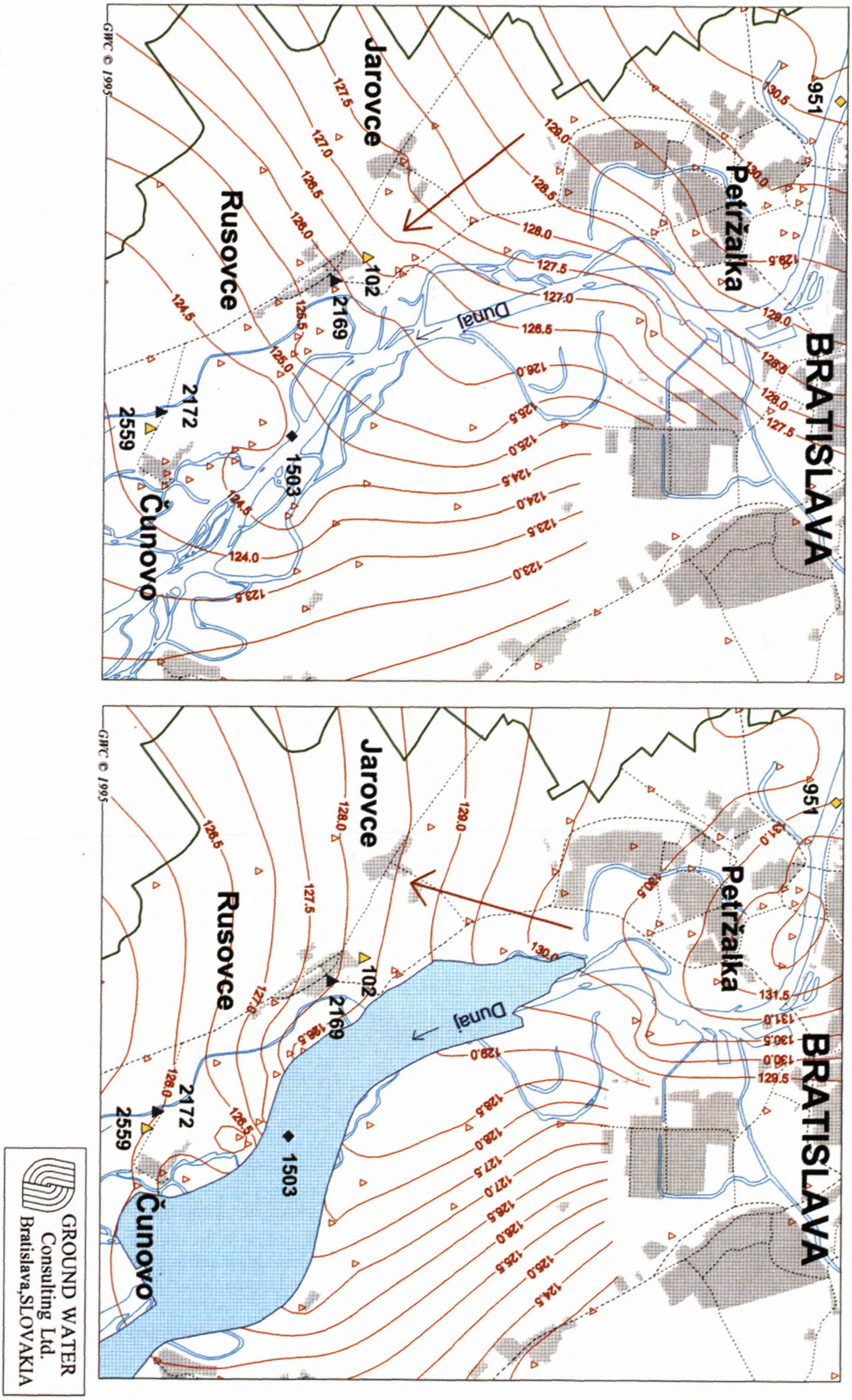

Fig. 11. Ground water level before and after damming the Danube.

States are party, by the rules of general international law and, in this particular case, by the rules of State responsibility; but it is governed, above all, by the applicable rules of the 1977 Treaty as a *lex specialis*."

The Gabčíkovo – Nagymaros Project has become a very discussed. There have been a large number of contradictory opinions expressed, which tended to give discussions with a highly emotive charge. For example, one of numerous very frequently used terms is "ecological catastrophe". The result of using such expressions and slogans in a discussion, without establishing its meaning is that discussion is changed as a consequence of misunderstanding to "passionate discussion" with a strong emotive trend without any positive result. It is natural, that all discussions based on incorrectly or insufficiently defined expressions are not constructive and they do not lead to valuable conclusion. When such incorrect expressions are used in non-scientific branches, but referring to science, the consequences are negative, even tragic. The result is misinformation which becomes worse when it is joined to negative argumentation. Such methods are sometime used by advocacy campaigns and as communication skills in brain-storming [Krcho, 1995].

Much political energy has gone into this dispute, and those who have seen the completed works on the Slovak side and the almost completed works on the Hungarian side find the demand to stop construction hard to understand. And worse still, the quasi-ecological discussion serves to divert attention from the real threats to the environment in the region. Nel van Dijk, an EU delegate, and very much against the project for so-called green reasons, had this to say in a report to the EU parliament in April 1993: ..."The obvious disaster on the ecological and environmental level is, in my opinion, not the most dominant element in the conflict. There is a much bigger political element in it that any of the parties is willing to admit". Such political pressure serves neither the people of the two countries, nor other people in the region.

The interpretation of ground water level changes is the basis for interpreting of soil moisture changes, biological monitoring, and further, environmental impact assessment. Thus, interpretation of ground water regime changes can support correct discussion not only of environmental questions but also discussion about political elements.

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