

# **HUNGARIAN-SLOVAK ENVIRONMENTAL MONITORING ON THE DANUBE**

**Results of the Environmental Monitoring based  
on the "Agreement between the Government of the Republic of Hungary  
and the Government of the Slovak Republic concerning certain temporary technical  
measures and discharges in the Danube and Mosoni branch of the Danube"**

**1995 - 2005**

**DANUBE MONITORING SCIENTIFIC CONFERENCE  
25-26 MAY 2006  
MOSONMAGYARÓVÁR - HUNGARY**

**Hungarian Section**

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measures and discharges in the Danube and Mosoni branch of the Danube"  
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**Programme**

**Abstracts**

**Recommendations for the harmonization of  
the monitoring systems established over the Upper-Danube  
(shortened version)**

## PROGRAMME

25 May

Chairman: Prof. István Láng

- 10:00 Opening Ceremony  
*Miklós Persányi, Minister for Environment and Water, Hungary*  
*László Miklós, Minister for Environment, Slovak Republic*  
*Vince Ördög, Dean of the University of West Hungary*
- 10:20 Results of the Upper-Danube's environment monitoring based on the Hungarian-Slovak Agreement, 1995-2005  
*Róbert Rakics, Deputy State Secretary, Ministry of Environment and Water, Hungary*
- 10:40 Anniversary of the joint Slovak-Hungarian environmental monitoring  
*Dominik Kocinger, Plenipotentiary of the Slovak Government for Construction and Operation of Gabčíkovo-Nagymaros Hydropower Scheme*
- 11:00 Historical changes of the Danube riverbed from Bratislava to Komárno  
*Peter Pišút*
- 11:15 Climate monitoring in the area of the Gabčíkovo project  
*Pavol Faško, Olga Majerčáková, Jozef Pecho, Pavel Šťastný*
- 11:30 Recharging of water and nature protection  
*Emil Janák, László Kárpáti*
- 11:45 Hydro-morphological changes in the Szigetköz  
*János Józsa*
- 12:00 Discussion
- 13:30 Changes in the morphology of riverbed and sediment analyses  
*László Rákóczi, Jenő Sass*
- 13:45 Hydrological and morphological changes in the Danube  
*Martin Bačík, Mária Borodajkevyčová, Zuzana Capeková, Katarína Holubová, Michal Martinka, Peter Škoda, Jozef Turbek*
- 14:00 Ground water regime monitoring  
*Ján Gavurník, Zoltán Hlavatý*
- 14:15 Quantitative status of the underground water-body, changes in the ground-water table  
*Adrienne Hajósy, Pál Liebe, József Szalai*
- 14:30 Hydraulic simulation of the status of subsurface waters  
*András Bárdossy, Gabriella Mohácsiné Simon, György Molnár, Zoltán Molnár, Ferenc Neppel†*
- 14:45 Danube surface water and riverbed sediment quality  
*Stanislava Bačíková, Katarína Kučárová, Magdaléna Valúchová*
- 15:00 Discussion

- 16:00 Characterisation of hydro-chemical status and trends in water-quality changes  
*Lajos Horváth, Rezső Mayer, Judit Pulai*
- 16:15 Hydro-chemical and hydrobiological investigation continued over the area of the water recharging system  
*Péter Bálint, Vince Ördög, Károly Pálffy*
- 16:30 Ground water quality monitoring  
*Andrea Luptáková, Lucia Kvapilová, Anna Žákovičová*
- 16:45 Chemical condition of the subsurface water body and recharging efforts  
*György Don, István Horváth, Pál Liebe, Antal Pentelényi, Péter Scharek, György Tóth*
- 17:00 Comprehensive evaluation of soil moisture and arable lands monitoring  
*Rastislav Dodok, Emil Fulajtár, Zoltán Hlavatý*
- 17:15 Vegetation over ruderal areas and changes in the moisture content of soils  
*Gyula Czímber, Gábor Koltai, Friderika Mikéné Hegedűs, Gusztáv Palkovits, Gyula Pinke, Péter Schummel, Péter Szabó*
- 17:30 Discussion

26 May

Chairman: Prof. Igor Mucha

- 9:00 Present knowledge on hydro-biological monitoring and prospects of development  
*Árpád Berczik, Mária Dinka, Gábor Gutí, Anita Kiss, Tihamér Kiss Keve, János Nosek, Nándor Oertel, Miklós Puky, Tamásné Ráth, Károly Schöll*
- 9:15 Hydrobiological and fish monitoring  
*Eva Bulánková, Jaroslav Černý, Marta Illyová, Vladimír Košel, Iľja Krno, Štefan Nagy, Ferdinand Šporka*
- 9:30 About the aquatic-riparian bryophyte vegetation and benthonic diatoms  
*Krisztina Buczkó, Beáta Papp, Miklós Rajczy*
- 9:45 Monitoring of aquatic habitats vegetation  
*Silvia Kubalová*
- 10:00 Results of the monitoring of forests  
*Gábor Illés, Zoltán Somogyi, Ildikó Szabados*
- 10:15 Growth, habitat characteristics and aerial survey of forest stands  
*Vladimír Bajcar, Ferdinand Kubíček, Július Oszlányi, Rastislav Raši*
- 10:30 Flora and forest vegetation monitoring  
*Eva Uherčíková*
- 10:45 Changes in vegetation of habitats since the diversion of the Danube  
*István Hahn, Attila Gergely, Sándor Barabás*
- 11:00 Discussion

- 12:00 Terrestrial fauna monitoring  
*Tomáš Čejka, Zbyšek Šustek, Mirko Bohuš*
- 12:15 Zoological monitoring – results and development options  
*András Ambrus, Balázs Benedek, Tibor Csóvári, Miklós Dombos, László Forró, András Gubányi, Tibor Kovács, András Kun, Gábor Majoros, Ferenc Mészáros, Péter Nagy, László Ronkay, Győző Szél, György Sziráki, Ákos Uherkovich, Attila Bankovics*
- 12:30 Environmental monitoring – present structure and proposals  
*Zoltán Hlavatý, Iľja Krno, Mikuláš Lisický*
- 12:45 Potentials of the future Danube ecosystems  
*Mikuláš Lisický, Igor Mucha*
- 13:00 Proposal of the joint monitoring at the stretch between Sap and Budapest  
*Zoltán Hlavatý*
- 13:15 Afterword  
*Prof. István Láng, Prof. Igor Mucha*

## Results of the Upper-Danube's environment monitoring based on the Hungarian-Slovak Agreement 1995-2005

Róbert Rakics

Deputy State Secretary

Ministry of Environment and Water, Hungary

It was on the day of April 19th 1995 that an *Agreement* was brought about between the governments of Slovakia and Hungary in favour of the provisional water-recharge of the Szigetköz. According to the Agreement emissaries of the two parties – i.e. the deputy state secretary in charge of environment protection on the Hungarian side and the government's commissioner dealing with issues connected with the Gabčíkovo Project on the Slovak – accepted a Statute the 29th of May 1995, devoted to the activities of the persons commissioned to operate the instruments measuring discharges and to take technical measures in compliance with the Agreement. The Statute contains statutory provisions concerning the measuring-observing activities of the parties, as well as about the exchange of data and the annual reports, documents to be compiled each year.

The present conference is aimed at summing up the results of the ten years long monitoring carried on by the two parties. It is not only the round anniversary that may be a reason for such a summary; the main aspect is to give a clear picture about the work accomplished both for professional bodies and for citizens, wanting to know more.

In the long years of monitoring a great deal of knowledge and valuable experience has been collected, about environmental procedures, which – in some of the cases - are unparalleled in the whole of Europe. In the impact area of the Gabčíkovo Dam major hydrological changes have manifested themselves and succession procedures also accelerated. Water recharge towards the Szigetköz is aimed at counterbalancing disadvantageous effects of the diversion of the Danube. The common monitoring is expected to keep track of the effects of water recharge. We shall see, that procedures evolving cannot be evaluated with a single yes/no decision. Talking about their results lecturer shall equally give account of advantageous and disadvantageous features.

It is deemed to be a positive feature in the eyes of both of the parties, that exchange of data has been going on during the last ten years in a good order, national and joint annual reports were edited year-by-year according to the regulations, and that factual data on the environmental impacts, as well as evaluation of them were invariably incorporated in these reports. Experts of the two countries did not only strove for thick volumes of books to be published, for efforts were also made to render availability of their knowledge accessible by means of the Internet.

After that much time devoted to the problem the question, if a modification of the regulations was necessary at all does inevitably emerge. Insisting upon stability and permanence is though a basic property of environmental monitoring programs still we have to give due consideration to the question, whether data base such generated would equally satisfy obligations which we have taken upon ourselves, if judged according to European norms.

There are, as it is, three guiding principles of the EU accepted by both countries, all three effecting our monitoring work in future. The framework principles of water management call for the introduction of new rules in respect of water quality measurements. Criteria of the Natura 2000 approach call for a switch-over as regards observations of the world of living creatures, since flood plane woods of the region qualify now as one of the habitats to be protected. And – last but not least – we shall come forward with a modification proposal concerning exchange of data and evaluation documents (and this in the spirit of the principle prescribing a free access of the public to data of an environmental character): all data should be accessible for anybody in an up-to-date (digitalised) format as one of the basic human rights.

We sincerely hope that a discussion about our proposals for changing the Statute shall be started with as with a part of the agenda of the Conference.

## Recharging of water and nature protection

Emil Janák (1), László Kárpáti (2)

(1) North-Transdanubian Environmental and Water Directorate

(2) Directorate of the Fertő-Hanság National Park

An efficient operation of the recharge system of the Szigetköz was rendered possible by the building of the bottom sill. The recharging system has a fundamental aim to save nature protection values obtained its operational water permit in 2001. Regulations, serving as a basis for the operational order were prepared by the North-Transdanubian Environmental and Water Directorate also involving the public in the composition of that. Operation of this system shall be evaluated by the Szigetköz Operational Committee assembled annually with the participation of all interested parties. The paper exposes major characteristics of the recharging system, describes the methodology of actual recharging and highlights fundamental principles adhered to. A few thoughts are given to the monitoring system, which does also participate in the evaluation of the operational order.

The Szigetköz Landscape Protection Area is – beside the Duna-Dráva National Park, extending over Gemenc-Béda-Karapanca – the second largest protected area of the Hungarian stretch of the Danube and the third largest along the whole length of the river. Unfortunately, a series of valuable habitats were left unconsidered at the time when protection of the park area was declared. Swampy meadows, marshlands, gallery forests left out of the Park area shall probably be placed under protection when a general enlargement of the area, - a move to take place sometimes in the years ahead of us - shall actually be accomplished. As it is however, the Szigetköz Nature 2000 area (the one to be introduced by the present lecture), has taken shape on the basis of habitats of special value from the point of view of nature protection, and this through the amalgamation of the area of the existing nature protection park with the territory of the envisaged extension area and with the surrounding lands, also satisfying the guidelines of the Habitat Protecting Principles of the EU.

## Hydro-morphological changes in Szigetköz

János Józsa

Budapest University of Technology and Economics  
Department of Hydraulic and Water Resources Engineering

Exploring hydro-morphological conditions and tracking their dynamic change has been an important issue in the past decade in Szigetköz area. As such changes are driven by hydrodynamics in various flow regimes, high resolution flow measurements and numerical modelling are essential to understand the phenomena and estimate the impact of the modifications in the river bed or flood plain land use. The talk focuses on presenting the 2- and 3D flow models recently implemented for the Szigetköz area including the main channel, the floodplains and the system of secondary branches both in Hungary and Slovakia. Model results calibrated against field data and their utility in assessing various natural changes or man-made interventions will be shown.

## Changes in the morphology of riverbed and sediment analyses

László Rákóczi, Jenő Sass

Environmental Protection and Water Management Research Institute

Closing the main channel of the Danube in 1992 and diversion of a decisive part of the discharge towards the upstream channel of the Gabčíkovo Hydropower Plant has fundamentally changed the channels of the Danube and those of the branch systems, as well as the runoff conditions of the riverflow. Results of the surveys (riverbed topography and bed material analyses), carried out repeatedly since the diversion of the river have confirmed, that the "maintenance discharge" provided causes adverse sedimentation processes in the main Danube channel and in the Szigetköz branches, disturbing the connection of surface and subsurface waters and generating drastic changes of the water conveyance (bed roughness) conditions.

Considering the entire Szap- Rajka section of the Danube, significant narrowing of the river channel, development of side bars and a rather dense and tall vegetation over them have occurred. The riverbed surveys showed that the area of the river channel decreased by 410 hectares, i.e. by 33 % compared to the one before the diversion.

According to the results provided by the control of channel changes of the Szigetköz Branch systems since 1992, the governing bed morphological process has been the aggradation. E.g. the channel of the Bagomér branch, denoted as a sediment trap has lost 346 000 cubic-meters of its original volume equalling to a specific filling-up of 60 cm. The uppermost 15-20 cm thick layer of this aggradation consists of silt.

## Quantitative status of the underground water-body, changes in the ground-water table

Adrienne Hajósy (1), Pál Liebe (2), József Szalai (2)

(1) Hungarian Academy of Sciences, Szigetköz Workgroup

(2) Environmental Protection and Water Management Research Institute

Surface and subsurface water-level measurements are carried on in the Szigetköz by several institutions. Summarising data from time to time is a commanding necessity, also in order to have a clear picture about the tendency of changes of measured parameters in time, about their territorial distribution and also in order to sum up different statistical characteristics of this vast quantity of data. The Environmental Protection and Water Management Research Institute has been involved in this activity for several decades by now; and called - a couple of years ago - a data base into being, one, that can also be used as an information system.

The paper makes one familiar with the changes of ground water table, supported there by time/data diagrams and contour maps plotted on the basis of a data bank initiated 50 years ago. Interdependencies between these and other types of data, with emphasis laid upon the relationship between these and the level of surface waters in the area.

## Hydraulic simulation of the status of subsurface waters

András Bárdossy, Gabriella Mohácsiné Simon, György Molnár, Zoltán Molnár, Ferenc Neppel†

North-Transdanubian Environmental and Water Directorate

The theme "*Elaboration of a ground-water management concept for the Austrian, Slovakian and Hungarian border area*" was dealt with within the frames of a Phare project, aimed at investigations of groundwater movements in the Szigetköz, and at the exposition of recharging procedures launched in order to restore the equilibrium state of the balance of subsurface waters. One of the results was the elaboration of a non-permanent 3D hydrodynamic model of the area. This has been brought into being in three versions, notably for the conditions prevailing *before* and *after* the diversion of the Danube, and for the second variant "after diversion" but also reflecting the effects of the water recharging system of the flood area also in operation. Processing geological and hydro-geological data took place - beside the traditional graphical method - by means of geo-statistical methods as well, with a final 3D model constructed by the use of parameters such obtained.

Authors shall brief the audience about the geo-statistical method applied and the results obtained after processing data. Structure of the 3D hydro-dynamical model shall be explained by and large, this followed by the presentation of the main directions of the ground water recharge system of the Szigetköz determined by means of modelling for the three situations tested, with the water-balance of the area also presented.

## Characterisation of hydro-chemical status and trends in water-quality changes

Horváth Lajos, Mayer Rezső, Pulai Judit

North-Transdanubian Environment Protection, Nature Conservation and Water Inspectorate, Győr

It is since the year of 1992, that the North-Transdanubian Environment Protection, Nature Conservation and Water Inspectorate, Győr was appointed to operate the Upper-Danube Environmental Observation System (hereinafter Danube Monitoring). Construction works on the Project were started with in the year of 1986.

The water quality control network operated in the Szigetköz does actually integrate all of the sampling points of the national network, and - in addition to that - all the 11 sampling places of the Hungarian-Slovak inter-governmental monitoring agreement, that had been concluded some time ago to improve the water supply of the flood planes and to promote the case of the water recharge to the Mosoni-Duna.

In case of surface waters the survey program extends over the waters of the Szigetköz flood area and of the protected area, as well as over the 35 sampling stations of the Mosoni-Duna and its tributaries where regular monthly (in case of reference stations two-weekly) physical and chemical analysis take place. Scope of parameters thus tested includes indicators of salt balance (anions and cations), oxygen household, indicators of nutrients and some of the micro contaminants.

Hydro-chemical conditions of water bodies can be reliably characterised by means of processing test results of the last ten years, also establishing the measure (degree) of contamination through these means. Results of the analysis of riverbed sediments throw light on the extent to which the accumulation of polluting agents has actually advanced.

## Hydro-chemical and hydrobiological investigation continued over the area of the water recharging system

Péter Bálint, Vince Ördög, Károly Pálffy

University of West Hungary, Faculty of Agricultural and Food Sciences  
Department of Plant Physiology and Plant Biotechnology

A series of tests was continued within the frames of the program "Hydro-chemical and Hydro-biological monitoring at the Surveys of the Szigetköz Water-recharging System" in the years of 2002 - 2005 on a regular monthly basis with analyses aimed at detecting water-quality characteristics as follows:

Water temperature and meteorological conditions were invariably recorded on each occasion. In addition to that dissolved oxygen concentration and Secchi-transparency was measured at the sampling point. The pH value of water samples was again measured in case of each sample delivered to the laboratory, together with the conductivity coefficient and chlorophyll-concentration. As for filtered water-samples parameters as follows have again been determined: total of ammonia, free ammonia and quantity of dissolved reactive phosphorous.

In the year of 2004 concentration of phosphorous retrievable for algae was determined in the bottom sediment of the river branches.

The lecture shall give account of the investigation and about the results obtained through them.

## Chemical state of the subsurface water body and recharging efforts

György Don (1), István Horváth (1), Pál Liebe (2), Antal Pentelényi (1), Péter Scharek (1), György Tóth (1)

(1) Geological Institute of Hungary  
(2) Environmental Protection and Water Management Research Institute

The authors present the monitoring activity of the Geological Institute of Hungary (MÁFI) and Environmental Protection and Water Management Research Institute (VITUKI) executed during the last 10 years. Emphasis is laid upon locations with dense investigation network and also on the methods applied. The observed hydrochemical changes are interpreted according to the following aspects:

- groups of wells deepened by VITUKI,
- sounding results of MÁFI,
- observation wells of MÁFI in the area of Dunakiliti.

Apart from the monitoring results the chemical state is presented on the basis of the work prepared for the 2005 National Report of the EU Water Framework Directive as well, considering all subsurface water quality data available for the water body. Additionally, the related part of the evaluation according to the EU Nitrate Directive will also be presented.

Regional assessment will be accomplished according to the following groups with special emphasis on the quality of the recharge water:

- site investigation along the main channel,
- observations along the water recharge system.

The pertinent figure indicates the observation points, whereas the table summarises the components tested and the results of the tests, grouped according to the most typical changes.

## Vegetation over ruderal areas and changes in the moisture content of soils

Gyula Czímber, Gábor Koltai, Friderika Mikéné Hegedűs, Gusztáv Palkovits,  
Gyula Pinke, Péter Schummel, Péter Szabó

University of West Hungary, Faculty of Agricultural and Food Sciences

Weeds are part of the flora of Szigetköz, part of the diversity of it. They have an important role in the maintenance of the multi-colouredness of the living world, and this in spite of the economical damage caused by them. Changes in the moisture content of the soil are indicated by weeds as well as by any other elements of native flora or by cultivated plants. Due to this they serve as a useful indicator system for plant growing over the impact area of them and also for nature protection efforts over this same area.

The Department of Botany does investigate the features of changing of weeds since the diversion of the Danube.

Investigations like that are carried on in all of the three regions of Szigetköz, with 7 - 7 permanent observation area in all of the regions. Surveys do actually take place on plots sown

with corn and wheat, or over ruderal areas. Repeated surveys are accomplished invariably in the autumn. Extensive and intensive cultivation areas are separately evaluated.

The paper acquaints the audience with the results of the survey and analysis of the weeds.

Moisture content of soils is measured by the Szigetköz Research Centre of the University at 30 stations. 23 of the stations are located on the protected side (22 of these over farmlands, 1 in a forest), with the remaining 7 situated in forests of the flood area. Number of annual surveys is 17 on an average. In the growth season surveys are performed with 14 days intervals, out of that though once a month only. Final data obtained is the total of moisture content in the vertical line, with measurement at every 10 cm interval.

The water quantity rise - through capillary movement - from the ground water up to the overlaying soil strata plays in the Szigetköz a very important role in the water balance of soils. Diversion of the Danube resulted in the sinking of the ground water table. In areas where the ground water table sunk to depths below the overburden this effect of moisture content enrichment got interrupted, a feature unquestionably proved by the regular measurements. Measures taken after the diversion of the Danube could not counterbalance this effect and failed to increase the groundwater level to the original heights. Lecturers shall demonstrate the modification of the moistening effect of the ground water through. data obtained at the survey spots at Rajka, Halászi, Dunasziget and Ásványráró in the year of 2002.

## Present knowledge on hydro-biological monitoring and prospects of development

Árpád Berczik, Mária Dinka, Gábor Guti, Anita Kiss, Tihamér Kiss Keve, János Nosek, Nándor Oertel, Miklós Puky, Tamásné Ráth, Károly Schöll

Hungarian Danube Research Station, Institute of Ecology and Botany of the Hungarian Academy of Sciences

It was in the year of 1991, that Hungarian Danube Research Station, Institute of Ecology and Botany of the Hungarian Academy of Sciences actually started with regular, monitoring-like hydro-biological surveys in the waters of Szigetköz, - whilst their own previous investigations reach back as far as the sixties of the previous century. The primary goal of the systematic monitoring work of more than a decade was the characterisation of the basic hydro-biological status of the waters surrounding the Szigetköz, with special attention paid to the identification and evaluation of environmental effects connected with operation of the Gabčíkovo Dam. Our research was aimed from the very beginning at the chemical properties of the water (and of the sediments thereof), the phytoplanktons (and at the trophic level of them), at the zooplanktons of the riverside stripe of the bed, such as mezo- and macro-fauna of invertebrates, at the stock of macrophytons, as well as conditions of fish population and biological circumstances of fishing. Surveys at almost 40 locations - in the main branches of the Danube, at side channels over the flood area, at water bodies along the protected side of the levees and - partially - along the Mosoni-Duna - were successful, in that they pointed out the sensitive, occasionally more enhanced changes of communities of aquatic organisms as corresponding to the changes of their living conditions.

Results of the monitoring enriched our knowledge with valuable teachings about the long-time dynamism of the groups of living organisms subject to our observations. Due to this we are in the position today to evaluate efficiency as well as certain shortcomings of the investigation with a great deal of experience to rely upon. Our hydro-biological research work has altogether yielded a clear evidence about the outstanding natural values of the water-bodies of the Szigetköz - also displaying a great biological diversity - about the direct damaging effects of the diversion of the Danube, about the consequences of measures aimed at the mitigation of damages, and about the standardisation, homogenisation procedure obviously taking place in the aquatic organisms at present. Data such obtained do however not fully satisfy latest information requirements, like those of the rehabilitation program of the water system of Szigetköz, or of the ones, which shall necessarily accompany the introduction of the framework guiding principles of the EU on water policy. It was under these circumstances, that the Hungarian Danube Research Station, Institute of Ecology and Botany of the Hungarian Academy of Sciences made preparations for the review of their monitoring strategy and for the definition of the general line of development, not losing sight of latest international results in respect of the methodology of hydro-biological research of great rivers, and concerning the activity taking actually shape in the fields of water-basin management.

## About the aquatic-riparian bryophyte vegetation and benthonic diatoms

Krisztina Buczkó, Beáta Papp, Miklós Rajczy

Hungarian Natural History Museum, Department of Botany, Budapest

Data on cryptogam plants as well as fungi (microscopic fungi and mushrooms) from the Szigetköz are available in the Herbarium of the Hungarian Natural History Museum since 1991. Subsequent to the initial period devoted to a general survey of the circumstances, from the year of 1994 there were two groups of plants, namely the benthonic diatoms and bryophytes (mosses and liverworts), the observation of which was regularly carried on. Reacting very fast to varying environmental conditions, bryophytes and diatoms are good and sufficiently sensitive indicator plants. Lately investigations took place according to the EU's Water Framework Directives with special attention paid to the recommendations concerning macrophytes and phytobenthos.

Documented facts presented on the occasion of the conference do positively prove the changes in species composition, as well as of loosing of the mosaic-like structure of the vegetation, and the decreased water supply of the area at all. Examples for the benthonic eutrophication of the branches will be presented and documented in the lecture.

## Results of the monitoring of forests

Gábor Illés, Zoltán Somogyi, Ildikó Szabados

Forest Research Institute, Budapest

The Forest Research Institute (FRI) started with landsite investigation and with the establishment of sample plots over the expected impact area of the Gabčíkovo-Nagymaros Dam as early as 1986, i.e. already 20 years ago. Laboratory analysis of forest-soils and classification according to the expected duration of inundation were primarily executed, and sample plots intended to serve as indicators after commissioning the Plant - pointing out hydrological and other site-specific changes - were equally marked out. Monitoring has been going on with minor extensions up to now and may be divided into the following major fields of interest:

1. Weekly measurement of girth growth of poplars and species of willow trees: here, effect of hydrological changes can unquestionably be pointed out, especially in case of willows.
2. Annual volume (quantity) estimation of living stock over the sample plots of the main species of stand forming trees: growth and increment analysis revealed the greatest fall-back in case of willow trees here too, the extent of which decreased at other species of trees in dependence of their water demand.
3. Standing dead tree surveys: quantity of dead trees in the forests follows a growing tendency from year to year.
4. Survey of physical condition of stands through site investigations and aerial imagery: as has been concluded quantity of foliage mass of the individual trees as well as the mass of the herbaceous plants has duly mirrored the changes of the hydrological conditions, and the same can be said about the distribution by species, better to say by the water requirement of the species originally growing here. It is to be noted, that aerial imagery alone proved to be insufficient for a reliable annual, large-scale survey of the physical condition of forest stands.



## Changes in the vegetation of the habitats since the diversion of the Danube

István Hahn (1), Attila Gergely (2), Sándor Barabás (3)

(1) Department of Plant Taxonomy and Ecology, Lorand Eötvös University, Budapest

(2) Department of Landscape Preservation and Reclamation, Corvinus University,

(3) Ecological and Botanical Research Institute, Hungarian Academy of Sciences, Vácrátót

We shall attempt to summarise the results of our Szigetköz measurements and observations within the frames of a short lecture. The first set of data (of a descriptive character at that) was collected in 1987, whereas regular observations were started with in the year of 1988. Survey in the field was carried on each year. Methods applied included interspecific correlation assessment according to Braun-Blanquet, reed-density and reed-height surveys, estimation of surface area of leaves of trees, and succession tests executed along transects (cross sections). Survey results thus obtained were complemented yet by experience collected during our site trips. In the course of this work we had to overcome the obligate difficulties of long-time botanical fieldwork. Needless to say, we had to face the winding up of some of our sample plots, or tolerate intrusive activities not related with the Danube, this meaning that the location got worthless from the point of view of monitoring. To substitute for lost sample areas investigation at new sites has immediately been started with. Our result can briefly be summarised as follows.

Alterations after the diversion of the Danube are presently – i.e. after the initial period of rapid major changes – in the stage of slowing down, this meaning that no significant modification occurs from one year to the other. Number and mass of species retrieved at one or the other sample area varies as corresponding to the weather conditions of the season of growth. Explanation for this is the great power of resistance of perennial plants. Even in case of a given area somehow becoming unsuitable for long-time sustaining existence of the species, individual plants and clones may still further flourish for decades, though not capable for multiplication any longer. Greatest alterations of the fauna were observed in the branches of the river and over the flood area. Water level of the Mosoni-Duna is kept stable artificially, accordingly no ground-water table sinking has taken place here, and the status of plants has not changed in a way, that could have been somehow connected with the diversion of the Danube.

## Databases

Adrienne Hajósy

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The overview of the investigation reports, summary evaluations and environmental monitoring data of the Szigetköz is greatly facilitated by the widespread use of electronic recording and storage. In the course of the years a vast data base came into being, consisting of numeric information, reports, photos and films, a part of which accessible in the Internet too. (The Szigetköz Workgroup of the Hungarian Academy of Sciences in charge has been maintaining web-sites for over ten years, all that in order to inform the public about eventual changes in respect of the Gabčíkovo-Nagymaros issue, and of the environmental alterations in the Szigetköz. The lecturer describes the structure of the system brought into being, and draws the attention to the knowledge on environmental problems of the Szigetköz, quantitatively enough to fill a library.

## Zoological monitoring – results and development options

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The Szigetköz can be described as a complex, mosaic-like system of wet habitats, with ecosystems of a water-circulation transformed through the effects of interferences. This is why we may assume that secondary transformation of the composition of species in case of communities of living organisms is largely depending on the changes of water circulation and on the change of the water balance. Due to this we might have reasonably concluded that temporal changes of the ingredient species of the fauna at the permanent sampling places of the zoological monitoring system can be utilised for drawing conclusions concerning ecological status and changes of the Szigetköz as well. Zoological investigations performed over the territories involved, offered good possibilities for the detailed description of vertebrate and invertebrate species of the fauna as well.

As regards fauna of the areas concerned we succeeded in the identification of about 2746 species at almost 800 sampling points, and arranged catching data in numbers up to almost 500 thousand entries into a relational database system. Also we could point out, that species-composition of some of the zoological communities of aquatic and semi-aquatic insects has undergone changes, a feature connected with some of the water-courses drying-up, on the one side, and caused by the increase of flow velocity, triggered off by the recharged water quantities, on the other.

Rate of hydrophilic insects has fallen back within the total of riverside insects, an indicator of wet habitats along the riverside obviously drying up. There are on the other hand – numerous invertebrate groups in case of which change in the composition of species could not be pointed out, not even after the diversion of the Danube, or after launching the water recharge operation.

# RECOMMENDATIONS

## for the harmonization of the monitoring systems established over the Upper-Danube (shortened version)

### 1. Introduction

The Ministry of Environment and Water set Environmental Protection and Water Management Research Institute the execution of a comprehensive analysis of the operation of observation systems accomplished over the Upper-Danube as a task, and this together with the elaboration of recommendations, with distinguished attention paid to the relevant parts of the Water Framework Directive (hereinafter WFD) of the EU.

Upper-Danube means in our paper the Szigetköz stretch of the Danube. The comprehensive review and the elaboration of recommendations shall cover observation systems operational in the Szigetköz region, incorporating the following main units:

- the hydrological and water quality control measurements continued by the North-Transdanubian Environment Protection, Nature Conservation and Water Inspectorate, the North-Transdanubian Environmental and Water Directorate;
- the geological monitoring, the research on the groups of wells located in the surroundings of the branches of the river, the monitoring of the development of conditions of riverbed morphology, sedimentation and bottom drift in respect of the Szigetköz stretch of the Danube and of the system of branches, all that coordinated by the Szigetköz Workgroup of the Hungarian Academy of Sciences and extending over issues like monitoring of surface coverage conditions, soil moisture monitoring, forests monitoring, botanical monitoring, hydro-biological monitoring algae and moss monitoring and zoological monitoring (not to mention programs of a lesser significance);
- common water-quality investigation moves on the Danube and its tributaries as corresponding to the resolution of the Hungarian-Slovak Boundary Waters' commission

Observations continued on the basis of the Agreement titled: "*Agreement between the Government of the Republic of Hungary and the Government of the Slovak Republic concerning certain temporary technical measures and discharges in the Danube and in the Mosoni branch of the Danube*" do not qualify like an independent scope of measurements, since they are component parts of the survey programs enumerated above anyhow.

Work was accomplished in two phases.

The first phase concentrates on collecting data on observation systems already operating giving account about their operation, about the groups of parameters presently recorded and also about the locations of these facilities. (Comprehensive overview of the operation of observation systems established on the Upper-Danube, September 2005, hereinafter *Evaluating Survey*). Whilst elaborating on the Evaluating Survey we did already give due attention to the envisaged tasks of the second phase. We have for instance collected different regulations of the EU, - needless to say that environmental monitoring played the role of the focal point at that - and submitted a couple of general proposals in different professional fields.

Working methods in the first phase were restricted, with special weight given to permanent - primarily Internet-based - consultations with institutions or with certain professional persons engaged in monitoring programs whatsoever. As a result of that we were in possession of basic data of all of the observation stations located in the Szigetköz, data, which are to be seen in the tables of the *Evaluating Survey*.

Whilst working on our recommendations due attention was still given to the national reports prepared to be annexed to the "Country Reviews" and the Government Decree, passed as practical guide to the implementation of Natura 2000 (digital version in the *Attachment*).

- Government Decree No. 275/2004.(X. 8.) on nature conservation areas of a significance at a European Community level,

- Report according to the Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for Community action in the field of water policy on analysis of the characteristics of the Hungarian part of the Danube River Basin District, and review of the environmental impact of human activities and economic analysis of water uses, March 2005,
- Status of the implementation of the Water Framework Directive in Hungary and in the Danube River Basin District, 2005.

The elaboration of the stuff of the second phase mainly requires the collection of proposals to further operation, (hereinafter: *Recommendations*).

In October 2005 the *Ecological Survey of Surface Waters, Hungary*, the final report of a EuropeAid Phare projekt (the so called BQE report), No/114951/D/SV/2002 containing prescriptions and considerations to be adhered to when hydro-biological measurements under auspices of WFD are performed was published. As for the hydro-biological observations envisaged in case of the Szigetköz monitoring program our proposal is already built up with BQE as a sound foundation.

The North-Transdanubian Environmental and Water Directorate prepared late 2005 a proposal for the optimalization of the near-surface monitoring network of the Szigetköz. It was again on the basis of recommendations of this that the proposal for the continued operation of the near-surface observation network could be put on a firm footing.

Unfortunately, the final document relying on the WFD prescriptions to be applied in Hungary for the investigation of subsurface waters shall only be ready after the closure of the *Recommendations*. When working on the *Recommendations* there shall be but a few preliminary conclusions available yet that we can make use of however in our own work. The same applies in case of the new working program of the Boundary Waters Commission as well. Under circumstances, the international negotiations may still offer better options and may render modifications in respect of the content of this paper possible.

It can be laid down as a fact, that no substantial modification is to be made in the joint, Hungarian-Slovakian monitoring of the water recharge towards the Szigetköz. This is also reflected by the fact, that the common documents issued in the last ten years did only call for a couple of minor changes of obviously technical character, and the demand to modify the *Statute* has not emerged at all.

At present, it is just because of the introduction of the rules of the EU, that we feel like proposing the incorporation of some new elements. These we have formulated on the basis of the *Recommendations*. We do accordingly propose:

1. to take over the WFD methods in the quality measurements of surface and subsurface waters,
2. to backfeed new scientific research results to our common activity aiming at the extension of the Natura network,
3. to abide without any restraints by the EU directive about the public availability of data on the environment,
4. finally - and this because of the technical changes of the last ten years - to check and correct the tables containing data on the sampling points and on sampling frequencies (these tables are attachments to the *Statute*).

Comprehensive documents prepared in the frames of this work have been put to the disposal of the Client both in printed and in digital form, whereas background materials of vast dimensions are only available as digital supporting documents.

### 2. EU regulations and tasks involved by their fulfilment

The EU membership brought for Hungary numerous new obligations with, among others some in connection with tasks to be handled as parts of the environmental monitoring. The attachment of the digital version of this paper contains the official translation of those EU directives (40 pcs) which actually contain prescriptions, recommendations or some kind of allusions concerning environmental monitoring.

From among the recommendations referring to the development of monitoring the guiding principle No 2000/60/EC, the so called Water Framework Directive rises high above the rest of regulations.

As regards other EU directives, it is the one under the registration number 92/43/EEC. A that again deserves special attention, the one, that has been devoted to the tasks to be solved in protection of natural habitats and of plants and animals living in the free nature. Extension of the network of Natura 2000 facilities shall bring with a great deal of new obligations for the monitoring system of the Szigetköz.

Directive No. 2152/2003/EC is devoted to the monitoring of forests, with emphasis laid upon the interdependencies of forests within the Community and their environment in a broader sense (Forest Focus November 17th 2003.). There has been a guide prepared on the basis of that: UN-ECE ICP (Forest Manual on Estimation of growth and Yield) 2004. It can be established altogether, that monitoring of the Szigetköz forests basically satisfies requirements of the EU. A proposal for the elimination of minor differences is presently being elaborated.

We thought to direct attention on regulation No. 2003/4/EC as fourth, since the Hungarian-Slovakian monitoring, keeping track with the effects of the water recharge can easily meet the demands connected with the public accessibility of information somehow related with environmental matters. Data on monitoring is made available in the practice of both of the parties through their website in the Internet. (The homepage *gabcikovo.gov.sk* has been operational for quite a time by now, whereas the website *szigetkozi-monitoring.hu* is presently being developed, providing data on the Internet has only been started with in this year). It would of course be very reasonable, if a statutory publicity clause was stipulated when the agreement on monitoring was finally cast in form.

According to WFD separate monitoring programs shall have to be worked out for each of the catchment basins for the purpose of keeping track of their water-dependent status in order to avoid untapped processes reducing the reliability of the results.

In order to be able of a tight follow up it is important that ecological status of natural water bodies and ecological potential in case of heavily influence water bodies be kept always under surveillance, notably by means of adopted versions of monitoring worked out in advance.

## 2.1 The Water Framework Directive

As has been prescribed by the *Water Framework Directive* (WFD) monitoring programs shall have to be worked out in respect of each catchment and that in order to be able of a continuous, broad and comprehensive judgement of the water-related conditions and ongoing procedures of each of these individual water-catchments. One has to be able to follow up the ecological conditions in case of water bodies of a natural character and/or the ecological potential, if it is about a distinctly modified water body. All that has to be done by using a monitoring program elaborated in advance.

The WFD demands three kind of monitorings (as corresponding to their different functions), such as surveillance, operational and investigative monitoring. *Surveillance* monitoring serves the purpose of supplementing impact-analyses, supports the design of additional observation networks and the exposition of long-range modifications caused by natural factors and/or triggered off as a consequence of human activities. *Operational* monitoring plays a role in the period between two *surveillance* monitorings in the interest of permanently controlling changes in the status of dangerous water-bodies, thus contributing to the realistic evaluation of the effects of measures taken. Finally, aim of the *investigative* monitoring program is to reveal relations between the causes and the results over areas, where such interdependencies are not yet known or proved. This type of monitoring is to be put in action also in the case of *havaría* type pollutions.

According to the Hungarian surface water typology (221/2004. (VII.21.) Government Decree) water bodies of the Szigetköz are strongly modified and they also play a fundamental role in the replenishment of subsurface water reserves. Qualifying as an important drinking water storing formation, the area also enjoys a protected status (219/2004. (VII.21.) Government Decree). The same applies if natural values of the area considered – the Szigetköz Natural Reserve (1/1987. (III.19.) OKTH decree) safeguards since 1987 the legal protection of the values. long range changes caused by the diversion of the al protection of the natural values. The status of a "natural reserve" means in the legislation of the EU equally protection and specific prescriptions concerning monitoring. It is this why WFD speaks out for the operation of an appropriately structured *surveillance monitoring*, thus assuring the follow up of long-range changes caused by the diversion of the Danube. On the other hand – in due consideration of the expectable or already manifest ecological changes of hydro-morphology and flow

patterns – it is equally necessary, that an *operational monitoring program* is also launched with the declared target of investigation of the ecological potential of the water-bodies.

In the regulations of EU concerning environmental monitoring – consequently in WFD as well – there appears a fundamental and quite definitely formulated demand that the monitoring should satisfy the conditions of a close follow-up of changes (whether of natural or technical character). It is in compliance with this requirement that parameters of the monitoring should be specified: such as the lateral distribution of the observation points, the time schedule of the surveys, the periodical supervision of the system. Judged from the point of view of the numerous. For as long as the Hague process is not closed down and international agreements prescribed in the sentence are not drawn up, persons dealing in the monitoring bear the heavy responsibility to carry on with collecting all those environmental data which shall gain a great importance from the point of view of sharing the water discharges of the Danube and when defining the extent of compensations for the infringement of lawful rights. Obviously, tasks of the Hague process of an environmental bearing and fulfilment of the WDF actually mean an almost identical obligation.

(The irreparable damages caused by inadequacy of data collection have already manifested themselves in the Gabcikovo-Nagymaros matter. The 20 years long interruption of surveys on drifted sediments measurement along the Upper Danube in the seventieths and eightieths (of the twentieth century) is a sad example in this respect, since this is why no reliable data – unquestionably acceptable also for international professional bodies – does exist about the changes of riverbed morphology. Without that there was no chance to convincingly demonstrate this of the greatest environmental damages that was caused by the diversion of the river.

## 2.2 The "Szigetköz" Natura 2000 Area

With Government Decree No. 275/2004. joining of Hungary to the network of Natura 2000 areas has been started with. This Decree announces, better to say marks out types of habitats of a public significance and of an enhanced public significance belonging to the network.

As regards the Szigetköz there are two titles by right of which parts to be protected might have been identified. Acc. to attachment No 5. a part of the area (SPA area, code: HUFH30004) qualified as a *distinguished bird protection area*. Attachment No 7. on the other hand earmarked certain areas to become *special nature reserves of distinguished significance* (pSCI area, code: HUFH000) Lands declared to be protected by virtue of two different titles are geographically identic. The Szigetköz Landscape Protection Area has been fully incorporated in the land specified as Natura 2000 area.

The "Szigetköz" Natura 2000 area comprises mainly the riverine belt forest territories along the Danube and the Mosoni-branch of the Danube in itself. Thus it extends at places over the customary geographical boundaries of the Szigetköz, since small patches may fall over the other side of the river. It seems to be reasonable to extend monitoring of the Szigetköz over this area as well. Lands involved are shown in the figure (the drawing was prepared on the basis of the map of the Fertő-Hanság National Park). Types of habitats, which are actually the cause of the earmarking, and species of flora and fauna can be found in the table of the attachment.

Demarcation of Natura 2000 areas – partly because of the new, international obligations – shall obviously add to the tasks of monitoring. As it is tasks shall then not be limited to the watching of birds and other living creatures, but keeping track of the changes of habitats shall also be part of the work.

An important aspect of this newly created scope of duties shall be as formulated by article 18. of Directive 92/43 EEC about protection of natural habitats and plants and animals living in the free nature:

(1) *Considering goals acc. to clause 2 and obligations as summed up in clause 11 Member States and the Committee shall further research and scientific work. Exchange of information – both on the level of member countries and on a Community level – shall serve the purpose of synchronisation of research programs.*

(2) *They shall pay special attention to the scientific work needed to accomplish article 4. and 10, and support co-operation of the member states also promoting joint programs of an international character. As to improve chances of success it is proposed to make use of the knowledge, experience and data base of monitoring specialists working at the Szigetköz for more than ten years by now, notably through involving them in the monitoring of changes of habitats.*

### 3. Evaluation of environmental monitoring presently in operation on the basis of EU directives

The systematisation of the *Country Report* issued in March 2005 separated in respect of the Szigetköz 7 surface and 2 subsurface water bodies. The main task of the Szigetköz monitoring according to WFD is to keep track of the changes of the following water bodies.

In case of water courses the selection of the water bodies strongly modified before the start of the program already was made on the basis of the identification of those stretches of the stream, which were under an obviously intensive effect from a hydro-morphological point of view. At water bodies assigned here a major change of aquatic organisms could readily be proved, whilst human interference may not possibly be replaced or counterbalanced by other solutions of reasonable costs, let alone advantages from an environmental aspect. Validation of this assignment as corresponding to the ecological status is another issue to be attended to, and the actual, cause vs. result type degradation (i.e. the mechanism, according to which human interference and condition of the communities of living organisms is interrelated) should also be subject of considerations.

The above demand is partly satisfied within the scope of the biological status assessment program realised within a PHARE-aided scheme. Continuation of that and its supplementation with the evaluation of hydro-morphological effects is absolutely necessary. A further task emerges here in that a detailed technical and economical analysis for distinctly modified water bodies is also to be prepared. Estimation of the conditions of the maximal ecological potential – for the strongly modified and totally artificial stretches of the water-course – shall be dealt with in a later section.

The *Country Report* and its attachments devote distinguished attention to the monitoring tasks connected with the typologisation. Generally speaking one can establish, that field-work, as it is presently exercised in the Szigetköz basically corresponds to the new concept at least from a structural point of view. This feature may primarily be thanked to the fact, that the present monitoring concept had been established with the contribution and understanding of EU experts. After the diversion of the Danube, in the year of 1993 the EU committee instituted a tri-lateral professional working team. This unit released two summary reports (and several background studies) and came forward with suggestions for the development of the Hungarian and Slovakian monitoring on the one part) and for a provisional sharing of the water discharges on the other. Their report on the monitoring passed through with a common understanding of the Hungarian and the Slovakian experts and the EU-delegate. Its summarising statements are presented in attachment No.2 The measuring circle corresponding to the new concept came into being in 1994 – 1995. urements acceptable also when the new concept came. The EU recommendations have been taken over by the slovakian experts as well, making use of them mainly in the deveopment of the Csallóköz monitoring. Systems like the one acc. to this agreement rendered later (in 1995) possible the births of the Hungarian-Slovakian Common Inter-governmental Monitoring Agreement which has lead to the efficient follow up of the water recharge to the Szigetköz.

It goes without saying that apart from the structurally advantageous development of the Szigetköz monitoring there are several factors which exert a negative effect, hindering us in the fulfilment of the EU expectations. One of our main concerns is the geographically mosaic-like character of the surveys. As it is, primarily because of the scarcity of resources, the number of observation sites of hydro-morphological and biological type is low, whilst researchers on their side strive for keeping track of possibly every characteristic process – and this for the sake of rendering evaluation of the conditions possible. In some of the cases of a lesser importance you may even encounter a kind of temporal fragmentation, this meaning that series of data are occasionally interrupted by time-gaps of half a year or an entire calendar year. As to meet expectations of the EU it is just this discontinuity which should be reduced some way or another. One should achieve a stage, in which research would not be confined to some sections of certain branches within the expanded water system of the Szigetköz. It is just the condition of the traceability of changes which may get hurt because of the present low number of observation sites, especially few in comparison with the complexity.

Two of the goals within reach could still be realised, even if we do not lose sight off the limited financial possibilities. First: the continuity of the row of data in case of the presently measured parameters should be maintained. Second: measurements of the new chemical and biological compounds picked up in the course of the water quality surveys should immediately be started with.

### 4. Aspects of preparation of the proposal

#### 4.1. General consideration concerning the planning of environmental monitoring

The main task of environmental monitoring is to make measurements (both in the outdoors and in the laboratories), the recording and processing of data, syntheses.

From among the tasks to be dealt with it is measurements that call for the most of resources, both in respect of expenses and time consuming. Development in respect of instrumentation brought a never before quantity and quality of data. Unfortunately, demand on resources has generally grown, instead of the expected sinking. This is why definition of the number of measurement points and of the frequency of measuring became the most critical part of the design.

Measurements can reasonably be divided into two groups in respect of frequencies:

- *monitoring measurement*: systematic measurements in pre-determined points of time, or under circumstances defined in advance (e.g. at a pre-determined water regime, or season). When deciding about times an evident point of decision is that changes of the phenomena to be analysed should be documented throughout;
- *quasy-monitoring measurement*: expeditionary measurement, (quasy expedites), in case of which it is aspects, (e.g. the financial possibilities), practically quite independent from the process that is subject to the investigation on the basis of which the time of measuring shall be determined, consequently the fact, that under circumstanceses the monitoring should not be executed, even though it is clear that phenomena which we were curious about does just undergo major changes becomes its main characteristic. Responsibility of the participants is much greater in case of planning quasy monitoring measurements.

Considerations like the ones above do of course not mean that all measurements are to be made on such a regular basis, there are other natural phenomena yet, which can only be studied in the frames of an expedition. Neither does it mean that fixed dates of monitoring measurements could not be changed, the more so if this does happen as adoption ourselves to a new kind of knowledge.

Within the domain of the radius of the Szigetköz , measurements - except for the water level gauging and for the chemical components of the water quality analyses – all measurements are accomplished as quasy-monitoring type operations. Due to the quasy-monitoring cathegory spread by WFD by and large, some of the hydro-biological elements shall now be classified as belonging to the regular type, whereas others may maintain their expeditional character.

The circle of quasy monitoring measurements was inaugurated in the years of 1993-1994 EU experts have also given recommendations for the optimum number of expeditions, other experts tried to define the minimum conditions as well. Apart from a row of minor or greater difficulties this measurement program was valid and operational till the budget squeeze of the years of 2003 and 2004. As it is, number of points has fallen back during these two years, and measurements have also become less frequent. The Head of the Working Group of the Hungarian Academy of Sciences has given distress signals, claiming that measurements may be put aside only for a while, but after that the program shall die away and the continuity of the row of data counts like interrupted after that.

The WFD declares the obligation that measurements have to point out the changes of the water body (and of the living organisms depending on it). This is the only way of whatever kind of compensation or reimbursement of personal expenses aimed at. If the spacing of the expeditionary shots is much too wide, we run the risk of not qualifying as victims of a natural catastrophe, since exposure of a complicated hydrological-hydrogeological procedure requires – in addition to the shots of the regular measurements (which are obligatory assets in the opinion of WFD) – one has to present for the promotion of his own case at least a limited amount of data obtained as a result of "expeditionary" measurements.

#### 4.2 Structure of the Proposal

1) As it is, the *Proposal* handles each professional area broken down in two separate packages, such as *monitoring* – *quasy-monitoring*. Reason for that is in the first place the organisational structure, whilst financial

considerations may also play a role. Participants of the quasi monitoring work are active within the Working Group of the Hungarian Academy of Sciences, their duties performed on the basis of annual contracts. Regular measurements shall be performed by the regional organisations of the Ministry, mostly as a kind of "official obligations" this meaning that the work qualifies like basic activity, with costs and expenses built into the normal budget of the institutions. In compliance with the prescriptions of WFD the paper reviews recently introduced hydro-biological measurements together with other regular measurements to be noted, that they shall be handled within the regular circle the first time now.

2) The proposal contains but a summary of a couple of sentences in case of all of the professional fields (what is measured, by whom and when), specifically indicating measurements which belong to the scope of the Hungarian - Slovakian exchange of data.

Modifications concerning the content of the scope of measurements shall be divided in two groups:

A) Small-scale modifications of a rather technical character, not involving any financial consequences are incorporated into the tables of the particular measuring stations, without even explaining or justifying them.

B) Wherever changes of greater extent if compared with the *Evaluating analysis* experienced, the *Recommendations* shall give a somewhat *detailed description* to that.

3) Financial aspects are handled by the proposal separately, divided up according to the professional area, also summarising at the ends of the chapters elements increasing or reducing the costs. The costs component is but a conscientious estimation given on the basis of informations available for us.

4) The last chapter is a proposal for the modification of the regulations of the common Hungarian - Slovakian monitoring. The table enumerating observation points and frequencies of measurements of stations belonging to the presently operating system and involved into the data exchange program can best be attached here, since the list of participants has already been changed on several occasions in the course of the ten year of operation.

Our proposal concerning data exchange recommended for evaluation (only proposal) would mean the s to say termination of the changing of data, this though simultaneously with the fulfilment of the guiding principles of the EU about publicity of data equally introduced and applied in respect of the Szigetköz and Csallóköz monitoring as well, this meaning, that measured data should become accessible for every EU citizens on the basis of their subjectivity.

## 5. An overview of the monitoring

In our composition herebelow monitoring activities of the upper Danube Region are reviewed thematically (in a professional grouping) and not according to the structure of the official systems of monitoring. Our proposals try hard to give attention to aspects of the EU directives concerning monitoring and to meet the expectations of the Water Framework Directive of the EU.

### 5.1 Systematic (monitoring) measurements

#### *Quantitative data on surface waters (hydrological monitoring)*

Reviewing the operation of those elements of the observation systems of the Upper Danube which are only involved in the collection of quantitative data we had to establish that the network of stations is equally capable of providing data for the water recharging systems and to the operation of the Dunakiliti bottom weir as well as for the monitoring of the Szigetköz and to the data exchange of the border waters respectively.

Based on the overview of the stations of the observation network and making ourselves acquainted with their measuring program the following recommendation may be made:

- the network of stations belonging to the Upper-Danube observation network and primarily engaged in the collection of quantitative data on surface waters is of a reasonable development, does not call for enlargement or other major improvements;

- scope of observed or measured data is satisfactory and suitable for the determination of quantitative characteristics of the water regime though number of water-discharge measuring stations should be increased, especially in respect of the entry and the departing section; and the reliability of the computed water discharge values is to be improved;
- displacements of sediments playing such an important role in case of the upsilting of the system of branches should be numerically defined through regular measurements;
- a more rigorous margin of error is to be introduced when border-water agreements are negotiated;
- it is equally necessary to check series of data at stations with exceptionally long records (e.g the gauge of Dunaremete) with engineering works (reconstructions) also considered.

#### *Ground water table observations*

In order to keep track of the ground water table of the Szigetköz and to be able of analysing the changes of their depth observation wells were deepened in the following networks:

- the trunk network wells,
- operational observation wells of the Szigetköz,
- wells of the Hungarian Geological Institute,
- wells of operational and prospectively sensitive aquifers,
- the so called monitoring wells, built out to the Gabcikovo - Nagymaros system.

Operation of the observation wells is in the hands of North-Transdanubian Water Inspectorate, except for the wells of Hungarian Geological Institute.

In the time of writing the *Evaluating Analysis* preparations for the optimisation of the groundwater observation network of the Szigetköz under the North-Transdanubian Water Inspectorate's direction was already going on, notably according to a detailed hierarchy of aspects. The preparatory study contained beside the actual observation stages, the present and the prospective phase of the aquifer presently run by the North-Transdanubian Water Inspectorate.

Optimalisation - complying with the WFD concept - sets out from the requirements raised against the information (data) supplied by the observation system. The most important demands, which the network shall have to be able of satisfying subsequent to optimalisation:

- the network shall be sufficiently dense to make possible the reconstruction of all flow directions and gradients with significance from a regional aspect.
- it is again to be assured, that - in a good knowledge of hydrogeological conditions - the extent of exchange or transfer between the different kinds of water bodies can reliably estimated, both in relation of surface waters vs. ground-water, but also between the ground-water and the water masses of a greater depth.

On the basis of our general recommendations in the *Evaluating Analysis* it is now the *optimisation proposal* which we suggest to modify as follows:

1. In case of pairs of wells of only a small distance inbetween it is proposed to abandon one of them notably the one with the shorter history of records. (According to the *optimisation proposal* criteria to be met it is as follows: extrapolation of the ground-water surface topography should be attained at "0" as a mean value and 10 cm as standard deviation. Considering the general descent of the Szigetköz it has to be accepted, that wells of a distance below 400 meters do not deliver new, independent data. Number of wells to be abandoned is 5 Nos., near-surface trunk network station, with another 6 Nos. of normal, monitoring stations. From among the pairs of wells it is always the one with a longer history of records, that we propose to keep.

2. Flood area wells and those located right on the protected side of the dams, are again to be kept on the network, the more so if they are complete with instruments of registration. The *proposal for optimisation* reckons with the abandonment of 18 such wells, out of which 11 Nos. are also equipped with the said instruments. It seems to be reasonable to apply such registration instruments at the 7 wells presently not having that. Without our supplementary proposal the present number of wells, ready for operation would be halved, and

this over an area (Cikola and Bodak system of branchest) that qualifies like one of the mossensible in respect of fluctuations in the level of ground water.

3. Wells earmarked for the exchange of data as defined in the *Statute* of the Hungarian-Slovak Common Monitoring Agreement should remain elements of the network.

4. Number of the water level observation wells in the Szigetköz runs up to about 200 in numbers, with only about one third of them belonging to the trunk network. There is not a single trunk network station in the flood area of the Danube. Again, we propose to classify from among the so called monitoring wells at least those located in the flood area and the wells of the Hungarian-Slovakian data exchange program to trunk network facilities.

5. A better overview could be attained if groups of stations were distinguished by the use of the customary "trunk network" and "operational" attributives.

### Surface water quality monitoring

Systematic observation of water quality along the Upper-Danube takes place in different monitoring systems.

- national, regional and local trunk network measurements for the characterisation of the quality of surface waters;
- common water quality tests on the Danube and its tributaries according to the resolution of the Hungarian-Slovak Boundary Waters Commission;
- joint water quality analyses as corresponding to the Hungarian-Slovak agreement of 19th April 1995;
- water quality monitoring of the Szigetköz water recharging system.

Measured data of some of the sampling stations shall become elements of several different systems. This means practically that results of trunk network measurements financed from the normal operational budget of the services shall get utilised without additional expenses, as obligations to be fulfilled in compliance with the resolution on Boundary Waters and with the Hungarian-Slovak Agreement of 1995.

#### Proposals

An operative monitoring proposal for the water-bodies of the Szigetköz area of the Upper Danube region has been elaborated within the design of the national monitoring network as prescribed by WFD. The elaborate rests on a risks analysis of the water-bodies investigating phenomena to the level of the water-body. Selection of the definite sampling areas within the water bodies shall take place in the fourth quarter of 2005.

Table containing data on sampling areas and frequencies of sampling.

### Subsurface water quality monitoring

Networks developed for observing subsurface water qualities and those, built for the purpose of measuring ground water levels are necessarily in an overlapping with each other.

Operational networks:

- observation wells of operating and prospective sensible water-bases,
- operational observation wells of the Szigetköz,
- operational observation wells of the Szigetköz, of varying use (industrial, agricultural),
- Szigetköz water quality monitoring (water quality and water level measuring wells) deepened along the side of the branches of the rivers.

In case of subsurface water quality tests measured characteristics of the productive wells obliged for measurements are to be involved into the investigation work as well. In case of non-obliged wells it is still advisable to accomplish periodically, (at 5 - 6 years intervals or so), expeditionlike sample collections, including here tritium tests as well, all that synchronised with ongoing operations continued within the frames of the geological monitoring or other works of the Hungarian Geological Institute.

### Proposal for continued operation

In consideration of the requirements of the WFD applying in the case of underground waters' quality monitoring in the Szigetköz it is to be pointed at, that our main concern is - as regards subsurface water quality observation - the uppermost 50 m thick formation, and attention is to be paid to the monitoring of areas of exceptionally intensive influx values. In view of the water quality components one has to keep in mind the rule, that subsequent to a broad survey aimed at a wide variety of components we have to systematically investigate the well-known indicating components, followed by tests aimed at relevant polluting agents. These are altogether requirements, basically satisfied by the present subsurface waters quality monitoring system.

Number of registered and observed wells within the groups sunk quite beside the river branches of the Szigetköz and meant for water level and water quality surveillance can now be reduced by about 30 p.c. as against the monitoring program of 2004.

## 4.2 Quasy-monitoring measurements

### Geological monitoring

The measurements were carried out by the researchers of the Geological Institute of Hungary.

The condition of the riverbeds, the water quality and the flow velocity of the surface waters have been changed and are being changed by the intrusions carried out along the upper reaches of the Danube in Hungary. At locations where these waters mean the only source of recharge the changes can be best kept track of by means of sondages and wells drilled as near to the effective stretches of the riverbed as possible. Since as far back as 1995, regular geological monitoring is carried out along the Rajka-Nagybajcs stretch of the Danube and its branches by the Geological Institute of Hungary. The target of the investigation of the river section is to determine the interrelation of the surface and subsurface waters, the documentation thereof and their interdependence with the geological formations. Engineering geological methods are needed to follow up the changes in the recharging and tapping capability of certain lengths of the river. Sampling stations and time spans of measurements are shown in Table.

### Riverbed morphology, and sediment monitoring

The measurements are accomplished by researchers of Environmental Protection and Water Management Research Institute.

The closure of the main channel of the Danube at Cunovo in October 1992 and the diversion of the decisive part of the discharge towards the upstream canal of the Bős hydraulic power plant transformed the Danube section between Rajka and Nagybajcs, not mentioning the system of branches of the river to a much greater extent than any of the earlier river trainings.

Monitoring of the riverbed, of its material and sediment monitoring was started by the registration of the zero status just before the October 1992 diversion. The general layout of monitoring activities between 1992 - 2004 has been summarized in Table.

Proposals for the continuation of the monitoring:

Minimum program:

- riverbed surveys of annual frequency along the Szap-Dunaremete and Dunakiliti-Rajka with the customary density,
- simultaneous sample of riverbed material from five-seven points of the registry section (VO) at points indicated in the Danube atlas,
- annual riverbed survey and bottom material sampling from every third survey section at the Ásvány and Bagomér branch system,
- survey of the areal extent and thickness of the mud layer deposited in the Bagomér branch, computation of the quantity/modification of the fine material (silt) deposited in the branch
- near-surface sampling at each river kilometer and sampling in the total depth (in the plumb line) at every fifth kilometer for suspended solids analyses in the laboratory.

Optimum program (in addition to the minimum program)

- Increasing temporal frequencies of the measurements and samplings with fitting these to the water regime: suspended solids sampling during greater floodwaves, riverbed survey short after their passage together with sampling of riverbed material,
- extension of sampling of riverbed, riverbed material and sediments monitoring as far as Vének (1793 river kilometer),
- definition of the shoreline of mean discharge riverbed changes - based on aerial photos and dry land survey - as a control of the previous,
- computation of mean discharge - and high flood channel water conveying capacity.

#### *Replenishment of subsurface waters*

Measurements accomplished by researchers of Environmental Protection and Water Management Research Institute.

In the year 1994 within the frame of a governmental project there were 11 groups of wells built - right next to the water-recharging branches in order to be able to investigate their role in the enrichment of the recharge water. Due to technical reasons and changes in the topography of the area, since 2006 observations are only going on in case of 4 of these groups of wells. It is like this that the remaining budget allows us to undertake measurements (in harmony with the WFD) beyond the ones of primary importance from the point of view of the judgement of redox procedures (ammonium, nitrite, nitrate, iron and mangan) and at the same time allows us to launch a wider variety of components identification than originally planned. When taking samples, the water levels are also recorded.

#### *Monitoring of water cover conditions in Szigetköz*

Series of aerial images have been taken in Szigetköz twenty times since 1984. Since 1992 the surveys have taken place at least once a year with equal parameters. The whole area of Szigetköz is covered by aerial images. The series of thematic maps compiled upon the photo sets provide a real display of the summer water cover conditions in Szigetköz. The maps represent a true picture on the state of vegetation and water cover in both the active floodplain and protected side.

Recommendation:

- it would be reasonable to take aerial images on the active floodplain of the Danube in Szigetköz yearly during the leafless period as well;
- it would be advisable to use the spatial images of the area in the remote sensing program.

#### *Soil moisture monitoring*

The measurements are taken by the staff of the University of West Hungary, Faculty of Agricultural and Food Sciences.

Soil moisture is measured in 20 sites, of which 11 is included in the Hungarian-Slovak data exchange. The measurements take place in moisture recording wells implemented beside water level observation wells usually once in two weeks between March and November. The observation sites are listed in the table and they are presented in the figure.

#### *Forestry monitoring*

The measurements are taken by the staff of the Forestry Research Institute.

Tree growth monitoring: In early spring the growth of trees identified by reference number are measured in 50 by 50 m experimental parcels (diameter, height).

Tree health monitoring: The individuals of the sample are qualified twice a year of the healthy to the perished ones.

Renewal experiment: In the frame of the experiment the composition of the spontaneously evolving tree stock is examined without human interference in tree-free clear-cut areas.

Continuous periphery measurements: Periphery growth is measured by dendrometer bands once a week during the vegetation period.

#### *Botanic monitoring*

The measurements are taken by the staff of the Department of Taxonomy and Ecology, Lorand Eötvös University as well as the Department of Botany, West-Hungarian University.

Coenological survey: It constitutes the registration of the coenological cover of all sprouting plants within a 25 by 25 m pilot area performed once a year in July.

Reed experiments: Measurement of sprouting density and the foot height of reed (*Phragmites australis*) takes place twice a year, in July and December.

Measurement of leaf surface: It consists of the determination of the size of fallen leaves. In order to perform the examination the leaves of pendunculated oak (*Quercus robur*), gluey alder (*Alnus glutinosa*) and white willow (*Salix alba*) are collected in December every year.

Monitoring the weed vegetation of Szigetköz: The survey is performed in 40 sites between June and August in corn and maize fields in both intensively and extensively cultivated fields for both cultures.

#### *Hydrobiological monitoring*

The investigation is performed by the staff of the Hungarian Danube Research Station, Institute of Ecology and Botany of the Hungarian Academy of Sciences. Full-scale examinations are performed twice a year (exceptionally a third measurement can also be performed). The parameter groups studied can be listed as follows:

- background hydrochemistry,
- phytoplankton, stock composition, trophic conditions,
- zooplankton,
- changes in macrophyton stock structures,
- representative littoral macroinvertebrate studies,
- fish biology, fishery ecology.

Investigation sites: 6 points on the Danube, 4 points in the active floodplain and 5 points in the protected side.

#### *Alga and moss monitoring*

The measurements are taken by the staff of the Hungarian Natural History Museum, Department of Botany. Due to the modified tasks the name of the work has changed to "Hydrobotanic monitoring in the Szigetköz".

Phytobenthos (periphytic diatom) studies have been carried out in the Cikola and Ásvány branch systems since 1992. Algal grasses have been investigated in the two branch systems since 1996. The related grasses of mosaic pattern are the indicators of benthonic eutrophication.

Mosses have been studied since 1994. The frequency of the occurrence of species is determined once a year on the basis of representative collection.

Sampling sites are listed in the table and they are presented in the figure.

#### *Zoological monitoring*

The investigation is carried out by the staff of the Hungarian Natural History Museum, Department of Zoology.

The studies have been performed since autumn 1993 in stationary sampling sites. They are focused essentially on the data of the presence/absence of specific groups of aqueous, in water evolving and terrestrial fauna.

From 2006 on in compliance with the application of the WFD the investigations proceed by introducing new evaluation methods and the assignment of new sampling sites in two task groups. 13 and 40 sites have been assigned to carry out the tasks formulated in the Water Framework Directive and to determine the terrestrial fauna (crab fauna, molluscs, butterflies, mammals, trichoptera, adder-flies, day-flies), respectively. It serves as the basis of the information involved in the Hungarian-Slovak data exchange.

The observation sites are listed in the table and they are presented in the figure.

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