WATER QUALITY ASSESSMENT OF THE DANUBE AND OTHER SURFACE WATERS PURSUANT TO THE WATER FRAMEWORK DIRECTIVE

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

Short name	Full name
ANOVA	Analysis of Variance, one of the most widely used parametric tests which compares the average of multiple samples.
ÁNTSz OTH	Office of the Chief Medical Officer at the National Service for Public Health and Medical Officers (NSPHMO)
ASPT	Average Score Per Taxon, derived from the BMWP system of scoring.
BM	Ministry of Interior
BME	Budapest University of Technology and Economics
BMWP	A scoring system of the Biological Monitoring Working Party used for classification on the basis of registering invertebrates in the benthos according to their families (in certain cases classes or genera).
CPUE	Catch per unit effort:: catch calculated for a unit of length, surface or period of time, usually defined in number of specimens.
DBC	Design Basis Conditions
DdKTVF	South Transdanubian Environmental Protection, Nature Conservation and Water Management Inspectorate
DDNPI	Danube-Drava National Park Directorate
EKD	Preliminary Consultation Document
EME	electronic sampling device
EQIHRF	Ecological Quality Index of Hungarian Fluvial Fishes, an EQR based multimetric ecological classification index based on fish communities developed for domestic watercourses
EQR	Ecological Quality Ratio
ERBE	MVM ERBE Zrt.
EüM	Ministry of Health
FB	phytobenthos
river km	river kilometre
FRH	liquid radioactive waste
FP	phytoplankton
GPS	Global Positioning System
HCLPF	High Confidence of Low Probability of Failure
HLPI	Hungarian limnological phytoplankton index
HRPI	Hungarian river phytoplankton index
KHV - KHT	Environmental Impact Study - Environmental Impact Assessment
KöM	Ministry of the Environment
KÖV	mid-water stage
KV/NV	high/low water stage
LE	inhabitant equivalent
LKV	minimum water level
LNV	maximum water level
MF	macrophyte
MgSZH	Central Agricultural Office
MIR	Modernised International Reactor
MMCP	Hungarian Macrozoobenthos Family Scoring System
MVM	MVM Hungarian Electricity Works Private Limited Company
MVM Paks II Zrt.	MVM Paks II Nuclear Power Plant Development Private Limited Company
MZB	macrozoobenthos
NBmR	National Biodiversity Monitoring System
NQr	Normalised river phytoplankton metrics
NV	High water
OMSz	National Meteorological Service
Paks II.	Paks II Nuclear Power Plant
Paks Nuclear Power Plant	MVM Paks Nuclear Power Plant Zrt.
TÁP	average score per taxon, a qualification method to be used for biological water quality determination based on binary macrozoobenthos data
TIR	Nature Conservation Information System
GHG	Greenhouse gases
VGT (OVGT)	River Basin Management Plan of Hungary
WFD	Water Framework Directive

12 WATER QUALITY ASSESSMENT OF THE DANUBE AND OTHER SURFACE WATERS PURSUANT TO THE WATER FRAMEWORK DIRECTIVE

12.1 LEGAL BACKGROUND, LIMIT VALUES, STUDY ELEMENTS, METHOD

12.1.1 LEGAL BACKGROUND

International directives

Council Directive 92/43/EEC of 21 May 1992 on the Conservation of natural habitats and of wild fauna and flora

Bern Convention on the Conservation of European Wildlife and Natural Habitats (1990/7. international convention)

Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy

Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy

Commission Directive 2009/90/EC of 31 July 2009 laying down, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, technical specifications for chemical analysis and monitoring of water status

Council Regulation (EEC) No. 793/93 of 23 March 1993 on the evaluation and control of risks of existing substances

Council Directive 83/513/EEC of 26 September 1983 on limit values and quality objectives for cadmium discharges

Council Directive 84/156/EEC of 8 March 1984 on limit values and quality objectives for mercury discharges by sectors other than the chlorine-alkali electrolysis industry

Council Directive 86/280/EEC of 12 June 1986 on limit values and quality objectives for discharges of certain dangerous substances included in List I of the Annex to Directive 76/464/EEC

Acts

Act No LIII of 1995 laying down the general rules for the protection of the environment

Act No LVII of 1995 on water management

Decree No 6 of 1986 with the force of law (Bonn Convention) promulgating the Convention on the Conservation of Migratory Species of Wild Animals dated on 23 June 1979 in Bonn.

Act No XLI of 1997 on fishing

Act No XXXII of 2003 promulgating the Convention on International Trade in Endangered Species of Wild Fauna and Flora adopted in on 3 March 1973 in Washington

Act No CII of 2013 on fish management and the protection of fishes

Government Decrees

Government Decree No 275/2004. (X.8.) on the areas of Community importance dedicated to nature conservation

Government Decree No 220/2004. (VII. 21.) laying down the rules for protecting the quality of surface waters

Government Decree No 221/2004. (VII. 21.) laying down certain rules for river basin management

Government Decree No 2/2005. (I. 11.) on the environmental study of certain plans and programmes

Government Decree No 314/2005. (XII.25.) on the Environmental Impact Assessment and the integrated licensing procedure for the utilisation of the environment

Government Decree No 100/2014. (III. 25.) amending certain Government Decrees in the context of the full transposition of the environmental objectives set by Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for the Community action in the field of water policy

Government Decision

Government Decision No. 1042/2012. (II. 23.) on the river basin management plan of Hungary

Ministerial Decrees

Ministerial Decree No. 78/1997. (XI. 4.) FM laying down certain rules for the implementation of Act No XLI of 1997 on fishing and angling

Ministerial Decree No.90/2000. (XI.14.) FVM amending Ministerial Decree No. 78/1997. (XI. 4.) FM laying down certain rules for the implementation of Act No XLI of 1997 on fishing and angling

Ministerial Decree No.13/2001.(V.9.) KöM of the Ministry of Environment publishing the lists of protected and strictly protected plant and animal species, strictly protected caves and plant and animal species of Community (European Union) nature conservation importance

Ministerial Decree No.31/2004. (XII. 30.) KvVM laying down certain rules for the monitoring and state assessment of surface waters

Joint Ministerial Decree No.6/2009. (IV. 14.) KvVM–EüM–FVM on the limit values necessary for the protection of the geological medium and underground water bodies against pollution and the measurement of contamination levels

Ministerial Decree No.10/2010. (VIII. 18.) VM on the limit values applicable to the contamination of surface waters and laying the rules for the application thereof

Ministerial Decree No.133/2013. (XII. 29.) VM laying down certain rules for fish management and fish protection

Ministerial Decree No.28/2004: (XII. 25.) KvVM on the limit values applicable to the contamination of waters and laying the rules for the application thereof

12.1.2 STUDY AREAS

In order to lay the foundations for the environmental impact study, tests with a view to the Water Framework Directive (WFD) were carried out in the years 2012 and 2013 in the profiles of the Danube between river kilometres 1560.6 and 1481.5, as well as in several water bodies having direct or indirect communication with the Danube [12-29], [12-30].

12.1.2.1 Danube

The following sample profiles were used for testing in the study section of the Danube.

I. Danube/Dunaföldvár

Distant upstream study section.
Sampling covered physico-chemical tests, examination of the phytoplankton and the phytobenthos in 2013.

II. Danube/Paks (ferry)

Near upstream study section.
In 2013 sampling operations covered macrophyte, macrozoobenthos, and fish community studies.
In 2012 samples for physico-chemical testing, as well as phytoplankton and phytobenthos examinations were taken in this profile.

III-V. Danube/Paks (hot water discharge, Nagysarkantyú, Uszód)

Near downstream study section.
Sampling in 2012 covered physico-chemical parameters, as well as phytoplankton and phytobenthos assessments.

VI. Danube/Gerjen-Foktő

Mid-distance downstream study section
Sampling in 2012 covered physico-chemical parameters, phytoplankton, phytobenthos, macrophyte, macrozoobenthos and fish community assessments.

VII. Danube/Dombori

Mid-distance downstream study section
Sampling in 2013 covered physico-chemical parameters, phytoplankton, phytobenthos, macrophyte, macrozoobenthos and fish community assessments.

VIII. Danube/Sió-Southl

Distant downstream study section
Sampling in 2013 covered physico-chemical parameters, phytoplankton, phytobenthos, macrophyte, macrozoobenthos and fish community assessments.

IX. Danube/Baja

Distant downstream study section
Sampling covered physico-chemical parameters, phytoplankton, phytobenthos, macrophyte, macrozoobenthos and fish community assessments alike.

For the purposes of the assessment in accordance with the WFD the sample profiles were divided into sections. These are the **upstream**, **near downstream**, **distant downstream sections**. In order to evaluate biological elements a **mid-distance (downstream) section** was also specified on the distant section.

Each of the profiles investigated belongs to the water body called "Danube between Szob and Baja" marked HURWAEP444. The water body concerned is the section of the Danube between 1708 to 1481 river kilometres.

This water body can be ranked as the type of the very large calciferous lowland rivers [12-45].

12.1.2.2 Other water bodies

Of the water bodies connected to the Danube assessment with the WFD aspects were done in the year of 2012 in the Kondor-Lake of Paks, the Fishing Ponds fed by the hot water discharged from the Paks Nuclear Power Plant and the Dead Danube of Fadd, periodically fed on hot water. Additionally, our tests were supplemented in 2013 with the Northern Dead Danube of Tolna and the downstream section of the Sió-channel. The Tolna-Dead-Danube also receives hot water intake periodically from the hot water canal of the power plant. As opposed to the other water bodies assessed, Sió-channel has no direct connections with the Paks Nuclear Power Plant, it merely has a slight influence on the water quality of the Danube below the Sió mouth through its organic matter and vegetative nutrient contamination. During floods, however, Danube water inundates Sió-channel as well, therefore potentially an indirect impact may emerge.

All of the assessed water spaces are part of the water bodies determined by the Water Framework Directive. The names and respective codes of each water body are presented in the table below.

Geographic name	Name of the water body	Code of the water body
Kondor-Lake	Paks Nuclear Power Plant HE Angler Ponds	HU_LW_AIH005
Angler Ponds	Paks Nuclear Power Plant HE Angler Ponds	HU_LW_AIH005
Dead Danube of Fadd	Dead Danube of Fadd	HU_LW_AIH066
Northern Dead Danube of Tolna	Northern Dead Danube of Tolna	HU_LW_AIH136
Sió	Sió low	HU_RW_AEP959

12.1.3 LIMIT VALUES

12.1.3.1 Physical and chemical properties of water

12.1.3.1.1 Limit values applicable to the Danube water under the WFD

Limit values for water quality in the Danube pursuant to Ministerial Decree No. 10/2010 (VIII.18) VM and according to the VGT 5_2 background material							
		high	good	Does not reach good status		
Component	**measured unit.**			**moderate**	**poor**	**bad**
pH		**6.5-8.0**	**8.0-8.5**	6.0-6.5 8.5-9.0	5.5-6.0 9.0-9.5	<5.5 >9.5
Conductivity	µS/cm	**<500**	**500-700**	700-3000	3000-5000	>5000
Chloride	mg/l	**<25**	**25-40**	40-300	300-500	500
Oxygen saturation	%	**70-110**	**110-120 70-80**	50-70 120-150	50-20 150-200	<20 >200
O_2	mg/l	**>8**	**7-8**	7-4	4-3	<3
BOD_5	mg/l	**<2**	**2-3**	3-15	15-25	>25
COD_k	mg/l	**<10**	**10-15**	15-50	50-70	>70
NH_4	mg/l	**0.13**	**0.13-0.26**	0.26-1.28	1.28-6.41	>6.4
Ammonium-N (NH_4^+-N)	mg/l	**<0.10**	**0.1-0.20**	0.20-1.0	1.0-5.0	>5,0
NO_2-N	mg/l	**<0.01**	**0.01-0.03**	0.03-0.3	0.3-1.0	>1
Nitrate-N (NO_3^--N)	mg/l	**<1.0**	**1.0-2**	<2.0	5.0-25	>25
Total nitrogen	mg/l	**<1.5**	**1.5-3.0**	1.5-3.0	3-10	10-50
Orto-phosphate-P (PO_4-P)	µg/l	**<50**	**50-80**	80-500	500-1000	>1000
Total phosphorus	µg/l	**<100**	**100-150**	150-1000	1000-2000	>2000
Cd	µg/l	**<0.08**	**0.08**	0.08-0.09	0.09-0.15	>0.15
Hg	µg/l	**0.05**				
Ni	µg/l	**20.0**				
Pb	µg/l	**7.2**				
Zn	µg/l	**75**				
Cu	µg/l	**10**				
Cr	µg/l	**20**				
As	µg/l	**20**				

Note:
highlighted (bold) values are included in the Ministerial Decree No 10/2010 (VIII.18) VM
non highlighted figures represent limits set forth in details in the VGT 5_2 background material

Table 12.1.3-1: WFD limit values applicable to the Danube

12.1.3.1.2 Limit values applicable to lakes under the WFD

For the purposes of evaluating the measured parameters of water samples originating from other lakes Annex No 1 and the limit values included in Column P (Type 13: ***calciferous-small size-shallow-open water surface-permanent***) of Annex No 2 of the Ministerial Decree No 10/2010. (VIII. 18.) VM were used. Limit values are provided in Table 12.1.3-2.

Limit values for water quality in the lakes within the surrounding of the site pursuant to Ministerial Decree No. 10/2010 (VIII.18) VM and according to the VGT 5_2 background material				
Component	measured unit.	**High**	**Good**	**Does not reach good status**
Chlorophyll	µg/l	<15	**15-40**	**>40**
Clarity	cm	120	**80**	**>80**
pH		7.7-8.3	**7.2-8.8**	**>8.8**
Conductivity	µS/cm	<600	**600-900**	**>900**
Chlorophyll	mg/l	<15	**15-40**	**>40**
Oxygen saturation	%	80-120	**70-130**	**>130**
O_2	mg/l	8-10	**7-11**	**>11**
BOD_5	mg/l	<3	**3-4**	**>4**
COD_k	mg/l	<25	**25-40**	**>40**
NH_4	mg/l	0.13	**0.38**	**>0.38**
Ammonium-N (NH_4^+-N)	mg/l	<0.10	**0.1-0.3**	**>0.3**
NO_3	mg/l	0.9	**1.8**	**>1.8**

Limit values for water quality in the lakes within the surrounding of the site pursuant to Ministerial Decree No. 10/2010 (VIII.18) VM and according to the VGT 5_2 background material				
Component	measured unit.	**High**	**Good**	**Does not reach good status**
Nitrate-N (NO_3^--N)	mg/l	<0.20	**0.2-0.4**	**>0.4**
Total nitrogen	mg/l	<1.5	**1.5-2.5**	**>2.5**
Orto-phosphate	mg/l	**0.15**	0.25	1.5
Orto-phosphate (PO_4-P)	µg/l	**<30**	30-120	>120.0
Total phosphorus	µg/l	**100**	**100-300**	**>300**
Cd	µg/l	**<0.08**	**0.08**	
Hg	µg/l	**0.05**		
Ni	µg/l	**20.0**		
Pb	µg/l	**7.2**		
Zn	µg/l	**75**		
Cu	µg/l	**10**		
Cr	µg/l	**20**		
As	µg/l	**20**		

Table 12.1.3-2: WFD limit values applicable to the lakes within the surrounding of the site

12.1.4 ASSESSED ELEMENTS

12.1.4.1 Physico-chemical parameters

12.1.4.1.1 Physical and chemical parameters of the Danube tested

Under the assessment of the Danube the following chemical elements were analysed in 2012 and 2013. For the elements it was specified to which WFD quality group the element tested belonged. In the former studies qualification was not only done pursuant to the WFD, this is why elements are included in the studies which have not been classified in any quality group by the Decree.

Elements	Unit of measurement	Water quality groups under the WFD
pH		Acidification status
Conductivity	µS/cm	Salinity
Dissolved oxygen	mg/l	Oxygenation conditions
Oxygen saturation	%	Oxygenation conditions
BOD_5	mg/l	Oxygenation conditions
CODk	mg/l	Oxygenation conditions
Ammonium-N (NH_4^+-N)	mg/l	Nutrient conditions
Nitrite-N (NO_2^--N)	mg/l	Nutrient conditions
Nitrate-N (NO_3^--N)	mg/l	Nutrient conditions
Total nitrogen	mg/l	Nutrient conditions
Orto-phosphate (PO_4-P	µg/l	Nutrient conditions
Total phosphorus	µg/l	Nutrient conditions
Cd	µg/l	Metals
Hg	µg/l	Metals
Ni	µg/l	Metals
Pb	µg/l	Metals
As	µg/l	Specific pollutants (hazardous chemical elements
Zn	µg/l	Specific pollutants (hazardous chemical elements
Cr	µg/l	Specific pollutants (hazardous chemical elements
Cu	µg/l	Specific pollutants (hazardous chemical elements
TPH	µg/l	
Water temperature	^{0}C	
Total suspended matte	mg/l	
Total alkalinity	mmol/l	
Nitrate (NO_3^-)	mg/l	
Nitrite (NO_2^-)	mg/l	
Orto-phosphate	µg/l	
Ammonium (NH_4^+)	mg/l	
Total cyanide	mg/l	

Table 12.1.4-1: Listing of the physical and chemical elements applicable to the Danube, including the WFD water quality groups

12.1.4.1.2 Physical and chemical parameters of lakes tested

The following chemical elements were analysed in 2012 and 2013 as part of the assessment of lakes within the neighbourhood of the site. For the elements it was specified to which WFD quality group the element tested belonged. In the former studies qualification was not only done pursuant to the WFD, this is why elements are included in the studies which have not been classified in any quality group by the Decree.

Elements	Unit of measurement	Water quality classification groups under the WFD
pH		Acidification status
Conductivity	µS/cm	Salinity
Dissolved oxygen	mg/l	Oxygenation conditions
Oxygen saturation	%	Oxygenation conditions
BOD_5	mg/l	Oxygenation conditions
CODk	mg/l	Oxygenation conditions
Ammonium-N (NH_4^+-N)	mg/l	Nutrient conditions
Nitrate-N (NO_3^--N)	mg/l	Nutrient conditions
Total nitrogen	mg/l	Nutrient conditions
Orto-phosphate (PO_4^{3-}-P	µg/l	Nutrient conditions
Total phosphorus	µg/l	Nutrient conditions
a-chlorophyll	µg/l	Nutrient conditions
Cd	µg/l	Metals
Hg	µg/l	Metals
Ni	µg/l	Metals
Pb	µg/l	Metals
Cu	µg/l	Specific pollutants (hazardous chemical elements)
Zn	µg/l	Specific pollutants (hazardous chemical elements)
Cr	µg/l	Specific pollutants (hazardous chemical elements)
As	µg/l	Specific pollutants (hazardous chemical elements)
CODps	mg/l	
Organic nitrogen	mg/l	
TPH	µg/l	
Water temperature	^{0}C	
Nitrite-N (NO_2^--N)	mg/l	
Total suspended matter	mg/l	
Total alkalinity	mmol/l	
Nitrate (NO_3^-)	mg/l	
Nitrite (NO_2^-)	mg/l	
Orto-phosphate	µg/l	
Ammonium (NH_4^+)	mg/l	
Total cyanide	mg/l	

Table 12.1.4-2: Listing of physical and chemical tests for lakes including the WFD water quality groups

12.1.4.2 Biological elements

The purpose of the study is to assess the environmental impacts associated with the establishment, operation and dismantling of the Paks II project, and the specification thereof pursuant to the aspects applied by the Water Framework Directive. According to this fundamental requirement the study plan was set up so that all the following considerations were taken into account and harmonised:

(1) the contents of Government Decree No 314/2005. (XII.25.) on the Environmental Impact Assessment and the integrated licensing procedure for the utilisation of the environment,

(2) the set of criteria laid down in the Water Framework Directive No 2000/60/EC, the domestically developed National River Basin Management Plan and of the standards and recommendations for monitoring included therein,

(3) the rules pertaining to the Ministerial Decree No 31/2004 (XII. 30.) KvVM of the Ministry of Environment laying down certain rules for monitoring and status assessment of surface waters, furthermore

(4) the findings of the research conducted within the area earlier on,

(5) the official opinion of the authority (DdKTVF) with the reference number 8588-32/2012 in the course of the EKD and last but not least

(6) theoretical and practical considerations of the monitoring process of the biological elements assessed.

During the development of the sampling methodology the fact, stated in the course of the studies intended to determine the heat load of the discharge from Paks Nuclear Power Plant earlier on, that is the discharge of Paks Nuclear Power Plant within the Danube water space concerned by the discharge does not cause any change in class of status according to the five stage robust classification method of the WFD (Kék Csermely Kft [12-22]). Therefore, it was attempted during the planning of the sampling and evaluation procedures to detect finer changes with the help of the findings in order to allow more accurate and exact determination of the expected impacts and impact areas.

In this sense the monitoring efforts conducted in the years of 2012 and 2013 laying the foundations for the Environmental Impact Study can be deemed as a monitoring programme included in paragraph (1) Article 8/A of the Ministerial Decree No 31/2004 KvVM intended to supplement the Environmental Impact Study, and as a study monitoring programme built up on the basis of an individual strategy under paragraph (1) and (2) of Article 8/C as well.

All biological elements included in the Water Framework Directive (Commission Directive 2000/60/EC), and in Ministerial Decree No 31/2004 (XII. 30.) KvVM of the Ministry of Environment laying down certain rules for monitoring and status assessment of surface waters and all the groups of biological organisms such as - phytoplankton (FP); phytobenthos (FB); macrophyte (MF); macroscopic aquatic invertebrates (MZB); and fishes have been tested. It should be noted at this point that no uniform and approved WFD based ecological status evaluation system exists for lakes with respect to the macrozoobenthos and fishes. The evaluation of these taxons is accomplished on the basis of individual, but WFD based considerations, taking into account the available recommendations (Halasi-Kovács et al. [12-17]).

The **phytoplankton** is a collective term for the microscopic plants living in the water mass in a suspended form without attaching to the bottom, but unable to automotion. Its amount and species composition is an important indicator of water quality. The phytoplankton in a submerged water sample reflects the current quality status of the water space, but the taxonomic composition also tells a tale on the impacts (inorganic or organic contamination exposure, changes in the meteorological situation) to which the water space concerned was exposed. The phytoplankton is the biological element which was used in the earliest stage of the history of biological water quality determination. Ecological tolerance of an overwhelming majority of the planktonic taxons is known, therefore they provided the basis for the development of a number of indices. The trophic scales (or index numbers, respectively) indicating the nutrient loads of plants are also based on the amount of the phytoplankton. Species composition provides information on the degree of trophity, exposure to organic substances (degree of saprobity), and certain hydrological properties of the lake.

The **phytobenthos** is the collective term of microscopic vegetative organisms attached to the water bottom or to any other base. As a consequence of their rapid generation cycles they are good indicator organisms of short term processes. At the same time due to their sedimentary lifestyles they are also better suited to detect longer exposure loads in water courses compared to the phytoplankton.

Macrophyte is a plant which can be observed and specified by the naked eye at the moment of observation in the water or at the banks of the water (Holmes & Whitton [12-20]), or such a species which is able to carry out the entire generative life cycle while its vegetative parts are submerged in water or are found on the ground soaked in water [12-8]. On this basis the macrophyte plant as a category includes aquatic vascular plants and mosses or plants and mosses which are strongly associated with waters at least in a certain part of their life cycles, as well as a considerable cluster of macro-algae. Vegetation is one of the most stable and useful indicator of the environmental conditions in a given area (weather, macro-climate, soil and water conditions, chemical reaction etc.). Vegetation basically defines the habitat of most animal communities, therefore it is difficult or impossible to interpret the results of zoological studies. Plants can not ‘escape’ from the impacts exerted onto habitats, migration or fleeing in active locomotion, resettlement typical for a large part of animal species does not work for plants, penetration processes are negligibly slow or do not work at all compared to the speed of anthropogenic interventions. Hence, they can provide key information on the status of habitats.

Aquatic **macroscopic invertebrates**, or the **macrozoobenthos** is understood as a community of organisms with wide taxonomic coverage, visible to the naked eye under field conditions, which is closely associated with water in some stage of its life but has many different strategies of life cycle. They are characterised by the broad scale of different life form types. They can be found in nearly all water space types. They populate the entire water space, since they can be found in the upper layer of the bed sediment surface just as well as on the surface membrane of the water. The explicit small scale spatial variability, in other words the preference of habitats makes this community particularly apt for the classification of habitats and environments. For the same reason, anthropogenic interventions are able to change the natural ecological structure of this living community to a great extent.

Fishes constitute a particularly important group of the aquatic ecosystem. The organisms on the top of the food pyramid are of great importance in the determination of the ecological status of the aquatic environment. This means that certain properties of a given water space (geographic, hydrological, physico-chemical properties, etc.) define its fish community in terms of both quality and quantity, and additionally, fishes are able to exert an influence on the parameters of their environment. In the course of their life activities various routes of material flow may be generated in aquatic ecosystems, and therefore they are able to determine or influence the characteristic properties of their habitat. Alterations in water quality of the aquatic spaces are sensitively reflected by the structure of the fish community, therefore the study of their composition is an appropriate tool to characterise the quality status of waters. Of the multiple benefits provided by the examination of fish communities it can be highlighted that the fish habitats are the closest in terms of size and scale to that of humans, therefore the responses given to the changes in the environment provide easy to use information.

12.1.5 Study methodologies

12.1.5.1 Test methods of physical and chemical parameters in water

During the sampling procedure the requirements and provisions laid down in the Hungarian standards No MSZ 12750-2:1971 (Assessment of surface waters. Sampling and preservation), No MSZ ISO 5667-6:1995 (Water quality. Sampling. Part 6: Guidelines for sampling from rivers and streamlets) and No MSZ ISO 5667-4:1995 (Water quality. Sampling. Part 4: Guidelines for sampling from natural and artificial lakes).

In the course of the **sampling of the Danube water** point samples were taken at the sampling points of the designated profiles (left bank, midstream, right bank) from two different depths, pending on the depth of the water and an average in depth sample was derived for the sampling point concerned on site. These in depth average samples were tested in an accredited laboratory in accordance with the respective applicable testing standards.

During sampling the temperature of the Danube water was measured at the sampling points (right bank, midstream, left bank), in a depth of 0.5-1.0 m.

The pH, specific electrical conductivity, the quantity and concentration of dissolved oxygen of the in-depth average samples were measured on site. On site measurement results were recorded in Sampling reports which constitute and annex to the Test reports.

During the **sampling procedure of the other surface waters** point samples were taken from the right bank, mid-water and left bank points of the lakes, from a depth of 0.5-1.0 m and a cross profile average sample was generated on site. Such in-depth average samples were tested in an accredited laboratory in accordance with the respective applicable testing standards.

The pH, specific electrical conductivity, the quantity and concentration of dissolved oxygen of the cross profile average samples were measured on site. On site measurement results were recorded in Sampling reports which constitute and annex to the Test reports.

Test results from the Danube and other waters were assessed in accordance with the background material No 5.2 issued to Chapter 5 of the VGT and pursuant to Ministerial Decree No.10/2010. (VIII. 18.) VM on the limit values applicable to the contamination of surface waters and laying the rules for the application thereof, which is intended to provide compliance with the provisions of Commission Directive 2000/60/EC ("Water Framework Directive").

Under Government Decision No 1042/2012. (II. 23.) and Ministerial Decree No 10/2010. (VIII. 18.) VM the evaluation of the measurement results was carried out in accordance with the limit values applicable to water quality and the methodology included in Annex No 1 (1.1. EQS TABLE) and Annex No 2 (1.1. WATER QUALITY LIMIT VALUES FOR WATERCOURSES, column "I" "Domestic section of the Danube") of Ministerial Decree No.10/2010. (VIII. 18.) VM on the limit values applicable to the contamination of surface waters and laying the rules for the application thereof (WFD) and in the background material No 5.2 issued to Chapter 5 of the River Basin Management Plan.

For the purposes of classification of groups of living organisms Annex No 5.1 of and the background material No 5.2 issued to Chapter 5 of the River Basin Management Plan (VGT) were relied upon.

Particulars of Ministerial Decree No 10/2010. (VIII. 18.) VM are as follows:

3. Requirements for limit values of environmental quality

Article 3 (1) Limit values for environmental quality of priority and other pollutants contaminating surface waters are contained in Annex No 1 to the Decree.

(2) Exceeding the environmental quality limit value established to a specific pollutant shall not be deemed to be a violation of the provisions laid down herein, provided evidence was furnished that it was the consequence of a transboundary pollution incident, no effective measure was available and the negotiation mechanisms provided for in the Government Decree laying down certain rules for the management of river basins were conducted with the country concerned.

4. Requirements concerning water quality limit values

Article 6 (1) Water quality limit values influencing the ecological status of surface waters are contained in Annex No to the Decree. The corresponding limit values of the elements investigated by us were collected from the column Type of body of water "I" – domestic section of the river Danube – and aggregated in the table. The water quality limit values – with the exception defined in paragraph (3) – concern water pollution specified as an annual average value.

(3) In the event the level of water pollution caused by the oxygenation conditions and nutrient contents reaches or exceeds the double of the water quality limit value set for the annual average, and in the case of dissolved oxygen fails to reach the half of it, the annual average value can not be taken into account for the purposes of evaluation and the classification procedure should be carried out on the basis of the actually measured level.

As required by the Decree, the classification procedure was completed on the basis of the average values and the associated limit values, and the graphic representation of the water quality parameters was also made on this basis. Classification rules and colour coding were applied pursuant to Ministerial Decree No.10/2010. (VIII. 18.) VM on the limit values applicable to the contamination of surface waters and laying the rules for the application thereof. When the evaluation was made in accordance with the standard, the samples were classified on the basis of the limits provided for in the law. (Table 12.1.3-1)

Encoding of the sampling sites was accomplished for each group of living organisms according to the following method. For example:

PLDFP11; P50DMZB12; P50THDH1

PL: Sampling made in 2012 as part of the Paks Lévai project;
P50: Sampling made in 2013 as part of the Paks 50 km extension project.
D: Danube; **KT:** Kondor Lake; **HT:** Angler Ponds; **FHD:** Dead Danube of Fadd; **THD:** Northern Dead Danube of Tolna; **S:** Sió
FP: phytoplankton; **FB:** phytobenthos, **MF:** macrophyte ; **MZB:** macrozoobenthos ; **H:** fish
1: number of sampling units (1 to 5)
1: right bank ; **2:** left bank ; **3:** midstream (only for sampling sites in the Danube)

12.1.5.2 Phytoplankton testing

12.1.5.2.1 Sampling

A total of 9 profiles were sampled for phytoplankton in the Danube in 2012 and – as a territorial extension – in 2013. In 2012 samples were taken at all sampling points in five different times, while in 2013 they were repeated twice.

When the sampling times were selected, the suitability of the Danube was taken into consideration. Sampling operations were harmonised with the times applicable to the physical and chemical testing of the water as well as with the times when the other groups of living organisms were assessed.

When sampling frequency was determined and the times for sampling selected in 2013, the results from the previous year's sampling were also taken into account (Table 12.1.5-1).

Section	Profile number	Name	Sample unit code	EOVX	EOVY	Date
UPSTREAM	I.	Dunaföldvár, bridge (1560.6 river km), left bank	P50DFP12	163063	641430	27.08.2013 11.10.2013
		Dunaföldvár, bridge (1560.6 river km), mainstream	P50DFP13	162916	641274	
		Dunaföldvár, bridge (1560.6 river km), right bank	P50DFP11	162770	641110	
	II.	Paks ferry (1533.5 river km) left bank	PLDFP12	143 416	638 232	23.12.2012
		Paks ferry (1533.5 river km) mainstream	PLDFP13	143 642	638 200	27.06.2012
		Paks ferry (1533.5 river km) right bank	PLDFP11	143 830	638 220	28.08.2012 26.09.2012 14.11.2012
NEAR DOWNSTREAM	III.	hot water canal mouth profile (1526.0 river km) left bank	PLDFP22	137820	637140	23.12.2012
		hot water canal mouth profile (1526.0 river km) mainstrear	PLDFP23	137 660	636 960	27.06.2012
		hot water canal mouth profile (1526.0 river km) right bank	PLDFP21	137 530	636 720	28.08.2012 26.09.2012 14.11.2012
	IV.	Nagysarkantyú (1525.3 river km) left bank	PLDFP32	137 455	637 510	23.12.2012
		Nagysarkantyú (1525.3 river km) mainstream	PLDFP33	137 251	637 355	27.06.2012
		Nagysarkantyú (1525.3 river km) right bank	PLDFP31	137 071	637 217	28.08.2012 26.09.2012 14.11.2012
	V.	Uszód (1524.7 river km) left bank	PLDFP42	136 910	637 882	23.12.2012
		Uszód (1524.7 river km) mainstream	PLDFP43	136 830	637 753	27.06.2012
		Uszód (1524.7 river km) right bank	PLDFP41	136 650	637 430	28.08.2012 26.09.2012 14.11.2012
MID-DISTANT DOWNSTREAM	VI.	Gerjen-Foktő (1516.0 river km) left bank	PLDFP52	128 275	639 835	23.12.2012
		Gerjen-Foktő (1516.0 river km) mainstream	PLDFP53	128 165	639 630	27.06.2012
		Gerjen-Foktő (1516.0 river km) right bank	PLDFP51	128 037	639 440	28.08.2012 26.09.2012 14.11.2012
	VII.	Dombori (1506.8 river km), left bank	P50DFP22	119560	638666	28.08.2013 10.10.2013
		Dombori (1506.8 river km), mainstream	P50DFP23	119676	638516	
		Dombori (1506.8 river km), right bank	P50DFP21	119869	638321	
DISTANT DOWNSTREAM	VIII.	Sió South, Gemenc (1496.0 river km), left bank	P50DFP32	109269	639091	28.08.2013 10.10.2013
		Sió South, Gemenc (1496.0 river km), mainstream	P50DFP33	109137	638972	
		Sió South, Gemenc (1496.0 river km), right bank	P50DFP31	119560	638866	
	IX.	Baja, bridge (1481.5 river km), left bank	P50DFP42	94263	640909	27.08.2013 11.10.2013
		Baja, bridge (1481.5 river km), mainstream	P50DFP43	94267	640733	
		Baja, bridge (1481.5 river km), right bank	P50DFP41	94272	640561	

Table 12.1.5-1: Phytoplankton sampling on the Danube

Sampling from other bodies of water is shown on the following table.

Name	Sample unit code	EOVX	EOVY	Date
Kondor Lake	PLKTFP	136349	636005	23.12.2012 27.06.2012 26.09.2012 14.11.2012
Angler Ponds	PLHTFP	136905	636083	14.11.2012
Dead Danube of Fadd 1. (ferry)	PLFHDFP1	124768	633461	23.12.2012 27.06.2012 26.09.2012 14.11.2012
Dead Danube of Fadd 2. (beach)	PLFHDFP2	121340	636694	23.12.2012 27.06.2012 26.09.2012 14.11.2012
Northern Dead Danube of Tolna 1.	P50THDFP1	119567	630528	27.08.2013 11.10.2013
Northern Dead Danube of Tolna 2.	P50THDFP2	122280	632612	
Sió-channel	P50SFP1	110692	636658	28.08.2013 10.10.2013

Table 12.1.5-2: Phytoplankton from additional water bodies

12.1.5.2.2 Sampling method

Sampling from the phytoplankton was carried out to obtain a quantitative sample complying with the Water Framework Directive, the Hungarian standard MSZ EN 15110 (sampling) and MSZ EN 14407:2004 (sample processing). Evaluation of the results on the basis of the EQR was made in accordance with the recommendations of the draft standardisation document CN TC 230 EU and with the recommendations developed for domestic application of the Water Framework Directive (Szilágyi et al.. [12-40], [12-41]).

Dipped phytoplankton samples were fixed in Lugol's solution on the site. Population density of the phytoplankton was defined by the reversed plankton microscope of UTERMÖHL.

Phytoplankton biomass was calculated on the basis of the population density and specific biomass data. Specific biomass for each taxon was determined by either direct measurements or, after making an estimate of their linear range of sizes on the logarithmic interval scale, they were deemed to be identical with the volume of the corresponding rotational ellipsoid (full sphere) (Németh, [12-31]).

Specific volumes were calculated one by one based on the linear dimensions measured for each specimen, and the data obtained were averaged. Once the volume was known, the specific biomass was expressed in mass units, taking density as a unitary parameter.

Phytoplankton biomass data and percentage distribution of the biomass with a view to the major taxonomic units as well as a-chlorophyll concentration values were summarised in the tables of the sub-chapter 12.3.1.2. Biomass results were expressed in µg/l units of measurement, but are referred to in the text converted into mg/l levels.

When the dominance structure of the phytoplankton is shortly characterised, relative abundance of each taxon expressed in biomass is provided according to the following interval scale:

Class of abundance	Range	
	proportion of total biomass	‰
1	0-1/16	0-63
2	1/16-1/8	64-125
3	1/8-1/4	126-250
4	1/4-1/2	251-500
5	1/2-3/4	501-750
6	3/4-7/8	751-875
7	7/8-15/16	876-938
8	15/16-1	939-1000

Identification codes for the dominant taxons are as follows:

pico:	pico-algae
FLAG:	Flagellates
CHRO:	Chroococcales
OSCI:	Oscillatoriales
NOST:	Nostocales
EUGL:	Euglenophyta
CRYP:	Cryptophyta
DINO:	Dinophyta
CHRY:	Chrysophceae
CENT:	Centrales
PENN:	Pennales
VOLV	Volvocales
CHLO:	Chlorococcales
ULOT:	Ulothricales
DESM:	Desmidiales

During work certain provisions of the draft standard of the European Union (CN TC 230) currently under development were also taken into consideration.

12.1.5.2.3 Method of evaluation

In the course of the phytoplankton based ecological evaluation according to the Water Framework Directive both quantitative (a-chlorophyll concentration) and qualitative (taxonomic composition) were taken into account (ÖKO Zrt. [12-34], Szilágyi et al. [12-40], [12-41]).

Evaluation on ***water courses*** was accomplished on the basis of the calculated values of the HRPI Hungarian river phytoplankton index, which can be used to characterise the ecological status of rivers. It should be noted that the average of the HRPI values from samples taken in the vegetation period (AnnHRPI=AverageHRPI) should be calculated for the accurate determination of the ecological status.

The calculation of the HRPI-index is made in the following steps:

1. Starting from the a-chlorophyll concentration data the NChl-a value is calculated using the formula developed for the type of water body investigated:

$$NChl\text{-}a = a\ Chl\text{-}a + b$$

where,

NChl-a: normalised value of the a-chlorophyll concentration
Chl-a: value of the a-chlorophyll concentration actually measured
a and b: contents characterising the type of water body under consideration

2. Based on the phytoplankton taxonomic composition the Q association-index, and from this, the Q_r value is determined according to the following formula:

$$Q=SUM(p_i*F_i)$$

where

p_i: relative abundance of taxons or codons in relation to the biomass,
F_i: weight factor associated with the taxon or codon concerned
$Q_r = Q/5$

The value of the weight factor is an integer number between 0 and 5. Taxons were categorised with the help of the study by Borics et al. [12-6].

The normalised value of Q_r (NQ_r) was calculated using the following formula developed for the type of body of waters into which the water course under consideration belonged.

NQ_r =0.7334x2+0.3253x-0.0137 (Group of types No 3)

3. Knowing the NChl-a and NQ_r values the HRPI value was obtained with the help of a formula which takes into account the quantitative conditions with a greater weight factor:

$$HRPI = (2NChl\text{-}a + NQ_r)/3$$

where

HRPI: Hungarian river phytoplankton index
NChl-a: normalised a-chlorophyll metrics
NQ_r: normalised river phytoplankton metrics

For the purposes of phytoplankton based evaluation of the ecological status the following table of limit values developed in the NQ_r = 0-1 and HRPI = 0-1 interval, respectively, with equal intervals (0.2) which can be used in the case of all types:

Ecological status	NQ_r
high	≥0.801
good	0.601-0.800
moderate	0.401-0.600
poor	0.201-0.400
bad	≤0.200

Degrees of trophity were summarised as follows (Németh, [12-31]) based on the ten grades scale developed by Felföldy [12-11].

Degree of trophity	Primary production*		Alga number	a-chlorophyll
	gC/m²/year	mgC/m²/day	10^6 ind/litre	mg/m³
0 atrophic (infertile)	0	0	0	0
1 ultra-oligotrophic (very low fertility	< 10	< 50	< 0.01	< 1
2 oligotrophic (low fertility)	10 - 25	50 - 125	0.01 - 0.05	1 - 3
3 oligo-mesotrophic	26 - 50	126 - 250	0.05 - 0.10	4 - 10
4 mesotrophic (average fertility)	51 - 100	251 - 500	0.1 - 0.5	11 – 20
5 meso-eutrophic	101 - 175	501 - 900	0.5 - 1.0	21 – 50
6 eutrophic (high fertility)	176 - 300	901 - 1 500	1.1 – 10	51 – 100
7 eu- polytrophic	301 - 500	1501 - 2500	11 – 100	101 – 200
8 polytrophic (very high fertility)	501 - 800	2501 - 4000	101 – 500	201 – 800
9 hypertrophic (too fertile)	> 800	> 4 000	> 500	> 800

**Annual production is two hundred fold of the daily production (Felföldy 1977: p. 228.)*

In order to define the value of the Q index provided for the determination of the ecological status of ***lakes*** the Fi weight factor values corresponding to the codons provided by the study of Borics et al. [12-6] for lakes were used for the purposes of calculation.

The normalised value of Q_r (NQ_r) was calculated according to the formula developed for the type of lake under consideration.

NQ_r (y=2.9044x3-5.8143x2+4.3764x-0.4666 (Type of lake No 13)

Normalised a-chlorophyll concentration: NChl-a =-0.00002*(Chl-a)²-0.0029*Chl-a+0.8348

Where: Chl-a (a-chlorophyll concentration (µg/l)

The HLPI-index taking the a-chlorophyll concentration values into account is

$$HLPI = (NChl\text{-}a + NQ_r)/2$$

For the purposes of phytoplankton based evaluation of the ecological status the following table of limit values developed in the NQ_r = 0-1 and HRPI = 0-1 interval, respectively, with equal intervals (0.2) which can be used in the case of all lake types:

Ecological status	NQ_r or HLPI
high	≥0.801
good	0.601-0.800
moderate	0.401-0.600
poor	0.201-0.400
bad	≤0.200

12.1.5.3 Phytobenthos testing

12.1.5.3.1 Sampling

A total of 9 profiles were sampled for phytobenthos in the Danube in 2012 and – as a territorial extension – in 2013. (Table 12.1.5-3).

Section	Profile number	Name	Sample unit code	EOVX	EOVY	Date
UPSTREAM	I.	Dunaföldvár, bridge (1560.6 river km), left bank	P50DFB12	163063	641430	27.08.2013
		Dunaföldvár, bridge (1560.6 river km), right bank	P50DFB11	162770	641110	11.10.2013
	II.	Paks ferry (1533.5 river km) left bank	PLDFB12	143416	638232	28.08.2012
		Paks ferry (1533.5 river km) right bank	PLDFB11	143830	638220	26.09.2012
NEAR DOWNSTREAM	III.	hot water canal mouth profile (1526.0 river km) right bank	PLDFB21	137530	636720	28.08.2012 26.09.2012
	IV.	Nagysarkantyú (1525.3 river km) left bank	PLDFB32	137455	637510	28.08.2012
		Nagysarkantyú (1525.3 river km) right bank	PLDFB31	137071	637217	26.09.2012
	V.	Uszód (1524.7 river km) left bank	PLDFB42	136910	637882	28.08.2012
		Uszód (1524.7 river km) right bank	PLDFB41	136650	637430	26.09.2012
MID-DISTANT DOWNSTREAM	VI.	Gerjen-Foktő (1516.0 river km) left bank	PLDFB52	128275	639835	28.08.2012
		Gerjen-Foktő (1516.0 river km) right bank	PLDFB51	128037	639440	26.09.2012
	VII.	Dombori (1506.8 river km), left bank	P50DFB22	119560	638666	28.08.2013 10.10.2013
		Dombori (1506.8 river km), right bank	P50DFB21	119869	638321	
DISTANT DOWNSTREAM	VIII.	Sió South, Gemenc (1496.0 river km), left bank	P50DFB32	109269	639091	28.08.2013
		Sió South, Gemenc (1496.0 river km), right bank	P50DFB31	119560	638866	10.10.2013
	IX.	Baja, bridge (1481.5 river km), left bank	P50DFB42	94263	640909	27.08.2013
		Baja, bridge (1481.5 river km), right bank	P50DFB41	94272	640561	11.10.2013

Table 12.1.5-3: Phytobenthos sampling on the Danube

Sampling was made twice each year during the vegetation period. When the sampling times were selected, the suitability of the Danube was taken into consideration. Sampling operations were harmonised with the times applicable to the physical and chemical testing of the water as well as with the times when the other groups of living organisms were assessed.

The data derived from the specified sampling periods provide conservative results (Kék Csermely [12-22]), and therefore they comply with the aspect of an environmental impact study, allow to obtain professionally competent and well founded results while they are also in line with the fundamental set of criteria set up by the WFD.

Sampling period	Average value (EQR)	Extremes (EQR)	Classification
March	0.726	0.639-0.797	good
June	0.787	0.662-0.970	good
August	0.678	0.409-0.882	moderate
October	0.625	0.378-0.882	moderate

Table 12.1.5-4: Classification categories and EQR values of phytobenthos for ecological status assessment according to the WFD based on the tests carried out in the Danube Paks/ferry - Gerjen-Foktő section in 2009-2010 in each of the sampling periods

The location and times of tests on other bodies of water are presented in Table 12.1.5-5.

Name	Sample unit code	EOVX	EOVY	Date
Kondor Lake	PLKTFB	136349	636005	27.06.2012 26.09.2012
Angler Ponds	PLHTFB	136905	636083	14.11.2012
Dead Danube of Fadd 1. (ferry)	PLFHDFB1	124768	633461	27.06.2012 26.09.2012
Dead Danube of Fadd 2. (beach)	PLFHDFB2	121340	636694	27.06.2012 26.09.2012
Northern Dead Danube of Tolna 1.	P50THDFB1	119567	630528	27.08.2013
Northern Dead Danube of Tolna 2.	P50THDFB2	122280	632612	11.10.2013
Sió-channel	P50SFP1	110692	636658	27.08.2013 10.10.2013

Table 12.1.5-5.: Phytobenthos sampling from other bodies of water

12.1.5.3.2 Sampling method

Sampling from the phytobenthos was carried out to obtain a quantitative sample complying with the Water Framework Directive, the Hungarian standard MSZ EN 15110 (sampling) and MSZ EN 14407:2004 (sample processing), taking into account the methodological guidelines by Ács and Kiss (2011) [12-1]. Evaluation of the results was made on the basis of the EQR values calculated from the IPS diatom index and in accordance with the recommendations developed for domestic application of the Water Framework Directive (Szilágyi et al.. [12-40], [12-41]).

Diatoms of the benthos were determined by the examination of the preparations embedded in Styrax resin following digestion in hydrogen peroxide under light-optical microscope (OPTON plankton microscope, 100-fold magnifying oil immersion objective and phase contrast setting) (Németh, [12-31]). For the qualitative determination of the diatom species the taxonomic concept of Krammer and Lange-Bertalot [12-24], [12-25], [12-26], [12-27] was followed.

12.1.5.3.3 Method of evaluation

The following diatom index conforming to the recommendation of the WFD Methodological Guidelines [12-44] typical for the extent of pollution is calculated on the basis of the relative abundance percentage values of the benthic diatom populations per species, genus and family as a function of specimens:

$$IPS_0=SUM(S_i*V_i*p_i)/SUM(V_i*p_i)$$

where

- S_i: indicator (sensitivity) value of the taxon
- V_i: indicator weight of taxon
- p_i: relative abundance of the taxon expressed in percentage value of the diatom specimens counted in the sample

The S_i value may vary between 1 (very tolerant) and 5 (very sensitive), the value of V_i between 1 (less specialised species) and 3 (very good indicator species for the variable concerned).

The IPS_0 diatom index varying in the range between 1 and 5 was rescaled for the range between 1 and 20 in order to allow better comparability to the other indexes:

$$IPS=4.75IPS_0 -3.75$$

Evaluation of the results for ***water courses*** was made on the basis of the EQR values calculated from the IPS diatom index and in accordance with the recommendations developed for domestic application of the Water Framework Directive (Szilágyi et al.. [12-40], [12-41]).

For the purposes of the type specific classification procedure the calculation of the EQR value was made on the basis of the formula corresponding to the type of the water course assessed.

For the purposes evaluation of the ecological status the following table of limit values developed with equal intervals (0.2) which can be used:

Ecological status	EQR
high	≥0.801
good	0.601-0.800
moderate	0.401-0.600
poor	0.201-0.400
bad	≤0.200

The ecological status of ***lakes*** is determined on the basis of the TDIL index calculated from the qualitative and quantitative testing of the diatom population in the phytobenthos (Stenger-Kovács et al. [12-39]). For the purposes of evaluating the results, the following classification method by Stenger-Kovács et al. [12-39] which is the original version of the method currently being progressed:

Ecological status	TDIL
high	4-5
good	3<4
moderate	2<3
poor	1<2
bad	0<1

12.1.5.4 Macrophyte testing

12.1.5.4.1 Sampling

Macrophyte sampling on the Danube in 2012 and 2013 was made in a total of one upstream and seven downstream profiles during the vegetation period (Table 12.1.5-6). In the course of the exact selection of the sampling times the suitability of the Danube was taken into consideration and sampling operations were harmonised with the times applicable to the physical and chemical testing of the water as well as with the times when the other groups of living organisms were assessed.

Section	Profile number	Name	Sample unit code	EOVX	EOVY	Date
Upstream	I.	Paks upstream right bank	P50DMF11	143810	638876	20.07.2013
		Paks upstream left bank	P50DMF12	143398	638622	06.10.2013
Near downstream	II.	Paks hot water discharge right bank	PLDMF11	137622	636605	02.07.2012
		Paks hot water discharge left bank	PLDMF12	137774	637254	30.09.2012
	III.	Nagysarkantyú right bank	PLDMF21	137077	637148	02.07.2012
		Nagysarkantyú left bank	PLDMF22	137392	637549	30.09.2012
	IV.	Uszód right bank	PLDMF31	136219	637711	02.07.2012
		Uszód left bank	PLDMF32	136213	638260	30.09.2012
Mid-distance downstream	V.	Gerjen-Foktő right bank	PLDMF41	130280	638212	02.07.2012
		Gerjen-Foktő left bank	PLDMF42	129609	639081	30.09.2012
	VI.	Dombori right bank	P50DMF21	121592	639411	20.07.2013
		Dombori left bank	P50DMF22	121000	639605	06.10.2013
Distant downstream	VII.	Sió South right bank	P50DMF31	108176	639604	20.07.2013
		Sió South	P50DMF32	108820	639554	06.10.2013
	VIII.	Baja	P50DMF41	97912	639050	20.07.2013
		Baja	P50DMF42	97576	639454	06.10.2013

Table 12.1.5-6: Macrophyte sampling on the Danube

The location and date of sampling from other bodies of water are shown on Table 12.1.5-7.

Name	Sample unit code	EOVX	EOVY	Date
Kondor Lake	PLKTMF1	136611	635862	01.07.2012 29.09.2012
	PLKTMF2	136317	636067	
Angler Ponds	PLHTMF1	136902	636063	01.07.2012 29.09.2012
	PLHTMF2	136887	636159	
	PLHTMF3	136387	636161	
	PLHTMF4	136257	636141	
	PLHTMF5	136805	635970	
Dead Danube of Fadd 1.	PLFHDMF1	126038	635541	01.07.2012 29.09.2012
	PLFHDMF2	126131	635105	
	PLFHDMF3	126101	634635	
Dead Danube of Fadd 2.	PLFHDMF4	123372	634779	
	PLFHDMF5	123036	634807	
	PLFHDMF6	122632	635730	
Northern Dead Danube of Tolna	P50THDMF1	120485	631078	21.08.2013 06.10.2013
	P50THDMF2	119338	630506	
	P50THDMF3	122212	634162	
	P50THDMF4	122270	634234	
	P50THDMF5	122022	632164	
Sió-channel	P50SMF	110702	636105	21.08.2013 06.10.2013

Table 12.1.5-7: Macrophyte sampling from other bodies of water

12.1.5.4.2 Sampling method

During the sampling procedure the provisions laid down in the European standards EN 15460 and EN 14184 were taken into account just as well as the compendium for the assessment of macrophyte stock in watercourses and lakes (Lukács et al. [12-28]), and the basic rules of statistics applicable to data collection, number of sampling units and randomness.

The sampling method applied in the field was based on the Kohler [12-23] methodology of the STAR project. In the course of macrophyte sampling the name of all species in the designated sampling zone must be recorded and a phytomass index estimated for each species. The phytomass is not identical with biomass (kg/unit area), it is rather interpreted as the amount of species imagined in the three dimensional space. Furthermore, the index is not based on relative cover (%), but includes vertical species arrangement.

The phytomass scale has five grades. Such grades range from the very sporadic occurrence of stand-alone stems up to continuous mass populations. The division of the five grades relies upon the subjective judgement of the surveyor in the field. However, according to the experiences gained the division of the five grades does not provide any major differences when individuals with different level of experiences use them. The following description assists in the division of the various grades on the scale:

1= rare species, occurrence in stand-alone stems.
2= rare species, occurrence in minor clusters.
3= frequent species in the assessment zone but does not constitute any continuous stands.
4= the species has extensive dense stands but only in a minor part of the assessment zone.
5= a species creating uninterrupted continuous stands in large quantities in the entire assessment zone.

Assessment of macrophyte in ***water courses*** is accomplished in longitudinal transects running in parallel with the banks.

Sampling should be forwarded in upstream direction, increasing the chance to detect the stock of macrophyte plants floating on the surface of the water. During the sampling procedure the appropriate location for sampling should be identified and the width of the sampling section determined.

Key sampling criteria for the sampling site are as follows:

– The sampling site should conform with the requirements formulated in Section 1.3 of Annex No V to the WFD.

- The sampling site should be adequately representative for the body of water as a whole since the entire body of water will be classified on the basis of relatively low number (1 to 3) of sites.
- Homogeneity. A river bed section must be designated where properly developed stocks of plants are found (in other words, which are not cut, sprayed, burnt etc.) and the most homogenous conditions possible prevail. Environmental conditions are understood mainly as the level of shade, flow rate of the water at the sampling site, and the land use patterns of the riparian areas adjacent to the river banks.

In the case of main canals, rivers and large rivers the survey must be made along one of the banks selected in an appropriate width of the sampling zone, because these habitats may entirely lack vegetation in their midstream due to the prevailing bed morphological properties there. The length of the sampling section should be 100 m. The least exactly specifiable part of the methodology is the width of the assessment zone and the designation of the boundary of the sampling zone towards the bank. However, based on field routine experiences this can be easily accomplished nevertheless. During sampling all plants which stand in water for at least 30% of the year should be included in the assessment.

Macrophyte assessment for ***lakes*** is accomplished along a number of transects positioned parallel with and along the shores pending on the size of the body of water. The number of transects shall be in accordance with the guidelines developed by Schaumburg et al. [12-35] as follows:

<0.5 km^2:	1-5 transects
0.5 – 2,0 km^2:	4-8 transects
2,0 – 5,0 km^2:	5-10 transects
5,0 - 10 km^2:	6-12 transects
>10 km^2:	8-15 transects

Based on the size of the lake, a clearly marked range is provided for sampling transects. The exact number of the transects is to be determined by the field assessor, during which process the variability of the riparian habitat types and natural conditions (disturbance) should be taken into account. The point is to survey as many kind of habitats from the body of water as possible in order to represent the body of water as a whole.

In the current assessment study 5 transects were determined in the case of lakes.

During the assessment of each transect running in parallel with the bank four additional belt transects were designated which are perpendicular to the bank. The width of the belt transects is 2 m, their length varies, ranging from the open water up to the boundary of the riparian macrophyte zone on the banks. Determination of the boundary for the banks will be made in the same manner as described for watercourses.

During the assessment of the belt transects each plant species and estimated phytomass within each of the belt transects were recorded the same way as described above. At the end of the survey (eventually, in the laboratory) the data sets from the four belts are consolidated and the various quantitative indexes of the same species averaged. During averaging, values from 0.5 are rounded upwards.

12.1.5.4.3 Method of evaluation

RI calculation is made on the basis of the data obtained on submerged, free floating rooted hair-weeds, mud and marsh plants. For the purposes of classification only the data obtained during the collection process based on the Kohler-method are evaluated. Abundance values determined on the site in the field ranging from 1 to 5 (Kohler [12-23]) are converted to quantitative values as follows:

Species identified at the sampling site are arranged in indicator clusters. The indicator clusters carry the following meanings:

Group A: Species occurring in the habitats with the referential or near referential ecological status in large numbers.

Group C: Species not or rarely occurring in the habitats with the referential or near referential ecological status. Typically dominant species of disturbed habitats.

Group B: Species which do not have any particular indicator properties. Typically they are found in large numbers both in disturbed habitats and habitats with the referential ecological status.

Classification of the species in indicator groups was made on the basis of the data sets from the ECOSURV study and expert estimates. For the purposes of classification the social behaviour types of individual species, water, salt and nutrient requirement parameters [12-5] and the categories of the German, Austrian and Slovak systems were taken into account.

Quantitative parameters of species within the same indication groups should be added up. In the event a species is found during the assessment period which is not included in the indication table, the species concerned should be considered as irrelevant for the purposes of calculation. If the number of such irrelevant species is high, this may distort the entire calculation matrix, therefore if the rate of the irrelevant species exceeds ≥ 25 % the calculated value for the index can not be regarded as reliable!

Calculation conditions for ***watercourses*** (1) The sum of indicator species numbers adds up to 16; (2) The rate of indicator species reaches 75 %. ***For lakes*** (1) The sum of macrophyte species numbers adds up to 55, except salt/natron lakes, where this value should be minimum 15; (2) The rate of indicator species should exceed 75%.

Additionally, if the number of species found is less than two, the classification outcome will not be relevant either for rivers, or for lakes. EQR = 5. If the following species appear in a predominant quantity (i.e. their total amount is at least 80 % compared to the entire quantity), the RI value should be diminished by 50. If the RI value becomes < -100 when these conditions are applied, then RI= -100.

- Amorpha fruticosa
- Elodea canadensis/ nuttallii
- Myriophyllum spicatum
- Najas marina
- Potamogeton pectinatus
- Ceratophyllum demersum
- Ceratophyllum submersum

The Reference Index is calculated with the following formula:

$$RI = \frac{\sum_{i=1}^{n_A} Q_{Ai} - \sum_{i=1}^{n_C} Q_{Ci}}{\sum_{i=1}^{n_g} Q_{gi}} * 100$$

where:

RI = reference index;
Q_{Ai} = 'Amount' of species in group 'A';
Q_{Ci} = 'Amount' of species in group 'C';
Q_{gi} = 'Amount' of species in all the three groups;
n_A = Number of species in group 'A';
n_C = Number of species in group 'C';
n_g = (A+B+C) full number of species.

The RI value is converted into the value within the 0 to 1 range required under the WFD with the help of the following formula.

$$EQR = \{(RI + 100) * 0.5\}/100$$

Classification limit values for lowland rivers:

	Ecological status	EQR	RI value
high	1	1.00 – 0.71	
good	2	0.70 – 0.48	
moderate	3	0.47 – 0.30	
bad	4	0.29 – 0.05	
poor	5	-	Lack of vegetation

for shallow lakes:

	Ecological status	EQR	RI value
high	1	1.00 – 0.75	
good	2	0.74 – 0.55	
moderate	3	0.54 – 0.35	
bad	4	0.34 – 0.05	
poor	5	–	Lack of vegetation

12.1.5.5 Assessment of macroscopic aquatic invertebrates (macrozoobenthos)

12.1.5.5.1 Sampling

Macroscopic aquatic invertebrate sampling on the Danube in 2012 and 2013 was made in a total of one upstream and seven downstream profiles during the vegetation period. Each of the sampling units consisted of three sampling sub-units (Table 12.1.5-8, Table 12.1.5-6). In the course of the exact selection of the sampling times the suitability of the Danube was taken into consideration and sampling operations were harmonised with the times applicable to the physical and chemical testing of the water as well as with the times when the other groups of living organisms were assessed.

Section	Profile number	Name	Sample subunit code	EOVX	EOVY	Date
UPSTREAM	I.	Paks upstream right bank	P50DMZB111	143810	638876	20.07.2013 06.10.2013
			P50DMZB112	143829	638808	
			P50DMZB113	143810	638677	
		Paks upstream left bank	P50DMZB121	143398	638622	
			P50DMZB122	143227	637537	
			P50DMZB123	143053	637345	
NEAR DOWNSTREAM	II.	right bank downstream of Paks hot water discharge	PLDMZB111	137622	636605	02.07.2012 30.09.2012
			PLDMZB112	137531	636653	
			PLDMZB113	137482	636739	
		left bank downstream of Paks hot water discharge	PLDMZB121	137774	637254	
			PLDMZB122	137594	637412	
			PLDMZB123	137457	637515	
	III.	Nagysarkantyú right bank	PLDMZB211	137077	637148	02.07.2012 30.09.2012
			PLDMZB212	137089	637194	
			PLDMZB213	136952	637296	
		Nagysarkantyú left bank	PLDMZB221	137392	637549	
			PLDMZB222	137272	637601	
			PLDMZB223	136978	637869	
	IV.	Uszód right bank	PLDMZB311	136219	637711	02.07.2012 30.09.2012
			PLDMZB312	136173	637743	
			PLDMZB313	135098	638049	
		Uszód left bank	PLDMZB321	136213	638260	
			PLDMZB322	136147	638276	
			PLDMZB323	135766	638359	
MID-DISTANT DOWNSTREAM	V.	Gerjen-Foktő right bank	PLDMZB411	130280	638212	02.07.2012 30.09.2012
			PLDMZB412	129031	638801	
			PLDMZB413	128639	638936	
		Gerjen-Foktő left bank	PLDMZB421	129609	639081	
			PLDMZB422	129192	639202	
			PLDMZB423	129038	639302	
	VI.	Dombori right bank	P50DMZB211	121592	639411	20.07.2013 06.10.2013
			P50DMZB212	121591	639399	
			P50DMZB213	121565	639392	
		Dombori left bank	P50DMZB221	121000	639605	
			P50DMZB222	120984	639601	
			P50DMZB223	120903	639556	

Section	Profile number	Name	Sample subunit code	EOVX	EOVY	Date
DISTANT DOWNSTREAM	VII.	Sió South right bank	P50DMZB311	108176	639604	20.07.2013 06.10.2013
			P50DMZB312	108081	639687	
			P50DMZB313	108017	639787	
		Sió South left bank	P50DMZB321	108820	639554	
			P50DMZB322	108719	639733	
			P50DMZB323	108548	639921	
	VIII.	Baja right bank	P50DMZB411	97912	639050	20.07.2013 06.10.2013
			P50DMZB412	97368	638972	
			P50DMZB413	97244	638949	
		Baja left bank	P50DMZB421	97576	639454	
			P50DMZB422	97474	639409	
			P50DMZB423	97276	639427	

Table 12.1.5-8: Sampling of macroscopic aquatic invertebrate taxons on the Danube

The location and date of testing on other bodies of water is provided in Table 12.1.5-9.

Name	Sample unit code	EOVX	EOVY	Date
Kondor Lake	PLKTMZB11	136611	635862	01.07.2012 29.09.2012
	PLKTMZB12	136317	636067	
	PLKTMZB13	136121	635805	
Angler Ponds	PLHTMZB	136902	636063	01.07.2012 29.09.2012
Dead Danube of Fadd 1.	PLFHDMZB11	126038	635541	01.07.2012 29.09.2012
	PLFHDMZB12	126131	635105	
	PLFHDMZB13	126101	634635	
Dead Danube of Fadd 2.	PLFHDMZB21	123372	634779	01.07.2012 29.09.2012
	PLFHDMZB22	123036	634807	
	PLFHDMZB23	122632	635730	
Northern Dead Danube of Tolna 1.	P50THDMZB11	122212	634162	21.08.2013 06.10.2013
	P50THDMZB12	120485	631078	
	P50THDMZB13	119338	630506	
Northern Dead Danube of Tolna 2.	P50THDMZB21	122270	634234	21.08.2013 06.10.2013
	P50THDMZB22	122022	632164	
	P50THDMZB23	119694	630551	
Sió-channel	P50SMZB11	110702	636105	21.08.2013 06.10.2013
	P50SMZB12	110699	636135	
	P50SMZB13	110702	636163	

Table 12.1.5-9: Sampling for macroscopic aqauatic invertebrate taxons in other bodies of water

12.1.5.5.2 Sampling method

Water courses

Sampling was based on the EU-STAR/AQEM sampling protocol [12-2], and its version adapted to Hungarian conditions, entitled "NBmR sampling procedure for aquatic macroscopic invertebrates". Sampling was carried out by taking into account the standards MSZ EN 27828:1998 (Water quality, Taking biological samples, Guidelines for taking samples of aquatic benthic macroscopic invertebrates using hand held nets (ISO 7828:1985) and MSZ EN 28265: 1998 (Water quality. The structure and use of quantitative sampling devices designed for the collection of aquatic benthic macroscopic invertebrates living in bodies of shallow freshwater with pebbly bottoms (ISO 8265:1988).

The samples should be taken in the case of rivers and large rivers (such as the Danube) a 3x10 metres section, which is deemed to be representative for a 500 metres length. The bottom should be stirred by the so called kick and sweep method, standing in the knee-deep beach zone holding out a standard pond net (0.25 x 0.25 m frame, 950 μm mesh) turned back downstream and treading on the spot or kicking the pebbles, and the aquatic benthic macroscopic invertebrate organisms, living in it or attached to the surface, which are drifted into the net by the current should be caught. In any one habitat type 5 AQEM type replicates need to be taken from each habitat in accordance with the percentage distribution of the habitats concerned (multihabitat sampling), which is handled as a single sample. During sampling, 3 sub-samples are taken from each sampling sites which can be seen as independent from one another, containing 5 replicates each (1 replicate = collection of from a 25x25 cm area). A total of 15 replicates are screened in any one sampling points, accounting for a surface area of 0.9375 m^2 per section.

Processing of the samples covers a total of 10 groups of macroscopic invertebrate organisms down to the species level to the extent possible, picked out on the spot, using a white photographic tray. They should include the followings taxons required by the NBmR protocol:

- Gastropoda (snails),
- Bivalvia (molluscs),
- Hirudinea (leeches),
- Malacostraca (lower ranks crabs),
- Ephemeroptera (mayflies),
- Odonata (dragon-flies),
- Plecoptera (stoneflies),
- Heteroptera (water bugs and pond skaters),
- Coleoptera (aquatic beetles),
- Trichoptera (caddis flies).

Groups of organisms beside the aforementioned taxons are also counted and identified down to the lowest possible rank of taxonomy. Identification is accomplished with the use of stereo microscopes. The data are recorded in an Excel based database, which contains the taxon name, AQEM/STAR code (ID_ART), the name of the sampling site (point) and the quantities of taxons in ind/m^2. This allows further analysis of the data obtained by the ASTERICS 3.3 software programme (www.aqem.de).

Lakes

No well established sampling protocol approved by the EU WFD is currently available for aquatic macroscopic invertebrate organisms living in lakes. The method used mostly follows the AQEM procedures.

The bottom section covered is 250 metres and can not be at any part of the lake bottom which concerns a substantial hydromorphological feature such as a bridge, beach, transverse embankment. The length of the sampling section is: 3x10 metres – a representative section for the 250 metre length covered earlier on, and samples are taken in these details of the bottom, as described above for watercourses. Micro-habitat types to be sampled include the hair-weedy, marshland vegetation, and the open sediment surface. Five replicates should be taken from each section and these handled later on the same way as described above for watercourses.

In the marshy vegetation the net should be swept three times on the given surface (0.25x0.25 m). When samples are taken from hair-weeds, a sweep must be made from the bottom to the top on the surface concerned (0.25x0.25 m) in addition to the sampling of the sediment surface, while on the open sediment surface area (0.25x0.25 m) the net should be swept so that its rim dipped a little bit into the silt.

Processing of the samples is done the same way as in the case of watercourses.

12.1.5.5.3 Method of evaluation

During the analysis of the quantitative data community structure indicators such as number of individuals (density ind/ m^2), and the number of taxons are determined. There are a number of statistical methods available for the purposes of comparing quantitative parameters of the samples (number of taxons, density, diversity). Distribution patterns of the data (standard or non-standard) were assessed using the Kolmogorov-Smirnov test, the similarity of variances by the Bartlett-test. Correspondingly, parametric testing (one way analysis of variance or ANOVA) is conducted.

Similarity and dissimilarity of quantitative samples (sampling sites) can be analysed by the ordination procedure generated with the Bray-Curtis function and principal component analysis (PCoA). The key of the procedure is that the sampling sites which are close to each other will show a higher level of similarity with respect to macro fauna composition and quantities than those situated further away from the cluster of points. This procedure may be suitable for separating sampling sites affected directly by some actual impact (such as hot water), and to determine, whether or not this impact is actually felt. The presence-absence matrix obtained during the qualitative processing of the samples (binary data) can be tested by a hierarchic classification method, the so called cluster analysis, the most widely accepted analytical method for the classification of living communities. The key feature of this method is that it is able to detect similarities and dissimilarities progressing from the top to down (in a hierarchic manner) on the basis of the composition of invertebrate communities of individual samples (sampling sites).

Ecological status assessment in watercourses

Ecological status assessment was accomplished on the basis of a so called multimetric index, the HMMI (Hungarian Multimetric Macroinvertebrate Index) required by the WFD (Várbíró et al. [12-42], [12-43]), which passed the intercalibration process of the European Union and its five grade EQR (Ecological Quality Ratio) classification scale (1-5) proved to be well suited for the evaluation of the ecological status in watercourses.

Ecological status assessment in lakes

Since no established sampling method is available at the time being for the assessment of macro invertebrate fauna of lakes, the ecological status was assessed on the basis of the family scoring system used in international references for macrozoobenthos [12-7].

12.1.5.6 Assessment of fishes

12.1.5.6.1 Sampling

Fishes were sampled in the Danube during 2012 and 2013 from a total of 7 profiles in one upstream and three downstream sections during the vegetation period. Each sampling unit consisted of several sampling sub units. Sampling subunits were distinguished on the basis of the habitat conditions and in particular those of the bottom (Table 12.1.5-10), taking into account the results from tests carried out in 2009 and 2010 (Kék Csermely [12-22]) In the course of the exact selection of the sampling times the suitability of the Danube was taken into consideration and sampling operations were harmonised with the times applicable to the physical and chemical testing of the water as well as with the times when the other groups of living organisms were assessed.

Section	Profile number	Name	Sample subunit code	Bottom types	EOVX	EOVY	Date
UPSTREAM	I.	Paks upstream right bank	P50DH1111F	natural	143808	638925	22.07.2013 08.10.2013
			P50DH1111A		143821	638836	
			P50DH1112F		143809	638744	
			P50DH1112A		143846	638291	
			P50DH112F	pebbled	138673	635785	
			P50DH112A		138193	636157	
		Paks upstream left bank	P50DH121F	pebbled	143407	638517	22.07.2013 08.10.2013
			P50DH121A		143400	637924	
			P50DH1221F	natural	142645	637012	
			P50DH1221A		142477	636850	
			P50DH1222F		141166	635895	
			P50DH1222A		140910	635816	
NEAR DOWNSTREAM	II.	right bank downstream of Paks hot water discharge	PLHD111F	pebbled	137636	636585	03.07.2013 01.10.2013
			PLHD111A		137599	636598	
			PLHD112F	natural	137572	636610	
			PLHD112A		137492	636739	
			PLHD113F	pebbled	137495	636749	
			PLHD113A		137477	636753	
			PLHD114F	natural	137451	636762	
			PLHD114A		137220	636951	
		left bank downstream of Paks hot water discharge	PLHD12F	natural	138031	637008	03.07.2013 01.10.2013
			PLHD12A		137616	637379	

Section	Profile number	Name	Sample subunit code	Bottom types	EOVX	EOVY	Date
	III.	Nagysarkantyú right bank	PLHD211F	pebbled	137085	637157	03.07.2013 01.10.2013
	III.	Nagysarkantyú right bank	PLHD211A	pebbled	137061	637156	03.07.2013 01.10.2013
	III.	Nagysarkantyú right bank	PLHD212F	natural	136978	637287	03.07.2013 01.10.2013
	III.	Nagysarkantyú right bank	PLHD212A	natural	136597	637452	03.07.2013 01.10.2013
	III.	Nagysarkantyú left bank	PLHD22F	natural	137277	637587	03.07.2013 01.10.2013
	III.	Nagysarkantyú left bank	PLHD22A	natural	136815	637932	03.07.2013 01.10.2013
	IV.	Uszód right bank	PLHD311F	natural	136279	637672	03.07.2013 01.10.2013
	IV.	Uszód right bank	PLHD311A	natural	136181	637745	03.07.2013 01.10.2013
	IV.	Uszód right bank	PLHD312F	pebbled	136181	637745	03.07.2013 01.10.2013
	IV.	Uszód right bank	PLHD312A	pebbled	136167	637789	03.07.2013 01.10.2013
	IV.	Uszód right bank	PLHD313F	natural	135146	638029	03.07.2013 01.10.2013
	IV.	Uszód right bank	PLHD313A	natural	134761	638133	03.07.2013 01.10.2013
	IV.	Uszód left bank	PLHD32F	pebbled	135045	638546	03.07.2013 01.10.2013
	IV.	Uszód left bank	PLHD32A	pebbled	134447	638637	03.07.2013 01.10.2013
MID-DISTANT DOWNSTREAM	V.	Gerjen-Foktő right bank	PLHD411F	natural	133531	638177	04.07.2013 02.10.2013
MID-DISTANT DOWNSTREAM	V.	Gerjen-Foktő right bank	PLHD411A	natural	133301	638202	04.07.2013 02.10.2013
MID-DISTANT DOWNSTREAM	V.	Gerjen-Foktő right bank	PLHD412F	pebbled	133259	638208	04.07.2013 02.10.2013
MID-DISTANT DOWNSTREAM	V.	Gerjen-Foktő right bank	PLHD412A	pebbled	133245	638205	04.07.2013 02.10.2013
MID-DISTANT DOWNSTREAM	V.	Gerjen-Foktő right bank	PLHD413F	pebbled	130948	638071	04.07.2013 02.10.2013
MID-DISTANT DOWNSTREAM	V.	Gerjen-Foktő right bank	PLHD413A	pebbled	130663	638089	04.07.2013 02.10.2013
MID-DISTANT DOWNSTREAM	V.	Gerjen-Foktő left bank	PLHD421F	pebbled	133609	638693	04.07.2013 02.10.2013
MID-DISTANT DOWNSTREAM	V.	Gerjen-Foktő left bank	PLHD421A	pebbled	133329	638692	04.07.2013 02.10.2013
MID-DISTANT DOWNSTREAM	V.	Gerjen-Foktő left bank	PLHD422F	natural	129184	639197	04.07.2013 02.10.2013
MID-DISTANT DOWNSTREAM	V.	Gerjen-Foktő left bank	PLHD422A	natural	128971	639328	04.07.2013 02.10.2013
MID-DISTANT DOWNSTREAM	VI.	Dombori right bank	P50DH211F	pebbled	122003	639644	22.07.2013 09.10.2013
MID-DISTANT DOWNSTREAM	VI.	Dombori right bank	P50DH211A	pebbled	121733	639493	22.07.2013 09.10.2013
MID-DISTANT DOWNSTREAM	VI.	Dombori right bank	P50DH212F	natural	121583	639398	22.07.2013 09.10.2013
MID-DISTANT DOWNSTREAM	VI.	Dombori right bank	P50DH212A	natural	121337	639228	22.07.2013 09.10.2013
MID-DISTANT DOWNSTREAM	VI.	Dombori left bank	P50DH221F	pebbled	122367	640294	22.07.2013 09.10.2013
MID-DISTANT DOWNSTREAM	VI.	Dombori left bank	P50DH221A	pebbled	122052	640158	22.07.2013 09.10.2013
MID-DISTANT DOWNSTREAM	VI.	Dombori left bank	P50DH222F	natural	121017	639616	22.07.2013 09.10.2013
MID-DISTANT DOWNSTREAM	VI.	Dombori left bank	P50DH222A	natural	120738	639452	22.07.2013 09.10.2013
DISTANT DOWNSTREAM	VII.	Sió South right bank	P50DH311F	pebbled	108977	638878	23.07.2013 09.10.2013
DISTANT DOWNSTREAM	VII.	Sió South right bank	P50DH311A	pebbled	108746	639076	23.07.2013 09.10.2013
DISTANT DOWNSTREAM	VII.	Sió South right bank	P50DH312F	natural	105195	639734	23.07.2013 09.10.2013
DISTANT DOWNSTREAM	VII.	Sió South right bank	P50DH312A	natural	104929	639632	23.07.2013 09.10.2013
DISTANT DOWNSTREAM	VII.	Sió South left bank	P50DH321F	natural	108832	639535	23.07.2013 09.10.2013
DISTANT DOWNSTREAM	VII.	Sió South left bank	P50DH321A	natural	108640	639816	23.07.2013 09.10.2013
DISTANT DOWNSTREAM	VII.	Sió South left bank	P50DH322F	pebbled	107480	640608	23.07.2013 09.10.2013
DISTANT DOWNSTREAM	VII.	Sió South left bank	P50DH322A	pebbled	107181	640634	23.07.2013 09.10.2013
DISTANT DOWNSTREAM	VIII.	Baja right bank	P50DH411F	natural	99622	639351	23.07.2013 10.10.2013
DISTANT DOWNSTREAM	VIII.	Baja right bank	P50DH411A	natural	99335	639314	23.07.2013 10.10.2013
DISTANT DOWNSTREAM	VIII.	Baja right bank	P50DH412F	pebbled	98624	639177	23.07.2013 10.10.2013
DISTANT DOWNSTREAM	VIII.	Baja right bank	P50DH412A	pebbled	98296	639123	23.07.2013 10.10.2013
DISTANT DOWNSTREAM	VIII.	Baja left bank	P50DH421F	natural	99779	639811	23.07.2013 10.10.2013
DISTANT DOWNSTREAM	VIII.	Baja left bank	P50DH421A	natural	99430	639772	23.07.2013 10.10.2013
DISTANT DOWNSTREAM	VIII.	Baja left bank	P50DH422F	pebbled	98199	639524	23.07.2013 10.10.2013
DISTANT DOWNSTREAM	VIII.	Baja left bank	P50DH422A	pebbled	97862	639460	23.07.2013 10.10.2013

Table 12.1.5-10*: Coordinated of fish community sampling sub-units on the Danube*

The location and date of testing on other bodies of water is provided in Table 12.1.5-11.

Name	Sample unit code	EOVX	EOVY	Date
Kondor Lake	PLKTH11F	136433	635966	05.07.2012 03.10.2012
	PLKTH11A	136320	636046	
	PLKTH12F	136176	635795	
	PLKTH12A	136099	635698	
Angler Ponds	PLHTH1F	136911	636078	01.07.2012 29.09.2012
	PLHTH1A	136875	635978	
Dead Danube of Fadd 1.	PLFHDH11F	121301	637163	05.07.2012 03.10.2012
	PLFHDH11A	121442	636911	
Dead Danube of Fadd 2.	PLFHDH21F	125648	633688	05.07.2012 03.10.2012
	PLFHDH21A	125685	633795	
	PLFHDH22F	125711	633979	
	PLFHDH22A	125586	633888	
Northern Dead Danube o Tolna 1.	P50THDH11F	119342	630550	21.07.2013 07.10.2013
	P50THDH11A	119537	630626	
	P50THDH12F	120370	630909	
	P50THDH12A	120511	630954	
Northern Dead Danube o Tolna 2.	P50THDH21F	122008	632297	21.07.2013 07.10.2013
	P50THDH21A	122117	632428	
	P50THDH22F	122293	632578	
	P50THDH22A	122361	632714	
Sió-channel	P50SH11F	110726	636174	23.07.2013 09.10.2013
	P50SH11A	110678	636580	
	P50SH12F	110720	636862	
	P50SH12A	110717	637199	

Table 12.1.5-11: Coordinates of fish community sampling sub-units in other bodies of water

12.1.5.6.2 Sampling method

Watercourses

For the purposes of designing of the sampling procedure the applicable parts of Ministerial Decree No.31/2004. (XII. 30.) KvVM laying down certain rules for the monitoring and state assessment of surface waters, the standard EN 14011:2003 Water quality - Sampling of fish with electricity, the chapters of the project “preparations for monitoring in accordance with the Birds Directive (79/409/EEC) and Habitat Directive (92/43/EEC) (2006/18/176.02.01) concerning sampling for fish, the contents of the NBmR fish sampling protocol, and the methodological guidelines of the Water Framework Directive for monitoring of fishes [12-16], [12-17]. Additionally, the methodological chapters and findings of the Environmental Impact Studies carried out in the environment of the Paks Nuclear Power Plant were also taken into account (Halasi-Kovács [12-14]; Kék Csermely [12-22]). Accordingly, the method of sampling complies with the WFD requirements.

The means of sampling was an electric sampling apparatus (EME) with 7 kW output operated from a direct current (DC) diesel generating set, type Hans-Grassl EL 64 II GI. Sampling was accomplished using a 40 cm diameter landing net mouth, hand held anode. The equipment conforms to the shock protection and registration requirements laid down in Ministerial Decree No 90/2000. (XI. 14.) FVM. Sampling was quantitative, partial (in other words, it was done in a section of the channel cross profile), and, whenever feasible or necessary, fragmented and stratified (that is, it consists of several subunits, the length of which is assigned in proportion of the typical habitats). The length of the sampling unit was 500 metres. Sampling was made from a boat, in line with the main stream, at constant speed. Taking into account the properties of the EME the sampling operation was made in the riparian zone. Top and bottom points of the sampling units were identified and recorded with the help of a GPS unit. For the purposes of assessing the results, the species found were identified, the number of specimens recorded on dictaphones for each sub unit. Offspring (0+) was also identified and counted, independently from the adult individuals. Sampling was completed twice, once in Summer and once in Winter. Exact date and time of sampling was made with due regard to the water level and the weather conditions. The optimal water level for sampling was found to be <200 cm as measured by the Paks watermark post. The time of sampling was during daylight. Identification of the fishes, taxonomical classification and nomenclature of the fishes was done in accordance with the works by Berinkey (1966) and Miller (1990), and Halasi-Kovács and Harka (2012). [12-49], [12-50], [12-51]

Lakes

The means of sampling was an electric sampling apparatus (EME) with 7 kW output operated from a direct current (DC) diesel generating set, type Hans-Grassl EL 64 II GI. Sampling was accomplished using a 40 cm diameter landing net mouth, hand held anode. The equipment conforms with the shock protection and registration requirements laid down in Ministerial Decree No 90/2000. (XI. 14.) FVM. Sampling was quantitative, partial (in other words, it was done in a section of the channel cross profile), and, whenever feasible or necessary, fragmented and stratified (that is, it consists of several subunits, the length of which is assigned in proportion of the typical habitats). The length of the sampling unit was 300 m. Taking into account the properties of the EME the sampling operation was made predominantly in the littoral zone. Top and bottom points of the sampling units were identified and recorded with the help of a GPS unit. Sampling length was also measured with GPS.

At the Fishing Ponds sampling point assessment was made using a lower output Hans Grassl IG 200 II/B type EME operated from batteries, equipped with a 30 cm diameter manual anode. The equipment conforms with the shock protection and registration requirements laid down in Ministerial Decree No 90/2000. (XI. 14.) FVM. Sampling was quantitative, partial (in other words, it was done in a section of the channel cross profile), but continuous. The length of sampling was 150 m. Top and bottom points of the sampling units were identified and recorded with the help of a GPS unit. Sampling length was also measured with GPS.

For the purposes of assessing the results, the species found were identified, the number of specimens recorded on dictaphones for each sub unit. Offspring (0+) was also identified and counted, independently from the adult individuals.

Sampling was completed twice, once in Summer and once in Winter. Exact date and time of sampling was harmonised with sampling on the Danube. The time of sampling was during daylight.

Identification of the fishes, taxonomical classification and nomenclature of the fishes was done in accordance with the works by Berinkey (1966) and Miller (1990), and Halasi-Kovács and Harka (2012). [12-49], [12-50], [12-51]

12.1.5.6.3 Method of evaluation

For the purposes of evaluation the occurrence of protected and strictly protected species and species covered by international conventions (Ministerial Decree No.13/2001.(V.9.) KöM of the Ministry of Environment publishing the lists of protected and strictly protected plant and animal species, strictly protected caves and plant and animal species of Community (European Union) nature conservation importance; Council Directive 92/43/EEC of 21 May 1992 on the Conservation of natural habitats and of wild fauna and flora; Government Decree No 275/2004. (X.8.) on the areas of Community importance dedicated to nature conservation as amended by Government Decree No 201/2006. (X.2.)) was also taken into account.

During the ecological analysis of the quantitative data the number of taxons (species), abundance (CPUE) were assessed for each sampling unit, per section, and – in order to assess on a fine resolution scale – at the subunit level as well, in the case of Danube samples. Evaluation and comparison of the data were accomplished using statistical methods.

Ecological status assessment in watercourses

Determination of the age structure in order to allow classification according to the WFD was achieved by separate identification of offspring (0+) and adult (>0+) generations. In the case of watercourses the results were evaluated by the use of the evaluation method developed for domestic watercourses in compliance with the WFD requirements (EQIHRF) (Halasi-Kovács and Tóthmérész [12-18]). Biological integration index provides the theoretical background for the ecological classification system based on the fish community structure of domestic water courses. The system developed is a multimetric evaluation procedure where variables are constituted by the ecological type clusters of fish communities and anthropogenic impacts appear in the results in an aggregated way.

According to the water type categories of the classification protocol the Danube is type 8. Classification is provided for each 2000 metres unit. Based on this classification grades are specified per section. Sió can be classified as "Small and medium size lowland rivers and canals " (Type 6). Classification was provided for each 1000 metres.

Ecological status assessment in lakes

Evaluation of the results for lakes was accomplished with the help of individual expert estimates since either a Hungarian, or a European classification system is not available at the time being. During classification, the contents of the document by Halasi-Kovács et al [12-17] were taken into account.

The expert classification consists of a three grade scale. They are the following: acceptable (3), average (2), bad (1). Quality status of the body of water of the lake concerned is specified on the basis of the arithmetic means of the values specified in the table. The five grade classification in the WFD corresponds to the following scores here:

1.00= bad (1)
1.33= poor (2)
1.66= poor (2)
2.00= moderate (3)
2.33= good (4)
2.66= good (4)
3.00= high (5)

For the purposes of classification results from both the Summer and Winter samples are taken into consideration so that the final status grade is determined as the arithmetic means of each classification scores in accordance with the rules pertaining to rounding.

Conditions taken into account for the purposes of classification	**Score**		
	1	**2**	**3**
Composite expert opinion based on species data sets	1	2	3
Relative abundance of specialists	<15%	15-33%	>33%
Relative abundance of native species	<33%	33-66%	>66

Table 12.1.5-12: Criteria taken into account for the purposes of classification of bodies of water in lakes based on the fish community

12.2 THE DANUBE SECTION ASSESSED (DUNAFÖLDVÁR-BAJA)

The Danube section assessed as part of the impact study belongs to the body of water marked **HURWAEP444**.

The Danube section assessed can be divided up into two major parts, a northern one and a southern one from the mouth of the hot water canal discharging from Paks Nuclear Power Plant (1526 river km). The Danube section which is free from the impact of the hot water discharge and the Danube section which is affected by the impact of the hot water discharge are called ***upstream section*** and ***downstream section.***

The general site map of the studies carried in 2012 and in 2013 is shown on Figure 12.1.5-1.

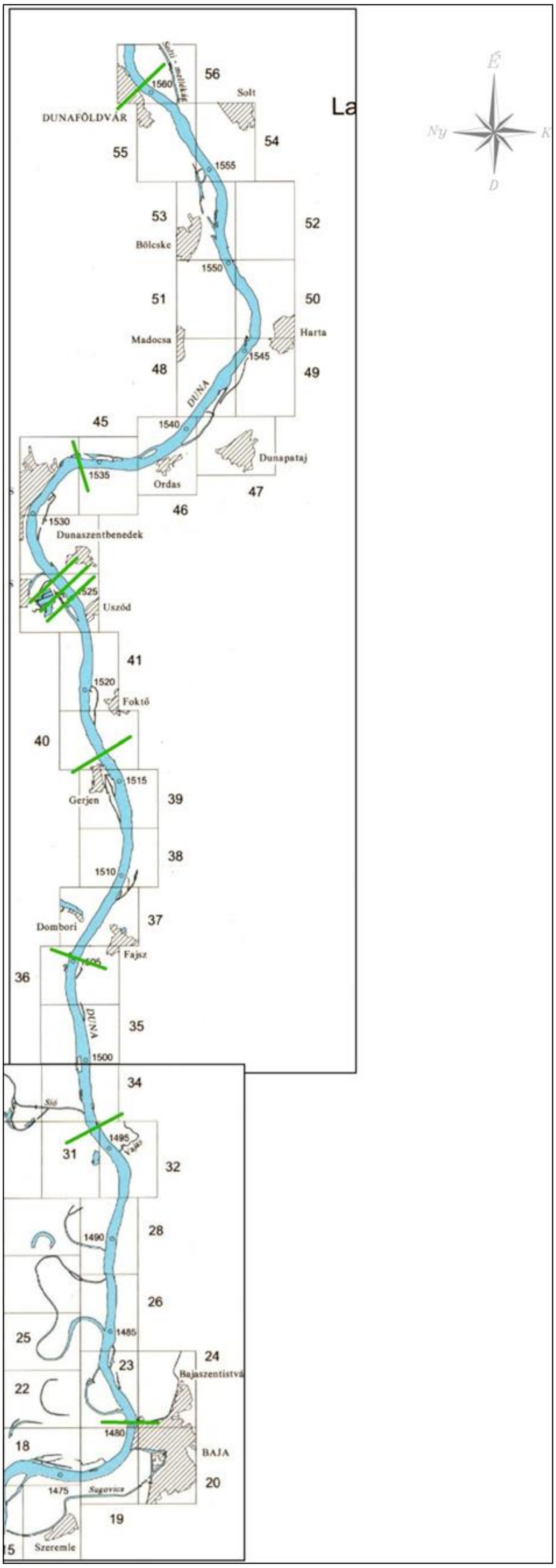

Figure 12.1.5-1: General site map of physico-chemical testing profiles on the Danube 2012. and 2013

Danube profiles where the studies made in 2012 and 2013 under the programme (PR) and where the results from the water quality backbone network (VmTH) were processed are described in Table 12.1.5-1.

No	Name of section	Danube river km	Profile number	Year	PR_study No.	Note
1	Dunaföldvár (road bridge)*	1560.6	0	2013	2	***Distant Danube upstream** profile.* **PR+VmTH studies.**
2	Paks (ferry)	1534,0	1	2012	12	***Near Danube upstream** profile.* **PR tests.**
3	Paks hot water canal	1526,0	2	2012	12	***Direct impacts downstream** profile.* **PR tests.**
4	Nagysarkantyú	1525.3	3	2012	12	***Direct impacts downstream** profile.* **PR tests.**
5	Uszód	1524.7	4	2012	12	***Direct impacts downstream** profile.* **PR tests.**
6	Gerjen-Foktő	1516,0	5	2012	12	***Direct impacts downstream** profile.* **PR tests.**
7	Fadd-Dombori*	1506.8	6	2013	6	***Distant downstream** profile.* **PR+VmTH tests**
8	Sió-South (Gemenc)	1496,0	7	2013	6	***Distant downstream** profile.* **PR tests**
9	Baja (road bridge)	1481.5	8	2013	2	***Distant downstream** profile.* **PR tests**

Table 12.1.5-1: Test profiles on the Danube and other characteristics

The general site map of study profiles on the Danube in 2012 is shown on Figure 12.1.5-2.

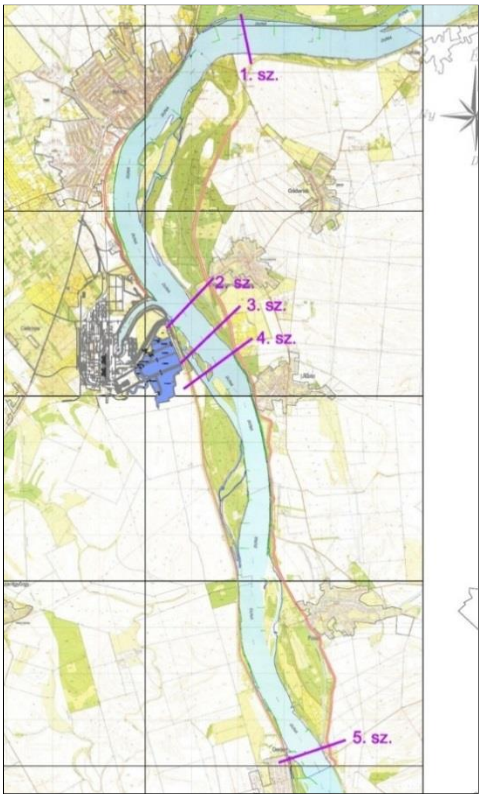

Figure 12.1.5-2: General site map of the physico-chemical testing profiles on the Danube in 2012

Studies in 2013 were justified by the extension of the area under investigation.

Detailed profile drawings of each of the test points can be seen later on when the base state of the individual profiles is presented, profile "0", "1", "2, 3, 4", "5", "6", "7" and "8" are shown on Figure 12.3.1-1, Figure 12.3.1-2, Figure 12.3.2-1, Figure 12.3.2-2,Figure 12.3.3-1, Figure 12.3.3-2, and Figure 12.3.3-3

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The assessment of the base state necessary for the purposes of laying the foundations of the Environmental Impact Study were completed on assignment from MVM ERBE Zrt. under the Lévai Project – Specialist field assessment and evaluation programmes laying the foundations for the compilation of the Environmental Impact Study (2012) and MVM Paks II Zrt. – Additional specialist field studies laying the foundations for the licensing procedure of the environmental protection license and of the site at Paks II (2013), and published in details in the Chapters entitled The state of the Danube and other surface waters of the final reports. In this documentation a summary evaluation is provided.

12.2.1 EVALUATION OF THE NATIONAL ARCHIVE DATA OF THE DANUBE SECTION ASSESSED

12.2.1.1 Physico-chemical variables

The assessed Danube Section is situated up to 34 kilometres from the Paks Nuclear Power Plant – relative to the Danube – to the north – which is the upstream section, and up to a distance of 45 km to the south – which is the downstream section. Two core network profiles fall within this stretch, Dunaföldvár and Fajsz stations. The classification of this Danube section according to the requirements of the WFD was characterised and completed by processing the archive water chemistry data sets for the period between 2007 and 2011 (Fajsz-2012).

Processing of the test results using the linear trend assessment method provides the basis for studying the chronological changes of the chemical elements in the water expected due to the increase in Danube water temperature.

The following groups of components are assessed as part of the study on changes caused by increased water temperature.

Acidification status: pH

Salinity: Conductivity

Oxygenation conditions -- Dissolved oxygen, Oxygen saturation BOD_5, $COD_{k,}$ Ammonium-N (NH_4+-N), Nitrite-N (NO_2^--N)

Nutrient conditions Nitrate-N (NO_3^--N), Total nitrogen, Total phosphorus, Orto-phosphate (PO_4^{3-}-P),

Metals: Cd, Hg, Ni, Pb

Specific pollutants (hazardous chemical elements): Zn, Cu, Cr, As

THE CLASSIFICATION OF THE DANUBE SECTION ASSESSED (DUNAFÖLDVÁR-FAJSZ) ACCORDING TO THE REQUIREMENTS OF THE WFD BASED ON ARCHIVE DATA SETS

Classification of the assessed Danube section (1560.6-1507.6 river km) was made based on the average values of tests between 2007 and 2011, in the case of Fajsz up to 2012, on the basis of the limit values specified in Table 12.1.3-1. Data classified in accordance with the WFD, containing the number of studies and average results were summarised in Table 12.2.1-1.

For the purposes of evaluating archive data the classification concerning physico-chemical components, completed in 2007, for the body of water marked HURWAEP444 the Danube between Szob and Baja (Type 24) from the national status assessment table of water bodies according to the WFD limit value system included in Annexes of VGT-k 5_1 (Table 12.2.1-2). In this table, the classification for the body of water marked HURWAEP445 Danube between Baja and Hercegszántó was also included for information.

- The **acidification status** can be classified as **good** on the basis of the average values of the assessment results throughout the period under consideration.
- The **salinity status** can be classified as **high** on the basis of the average values of the assessment results throughout the period under consideration.
- The average of **oxygenation conditions** status per class is 4.5. It is deemed to be of **good status** based on the WFD requirements.
- The average of **nutrients** status per class is 4.2. Based on the methodology specified by the WFD it is deemed to be in good ecological status.

- The average of **metals** status per class is 4.5. Based on the methodology specified by the WFD it is deemed to be in good ecological status.

The ecological status of the Danube between Dunaföldvár and Fajsz was classified as good, in terms of specific pollutants (hazardous chemical elements) good and acceptable on the basis of the water quality tests carried out in the period of 2007-2011 (2012). The ranking of the Danube Baja-Hercegszántó body of water in terms of physico-chemical element groups equals with that of the Dunaföldvár-Fajsz section.

This classification result **(with the exception of acidification - good)** concurs with the findings of the 2010 assessment of water bodies carried out in accordance with the limit values of the WFD and attached in the annex 5_1 of the VGT which is enclosed here in Table 12.2.1-2.

	Code of sampling site		101180039		101178210		101178933		101179653		101178232		Water quality
	Monitoring place		**Dunaföldvár**						**Fajsz**		**Hercegszántó**		**groups according to the WFD**
			left bank		**mainstream line**		**right bank**						
	Number of Danube river km profile		**1560.6 river km**		**1560.6 river km**		**1560.6 river km**		**1507.6 river km**		**1433.0 river km**		
KAJ	**Water quality parameters**		db	average	db	average	db	average	db	average	db	average	
156075	pH (laboratory measurement)		97	**8.2**	97	**8.2**	97	**8.2**	87	**8.3**	140	**8.3**	**Acidification**
155201	Chloride (Cl^-)	mg/l	86	**23.7**	86	**24.1**	86	**24.4**	49	**22.7**	121	**22.9**	**Salinity**
159469	Conductivity	µS/cm	97	**405**	97	**414**	97	**424**	87	**403**	140	**405**	**Salinity**
158420	Oxygen (dissolved) (O_2)	mg/l	97	**10.0**	97	**10.0**	97	**9.8**	75	**10.1**	140	**10.0**	**Oxygenation conditions**
159487	Dissolved oxygen (percent of oxygen saturation)	%	97	**91.9**	97	**91.9**	97	**90.5**	75	**95.0**	140	**93.8**	**Oxygenation conditions**
158970	Biochemical oxygen demand (BOD_5)	mg/l	97	**2.7**	97	**2.7**	97	**2.7**	75	**2.7**	140	**2.7**	**Oxygenation conditions**
159001	Oxygen consumption(COD_d) original	mg/l	97	**12.0**	97	**11.9**	97	**11.9**	75	**11.3**	140	**11.4**	**Oxygenation conditions**
156754	Ammonia-ammonium-nitrogen (NH_{3}-,NH_4^--N)	mg/l	97	**0.074**	97	**0.064**	97	**0.064**	75	**0.072**	140	**0.063**	**Nutrient conditions**
160551	Nitrite-nitrogen (NO_2-N)	mg/l	97	**0.026**	97	**0.020**	97	**0.019**	75	**0.017**	140	**0.016**	**Nutrient conditions**
160560	Nitrate-nitrogen (NO_3-N)	mg/l	97	**2.0**	97	**2.0**	97	**2.0**	75	**1.8**	140	**1.9**	**Nutrient conditions**
159405	Total nitrogen (N)	mg/l	97	**2.6**	96	**2.7**	97	**2.7**	87	**2.4**	139	**2.5**	**Nutrient conditions**
	Orto-phosphate-P (PO_4-P)	µg/l	97	**57.1**	97	**58.0**	97	**53.5**	75	**61.6**	140	**47.4**	**Nutrient conditions**
158154	Total phosphorus (P)	mg/l	97	**0.11**	97	**0.11**	97	**0.11**	87	**0.11**	140	**0.12**	**Nutrient conditions**
157601	Cadmium (dissolved) (Cd)	µg/l	57	**0.090**	56	**0.060**	57	**0.062**	22	**<0.05**	92	**0.125**	**Metals**
157472	Mercury (dissolved) (Hg)	µg/l	57	**0.075**	56	**<0.05**	57	**0.050**	23	**0.063**	92	**0.1**	**Metals**
157885	Nickel (dissolved) (Ni)	µg/l	57	**0.7**	56	**0.8**	57	**0.7**	22	**0.9**	92	**0.8**	**Metals**
158099	Lead (dissolved) (Pb)	µg/l	57	**1.9**	56	**<0.5**	57	**<0.5**	24	**<0.5**	92	**4.3**	**Metals**
157665	Chlorophyll-a	µg/l	96	**28.0**	96	**27.9**	96	**28.3**	74	**28.4**	140	**26.4**	
120498	Arsenic (As)	µg/l	6	**1.8**	6	**1.6**	6	**1.6**	0		6	**1.6**	**Specific pollutants (hazardous chemical elements)**
157050	Zinc (dissolved) (Zn)	µg/l	57	**4.9**	56	**5.5**	57	**4.7**	25	**4.4**	92	**6.2**	**Specific pollutants (hazardous chemical elements)**
120434	Chromium total (Cr)	µg/l	6	**0.6**	6	**0.7**	6	**0.5**	0		6	**0.7**	**Specific pollutants (hazardous chemical elements)**
156204	Copper (dissolved) (Cu)	µg/l	57	**3.7**	56	**1.8**	57	**1.7**	25	**1.3**	92	**2.1**	**Specific pollutants (hazardous chemical elements)**

Table 12.2.1-1: Average values from the Core Network studies completed between 2007 and 2011 in a classification structure according to the WFD

VGT Annex No - 5-1.1: Status of surface water bodies - Ecological status of watercourse water bodies

Subunit	KÖVIZIG	Water body category	vt-VOR	Water body name	**Physico-chemical elements**					
					Organic matter	**Nutrients**	**Salt content**	**Acidity**	**Status of the physico-chemical elements**	**Reliability of physico-chemical classification**
1-10	**3**	**natural**	**AEP444**	**Danube Szob-Baja**	**good**	**good**	**high**	**high**	**good**	**medium**

Table 12.2.1-2: Ecological status assessment of the HURWAEP444 Danube Szob-Baja section (Type 24) body of water according to the limit value system of the WFD

12.2.1.2 Biological elements

Archive data concerning the Dunaföldvár-Baja study section of the Danube (HURWAEP444) were already compiled and evaluated in the basic professional documentation of the Paks II environmental impact study (MVM ERBE [12-29], [12-30]). The following statements can be done based on these.

- The Danube-section concerned – with special emphasis on the environs of the Paks Nuclear Power Plant – was subjected to regular hydrobiological testing in the past 15 years. As a result, historical phytoplankton, phytobenthos, macrozoobenthos, and fish community data are available. Former macrophyte assessments provide information only to the terrestrial vegetation of the Paks Nuclear Power Plant area.
- Full sets of coherent historical data allowing ecological status determination pursuant to the Water Framework Directive are available as a result of the studies carried out in 2009 and 2010 (Kék Csermely Kft. [12-22]), while data lending themselves to evaluation according to the WFD are available sporadically for individual groups of living organisms.
- Status evaluation of the assessment results from 2009 and 2010 in accordance with the WFD aspects indicated that FP was in a good status; FB in moderate, MZB in moderate, and the fish community in good status in the Paks Danube-section. Following the classification principle of "one bad means all bad" on this basis the ecological status of the Danube is moderate. According to the classification efforts made in accordance with the WFD aspects there is not detectable difference between the upstream and downstream section relative to the nuclear plant discharge which would cause a leap in grades.
- Historical data suggest that the Danube-section marked HURWAEP444 between Dunaföldvár and Baja was of moderate ecological status. Within this, phytoplankton and fishes typically reflect good, while phytobenthos and macrozoobenthos typical reflect moderate statuses.
- Based on the partial river basin management plan of the Danube the entire domestic stretch of the Danube has a moderate ecological status. This can be attributed partly to quality related but also at the same weight hydromorphological reasons. Good ecological status of the water body of the Danube marked HURWAEP 444 between Szob and Baja can be achieved by 2027 according to the plans (VKKI [12-45]).
- Historical data are also available for the impact of cooling water discharges from Paks Nuclear Power Plant on the Danube. Physiological testing of algae indicate that the algal intensity of photosynthesis in the hot water canal was lower than in the cold water canal, demonstrating that algal biomass of the cooling water is damaged to a certain extent while passing the cooling system. At the same time samples from the Danube did not confirm the impact of the discharge in the case of phytoplankton or phytobenthos. Based on the findings from the fine resolution ecological assessments of macrozoobenthos and fish communities the impact of the cooling water load discharged into the Danube was detectable along an approximately 2 km long longitudinal profile (Halasi-Kovács [12-14], Kék Csermely Kft. [12-22]). This resulted in mainly qualitative and mainly quantitative changes in the case of the MZB and the fish community.
- Fishing and angling catches were investigated in the Paks section of the Danube from 2000 on. They all reflect a gradual decline of both fishing and angling yields. The decline stopped in 2011 and 2012, and a slight increase could be observed in these years. All in all, no correlation can be demonstrated between the operation of the Paks Nuclear Power Plant and the quantitative changes in the utilisation rates of fishes in the Danube partly because of the uncertainty of the catch data which concern a very small area only and partly because the catching structure typical for the Danube, which is different from other large rivers to a great extent (Halasi-Kovács and Váradi [12-19]).
- Conclusions which could be drawn from the historical data were taken into account, but for the purposes of analysis only the results of the 2012 and 2013 studies were used in the course of the Paks II environmental impact study, partly because the historical data are scarce and sporadic, have a lower confidence level and partly because the studies carried out in the years 2012 and 2013 provided data sets of appropriate quality and quantity which were in addition entirely coherent, in contrast to the earlier investigations.

12.3 BASE STATE OF THE DANUBE SECTION ASSESSED (1560.6 RIVER KM-1481.5 RIVER KM)

The assessed Danube section was characterised on the basis of historical data 2006-2011 (2012), and those obtained as part of the current project in 2012 and 2013. On Figure 12.2.1-1, Figure 12.2.1-2 and Figure 12.2.1-3 the hydrological characteristics of this period are presented.

The profiles were classified according to the WFD derived limit values for the Danube (Table 12.1.3-1).

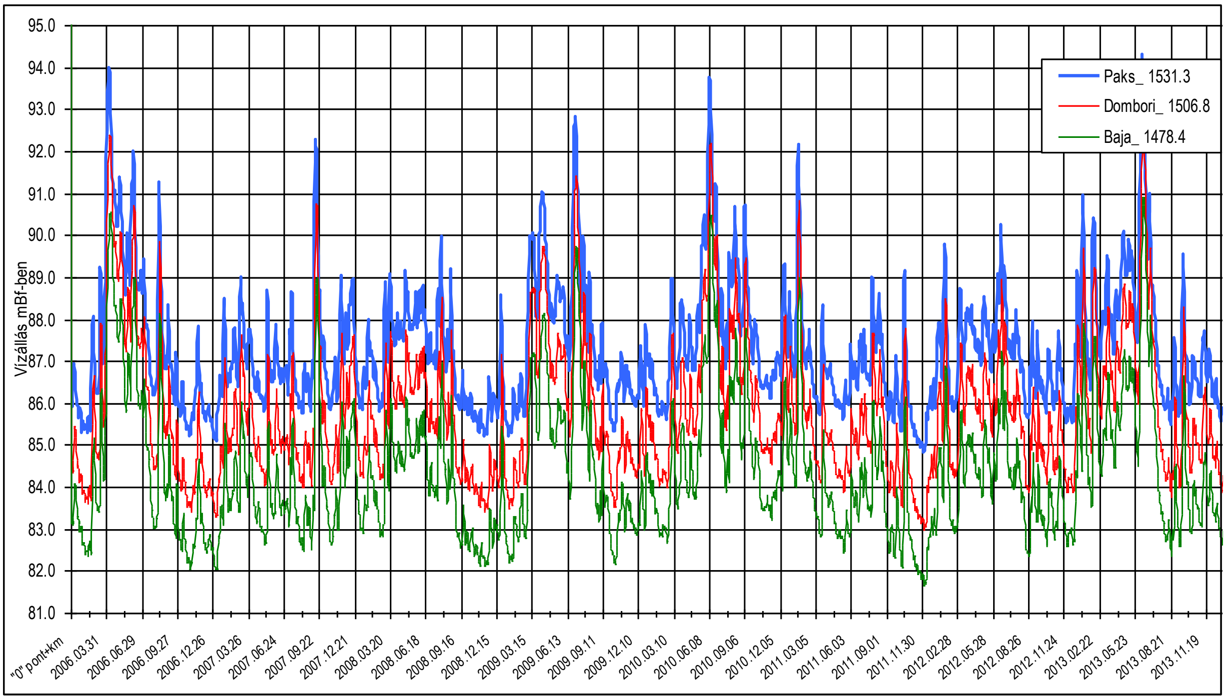


Figure 12.2.1-1: The water regime of the Danube (Paks-Dombori-Baja) between 2006 and 2013

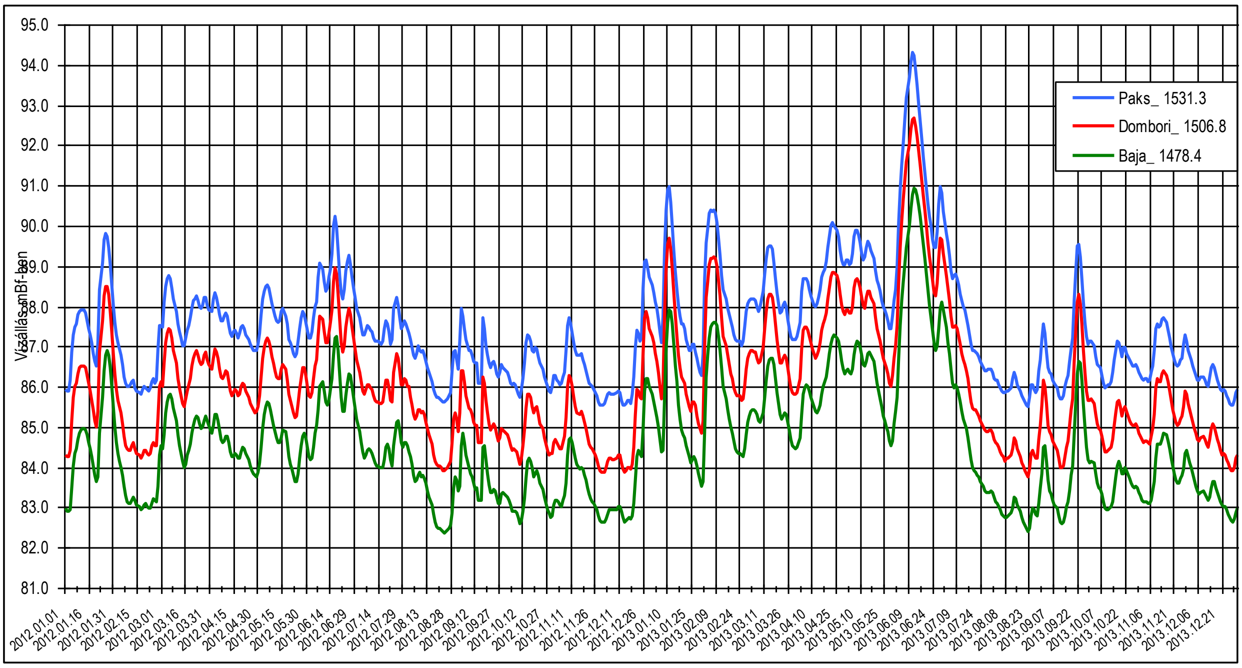
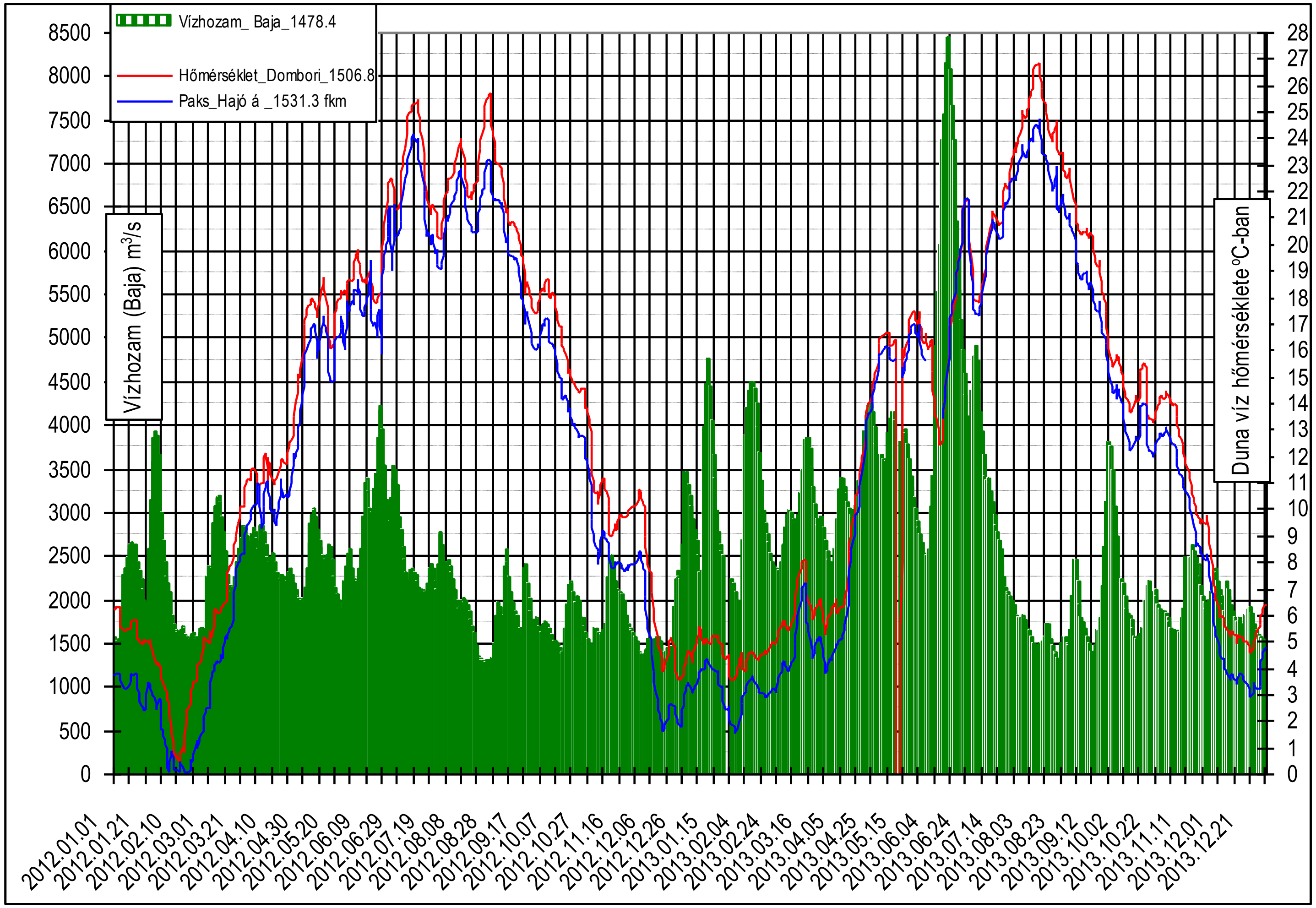
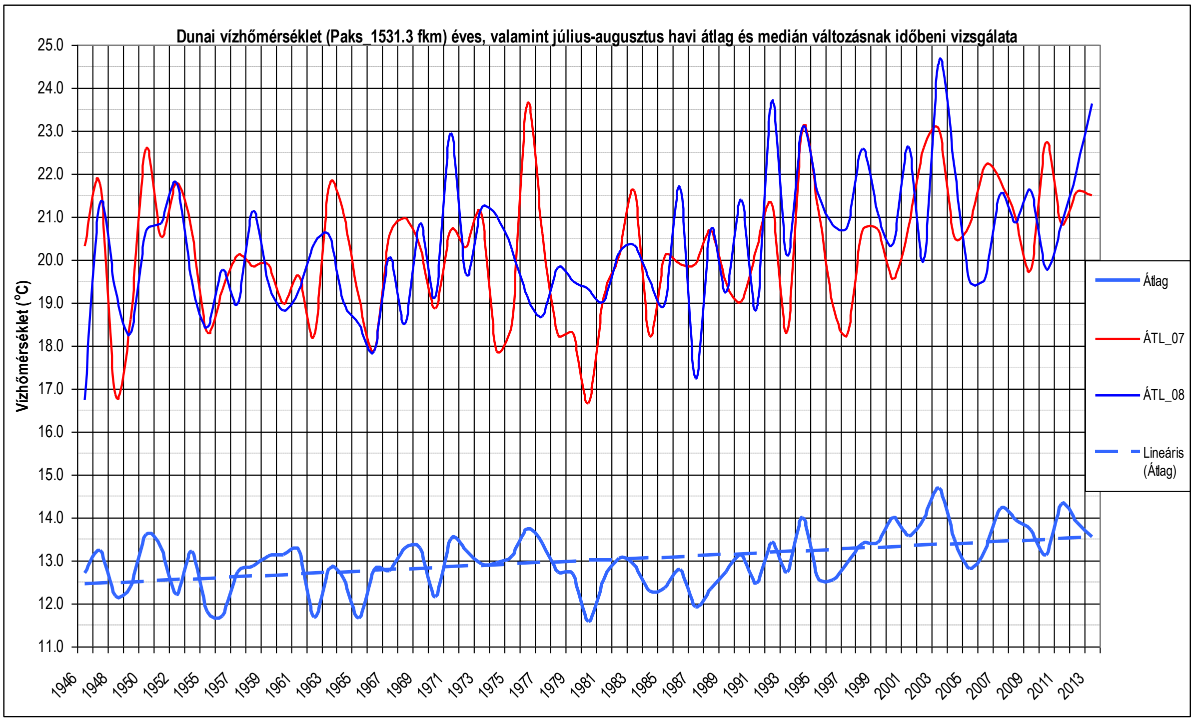


Figure 12.2.1-2: Water regime of the Danube (Paks-Dombori-Baja) between 2012 and 2013



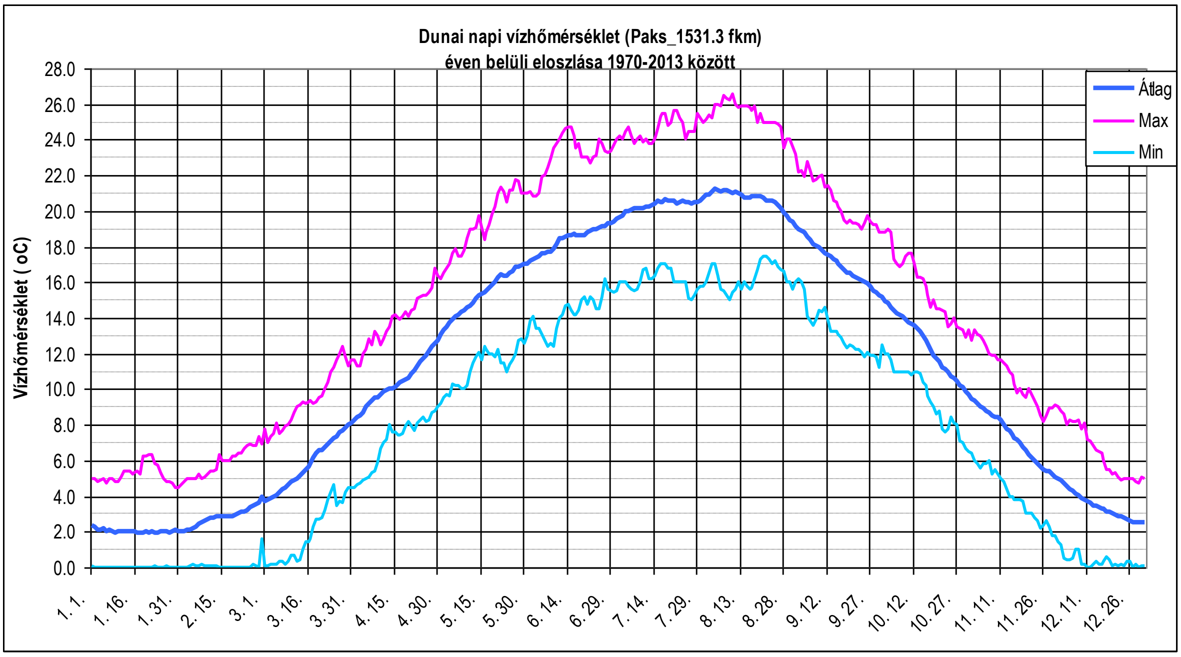
Vízhozam – discharge rate
Hőmérséklet – temperature
Hajó á – port
Duna víz hőmérséklete – water temperature of the Danube

Figure 12.2.1-3: Changes in the discharge rate and water temperature of the Danube (Paks-Dombori-Baja) in 2012 and 2013



Vízhőmérséklet – water temperature
Dunai vízhőmérséklet (Paks, 1531,3 fkm) éves, valamint július-augusztus havi átlag és medián változásnak időbeli vizsgálata – Chronological changes of the annual average and median water temperature of the Danube (Paks, 1531.3 river km) in the period of July-August
átlag – average
lineáris – linear

Figure 12.2.1-4: Chronological changes of the annual average water temperature of the Danube (Paks) between 1970 and 2013



Vízhőmérséklet – water temperature
Dunai napi vízhőmérséklet (Paks, 1531,3 fkm) éven belüli eloszlása 1970-2013 között – Annual distribution of daily water temperatures of the River Danube (Paks 1531.3 river km) in the period 1970-2013
fkm – river km
átlag – average
max – maximum
min - minimum

Figure 12.2.1-5: Annual distribution of the daily water temperatures of the Danube (Paks) in the period between 1970 and 2013

12.3.1 UPSTREAM PROFILES OF THE DANUBE SECTION ASSESSED

The Danube profiles situated to the north of the hot canal mouth (1526 river km), which is free from the impact of hot water, is ranked in the group of "upstream profiles".

12.3.1.1 Physico-chemical properties

The Dunaföldvár (road bridge) 1560.6 river km profiles are shown on Figure 12.3.1-1, the Paks (ferry) 1534.0 river km profiles on Figure 12.3.1-2.

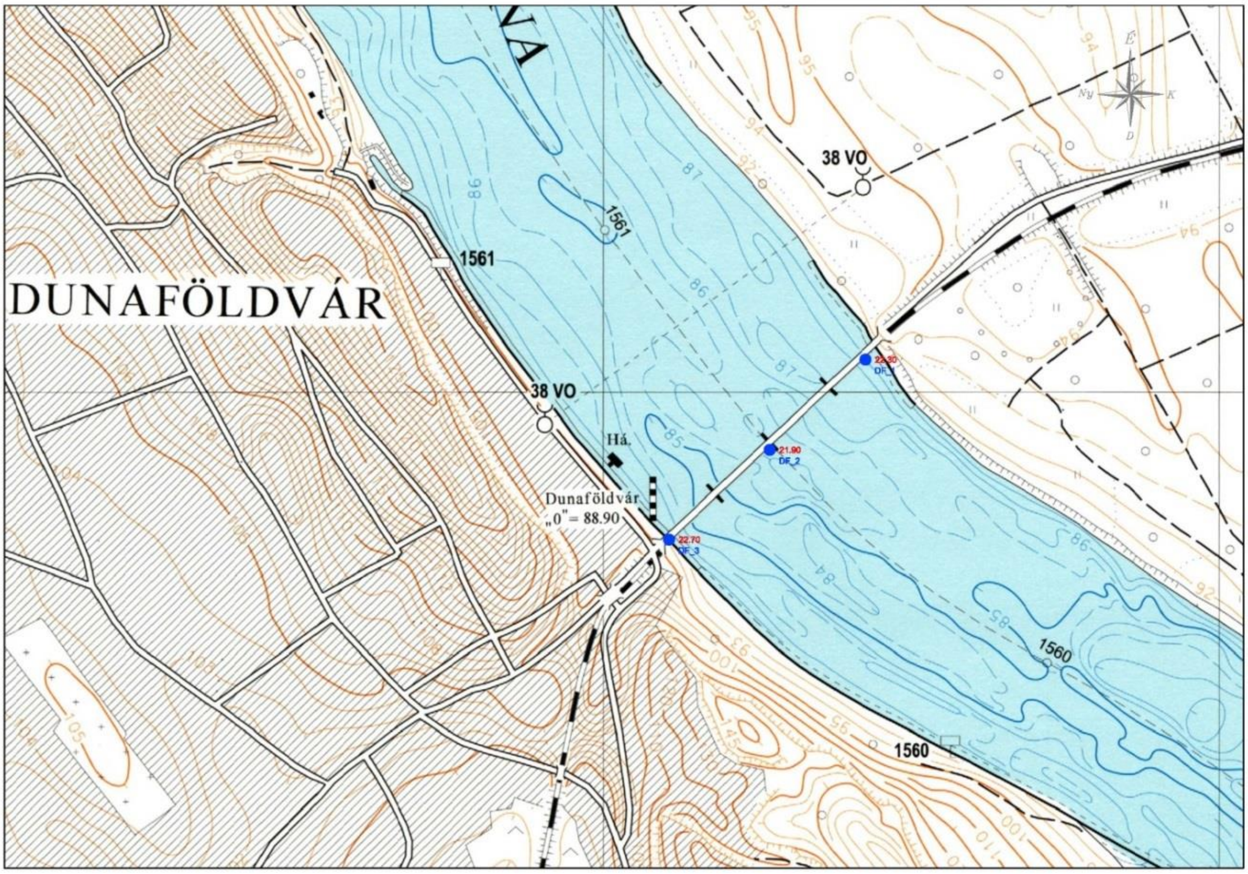
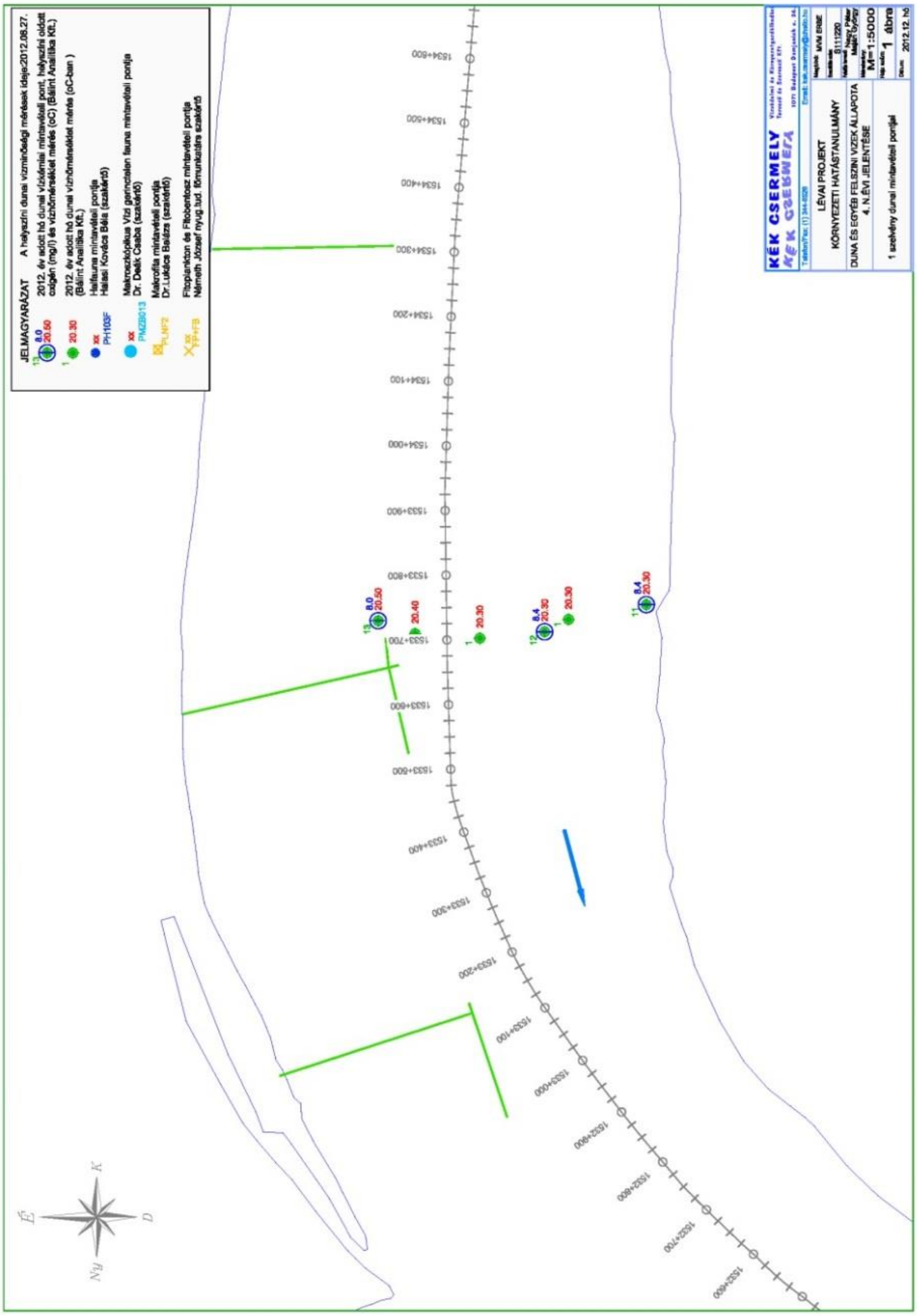


Figure 12.3.1-1: General site map of the Dunaföldvár 1560.6 river km study profile No 0

In the Dunaföldvár profile studies intended to define physico-chemical parameters were carried out twice in the course of the second half of the year 2013. Water quality data obtained from the 2013 tests and containing WFD classification grades are provided in Table 12.3.1-1.

It should be noted that water quality testing of the Danube water is carried out in the Dunaföldvár profile as part of the measurement under the National Core Network on the right and left bank, and in the main streamline.



Jelmagyarázat: Legend
A helyszíni dunai vízminőség mérések ideje – Date of the water quality assessments of the River Danube at site
2012 év adott hó dunai vízkémiai mintavételi pont, helyszíni oldott oxigén (mg/l) és vízhőmérséklet (°C) mérés – measurement of dissolved oxygen (mg/l) and water temperature (°C) at the water chemistry sampling point of the River Danube in 2012
Halfauna mintavételi pontja – sampling point of the fish fauna
Makroszkópikus vízi gerinctelen fauna mintavételi pontja – sampling point of macroscopic invertebrate fauna
Szakértő – expert
Makrofita mintavételi pontja – sampling point of macrophytes
Fitoplankton és Fitoberitosz mintavételi pontja – sampling point of phytoplankton and Phytoberitos
LÉVAI PROJEK KÖRNYEZETI HATÁSTANULMÁNY – PROJECT LÉVAI ENVIRONMENTAL IMPACT ASSESSMENT STUDY
Duna és egyéb felszíni vízek állapota 4. n.évi jelentése – Conditions of the River Danube and other surface waters – Quarterly Report of Quarter 4
1 szelvény dunai mintavételi pontja – sampling point of profile 1 of the River Danube

Figure 12.3.1-2: Paks ferry profile 1 (1533.5 river km) testing and sampling points

Tests indented to determine the physico-chemical parameters in the Paks ferry profile were conducted once a month throughout the entire year of 2012 (12 occasions).

Elements	Unit of measureme	Dunaföldvár_B_1 560.6	Dunaföldvár_K_1 560.6	Dunaföldvár_J_15 60.6	Paks ferry B_1533.5 river km	Paks ferry K_1533.5 river km	Paks ferry J_1533.5 river km	Dunaföldvár_1560.6 profile classification	Paks ferry_1533.5 profile classification
		average	average	average	average	average	average		
pH		8.15	8.15	8.06	8.18	8.21	8.19	5	4
Acidification status								**5.0**	**4.0**
Conductivity	µS/cm	418	414	417	376	374	376	5	5
Salinity								**5.0**	**5.0**
Dissolved oxygen	mg/l	9.4	9.3	9.0	11.8	12.1	11.5	5	5
Oxygen saturation	%	100.0	98.0	96.0				5	
BOD_5	mg/l	3.2	3.4	3.3	3.14	3.17	3.71	3	3
CODk	mg/l	11.3	10.2	21.4	11.60	10.74	11.66	3	4
Oxygenation conditions								**4.0**	**4.0**
Ammonium-N (NH_4^+-N)	mg/l	0.030	0.060	0.075	0.043	0.044	0.061	5	5
Nitrite-N (NO_2^--N)	mg/l	0.009	0.009	0.031				3	
Nitrate-N (NO_3^--N)	mg/l	1.3	1.2	0.6	1.7	1.7	1.7	4	4
Total nitrogen	mg/l	2.3	2.3	3.6	2.7	2.7	2.8	3	4
Orto-phosphate (PO_4-P)	µg/l	43.5	44.5	48.0	52.5	55.4	48.9	5	4
Total phosphorus	µg/l	60	125	75	71	57	54	4	5
Nutrient conditions								**4.0**	**4.4**
Cd	µg/l	0.005	0.013	0.008	0.018	0.019	0.020	5	5
Hg	µg/l	0.038	0.043	0.038	0.03	0.12	0.07	5	5
Ni	µg/l	2.32	2.59	2.58	1.95	1.90	1.98	5	5
Pb	µg/l	0.01	0.01	0.04	0.05	0.09	0.05	5	5
Metals								**5.0**	**5.0**
Zn	µg/l	7.19	9.66	11.92	9.20	11.18	10.98	5	5
Cu	µg/l	2.12	2.16	2.48	4.05	4.54	4.61	5	5
Cr	µg/l	0.95	0.92	1.49	0.30	0.27	0.27	5	5
As	µg/l	1.43	1.30	1.26	1.46	1.44	1.24	5	5
Specific pollutants (hazardous chemical elements)								**5.0**	**5.0**
Ecological status assessment of the Danube (HURWAEP444 WATER BODY) section concerned based on physico-chemical parameters according to WFD								**good status**	**good status**

Table 12.3.1-1: Classification of upstreami Danube profile water quality testing according to the WFD

DUNAFÖLDVÁR PROFILE CLASSIFICATION ACCORDING TO THE WFD

- The **acidification status** can be classified as **high** on the basis of the average values of the assessment results throughout the period under consideration.
- The **salinity status** can be classified as **high** on the basis of the average values of the assessment results throughout the period under consideration.
- The average of **oxygenation conditions** status per class is 4.0. It is deemed to be of **good status** based on the WFD requirements.
- The average of **nutrients** status per class is 4.0. Based on the methodology specified by the WFD it is deemed to be in **good** ecological status.
- The average of **metals** status per class is 5. Based on the methodology specified by the WFD it is deemed to be in high ecological status.

The Danube section at Dunaföldvár (1560.6 river km) can be deemed to be of good status from the ecological perspective and good, appropriate status from the specific pollutants (hazardous chemical elements) perspective on the basis of the quality testing procedures carried out in the second half of the year of 2013.

PAKS FERRY PROFILE CLASSIFICATION ACCORDING TO THE WFD

- The **acidification status** can be classified as **good** on the basis of the average values of the assessment results throughout the period under consideration.
- The **salinity status** can be classified as **high** on the basis of the average values of the assessment results throughout the period under consideration.
- The average of **oxygenation conditions** status per class is 4.0. It is deemed to be of **good status** based on the WFD requirements.
- The average of **nutrients** status per class is 4.4. Based on the methodology specified by the WFD it is deemed to be in good ecological status.
- The average of **metals** status per class is 5. Based on the methodology specified by the WFD it is deemed to be in high ecological status.

The Danube section at Paks ferry port (1533.5 river km) can be deemed to be of good status from the ecological perspective and good, appropriate status from the specific pollutants (hazardous chemical elements) perspective on the basis of the semi-annual water quality testing procedures carried out in the year of 2012.

CLASSIFICATION OF THE UPSTREAM DANUBE PROFILES

Dunaföldvár	1560.6 river km	**good status**
Paks ferry	1533.5 river km	**good status**

Table 12.3.1-2: Upstream Danube section (1560.6-1533.5 river km) WFD classification

Based on the outcome of the classification pursuant to WFD the Danube (HURWAEP444 WATER BODY) 1560.6-1533.5 river km section belongs to good status in terms of physico-chemical parameters.

12.3.1.2 Phytoplankton

Dipped phytoplankton samples were taken from the upstream Danube section in the Dunaföldvár profile twice in 2013, 27 August and 11 October, at three sampling points (left bank (P50DFP12), midstream (P50DFP13), right bank (P50DFP11)), five times in the Paks profile during 2012, 22 March, 27 June, on August 28 on 26 September and 14 November, at three sampling points (left bank (PLDFP12), midstream (PLDFP13), right bank (PLDFP11)).

TAXONS	PLDFP12	PLDFP13	PLDFP11
	Paks: ferry		
	left	midstream	right
	23.12.2012	23.12.2012	23.12.2012
SUM pico	45	44	29
SUM nano	10	6	2
SUM Flagellates	106	110	94
SUM Chroococcales	0	2	0
SUM Oscillatoriales	2	7	4
SUM Nostocales	0	0	0
SUM Euglenophyta	25	0	0
SUM Cryptophyta	295	130	113
SUM Dinophyta	0	0	0
SUM Chrysophyceae	132	228	113
SUM Xanthophyceae	0	0	0
SUM Centrales	10943	13208	13772
SUM Pennales	302	358	336
SUM Volvocales	164	245	200
SUM Chlorococcales	64	60	47
SUM Ulothricales	1	1	6
SUM Desmidiales	0	0	0
SUM Zygnematales	0	0	0
SUM biomass (µg/l)	**12088**	**14398**	**14717**
a-chlorophyll concentration (µg/l)	**20.5**	**21,3**	**20.7**
a-chlorophyll contents of biomass (%)	**0.170**	**0.148**	**0.141**
degree of trophity	**5 (m-eu)**	**5 (m-eu)**	**5 (m-eu)**

Table 12.3.1-3: Phytoplankton biopmass (µg/l) and a-chlorophyll concentration (µg/l) during sampling from the Danube upstream section in March

TAXONS	PLDFP12	PLDFP13	PLDFP11
	Paks ferry		
	left	midstream	right
	27.06.2012	27.06.2012	27.06.2012
SUM pico	44	19	29
SUM nano	6	10	26
SUM Flagellates	85	105	36
SUM Chroococcales	5	0	0
SUM Oscillatoriales	0	0	6
SUM Nostocales	0	40	0
SUM Euglenophyta	0	0	2
SUM Cryptophyta	94	163	53
SUM Dinophyta	0	0	41
SUM Chrysophyceae	27	93	0
SUM Xanthophyceae	2	0	0
SUM Centrales	1825	1643	1609
SUM Pennales	37	176	86
SUM Volvocales	43	170	51
SUM Chlorococcales	170	135	269
SUM Ulothricales	0	0	0
SUM Desmidiales	0	0	0
SUM Zygnematales	0	0	0
SUM biomass (µg/l)	**2337**	**2555**	**2209**
a-chlorophyll concentration (µg/l)	**11.1**	**10.4**	**11.8**
a-chlorophyll contents of biomass (%)	**0.475**	**0.407**	**0.534**
degree of trophity	**4 (m)**	**3 (o-m)**	**4 (m)**

Table 12.3.1-4: Phytoplankton biomass (µg/l) and a-chlorophyll concentration (µg/l) during sampling from the Danube upstream section in June

TAXONS	P50DFP12	P50DFP13	P50DFP11	PLDFP12	PLDFP13	PLDFP11
	Dunaföldvár			Paks ferry		
	left	midstream	right	left	midstream	right
	27.08.2013	27.08.2013	27.08.2013	28.08.2012	28.08.2012	28.08.2012
SUM pico	19	48	10	41	36	22
SUM nano	9	11	5	12	3	0
SUM Flagellates	9	39	31	23	88	6
SUM Chroococcales	0	0	0	195	0	0
SUM Oscillatoriales	1	3	13	1	0	0
SUM Nostocales	0	0	0	0	0	0
SUM Euglenophyta	0	0	0	0	0	0
SUM Cryptophyta	294	49	77	198	177	98
SUM Dinophyta	17	5	0	12	170	0
SUM Chrysophyceae	0	0	0	18	20	0
SUM Xanthophyceae	0	0	0	0	0	0
SUM Centrales	1180	4796	227	8390	13141	2687
SUM Pennales	25	15	37	8	19	17
SUM Volvocales	60	173	1	42	146	21
SUM Chlorococcales	128	378	59	241	225	54
SUM Ulothricales	0	1	1	0	0	0
SUM Desmidiales	0	0	0	0	0	85
SUM Zygnematales	0	0	0	0	0	0
SUM biomass (µg/l)	**1743**	**5517**	**459**	**9181**	**14025**	**2990**
a-chlorophyll concentration (µg/l)	**3.0**	**11.8**	**5.9**	**28.4**	**44.4**	**29.6**
a-chlorophyll contents of biomass (%)	**0.172**	**0.214**	**1.284**	**0.309**	**0.317**	**0.990**
degree of trophity	**2 (o)**	**4 (m)**	**3 (o-m)**	**5 (m-eu)**	**5 (m-eu)**	**5 (m-eu)**

Table 12.3.1-5: Phytoplankton biopmass (µg/l) and a-chlorophyll concentration (µg/l) during sampling from the Danube upstream section in August

TAXONS	P50DFP12	P50DFP13	P50DFP11	PLDFP12	PLDFP13	PLDFP11
	Dunaföldvár			Paks ferry		
	left	midstream	right	left	midstream	right
	11.10.2013	11.10.2013	11.10.2013	26.09.2012	26.09.2012	26.09.2012
SUM pico	6	6	6	10	10	7
SUM nano	0	3	0	0	2	0
SUM Flagellates	1	0	4	8	11	11
SUM Chroococcales	0	0	0	0	0	0
SUM Oscillatoriales	0	12	6	0	0	11
SUM Nostocales	0	0	0	0	0	0
SUM Euglenophyta	0	0	0	0	0	5
SUM Cryptophyta	35	54	11	37	7	64
SUM Dinophyta	0	0	0	0	0	0
SUM Chrysophyceae	0	0	0	2	0	0
SUM Xanthophyceae	0	0	0	0	0	0
SUM Centrales	18	138	17	155	165	140
SUM Pennales	1	0	0	2	23	4
SUM Volvocales	1	0	0	0	0	15
SUM Chlorococcales	0	6	0	14	15	7
SUM Ulothricales	0	0	0	0	0	0
SUM Desmidiales	0	0	0	0	9	0
SUM Zygnematales	0	0	0	0	0	0
SUM biomass (µg/l)	**64**	**220**	**45**	**228**	**241**	**265**
a-chlorophyll concentration (µg/l)	**<0.1**	**<0.1**	**<0.1**	**1.2**	**0.6**	**1.2**
a-chlorophyll contents of biomass (%)	**-**	**-**	**-**	**0.526**	**0.249**	**0.453**
degree of trophity	**1 (u-o)**	**1 (u-o)**	**1 (u-o)**	**2 (o)**	**1 (u-o)**	**2 (o)**

Table 12.3.1-6: Phytoplankton biopmass (µg/l) and a-chlorophyll concentration (µg/l) during sampling from the Danube upstream section in Autumn (September 2012, October 2013)

TAXONS	PLDFP12	PLDFP13	PLDFP11
	Paks ferry		
	left	midstream	right
	14.11.2012	14.11.2012	14.11.2012
SUM pico	6	6	10
SUM nano	0	3	0
SUM Flagellates	13	3	2
SUM Chroococcales	0	0	0
SUM Oscillatoriales	0	21	4
SUM Nostocales	0	0	0
SUM Euglenophyta	0	0	0
SUM Cryptophyta	122	53	114
SUM Dinophyta	0	0	0
SUM Chrysophyceae	0	9	7
SUM Xanthophyceae	0	0	0
SUM Centrales	73	279	13
SUM Pennales	4	0	69
SUM Volvocales	0	0	0
SUM Chlorococcales	3	22	11
SUM Ulothricales	0	0	0
SUM Desmidiales	0	0	0
SUM biomass (µg/l)	**221**	**397**	**230**
a-chlorophyll concentration (µg/l)	**0.6**	**1.8**	**2.4**
a-chlorophyll contents of biomass (%)	**0.271**	**0.453**	**1.045**
degree of trophity	**1 (u-o)**	**2 (o)**	**2 (o)**

Table 12.3.1-7: Phytoplankton biopmass (µg/l) and a-chlorophyll concentration (µg/l) during sampling from the Danube upstream section in November

In the Dunaföldvár profile of the Danube phytoplankton biomass on *7 August 2013* in the sequence of left bank, midstream, right bank was 1.74 mg/l, 0.55 mg/l and 0.46 mg/l, a-chlorophyll concentration to 3.0 µg/l, 11.8 µg/l and 5.9 µg/l, corresponding to the 2 (oligotrophic), a 4 (mesotrophic) and a 3 (oligo-mesotrophic) grades on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (67.7%, 86.9% and 49.4%). Proportions of the grooved cryptomonads (Cryptophyta) represented mainly by Rhodomonas species in the sequence of left bank, midstream, right bank were 16.9%, 0.9% and 16.7%, green algae from the Chlorococcales order were 7.4%, 6.8% and 12.9%.

In the Dunaföldvár profile of the Danube phytoplankton biomass on *11 October 2013* in the sequence of left bank, midstream, right bank was 0.064 mg/l, 0.22 mg/l and 0.045 mg/l, a-chlorophyll concentration was below the detection level on all three sampling points (<0.1mg/l), the latter corresponding to grade 1 (ultra-oligotrophic). Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (28.7%, 62.6% and 25.5%). Proportions of the grooved cryptomonads (Cryptophyta) represented mainly by Rhodomonas species in the sequence of left bank, midstream, right bank were 55.7%, 24.6% and 16.7%.

In the Paks ferry profile of the Danube phytoplankton biomass on *22 March 2012* in the sequence of left bank, midstream, right bank was 12.1 mg/l, 14.4 mg/l and 14.7 mg/l, a-chlorophyll concentrations 20.5 µg/l, 21.3 µg/l and 20.7 µg/l respectively, corresponding to the 5 (meso-eutrophic) grade on all three sampling points on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (90.5%, 91.7% and 93.6%). Proportions of the diatom species in the Pennales order in the sequence of left bank, midstream, right bank were 2.2%, 2.5% and 2.3%, of the flagellate golden-brown algae (Chrysophyceae) 1.1%, 1.6% and 0.8%, of the grooved cryptomonads (Cryptophyta) 2.4%, 0.9% and 0.8%, and flagellates listed in the various taxonomic categories (Flagellates) 0.9%, 0.8% and 0.6%, green algae listed in the Volvocales-order 1.4%, 1.7% and 1.4%, green algae listed in the Chlorococcales-order 0.5%, 0.4% and 0.3%.

On 27 June 2012 phytoplankton biomass in the sequence of left bank, midstream, right bank ranged up to 2.3 mg/l, 2.6 mg/l and 2.2 mg/l, a-chlorophyll concentration to 11.1 µg/l, 10.4 µg/l and 11.8 µg/l respectively, corresponding to the 4 (mesotrophic) grade on the left and right bank, and to 3 (oligo-mesotrophic) grade in the midstream on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (78.1%, 64.3% and 72.9%). Proportions of the diatom species in the Pennales order in the sequence of left bank, midstream, right bank were 1.6%, 6.9% and 3.9%, of the flagellate golden-brown algae (Chrysophyceae) 1.1%, 3.6% and 0.0%, of the grooved cryptomonads (Cryptophyta) 4.0%, 6.4% and 2.4%, and flagellates listed in the various taxonomic categories (Flagellates) 3.6%, 4.1% and 1.6%, green algae listed in the Volvocales-order 1.8%, 6.7% and 2.3%, green algae listed in the Chlorococcales-order 7.3%, 5.3% and 12.2%. The share of pico-algae in the sequence of left bank, midstream, right bank was 1.9%, 0.7% and 1.3%.

In the Paks profile of the Danube *on August 28 of 2012* phytoplankton biomass in the sequence of left bank, midstream, right bank was 9.2 mg/l, 14.0 mg/l and 3.0 mg/l, a-chlorophyll concentration 28.4 µg/l, 44.4 µg/l and 29.6 µg/l, corresponding in all sampling points to the 5 (meso-eutrophic) grade on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (91.4%, 93.7% and 89.9%). Proportions of the diatom species in the Pennales order in the sequence of left bank, midstream, right bank were 0.1%, 0.1% and 0.6%, of the flagellate golden-brown algae (Chrysophyceae) 0.2%, 0.1% and 0.0%, a grooved cryptomonads (Cryptophyta) 2.2%, 1.3% and 3.3%, and flagellates listed in the various taxonomic categories (Flagellates) 0.3%, 0.6% and 0.2%, green algae listed in the Volvocales-order 0.5%, 1.0% and 0.7%, green algae listed in the Chlorococcales-order 2.6%, 1.6% and 1.8%. The share of pico-algae in the sequence of left bank, midstream, right bank was 0.4%, 0.3% and 0.7%.

In the Paks profile of the Danube *on 26 September 2012* phytoplankton biomass in the sequence of left bank, midstream, right bank was 0.2 mg/l, 0.2 mg/l and 0.3 mg/l, a-chlorophyll concentration 1.2 µg/l, 0.6 µg/l and 1.2 µg/l, corresponding to the 1 (ultra-oligotrophic) and 2 (oligotrophic) grade in the midstream sampling points and at the riparian sampling points, respectively, on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (68.0%, 68.4% and 53.0%). Proportions of the diatom species in the Pennales order in the sequence of left bank, midstream, right bank were 0.7%, 9.4% and 1.5%, of the flagellate golden-brown algae (Chrysophyceae) 0.9%, 0.0% and 0.0%, a grooved cryptomonads (Cryptophyta) 16.2%, 3.0% and 24.0%, and flagellates listed in the various taxonomic categories (Flagellates) 3.6%, 4.6% and 4.2%, green algae listed in the Volvocales-order 0.0%, 0.0% and 5.6%, green algae listed in the Chlorococcales-order 6.3%, 6.0% and 2.6%. The share of pico-algae in the sequence of left bank, midstream, right bank was 4.2%, 3.9% and 2.6%.

On 14 November 2012 a Danube Paks-ferry profile phytoplankton biomass in the sequence of left bank, midstream, right bank was 0.2 mg/l, 0.4 mg/l and 0.2 mg/l, a-chlorophyll concentration 0.6 µg/l, 1.8 µg/l and 2.4 µg/l, corresponding to the 1 (ultra-oligotrophic) and 2 (oligotrophic) grades at the left bank sampling point and in the midstream and right bank sampling points, respectively, on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (32.9%, 70.3% and 5.5%). Proportions of the diatom species in the Pennales order in the sequence of left bank, midstream, right bank were 1.6%, 0.1% and 30.1%, of the flagellate golden-brown algae (Chrysophyceae) 0.0%, 2.4% and 2.9%, of the grooved cryptomonads (Cryptophyta) 55.1%, 13.4% and 49.7%, and flagellates listed in the various taxonomic categories (Flagellates) 6.0%, 0.8% and 0.9%, green algae listed in the Chlorococcales-order 1.3%, 5.4% and 4.6%. The share of pico-algae in the sequence of left bank, midstream, right bank was 2.9%, 1.6% and 4.1%.

Based on the sampling results it can be stated that the highest ratios in the composition of the phytoplankton biomass on the upstream section were diatom species in the Centrales order in all times. Biomass and chlorophyll-a concentration of the sampling units shows a significant deviation even within the same period. Sampling results from the years 2012 and 2013 indicate that higher level of biomass was present in 2012 in the same period. At the same time major changes can be recorded for each period in terms of differences across years. This confirms the statement that test results from samples taken in two different years reinforce each other, and projected on a longer time horizon they provide adequate results. The periods characterised by the highest level of biomass are March and August, while the biomass index is the lowest in the months of September/October and November.

CLASSIFICATION OF THE UPSTREAM SECTION IN ACCORDANCE WITH THE WFD ON THE BASIS OF THE PHYTOPLANKTON

In the table below EQR values and ecological status assessment results of the upstream-section at the Dunaföldvár and Paks profiles were summarised.

Sampling unit	23.12.2012		27.06.2012		28.08.2012; 27.08.2013		26.09.2012; 11.10.2013		14.11.2012	
	EQR	**Ecological status (based on HRPI)**	**EQR**	**Ecological status (based on HRPI)**	**EQR**	**Ecological status (based on HRPI)**	**EQR**	**Ecological status (based on HRPI)**	**EQR**	**Ecological status (based on HRPI)**
P50DFP12					0.825	high	0.835	high		
P50DFP13					0.769	good	0.83	high		
P50DFP11					0.780	good	0.8	good		
Average season 2013					**0.791**	**good**	**0.822**	**high**		
PLDFP12	0.712	good	0.765	good	0.633	good	0.852	high	0.828	high
PLDFP13	0.707	good	0.763	good	0.497	moderate	0.863	high	0.839	high
PLDFP11	0.715	good	0.756	good	0.629	good	0.818	high	0.838	high
Average season 2012	**0.711**	**good**	**0.761**	**good**	**0.586**	**moderate**	**0.844**	**high**	**0.835**	**high**
Average season 2012-2013	**0.711**	**good**	**0.761**	**good**	**0.689**	**good**	**0.833**	**high**	**0.837**	**high**
Classification of the section	**0.766**					**good**				

Table 12.3.1-8: Phytoplankton based classification of the upstream-section according to the WFD.

For the purposes of characterising the ecological status of the upstream-section the HRPI index taking into account the a-chlorophyll concentration proportional to the NQr and phytoplankton biomass calculated on the basis of the species composition was used. In the case when a-chlorophyll content is not within the detectable concentration range, the variable takes automatically the highest (1) value. Classification of individual sampling points does not carry any information contents in itself with respect to the section in question for any of the groups of living organisms tested, but in order to illustrate the results better, the associated classification grade was indicated in the table beside the EQR value.

The EQR values of sampling sites indicate a seasonal trend. Evaluation results were equally good both in March and June. Findings of the August sampling in 2012 were of moderate status, in 2013 for the same period at the Dunaföldvár profile the good ecological status was dominant. Results from September/October samples provided high status in both years, and the same applies to sample results taken in November.

Based on the ecological status assessment of the sampling units from the upstream section the following statements can be made.

(1) Differences in grades can occur between individual sampling units within the same sampling period.

(2) The highest level of biomass can typically be measured in the main stream line in the assessed profiles in all seasons, but the difference is not of the extent which would cause a grade leap in accordance with the cross profile.

(3) Grade level differences could be detected across samples taken in the same period of different years.

(4) Seasonal dynamics of the FP biomass is adequately reflected in the classification results.

The facts above substantiate that a stable outcome can be derived by making the classification with the use of average values of the most possible parameters. At the same time the robust five grade scale of the WFD is not sensitive to any more delicate changes. For the purposes of the impact assessment the most critical state is represented by the summer period. Correspondingly, the ecological status assessment of the section on the basis of the WFD was determined on the basis of the average taken from the sampling units.

The ecological status of the upstream section based on the phytoplankton was good.

12.3.1.3 Phytobenthos

Phytobenthos samples were taken from the upstream Danube section in the Dunaföldvár profile twice in 2013, 27 August and 11 October, at two sampling points (left bank (P50DFP12), right bank (P50DFP11)), and also twice in the Paks profile during 2012, on August 28 on 26 September, at two sampling points (left bank (PLDFP12), right bank (PLDFP11)).

TAXONS	P50DFB12	P50DFB11	PLDFB12	PLDFB11
	Dunaföldvár		Paks ferry	
	left	right	left	right
	27.08.2013	27.08.2013	28.08.2012	28.08.2012
	Relative abundance (%)			
CENTRALES				
SUM Centrales	66.6	63.4	63.7	44.0
PENNALES				
SUM Fragilariaceae	0.7	0.0	3.6	4.6
SUM Eunotiaceae	0.0	0.0	0.0	0.0
SUM Achnanthaceae	1.4	0.9	12.1	7.8
SUM Naviculaceae	11.0	8.1	14.1	35.1
SUM Bacillariaceae	20.0	27.7	5.2	7.3
SUM Epithemiaceae	0.0	0.0	0.0	0.0
SUM Surirellaceae	0.3	0.0	0.3	0.2
SUM Pennales spp. (other)	0.0	0.0	1.0	0.9
SUM	**100.0**	**100.0**	**100.0**	**100.0**
IPS index	**5.97**	**5.56**	**12.30**	**12.47**

Table 12.3.1-9: Cumulative table of the phytobenthos taxons identitied in the upstream section during the Summer sampling season

At the left bank sampling point of the **Dunaföldvár Danube profile** on *27 August 2013* 66.6% of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, of which the relative abundance of Cyclotella meneghiniana was 34.5%. The highest ratio components of the Pennales-diatom populations (67.0%) were part of the Bacillariaceae-family, of which the share of Nitzschia palea was 8.6%. The Naviculaceae-family was represented by (11.0%) Amphora-, Gomphonema- and Navicula species.

At the right bank at the sampling point of the Dunaföldvár Danube profile on 27 August 2013 63.4% of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, of which relative abundance of Cyclotella meneghiniana was 25.5%. The share of the diatom species in the order Pennales was 36.6%. The highest number of the Pennales-diatom species populations (27.7%) were part of the Bacillariaceae-family, of which the share of Nitzschia palea was 14.0%. The Naviculaceae-family was represented by (8.1%) Amphora-, Gomphonema- and Navicula species.

In the **Paks Danube profile** at the left bank sampling point *on August 28 of 2012* 63.7% of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, of which relative abundance of Cyclotella meneghiniana was 10.8%. The share of Stephanodiscus hantzschii was 6.9%. The components in the highest rate of the Pennales-diatom stock were the taxons in the Naviculaceae-family, the relative abundance of which for the individuals counted was 14.1%. The species with the highest level of relative abundance in the Naviculaceae family included Navicula tripunctata (3.6%), Navicula lanceolata (1.0%) Amphora pediculus (1.6%), Amphora libyca (1.3%), Reimeria sinuata (1.0%), and Gomphonema-species (1.0%). The share of the Achnanthaceae family was 12.1%. The Achnanthaceae-family was represented by Achnanthidium minutissimum (=Achnanthes minutissima) (7.8%) and Cocconeis placentula (3.9%). The share of the Bacillariaceae family represented by only the Nitzschia species was 5.2%. A Fragilaria-species (1.3%), as well as Diatoma ehrenbergii (0.3%), Diatoma mesodon (0.7%), Diatoma moniliformis (0.3%), Diatoma vulgaris (0.3%) and Asterionella formosa (0.7%) The share of the Fragilariaceae-family represented by was 3.6%.

In the Paks Danube profile at the right bank sampling point *on August 28 of 2012* 44.0 % of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, of which relative abundance of Cyclotella meneghiniana was 3.4%. The share of Stephanodiscus hantzschii was 3.7%. The components in the highest rate of the Pennales-diatom stock were the taxons in the Naviculaceae-family, of which the relative abundance projected to the individuals counted was 35.1%. The species with the highest level of relative abundance in the Naviculaceae family included Navicula recens (10.3%), Navicula tripunctata (4.6%), Navicula goeppertiana (1.8%), Amphora pediculus (3.9%), Amphora libyca (0.9%), Gyrosigma acuminatum (1.6%), as well as by

Gomphonema-species (1.1%). The share of the Achnanthaceae family was 7.8%. The Achnanthaceae-family was represented by Achnanthidium minutissimum (=Achnanthes minutissima) (3.7%), Achnanthes-species (1.4%) and Cocconeis placentula (2.8%). The share of the Bacillariaceae family represented by only the Nitzschia species was 7.3%. The share of the Fragilariaceae-family represented by Fragilaria pinnata (1.1%) and other Fragilaria-species (1.5%) as well as by Diatoma mesodon (0.7%), Diatoma moniliformis (0.7%), Diatoma vulgaris (0.2%) and Asterionella formosa (0.2%) was 4.6%.

TAXONS	**P50DFB12**	**P50DFB11**	**PLDFB12**	**PLDFB11**
	Dunaföldvár		**Paks ferry**	
	left	**right**	**left**	**right**
	11.10.2013	**11.10.2013**	**26.09.2012**	**26.09.2012**
	Relative abundance (%)			
CENTRALES				
SUM Centrales	5.4	57.0	13.3	17.6
PENNALES				
SUM Fragilariaceae	0.0	1.2	1.0	1.2
SUM Achnanthaceae	1.5	6.6	5.8	6.1
SUM Naviculaceae	39.4	20.9	59.4	48.0
SUM Bacillariaceae	52.5	12.4	18.5	26.2
SUM Surirellaceae	1.2	0.4	1.0	0.4
SUM Pennales spp. (other)	0.0	1.6	1.0	0.4
SUM	**100.0**	**100.0**	**100.0**	**100.0**
IPS index	**15.48**	**10.24**	**10.08**	**8.44**

Table 12.3.1-10: Cumulative table of the phytobenthos taxons identitied in the upstream section during the Autumn sampling season

At the left bank sampling point of the **Dunaföldvár Danube profile** on *11 October 2013* 5.4% of the individuals counted in the diatom population of the benthos came from the order Centrales, 94.6% of them belonged to diatom species in the order Pennales. The highest ratio components of the Pennales-diatom populations (52.5%) were part of the Bacillariaceae-family, of which the share of Nitzschia dissipata was 38.6%. The Naviculaceae-family was represented by (39.4%) Amphora-, Gomphonema- and Navicula species.

At the right bank sampling point of the **Dunaföldvár Danube profile** on *11 October 2013* 57.0% of the individuals counted in the diatom population of the benthos came from the order Centrales, 43.0% of them belonged to diatom species in the order Pennales. The highest ratio components of the Pennales-diatom populations (20.9%) were Naviculaceae-taxons represented by Amphora-, Gomphonema- and Navicula-species. The share of the Bacillariaceae-family was 12.4% within them relative abundance of Nitzschia dissipata ranged up to 6.6%.

In the **Paks Danube profile** at the left bank sampling point *on 26 September 2012* 13.3 % of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, of which relative abundance of Cyclotella meneghiniana was 3.2%. The components in the highest rate of the Pennales-diatom stock were the taxons in the Naviculaceae-family, of which the relative abundance projected to the individuals counted was 59.4%. The species with the highest level of relative abundance in the Naviculaceae family included Navicula recens (9.7%), Navicula recens form (7.8%), Navicula erifuga (7.1%), Navicula lanceolata (5.5%), Navicula viridula var. rostellata (4.9%), Navicula tripunctata (3.6%), Navicula goeppertiana (1.3%), Navicula veneta (1.3%), and other Navicula-species (8.4%), Amphora pediculus (1.3%), Cymbella silesiaca (1.0%), Gyrosigma scalproides (1.9%) and other Gyrosigma- (1.6%), as well as Gomphonema-species (1.6%). The share of the Bacillariaceae family represented by only the Nitzschia species was 18.5%. The species with the highest level of relative abundance in the Bacillariaceae family included Nitzschia dissipata (4.5%), Nitzschia palea (3.2%), Nitzschia recta (2.9%), Nitzschia gisela (2.9%) and Nitzschia (Lanceolatae) spp. (3.9%). The share of the Achnanthaceae family was 5.8%. The Achnanthaceae-family was represented by Achnanthidium minutissimum (=Achnanthes minutissima) (1.3%), Achnanthes-species (0.6%), Cocconeis placentula (3.6%) and Cocconeis pediculus (0.3%). The share of the Fragilariaceae-family represented by only Fragilaria-species was 1.0%.

In the **Paks Danube profile** at the right bank sampling point *on 26 September 2012* 17.6 % of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, of which relative abundance of Cyclotella meneghiniana was 0.8%, of other Cyclotella-species 4.1%. The share of Stephanodiscus hantzschii was 1.2%, the other Stephanodiscus-species 2.0%. The components in the highest rate of the Pennales-diatom stock were the taxons in the Naviculaceae-family, of which the relative abundance projected to the individuals counted was 48.0%. The species with the highest level of relative abundance in the Naviculaceae family included Navicula recens (5.7%), Navicula present form (4.9%), Navicula erifuga (5.3%), Navicula cryptocephala (4.5%), Navicula viridula var. rostellata (4.5%), Navicula lanceolata (2.5%), Navicula tripunctata (2.5%), Navicula halophila (1.6%), Navicula veneta (1.3%), Navicula (Minusculae) spp.(1.2%) and other Navicula- (11.9%) and Amphora-species (1.2%). The share of the Bacillariaceae family represented by only the Nitzschia species was 26.2%. The species with the highest level of relative abundance in the Bacillariaceae family included Nitzschia palea (14.3%), Nitzschia dissipata (4.5%), Nitzschia sp. (aff. supralitorea) (1.2%) and Nitzschia (Lanceolatae) spp. (4.9%). The share of the Achnanthaceae family was 6.1%. The Achnanthaceae-family was represented by Achnanthidium minutissimum (=Achnanthes minutissima) (3.3%), Achnanthes lanceolata (0.8%), and Cocconeis placentula (2.0%). The share of the Fragilariaceae-family represented by Asterionella formosa (0.4%), Fragilaria capucina var. vaucheriae (0.4%) and Tabellaria flocculosa (0.4%) was 1.2%.

Classification of the upstream section in accordance with the WFD on the basis of the phytobenthos

In the table below EQR values and ecological status assessment results of the upstream-section sampling units at the Dunaföldvár and Paks profiles were summarised.

Sampling unit	28.08.2012; 27.08.2013		26.09.2012; 2012.10.11	
	EQR	Ecological status (based on EQR)	EQR	Ecological status (based on EQR)
P50DFB12	0.234	poor	0.736	good
P50DFB11	0.213	poor	0.46	moderate
Average season 2013	**0.224**	**poor**	**0.598**	**moderate**
PLDFB12	0.569	moderate	0.451	moderate
PLDFB11	0.577	moderate	0.365	poor
Average season 2012	**0.573**	**moderate**	**0.408**	**moderate**
Average season 2012-2013	**0.398**	**poor**	**0.503**	**moderate**
Classification of the section	**0.451**		**moderate**	

Table 12.3.1-11. Phytobenthos based classification of the upstream-section according to the WFD.

Based on the ecological status assessment of the sampling units the following statements can be made.

(1) Grade level differences could be detected across samples taken form the right and left bank the same period both in the Dunaföldvár, and the Paks/ferry profile.

(2) In the summer season the Dunaföldvár profile sampled in 2013 indicated one grade lower status as the Paks ferry profile sampled in 2012, while no such grade level difference exists in Autumn, although the EQR value of the Dunaföldvár profile reflects a somewhat better status.

(3) The classification results of the section concur with the outcome of the assessments in 2009 and 2010 (c.f. Table 12.1.5-4).

The facts above – as it was stated for the phytoplankton – substantiate that a stable outcome can be derived by making the classification with the use of average values of the most possible parameters. At the same time the robust five grade scale of the WFD is not sensitive to any more delicate changes. Correspondingly, the ecological status assessment for the left and right bank sampling points of the Dunaföldvár and Paks profiles on the basis of the WFD was determined on the basis of the average values of the summer and autumn EQR values.

The ecological status of the upstream section based on the phytobenthos was moderate.

12.3.1.4 Macrophyte

Sampling on the upstream Paks section – which can be regarded as the control section – macrophyte sampling was made in two seasons – summer and autumn – in 2013. Four sampling units in a length of 100 metres each and 400 metres altogether were tested on both the right and the left bank area. Data concerning the respective banks of the Danube were aggregated. Various habitat types were included among the sampling units. Sampling subunits were identical in the summer and autumn sampling seasons. A total of nine species were identified during the summer and autumn sampling operations in the two sampling units designated along the Paks Danube section (Table 12.3.1-12).

Scientific name	English name	P50DMF1.1	P50DMF1.2
Fraxinus pennsylvanica	Green ash or red ash	1	1
Rorippa sylvestris	Creeping yellowcress	2	1
Populus alba	White poplar	2	2
Juncus articulatus	Jointleaf rush	2	
Salix alba	White willow	3	2
Salix fragilis	Crack willow or brittle willow	5	4
Rubus cf. caesius	Dewberry	5	
Aster lanceolatus	Panicled aster		2
Lolium perenne	English ryegrass		4
NUMBER OF SPECIES		**7**	**7**

Table 12.3.1-12: Estimated amount of macrophyte species found on the Paks upstream section and their estimated DAFOR quantities

None of the species found in the sampling profile was protected. Several species can be considered to be introduced (red ash, panicled aster), the abundance of which refers to the disturbed nature of the area.

The section assessed is part of the SCI area identified as HUDD20023 Tolnai Danube. The indicator species of the area is the creeping marshwort (*Apium repens* (Jacq.) Lagesca) [12-46]. The species was not found along the sampling section.

CLASSIFICATION OF THE UPSTREAM SECTION IN ACCORDANCE WITH THE WFD ON THE BASIS OF THE MACROPHYTES

Ecological water quality of the section on the basis of macrophytes was carried out in accordance with the set of criteria of the WFD, based on the macrophyte method established in Hungary (Lukács et al. [12-28]). Aggregate data from the total length of 400 metres of the four sampling units were used for classification purposes. From the professional perspective, the findings are of limited reliability for the purposes of status assessment, since macrophyte communities appear along large rivers – such as at the sampling site – only in small quantities and therefore the ecological status defined by the evaluation of them is uncertain. In spite of this classification was done both on the upstream and downstream sections. This is indicated by the fact that the number of plant species and their abundance did not allow exact classification, since they did not reach the minimum level necessary. The data obtained this way are for information only. Due to these uncertainties a finer resolution analysis of the data was also carried out for the whole study section which will be presented in Chapter 12.3.4.4.

	Aggregate DAFOR cubic value	Number of species
A (indicator species)	8	1
B (neutral species)	129.5	2
C (disturbance indicator species)	8	1
SUM	145.5	4
Reference Index	0	
EQR Value	0.5	
Classification	**moderate**	

Table 12.3.1-13.: The results of the ecological status classification based on the Summer and Autumn sampling season on the upstream section in terms of macrophyte data

During the classification procedure, five species with indicator capabilities were identified.
Based on the findings of the assessment it can be stated that the ecological status of the upstream section not affected by hot water discharge according to the macrophyte analysis was moderate.

12.3.1.5 Macrozoobenthos

Sampling on the upstream Paks section – which can be regarded as the control section – macroscopic aquatic invertebrates sampling was made in two seasons – summer and autumn – in 2013 both on the right and the left bank. When the sites for sampling units were identified, the requirements provided, sampling sites of former assessments and the environmental conditions, suitability of the sampling site for carrying out the sampling procedure – determined during a field visit – were all taken into consideration. Sampling units were divided up to several subunits. The key consideration for the identification of the subunits included keeping an eye on the objective of the assessment and the representative nature of the sampling. Correspondingly, sampling sub units were assigned in areas with a number of different habitat types. During the summer and autumn sampling seasons a total of 27 different macroscopic invertebrate taxons could be detected (Table 12.3.1-14.).

Taxons	P50DMZB 11	P50DMZB 12
Aquatic worms (Oligochaeta)	9	9
Bristle worms (Polychaeta)		
Hypania invalida (GRUBE, 1860)	1	
Snails (Gastropoda)		
Borysthenia naticina (MENKE, 1845)	13	
Gyraulus albus (O.F. MÜLLER, 1774)	1	
Fagotia acicularis (FERRUSAC, 1823)	7	2
Lithoglyphus naticoides (C. PFEIFFER 1828)	1415	132
Potamopyrgus antipodarum (J. E. GRAY, 1843)		3
Theodoxus fluviatilis (LINNAEUS 1758)	3	3
Valvata piscinalis (O.F. MÜLLER, 1774)	45	
Viviparus acerosus (BOURGUIGNAT, 1862)	1	
Mussels (Bivalvia)		
Corbicula fluminea (O.F. MÜLLER, 1774)	11	50
Corbicula sp.	2	
Dreissena polymorpha (PALLAS, 1771)	4	30
Pisidium amnicum (O.F. MÜLLER, 1774)	23	
Sphaerium rivicola (LAMARCK, 1818)	1	
Unio tumidus RETZIUS, 1788	11	5
Crustaceans (Crustacea)		
Corophium curvispinum (SARS, 1895)	37	7
Dikerogammarus sp.	2	10
Dikerogammarus villosus (SOWINSKY, 1758)	23	62
Limnomysis benedeni CZERNIAVSKY, 1882	542	20
Obesogammarus obesus VIEUILLE, 1979	1	16
Orconectes limosus RAFINESQUE, 1872	1	
Dragonflies (Odonata)		
Coenagrionidae	1	
Gomphus flavipes (CHARPENTIER, 1825)	3	1
True bugs (Heteroptera)		
Sigara lateralis (LEACH, 1817)		1
Sigara striata (LINNAEUS, 1758)		1
Diptera (Diptera)		
Chironominae	30	3

Table 12.3.1-14.: List of macroinvertebrate taxons identified on the upstream Paks section

A substantial part of the macroscopic invertebrate taxons identified were invasive, intensively and aggressively penetrating introduced elements originating from the Ponto-Caspian region which are able to adapt to the changing environmental conditions at a rapid rate, have quick reproduction capabilities and a part of them may threaten the native, indigenous fauna. The gravel snail (*Lithoglyphus naticoides*) which comes sometimes in large numbers, zebra mussel, (*Dreissena polymorpha*), Asian clam (*Corbicula fluminea*) and a very aggressive species of a type of crab called *Dikerogammarus villosus*, which carries often the lifestyle of a predator can be highlighted from them.

The protected dragonfly species named *Gomphus flavipes* was identified in small numbers in both sampling sessions. The thick shelled river mussel (*Unio crassus*), the macrozoobenthos species indicating the HUDD20023 SCI area, was not found during the sampling procedure.

Density differences were observed between the samples in the Paks upstream profile (P50DMZB 11 and 12), caused by the outstanding high number of individuals of the extremely high density of Lithoglyphus naticoides detected on the right bank. It could be stated that the average number of individuals was lower in the samples taken from the left bank of the Danube compared to the right bank, which might possibly be attributed to the differences in the channel bottom material and hence, the different number of the microhabitats. The snail referred to above is an invasive species which is able to spread rapidly and in great numbers, therefore its density is usually prominent.

The number of taxons in the samples taken on the right bank (like density) was somewhat higher than that of the left bank, most probably with similar reasons as it was referred to in the case of numbers of individuals.

Diversity indicators are basically values based on the correlations between the number of individuals and the number of taxons, in other words wherever density is high, but the number of taxons is low (dominance), usually a lower level of diversity can be reckoned with. In spite of the fact that more taxons could be identified on the right bank, in this profile the left bank proved to be more diverse, caused by the extreme density of the gravel snail on the right bank and this had a strong influence on the level of the diversity index.

CLASSIFICATION OF THE UPSTREAM SECTION IN ACCORDANCE WITH THE WFD ON THE BASIS OF THE AQUATIC MACROZOOBENTHOS

Ecological status assessment was accomplished on the basis of a so called multimetric index, the HMMI (Hungarian Multimetric Macroinvertebrate Index) required by the WFD (Várbíró et al. [12-42], [12-43]), which passed the intercalibration process of the European Union and its five grade EQR (Ecological Quality Ratio) classification scale (1-5) proved to be well suited for the evaluation of the ecological status in watercourses (Table 12.3.1-15).

	Summer		**Autumn**	
Upstream section	HMMI EQR	Classificatior	HMMI EQR	Classificatior
P50DMZB 11	0.57	moderate	0.46	moderate
P50DMZB 12	0.58	moderate	0.53	moderate
average:	**HMMI EQR**		**Classification**	
	0.53		**moderate**	

Table 12.3.1-15: Ecological status classification of the upstream section based on Summer and Autumn macroinvertebrate samples

The seasonal difference can be observed in the multimetric ecological status assessment of the profiles, in other words the values in autumn samples are usually lower, which however did not cause any quality grade leap in this case.

Based on the findings of the assessment it can be stated that the ecological status of the upstream section not affected by hot water discharge according to the aquatic macroscopic invertebrate analysis was moderate (HMMI EQR: 0.53).

12.3.1.6 Fishes

Sampling on the upstream Paks section – which can be regarded as the control section – macroscopic aquatic invertebrates sampling was made in two seasons – summer and autumn – in 2013. Four sampling units in a length of 500 metres each and 2000 metres altogether were tested on both the right and the left bank area. Sampling subunits included both natural and paved bottom profiles (see *Table 12.1.5-10*). Sampling subunits were identical in the summer and autumn sampling seasons.

A total of 2 489 individuals of 28 species were identified during the summer and autumn sampling operations in the four sampling units designated along the Paks Danube section (Table 12.3.1-16).

Scientific name	English name	P50DH111	P50DH112	P50DH121	P50DH122
*Eudontomyzon mariae (Berg, 1931)**	Ukrainian brook lamprey	0	0	1	1
Anguilla anguilla (Linnaeus, 1758)	Eel	0	0	0	1
Rutilus rutilus (Linnaeus, 1758)	Common roach	1	1	1	1
Squalius cephalus (Linnaeus, 1758)	European chub	1	1	1	1
Leuciscus idus (Linnaeus, 1758)	Ide	1	1	1	1
Aspius aspius (Linnaeus, 1758)	Bream	1	1	1	1
Alburnus alburnus (Linnaeus, 1758)	Small river bleak	1	1	1	1
Blicca bjoerkna (Linnaeus, 1758)	Silver bream	1	0	1	1
Abramis brama (Linnaeus, 1758)	Bream	0	0	0	1
Chondrostoma nasus (Linnaeus, 1758)	Nose-carp	1	1	0	0
Barbus barbus(Linnaeus, 1758)	Barbel	0	0	0	1
*Romanogobio vladykovi (Fang, 1943)**	Danube whitefin gudgeon	1	0	1	1
*Rhodeus amarus (Bloch, 1782)**	European bitterling	0	0	1	1
Carassius gibelio (Bloch, 1782)	Prussian carp	1	1	0	1
Cyprinus carpio (Linnaeus, 1758)	Carp	0	1	0	1

Scientific name	English name	P50DH111	P50DH112	P50DH121	P50DH122
Silurus glanis Linnaeus, 1758	European wels	0	1	1	0
Esox lucius Linnaeus, 1758	Pike	1	1	1	1
Lota lota (Linnaeus, 1758)	Burbot	0	1	1	1
Perca fluviatilis Linnaeus, 1758	Perch	1	1	1	1
Gymnocephalus baloni Holčík & Hensel, 1974	Balon's ruffe	0	1	1	1
Gymnocephalus schraetser (Linnaeus, 1758)	Striped ruffe	1	0	0	1
Sander lucioperca (Linnaeus, 1758)	Zander	1	0	1	1
*Zingel zingel (Linné, 1766)**	Zingel	0	1	0	0
Proterorhinus semilunaris (Heckel, 1837)	Western tubenose goby	1	1	1	1
Neogobius fluviatilis (Pallas, 1814)	Monkey goby	1	0	0	1
Ponticola kessleri (Günther, 1861)	Bighead goby	1	1	1	1
Neogobius melanostomus (Pallas, 1814)	Round goby	1	1	1	1
Babka gymnotrachelus (Kessler, 1857)	Racer goby	1	1	1	1
NUMBER OF SPECIES		**18**	**18**	**19**	**25**

Table 12.3.1-16: Fish species found on the Paks upstream section

Four (*Romanogobio vladykovi, Rhodeus amarus, Gymnocephalus baloni, Gymnocephalus schraetser*) of the species identified during sampling were protected and two of them (*Eudontomyzon mariae, Zingel zingel*) strictly protected.

The section assessed is part of the SCI area identified as HUDD20023 Tolnai Danube. The indicator species of the area are as follows: *Eudontomyzon spp., Rutilus virgo, Aspius aspius, Misgurnus fossilis, Umbra krameri, Gymnocephalus baloni, Gymnocephalus schraetser, Zingel zingel, Zingel streber* [12-47], [12-48]. Of them *Eudontomyzon mariae, Aspius aspius, Zingel zingel, Gymnocephalus baloni and G. schraetser* were found in the section assessed during the 2012 sampling session. *Rutilus virgo* was found during the 2009 sampling season both from the upstream and the downstream section (SCIAP Kft. [12-37]), and it was also observed in lesser numbers during the sampling season of 2013 in the distant downstream sample section. *Misgurnus fossilis*, a stagnophile species, as well as *Umbra krameri* due to its environmental requirements are not typical for the mainstream channel bottom of the Danube. Two specimen of *Misgurnus fossilis* were caught in 2003 in the cold water canal (Halasi-Kovács [12-14]). Information is available on the occurrence of *Zingel streber* in a small number based on the sampling efforts made during the night on both the upstream and the downstream sections (MVM ERBE [12-29]). On this basis it can be claimed that the indicator fish species characterising the mainstream channel bottom of the NATURA 2000 area can be detected on the upstream section.

No body length measurements were made on the individuals caught during sampling, since the additional information obtained this way is negligible, while it slows the sampling procedure down considerably, while costs would have been increased several times. It should also be noted that the domestic protocol based on the WFD criteria requires the separation of the offspring only, which was done.

Young individuals of 24 species from the total of 28 identified species were found in the samples. This means that 86 % of the species is present in the section in the form of progeny, indicating the stability of their respective populations.

Age group distribution of the individuals identified in the sampling units is presented on the following tables.

Summer	Adult (piece)	Offspring(piece)	Total (piece)
P50DH11	330	85	415
P50DH11	343	41	384
P50DH12	238	74	312
P50DH12	159	56	215
Autumn	**Adult (piece)**	**Offspring(piece)**	**Total (piece)**
P50DH11	118	29	147
P50DH11	122	206	328
P50DH12	192	297	489
P50DH12	149	50	199

Table 12.3.1-17: Basic data of catches in the sampling units based on the summer and autumn samples

Total (adult plus offspring) catch per unit effort (CPUE) on the 100 metre units reflected an expressly high level of 79.9 compared to earlier upstream assessment results in the sampling units on the right bank during the summer sampling season, while the CPUE value of the left bank sampling units can be seen as average (52.7).

Sample profiles	CPUE (100 m)
"Upstream" 2003-2004 (Halasi-Kovács 2005	53.3
"Upstream" 2009 (SCIAP 2010)	49.9
P50HD1.1.1-2	79.9
P50HD1.2.1-2	52.7

Table 12.3.1-18: Comparison of CPUE values with earlier findings

Thus the assessment of the Paks Danube-section, the control which is not affected by the hot water discharge shows that the species inventory of the catch was substantially similar to the results of former assessments. Differences between individual sampling subunits may be attributed to the various habitat conditions. The strictly protected species *Eudontomyzon mariae* was found again in the section. Spawning season in 2013 – in particular species with a spawning season started earlier – was successful, as demonstrated by the high ratio of species with offspring and the high number of young individuals. This fact however need to be taken into account when comparing with quantitative data from the previous year. During the summer sampling season – as a typical feature again – higher numbers of individuals could be observed. At the same time, the lower water levels and lower water temperature in the autumn season – reflecting a true autumnal aspect of the river – resulted in a more homogeneous mass of data than the summer aspect, assisting lower scale analysis effectively. All in all, the outcome of the sampling efforts carried out in both seasons resulted an appropriate data set for the purposes of water quality classification according to the WFD requirements.

CLASSIFICATION OF THE UPSTREAM SECTION IN ACCORDANCE WITH THE WFD ON THE BASIS OF THE FISH COMMUNITY

Ecological water quality of the section on the basis of fish communities was carried out in accordance with the set of criteria of the WFD, based on the EQIHRF method established in Hungary (Halasi-Kovács et al. [12-17]). For the purposes of classification the aggregate data of the total length of 2 000 metres long profile of the four sampling units were used. Although summer sampling should be considered relevant on the basis of the EQIHRF protocol, classification was also made according to the autumn samples. However, for the purposes of the outcomes, the summer results were accepted as relevant. (Table 12.3.1-19, Table 12.3.1-20).

Based on the findings of the assessment it can be stated that the ecological status of the upstream section not affected by hot water discharge according to the aquatic fish community analysis was good.

Upstream section summer	Number of scores	Value
1. Relative abundance of the omnivorous species (%)	64,16	5
2. Relative abundance of the open water species	3,00	3
3. Relative abundance of the metaphyte species (%)	15,69	4
4. Number of benthic species (piece)	18,00	4
5. Number of litophile species (piece)	7,00	4
6. Relative abundance of the phytophile species (%)	2,32	4
7. Number of rheophilic species(piece)	10.00	4
8. Relative abundance of the stagnophile species (%)	0.84	3
9. Relative abundance of the specialist species (%)	38,63	5
10. Relative abundance of the indigenous species (%)	68,71	2
Total number of scores		**38**
Classification		**good**

Table 12.3.1-19: Results of the ecological status assessment a summer sampling alapján a felvizen

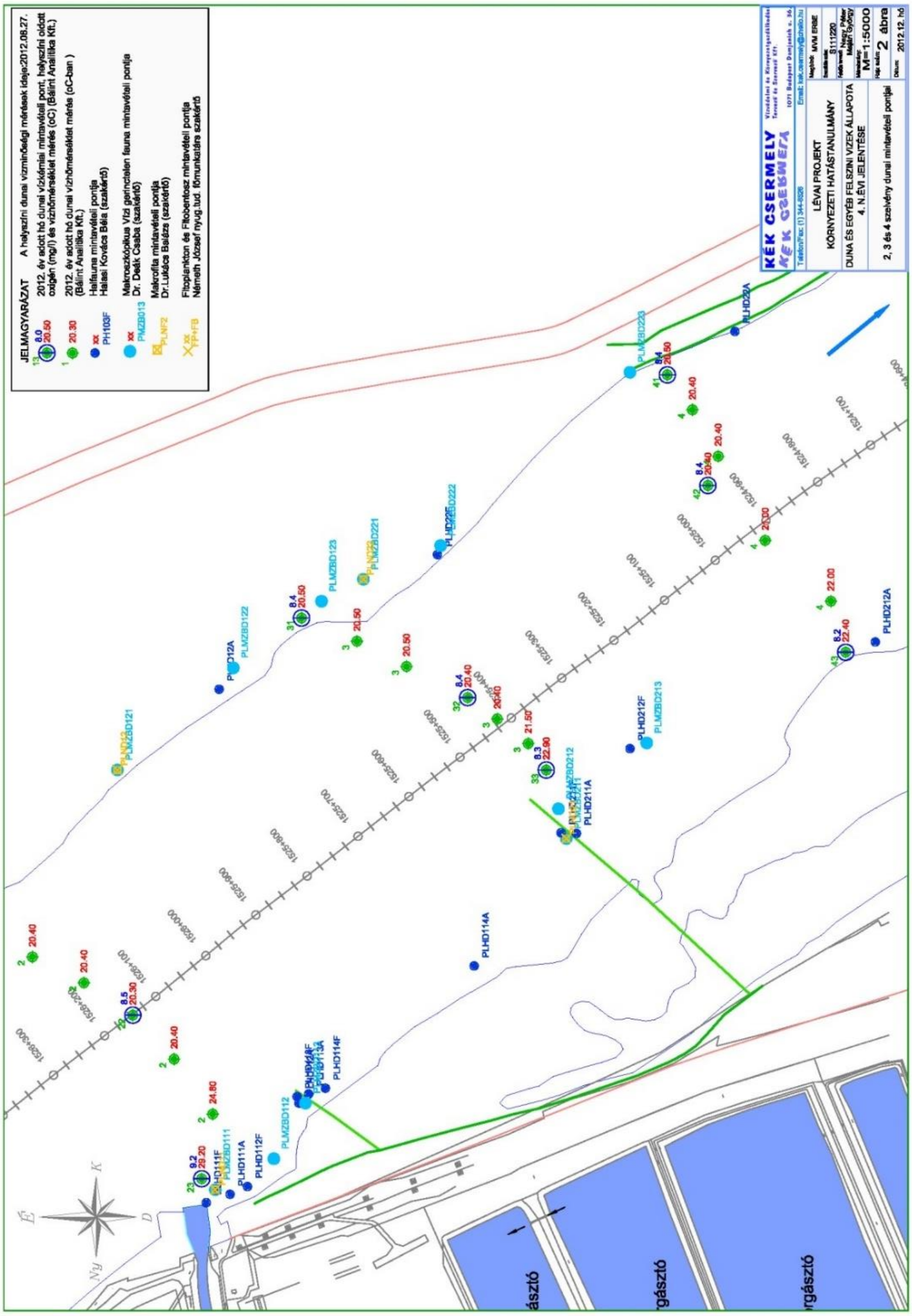
Upstream section autumn	Number of scores	Value
1. Relative abundance of the omnivorous species (%)	47,68	4
2. Relative abundance of the open water species	3,00	3
3. Relative abundance of the metaphyte species (%)	5,15	5
4. Number of benthic species (piece)	13,00	3
5. Number of litophile species (piece)	5,00	3
6. Relative abundance of the phytophile species (%)	2,06	4
7. Number of rheophilic species(piece)	9,00	3
8. Relative abundance of the stagnophile species (%)	1,37	4
9. Relative abundance of the specialist species (%)	52,66	5
10. Relative abundance of the indigenous species (%)	57,46	2
Total number of scores		**36**
Classification		**moderate**

Table 12.3.1-20: Results of the ecological status assessment on the basis of the Autumn samples upstream

12.3.2 DIRECT DOWNSTREAM PROFILES OF THE DANUBE SECTION ASSESSED

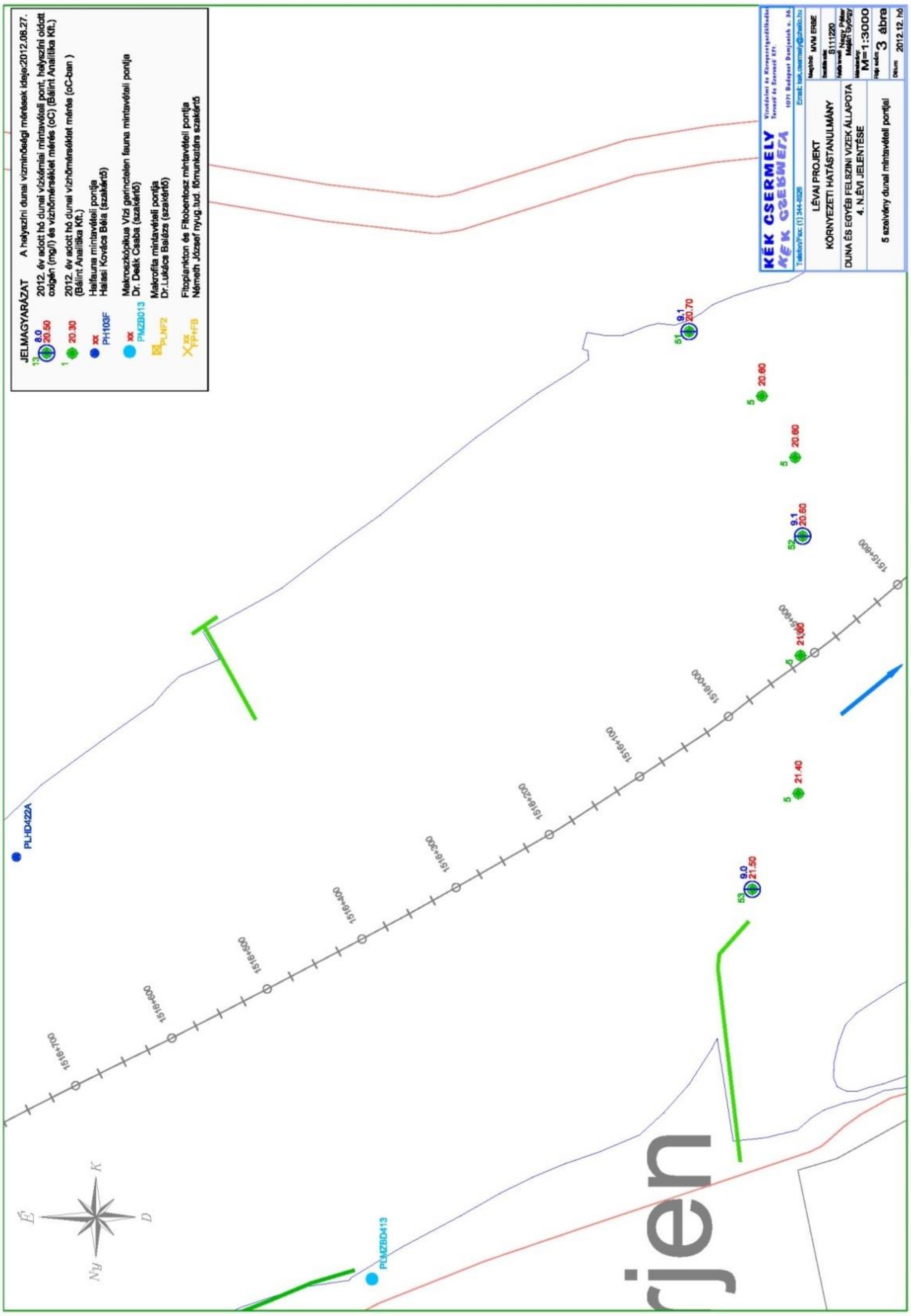
12.3.2.1 Physico-chemical properties

The profiles classified in the group of "direct downstream profiles" are situated in the next proximity of the mouth of the hot water canal (1526 river km). Tests intended to determine the physico-chemical parameters were conducted once a month in these profiles throughout the year of 2012. Paks hot water canal 1526.0 river km, Nagysarkantyú 1525.3 river km, and Uszód 1524.7 river km profiles are shown on Figure 12.3.2-1, Gerjen-Foktő 1516.0 river km profile is illustrated by Figure 12.3.2-2. The water quality table prepared on the basis of the 2012 assessments and also including the classification grade according to the WFD is attached as Table 12.3.2-1, and the classification of the profile section in accordance with the WFD requirements in Table 12.3.2-1.



Jelmagyarázat: Legend
A helyszíni dunai vízminőség mérések ideje – Date of the water quality assessments of the River Danube at site
2012 év adott hó dunai vízkémiai mintavételi pont, helyszíni oldott oxigén (mg/l) és vízhőmérséklet (°C) mérés – measurement of dissolved oxygen (mg/l) and water temperature (°C) at the water chemistry sampling point of the River Danube in 2012
Halfauna mintavételi pontja – sampling point of the fish fauna
Makroszkópikus vízi gerinctelen fauna mintavételi pontja – sampling point of macroscopic invertebrate fauna
Szakértő – expert
Makrofita mintavételi pontja – sampling point of macrophytes
Fitoplankton és Fitoberitosz mintavételi pontja – sampling point of phytoplankton and Phytoberitos
LÉVAI PROJEK KÖRNYEZETI HATÁSTANULMÁNY – PROJECT LÉVAI ENVIRONMENTAL IMPACT ASSESSMENT STUDY
Duna és egyéb felszíni vízek állapota 4. n.évi jelentése – Conditions of the River Danube and other surface waters – Quarterly Report of Quarter 4
2, 3 és 4 szelvény dunai mintavételi pontja – sampling point of profiles 2, 3 and 4 of the River Danube

Figure 12.3.2-1: General site maps of the profiles Paks hot water (2), Nagysarkantyú (3), and Uszód (4), 1526.0-1524.8 river km



Jelmagyarázat: Legend
A helyszíni dunai vízminőség mérések ideje – Date of the water quality assessments of the River Danube at site
2012 év adott hó dunai vízkémiai mintavételi pont, helyszíni oldott oxigén (mg/l) és vízhőmérséklet (°C) mérés – measurement of dissolved oxygen (mg/l) and water temperature (°C) at the water chemistry sampling point of the River Danube in 2012
Halfauna mintavételi pontja – sampling point of the fish fauna
Makroszkópikus vízi gerinctelen fauna mintavételi pontja – sampling point of macroscopic invertebrate fauna
Szakértő – expert
Makrofita mintavételi pontja – sampling point of macrophytes
Fitoplankton és Fitoberitosz mintavételi pontja – sampling point of phytoplankton and Phytoberitos
LÉVAI PROJEK KÖRNYEZETI HATÁSTANULMÁNY – PROJECT LÉVAI ENVIRONMENTAL IMPACT ASSESSMENT STUDY
Duna és egyéb felszíni vízek állapota 4. n.évi jelentése – Conditions of the River Danube and other surface waters – Quarterly Report of Quarter 4
5 szelvény dunai mintavételi pontja – sampling point of profile 5 of the River Danube

Figure 12.3.2-2: General site map of the test and sammpling points in the Gerjen 5. profile (1516 river km)

-CLASSIFICATION OF THE NEAR DOWNSTREAM DANUBE SECTION BASED ON THE 2012 TESTS ACCORDING TO THE WFD

Name of section		Paks hot water canal left bank 1526 river km	Paks hot water canal midstream 1526 river km	Paks hot water canal right bank 1526 river km	Nagy sarkantyú left bank 1525.3 river km	Nagy sarkantyú midstream 1525.3 river km	Nagy sarkantyú right bank 1525.3 river km	Uszod left bank 1524.8 river km	Uszod midstream 1524.8 river km	Uszod right bank 1524.8 river km	Gerjen-Foktő left bank 1516.0 river km	Gerjen-Foktő midstream 1516.0 river km	Gerjen-Foktő right bank 1516.0 river km	Paks hot water canal 1526 river km profile classification	Nagy sarkantyú 1525.3 river km profile classification	Uszod 1524.8 river km profile classification	Gerjen-Foktő 1516.0 river km profile classification
pH		**8.21**	**8.19**	**8.13**	**8.20**	**8.18**	**8.13**	**8.21**	**8.18**	**8.14**	**8.18**	**8.19**	**8.11**	4	4	4	4
Acidification status														**4.0**	**4.0**	**4.0**	**4.0**
Conductivity	µS/cm	**376**	**375**	**386**	**377**	**375**	**383**	**377**	**375**	**382**	**377**	**376**	**379**	5	5	5	5
Salinity														**5.0**	**5.0**	**5.0**	**5.0**
Dissolved oxygen	mg/l	**12.3**	**12.1**	**11.4**	**12.1**	**12.0**	**11.7**	**12.2**	**11.9**	**11.4**	**11.9**	**12.0**	**11.5**	5	5	5	5
BOD_5	mg/l	**2.96**	**2.53**	**3.49**	**2.88**	**3.29**	**2.70**	**2.98**	**3.08**	**3.37**	**2.93**	**3.02**	**3.06**	4	4	3	4
CODk	mg/l	**12.17**	**12.19**	**11.91**	**11.58**	**12.09**	**11.46**	**12.08**	**10.76**	**11.52**	**13.33**	**12.95**	**12.47**	4	4	4	4
Oxygenation conditions														**4.3**	**4.3**	**4.0**	**4.3**
Ammonium-N (NH_4-N)	mg/l	**0.042**	**0.042**	**0.040**	**0.043**	**0.043**	**0.041**	**0.041**	**0.039**	**0.040**	**0.048**	**0.035**	**0.040**	5	5	5	5
Nitrate-N (NO_3^--N)	mg/l	**1.73**	**1.68**	**1.66**	**1.67**	**1.65**	**1.74**	**1.61**	**1.64**	**1.70**	**1.55**	**1.72**	**1.72**	4	4	4	4
Total nitrogen	mg/l	**2.77**	**3.08**	**2.95**	**2.91**	**2.99**	**2.77**	**2.61**	**2.96**	**2.77**	**2.73**	**2.98**	**2.77**	4	4	4	4
Orto-phosphate (PO_4-P)	µg/l	**55.01**	**55.01**	**50.12**	**55.01**	**53.79**	**53.38**	**55.83**	**54.20**	**52.16**	**55.01**	**53.38**	**51.35**	4	4	4	4
Total phosphorus	µg/l	**146**	**118**	**62**	**104**	**140**	**138**	**112**	**106**	**61**	**95**	**165**	**183**	4	4	4	4
Nutrient conditions														**4.2**	**4.2**	**4.2**	**4.2**
Cd	µg/l	**0.016**	**0.018**	**0.013**	**0.020**	**0.022**	**0.017**	**0.016**	**0.028**	**0.018**	**0.017**	**0.014**	**0.018**	5	5	5	5
Hg	µg/l	**0.02**	**0.03**	**0.03**	**0.02**	**0.01**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.03**	**0.02**	5	5	5	5
Ni	µg/l	**1.96**	**1.78**	**1.84**	**1.83**	**1.80**	**1.93**	**1.80**	**1.82**	**1.87**	**1.81**	**1.86**	**2.10**	5	5	5	5
Pb	µg/l	**0.058**	**0.068**	**0.046**	**0.057**	**0.064**	**0.219**	**0.057**	**0.050**	**0.041**	**0.058**	**0.055**	**0.053**	5	5	5	5
Metals														**5.0**	**5.0**	**5.0**	**5.0**
Zn	µg/l	**7.26**	**8.02**	**7.04**	**9.06**	**8.47**	**8.21**	**7.69**	**7.04**	**6.92**	**7.82**	**7.98**	**7.78**				
Cu	µg/l	**3.49**	**4.83**	**3.51**	**3.72**	**4.31**	**3.87**	**3.44**	**3.19**	**3.03**	**4.13**	**4.47**	**3.56**				
Cr	µg/l	**0.25**	**0.27**	**0.24**	**0.22**	**0.21**	**0.23**	**0.29**	**0.22**	**0.25**	**0.22**	**0.25**	**0.25**				
As	µg/l	**1.39**	**1.36**	**1.31**	**1.36**	**1.30**	**1.24**	**1.40**	**1.30**	**1.31**	**1.32**	**1.27**	**1.23**				
Specific pollutants (hazardous chemical elements)														**5.0**	**5.0**	**5.0**	**5.0**
Danube (HURWAEP444 WATER BODY) section's physico-chemical parameters, ecological status assessment according to the WFD														**good status**	**good status**	**good status**	**good status**

Table 12.3.2-1: Summary table of the annual average values from the 2012 studies on the direct downstream section of the Danube (1534-1516 river km) including WFD grades

PAKS HOT WATER CANAL 1526 RIVER KM PROFILE CLASSIFICATION ACCORDING TO THE WFD

- The **acidification status** can be deemed to be of **good status** on the basis of the 4.0 annual average of the assessment results.
- The **salinity status** can be deemed to be of **high status** on the basis of the 5.0 annual average of the assessment results.
- The average of **oxygenation conditions** status per class is 4.3. It is deemed to be of **high status** based on the WFD requirements.
- The average of **nutrients** status per class is 4.2. Based on the methodology specified by the WFD it is deemed to be in **good** ecological status.
- The annual average value of the ecological status in terms of metals is 5.0. Based on the methodology specified by the WFD it is deemed to be in high ecological status.

The Danube section at Paks hot water canal (1526 river km) can be deemed to be of good status from the ecological perspective and good, appropriate status from the specific pollutants (hazardous chemical elements) perspective on the basis of the water quality testing procedures carried out in the year of 2012.

NAGYSARKANTYÚ 1525.3 RIVER KM PROFILE CLASSIFICATION ACCORDING TO THE WFD

- The **acidification status** can be deemed to be of **good status** on the basis of the 4.0 annual average of the assessment results.
- The **salinity status** can be deemed to be of **high status** on the basis of the 5.0 annual average of the assessment results.
- The average of **oxygenation conditions** status per class is 4.3. It is deemed to be of **high status** based on the WFD requirements.
- The average of **nutrients** status per class is 4.2. Based on the methodology specified by the WFD it is deemed to be in good ecological status.
- The annual average value of the ecological status in terms of metals is 5.0. Based on the methodology specified by the WFD it is deemed to be in high ecological status.

The Danube section at Nagysarkantyú canal (1525.3 river km) can be deemed to be of good status from the ecological perspective and good, appropriate status from the specific pollutants (hazardous chemical elements) perspective on the basis of the monthly water quality testing procedures carried out in the year of 2012.

USZÓD 1524.8 RIVER KM PROFILE CLASSIFICATION ACCORDING TO THE WFD

- The **acidification status** can be deemed to be of **good status** on the basis of the 4.0 annual average of the assessment results.
- The **salinity status** can be deemed to be of **high status** on the basis of the 5.0 annual average of the assessment results.
- The average of **oxygenation conditions** status per class is 4.0. It is deemed to be of **good status** based on the WFD requirements.
- The average of **nutrients** status per class is 4.2. Based on the methodology specified by the WFD it is deemed to be in good ecological status.
- The annual average value of the ecological status in terms of metals is 5.0. Based on the methodology specified by the WFD it is deemed to be in high ecological status.

The Danube section at Uszód (1524.8 river km) can be deemed to be of good status from the ecological perspective and good, appropriate status from the specific pollutants (hazardous chemical elements) perspective on the basis of the monthly water quality testing procedures carried out in the year of 2012.

GERJEN-FOKTŐ 1516.0 RIVER KM PROFILE CLASSIFICATION ACCORDING TO THE WFD

- The **acidification status** can be deemed to be of **good status** on the basis of the 4.0 annual average of the assessment results.
- The **salinity status** can be deemed to be of **high status** on the basis of the 5.0 annual average of the assessment results.
- The average of **oxygenation conditions** status per class is 4.3. It is deemed to be of **high status** based on the WFD requirements.
- The average of **nutrients** status per class is 4.2. Based on the methodology specified by the WFD it is deemed to be in good ecological status.
- The annual average value of the ecological status in terms of metals is 5.0. Based on the methodology specified by the WFD it is deemed to be in high ecological status.

The Danube section at Gerjen-Foktő (1516.0 river km) can be deemed to be of good status from the ecological perspective and good, appropriate status from the specific pollutants (hazardous chemical elements) perspective on the basis of the monthly water quality testing procedures carried out in the year of 2012.

CLASSIFICATION OF THE DIRECT DOWNSTREAM DANUBE (1534-1516 RIVER KM) PROFILE

Paks hot water canal	**1526.0 river km**	**good status**
Nagy sarkantyú	1525.3 river km	**good status**
Uszod	1524.8 river km	**good status**
Gerjen-Foktő	1516.0 river km	**good status**

Table 12.3.2-2: WFD classification of the direct downstream Danube section (1526-1516 river km)

Based on the outcome of the classification pursuant to WFD the Danube (HURWAEP444 WATER BODY) 1534-1516 river km section belongs to good status in terms of physico-chemical parameters.

12.3.2.2 Phytoplankton

The near downstream section consists of the sampling points at the hot water canal mouth profile (PLDFP22, PLDFP23, PLDFP21), Nagy-sarkantyú (PLDFP32, PLDFP33, PLDFP31), as well as Uszód (PLDFP42, PLDFP43, PLDFP41) profiles. Dipped phytoplankton samples were taken in the near downstream section profiles during the year 2012 five times 22 March, 27 June, on August 28 on 26 September and 14 November at three sampling points each (left bank, midstream, right bank).

TAXONS	PLDFP22	PLDFP23	PLDFP21	PLDFP32	PLDFP33	PLDFP31	PLDFP42	PLDFP43	PLDFP41
	mouth of the hot water canal			Nagy-sarkantyú			Uszód		
	left	midstream	right	left	midstream	right	left	midstream	right
	23.12.2012	23.12.2012	23.12.2012	23.12.2012	23.12.2012	23.12.2012	23.12.2012	23.12.2012	23.12.2012
SUM pico	63	57	76	54	54	25	25	45	51
SUM nano	44	2	23	4	4	2	14	11	3
SUM Flagellates	129	121	101	217	345	202	281	87	315
SUM Chroococcales	1	0	0	0	0	0	2	0	0
SUM Oscillatoriales	0	0	2	1	3	1	1	1	4
SUM Nostocales	0	0	0	0	0	0	0	0	16
SUM Euglenophyta	0	0	23	0	0	115	0	0	216
SUM Cryptophyta	83	99	117	144	459	96	150	89	219
SUM Dinophyta	49	0	3	0	0	170	112	376	0
SUM Chrysophyceae	151	204	264	77	226	515	231	329	215
SUM Xanthophyceae	0	0	0	0	0	0	0	0	0
SUM Centrales	15413	10491	11115	14012	14445	12577	12222	11835	12394
SUM Pennales	444	627	194	350	213	264	595	393	318
SUM Volvocales	226	166	81	192	172	222	248	179	144
SUM Chlorococcales	65	154	25	38	35	33	23	21	34
SUM Ulothricales	4	1	6	4	4	4	7	3	4
SUM Desmidiales	0	0	0	0	0	0	0	0	0
SUM Zygnematales	0	0	0	0	0	0	0	0	0
SUM biomass (µg/l)	**16672**	**11922**	**12030**	**15093**	**15960**	**14228**	**13912**	**13369**	**13934**
a-chlorophyll concentration (µg/l)	**21.4**	**22.3**	**20.8**	**21.6**	**20.7**	**20.8**	**21.7**	**21.9**	**21.5**
a-chlorophyll contents of biomass (%)	**0.128**	**0.187**	**0.173**	**0.143**	**0.130**	**0.146**	**0.156**	**0.164**	**0.154**
degree of trophity	**5 (m-eu)**	**5 (m-eu)**	**5 (m-eu)**	**5 (m-eu)**	**5 (m-eu)**	**5 (m-eu)**	**5 (m-eu)**	**5 (m-eu)**	**5 (m-eu)**

Table 12.3.2-3: Phytoplankton biomass (µg/l) and a-chlorophyll concentration (µg/l) on the Danube near downstream section during the March sampling season

TAXONS	PLDFP22	PLDFP23	PLDFP21	PLDFP32	PLDFP33	PLDFP31	PLDFP42	PLDFP43	PLDFP41
	mouth of the hot water canal			Nagy-sarkantyú			Uszód		
	left	midstream	right	left	midstream	right	left	midstream	right
	27.06.2012	27.06.2012	27.06.2012	27.06.2012	27.06.2012	27.06.2012	27.06.2012	27.06.2012	27.06.2012
SUM pico	25	26	29	22	35	29	29	37	29
SUM nano	11	5	11	25	4	5	6	2	11
SUM Flagellates	39	29	64	90	38	24	101	65	153
SUM Chroococcales	0	0	0	0	0	4	0	0	2
SUM Oscillatoriales	0	1	0	1	0	24	1	10	4
SUM Nostocales	0	31	7	0	0	0	0	4	0
SUM Euglenophyta	0	0	0	0	0	0	0	0	0
SUM Cryptophyta	112	108	136	48	61	80	85	122	174
SUM Dinophyta	0	0	0	0	0	0	0	302	0
SUM Chrysophyceae	28	14	30	17	41	47	12	61	60
SUM Xanthophyceae	4	0	2	0	0	0	0	10	0
SUM Centrales	903	1363	1645	1595	1026	1356	1637	1816	1606
SUM Pennales	12	46	25	1	5	15	4	7	18
SUM Volvocales	19	13	20	49	36	12	62	98	63
SUM Chlorococcales	114	241	225	157	163	109	206	130	87
SUM Ulothricales	2	0	0	0	0	0	11	0	0
SUM Desmidiales	0	0	0	0	0	0	0	0	0
SUM Zygnematales	0	0	0	0	0	0	0	0	0
SUM biomass (µg/l)	**1269**	**1877**	**2194**	**2005**	**1408**	**1706**	**2154**	**2663**	**2205**
a-chlorophyll concentration (µg/l)	**13.3**	**11.1**	**10.4**	**8.9**	**10.4**	**10.4**	**8.9**	**8.9**	**11.1**
a-chlorophyll contents of biomass (%)	**1.048**	**0.591**	**0.474**	**0.444**	**0.739**	**0.610**	**0.413**	**0.334**	**0.503**
degree of trophity	**4 (m)**	**4 (m)**	**3 (o-m)**	**3 (o-m)**	**3 (o-m)**	**3 (o-m)**	**3 (o-m)**	**3 (o-m)**	**4 (m)**

Table 12.3.2-4: Phytoplankton biomass (µg/l) and a-chlorophyll concentration (µg/l) on the Danube near downstream section during the June sampling season

TAXONS	PLDFP22	PLDFP23	PLDFP21	PLDFP32	PLDFP33	PLDFP31	PLDFP42	PLDFP43	PLDFP41
	mouth of the hot water canal			Nagy-sarkantyú			Uszód		
	left	midstream	right	left	midstream	right	left	midstream	right
	28.08.2012	28.08.2012	28.08.2012	28.08.2012	28.08.2012	28.08.2012	28.08.2012	28.08.2012	28.08.2012
SUM pico	16	67	16	19	35	19	26	26	16
SUM nano	2	20	2	3	17	1	2	5	2
SUM Flagellates	14	82	25	11	59	24	44	13	9
SUM Chroococcales	2	0	4	0	1	2	0	0	0
SUM Oscillatoriales	0	0	11	0	1	9	0	0	1
SUM Nostocales	0	0	6	0	0	15	0	0	0
SUM Euglenophyta	0	0	0	0	0	0	0	0	0
SUM Cryptophyta	188	270	104	140	281	52	107	226	136
SUM Dinophyta	0	3	0	0	0	0	0	0	0
SUM Chrysophyceae	67	8	10	32	30	11	9	39	5
SUM Xanthophyceae	0	0	100	0	378	0	1	18	0
SUM Centrales	5613	11934	4263	5944	12974	4841	9153	10330	3055
SUM Pennales	54	64	26	101	35	2	64	13	20
SUM Volvocales	80	124	50	78	72	57	75	265	7
SUM Chlorococcales	55	328	73	113	204	63	205	204	86
SUM Ulothricales	0	3	0	0	0	0	0	0	0
SUM Desmidiales	0	0	0	0	0	0	32	0	0
SUM biomass (µg/l)	**6091**	**12903**	**4689**	**6442**	**14088**	**5096**	**9718**	**11140**	**3336**
a-chlorophyll concentration (µg/l)	**36.1**	**41.7**	**35.5**	**37.8**	**41.9**	**38.3**	**65.7**	**70.5**	**61.0**
a-chlorophyll contents of biomass (%)	**0.593**	**0.323**	**0.757**	**0.587**	**0.297**	**0.752**	**0.676**	**0.633**	**1.828**
degree of trophity	**5 (m-eu)**	**5 (m-eu)**	**5 (m-eu)**	**5 (m-eu)**	**5 (m-eu)**	**5 (m-eu)**	**6 (eu)**	**6 (eu)**	**6 (eu)**

Table 12.3.2-5: Phytoplankton biomass (µg/l) and a-chlorophyll concentration (µg/l) on the Danube near downstream section during the August sampling season

TAXONS	PLDFP22	PLDFP23	PLDFP21	PLDFP32	PLDFP33	PLDFP31	PLDFP42	PLDFP43	PLDFP41
	mouth of the hot water canal			Nagy-sarkantyú			Uszód		
	left	midstream	right	left	midstream	right	left	midstream	right
	26.09.2012	26.09.2012	26.09.2012	26.09.2012	26.09.2012	26.09.2012	26.09.2012	26.09.2012	26.09.2012
SUM pico	6	10	10	7	16	6	7	10	6
SUM nano	8	1	0	0	0	1	1	1	0
SUM Flagellates	23	1	2	12	7	4	0	2	1
SUM Chroococcales	0	0	0	0	0	0	0	0	0
SUM Oscillatoriales	0	0	4	0	0	2	0	9	10
SUM Nostocales	5	0	3	0	0	0	0	2	0
SUM Euglenophyta	0	0	0	0	0	0	0	0	0
SUM Cryptophyta	170	2	23	41	22	15	16	18	21
SUM Dinophyta	0	0	0	0	0	0	0	0	0
SUM Chrysophyceae	5	0	2	0	1	0	0	0	4
SUM Xanthophyceae	0	0	0	0	0	0	0	0	0
SUM Centrales	192	343	101	146	271	114	84	253	131
SUM Pennales	65	3	33	133	2	39	6	1	8
SUM Volvocales	0	15	0	0	0	0	0	0	0
SUM Chlorococcales	77	6	6	4	11	1	46	14	21
SUM Ulothricales	0	0	0	0	0	0	0	0	0
SUM Desmidiales	0	0	0	0	0	0	0	0	0
SUM biomass (µg/l)	**551**	**379**	**183**	**342**	**331**	**182**	**159**	**310**	**202**
a-chlorophyll concentration (µg/l)	**1.2**	**0.6**	**0.1**	**1.8**	**1.2**	**1.8**	**2.4**	**0.6**	**0.1**
a-chlorophyll contents of biomass (%)	**0.218**	**0.158**	**0.055**	**0.526**	**0.363**	**0.987**	**1.505**	**0.193**	**0.049**
degree of trophity	**2 (o)**	**1 (u-o)**	**1 (u-o)**	**2 (o)**	**2 (o)**	**2 (o)**	**2 (o)**	**1 (u-o)**	**1 (u-o)**

Table 12.3.2-6.: Phytoplankton biomass (µg/l) and a-chlorophyll concentration (µg/l) on the Danube near downstream section during the September sampling season

TAXONS	PLDFP22	PLDFP23	PLDFP21	PLDFP32	PLDFP33	PLDFP31	PLDFP42	PLDFP43	PLDFP41
	mouth of the hot water canal			Nagy-sarkantyú			Uszód		
	left	midstream	right	left	midstream	right	left	midstream	right
	14.11.2012	14.11.2012	14.11.2012	14.11.2012	14.11.2012	14.11.2012	14.11.2012	14.11.2012	14.11.2012
SUM pico	6	10	26	32	6	10	10	3	13
SUM nano	11	1	1	1	1	2	1	0	0
SUM Flagellates	11	5	6	11	7	2	5	18	28
SUM Chroococcales	0	0	18	0	1	1	0	0	2
SUM Oscillatoriales	0	5	17	1	3	8	0	2	18
SUM Nostocales	0	0	0	0	0	10	0	0	0
SUM Euglenophyta	0	0	0	0	0	0	0	0	58
SUM Cryptophyta	39	30	18	26	48	5	73	13	53
SUM Dinophyta	0	0	0	0	0	0	0	0	0
SUM Chrysophyceae	0	0	2	0	10	0	4	18	0
SUM Xanthophyceae	0	0	0	0	0	0	0	0	0
SUM Centrales	107	129	152	106	82	195	40	85	97
SUM Pennales	0	38	6	16	2	39	157	17	28
SUM Volvocales	6	0	0	0	0	0	0	0	9
SUM Chlorococcales	21	7	67	5	6	19	5	5	10
SUM Ulothricales	0	0	0	0	0	0	0	0	0
SUM Desmidiales	0	2	5	0	0	0	0	0	0
SUM biomass (µg/l)	**202**	**227**	**317**	**197**	**166**	**290**	**295**	**161**	**316**
a-chlorophyll concentration (µg/l)	**2.4**	**0.6**	**4.1**	**1.2**	**2.4**	**2.4**	**1.2**	**1.2**	**3.0**
a-chlorophyll contents of biomass (%)	**1.189**	**0.264**	**1.294**	**0.610**	**1.444**	**0.827**	**0.406**	**0.744**	**0.950**
degree of trophity	**2 (o)**	**1 (u-o)**	**3 (o-m)**	**2 (o)**	**2 (o)**	**2 (o)**	**2 (o)**	**2 (o)**	**2 (o)**

Table 12.3.2-7: Phytoplankton biomass (µg/l) and a-chlorophyll concentration (µg/l) on the Danube near downstream section during the Novemer sampling season

In the **hot water canal mouth profile** phytoplankton biomass *on 22 March 2012* in the sequence of left bank, midstream, right bank was 16.7 mg/l, 11.9 mg/l and 12.0 mg/l, a-chlorophyll concentration 21.4 µg/l, 22.3 µg/l and 20.8 µg/l, corresponding to the 5 (meso-eutrophic) grade on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) on all three sampling points [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (92.4%, 88.0% and 92.4%). Proportions of the diatom species in the Pennales order in the sequence of left bank, midstream, right bank were 2.7%, 5.3% and 1.6%, of the flagellate golden-brown algae (Chrysophyceae) 0.9%, 1.7% and 2.2%, of the grooved cryptomonads (Cryptophyta) 0.5%, 0.8% and 1.0%, and flagellates listed in the various taxonomic categories (Flagellates) 0.8%, 1.0% and 0.8%, green algae listed in the Volvocales-order 1.4%, 1.4% and 0.7%, green algae listed in the Chlorococcales-order 0.4%, 1.3% and 0.2%.

On 27 June 2012 phytoplankton biomass in the sequence of left bank, midstream, right bank was 1.3 mg/l, 1.9 mg/l and 2.2 mg/l, a-chlorophyll concentration 13.3 µg/l, 11.1 µg/l and 10.4 µg/l, corresponding to the 4 (mesotrophic) grade at the sampling points on the left bank and from the main current line, and to 3 (oligo-mesotrophic) grade on the right bank on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (71.2%, 72.6% and 75.0%). Proportions of the diatom species in the Pennales order in the sequence of left bank, midstream, right bank were 1.0%, 2.5% and 1.2%, of the flagellate golden-brown algae (Chrysophyceae) 2.2%, 0.7% and 1.4%, of the grooved cryptomonads (Cryptophyta) 8.8%, 5.8% and 6.2%, and flagellates listed in the various taxonomic categories (Flagellates) 3.1%, 1.6% and 2.9%, green algae listed in the Volvocales-order 1.5%, 0.7% and 0.9%, green algae listed in the Chlorococcales-order 9.0%, 12.8% and 10.3%. The share of pico-algae in the sequence of left bank, midstream, right bank was 2.0%, 1.4% and 1.3%, respectively.

On August 28 of 2012 phytoplankton biomass in the sequence of left bank, midstream, right bank was 6.1 mg/l, 12.9 mg/l and 4.7 mg/l, a-chlorophyll concentration 36.1 µg/l, 41.7 µg/l and 35. µg/l, corresponding to the 5 (meso-eutrophic) grade on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) on all three sampling points [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (92.1%, 92.5% and 90.9%). Proportions of the diatom species in the Pennales order in the sequence of left bank, midstream, right bank were 0.9%, 0.5% and 0.5%, of the flagellate golden-brown algae (Chrysophyceae) 1.1%, 0.1% and 0.2%, of the grooved cryptomonads (Cryptophyta) 3.1%, 2.1% and 2.2%, and flagellates listed in the various taxonomic categories (Flagellates) 0.2%, 0.6% and 0.5%, green algae listed in the Volvocales-order 1.3%, 1.0% and 1.1%, green algae listed in the Chlorococcales-order 0.9%, 2.5% and 1.6%. The share of pico-algae in the sequence of left bank, midstream, right bank was 0.3%, 0.5% and 0.3%.

2012. on 26 September phytoplankton biomass in the sequence of left bank, midstream, right bank was 0.6 mg/l, 0.4 mg/l and 0.2 mg/l, a-chlorophyll concentration 1.2 µg/l, 0.6 µg/l and 0.1 µg/l, corresponding to the 2 (oligotrophic) grade at the sampling point on the left bank, and 1 (ultra-oligotrophic) grade at the sampling points midstream and on the right bank on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (34.9%, 90.3% and 55.0%). Proportions of the diatom species in the Pennales order in the sequence of left bank, midstream, right bank were 11.8%, 0.7% and 18.0%, of the flagellate golden-brown algae (Chrysophyceae) 0.8%, 0.0% and 1.0%, of the grooved cryptomonads (Cryptophyta) 30.9%, 0.5% and 12.6%, and flagellates listed in the various taxonomic categories (Flagellates) 4.1%, 0.3% and 1.0%, green algae listed in the Volvocales-order 0.0%, 3.9% and 0.1%, green algae listed in the Chlorococcales-order 14.0%, 1.5% and 3.2%. The share of pico-algae in the sequence of left bank, midstream, right bank was 1.2%, 2.5% and 5.2%.

On 14 November 2012 phytoplankton biomass in the sequence of left bank, midstream, right bank was 0.2 mg/l, 0.2 mg/l and 0.3 mg/l, a-chlorophyll concentration 2.4 µg/l, 0.6 µg/l and 4.1 µg/l, corresponding to the 2 (oligotrophic) grade at the sampling point on the left bank, 1 (ultra-oligotrophic) grade at the sampling point midstream and 3 (oligo-mesotrophic) at the sampling point on the left bank, respectively, on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (52.8%, 56.9% and 48.0%). Proportions of the diatom species in the Pennales order in the sequence of left bank, midstream, right bank were 0.0%, 16.6% and 1.9%, of the flagellate golden-brown algae (Chrysophyceae) 0.0%, 0.0% and 0.6%, of the grooved cryptomonads (Cryptophyta) 19.5%, 13.3% and 5.6%, and flagellates listed in the various taxonomic categories (Flagellates) 5.4%, 2.1% and 2.0%, green algae listed in the Volvocales-order 3.2%, 0.0% and 0.0%, green algae listed in the Chlorococcales-order 10.6%, 3.3% and 21.0%, and green algae listed in the order Desmidiales 0.0%, 1.0% and 1.5%, respectively. The share of pico-algae in the sequence of left bank, midstream, right bank was 3.1%, 4.2% and 8.1%.

A **Nagysarkantyú profile** *on 22 March 2012* phytoplankton biomass in the sequence of left bank, midstream, right bank was 15.1 mg/l, 16.0 mg/l and 14.2 mg/l, a-chlorophyll concentration 21.6 µg/l, 20.7 µg/l and 20.8 µg/l, corresponding to the 5 (meso-eutrophic) grade on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) on all three sampling points [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (92.8%, 90.5% and 88.4%). Proportions of the diatom species in the Pennales order in the sequence of left bank, midstream, right bank were 2.3%, 1.3% and 1.9%, of the flagellate golden-brown algae (Chrysophyceae) 0.5%, 1.4% and 3.6%, of the grooved cryptomonads (Cryptophyta) 1.0%, 2.9% and 0.7%, and flagellates listed in the various taxonomic categories (Flagellates) 1.4%, 2.2% and 1.4%, green algae listed in the Volvocales-order 1.3%, 1.1% and 1.6%, green algae listed in the Chlorococcales-order 0.3%, 0.2% and 0.2%, respectively.

On 27 June 2012 phytoplankton biomass in the sequence of left bank, midstream, right bank was 2.0 mg/l, 1.4 mg/l and 1.7 mg/l, a-chlorophyll concentration 8.9 µg/l, 10.4 µg/l and 10.4 µg/l, corresponding to the 3 (oligo-mesotrophic) grade on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) on all three sampling points [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (79.5%, 72.9% and 79.5%). Proportions of the diatom species in the Pennales order in the sequence of left bank, midstream, right bank were 0.1%, 0.3% and 0.9%, of the flagellate golden-brown algae (Chrysophyceae) 0.8%, 2.9% and 2.8%, of the grooved cryptomonads (Cryptophyta) 2.4%, 4.3% and 4.7%, and flagellates listed in the various taxonomic categories (Flagellates) 4.5%, 2.7% and 1.4%, green algae listed in the Volvocales-order 2.5%, 2.6% and 0.7%, green algae listed in the Chlorococcales-order 7.8%, 11.6% and 6.4%, respectively. The share of pico-algae in the sequence of left bank, midstream, right bank was 1.1%, 2.5% and 1.7%.

On August 28 of 2012 phytoplankton biomass in the sequence of left bank, midstream, right bank was 6.4 mg/l, 14.1 mg/l and 5.1 mg/l, a-chlorophyll concentration 37.8 µg/l, 41.9 µg/l and 38.3 µg/l, corresponding to the 5(meso-eutrophic) grade on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) on all three sampling points [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (92.3%, 92.1% and 95.0%). Proportions of the diatom species in the Pennales order in the sequence of left bank, midstream, right bank were 1.6%, 0.2% and 0.0%, of the flagellate golden-brown algae (Chrysophyceae) 0.5%, 0.2% and

0.2%, of the grooved cryptomonads (Cryptophyta) 2.2%, 2.0% and 1.0%, and flagellates listed in the various taxonomic categories (Flagellates) 0.2%, 0.4% and 0.5%, green algae listed in the Volvocales-order 1.2%, 0.5% and 1.1%, green algae listed in the Chlorococcales-order 1.8%, 1.5% and 1.2%, respectively. The share of pico-algae in the sequence of left bank, midstream, right bank was 0.3%, 0.2% and 0.4%.

On 26 September 2012 phytoplankton biomass in the sequence of left bank, midstream, right bank was 0.3 mg/l, 0.3 mg/l and 0.2 mg/l, a-chlorophyll concentration 1.8 µg/l, 1.2 µg/l and 1.8 µg/l, corresponding to the 2 (oligotrophic) grade on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) on all three sampling points [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (42.7%, 82.0% and 62.6%). Proportions of the diatom species in the Pennales order in the sequence of left bank, midstream, right bank were 38.8%, 0.5% and 21.6%, of the flagellate golden-brown algae (Chrysophyceae) 0.0%, 0.3% and 0.0%, of the grooved cryptomonads (Cryptophyta) 11.9%, 6.7% and 8.0%, and flagellates listed in the various taxonomic categories (Flagellates) 3.4%, 2.1% and 1.9%, green algae listed in the Chlorococcales-order 1.1%, 3.4% and 0.6%, respectively. The share of pico-algae in the sequence of left bank, midstream, right bank was 1.9%, 4.8% and 3.5%.

On 14 November 2012 phytoplankton biomass in the sequence of left bank, midstream, right bank was 0.2 mg/l, 0.2 mg/l and 0.3 mg/l, a-chlorophyll concentration 1.2 µg/l, 1.2 µg/l and 2.4 µg/l, corresponding to the 2 (oligotrophic) grade on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) on all three sampling points [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (53.8%, 49.6% and 67.1%). Proportions of the diatom species in the Pennales order in the sequence of left bank, midstream, right bank were 7.9%, 1.3% and 13.6%, of the flagellate golden-brown algae (Chrysophyceae) 0.0%, 5.8% and 0.0%, of the grooved cryptomonads (Cryptophyta) 13.0%, 28.7% and 1.7%, and flagellates listed in the various taxonomic categories (Flagellates) 5.8%, 4.4% and 0.5%, green algae listed in the Chlorococcales-order 2.6%, 3.5% and 6.6%, respectively. The share of pico-algae in the sequence of left bank, midstream, right bank was 16.1%, 3.8% and 3.3%.

At the U**szód profile** of the **Danube** *on 22 March 2012* phytoplankton biomass in the sequence of left bank, midstream, right bank was 13.9 mg/l, 13.4 mg/l and 13.9 mg/l, a-chlorophyll concentration 21.7 µg/l, 21.9 µg/l and 21.5 µg/l, corresponding to the 5 (meso-eutrophic) grade on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) on all three sampling points [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (87.9%, 88.5% and 88.9%). Proportions of the diatom species in the Pennales order in the sequence of left bank, midstream, right bank were 4.3%, 2.9% and 2.3%, of the flagellate golden-brown algae (Chrysophyceae) 1.7%, 2.5% and 1.5%, of the grooved cryptomonads (Cryptophyta) 1.1%, 0.7% and 1.6%, and flagellates listed in the various taxonomic categories (Flagellates) 2.0%, 0.7% and 2.3%, green algae listed in the Volvocales-order 1.8%, 1.3% and 1.0%, green algae listed in the Chlorococcales-order 0.2%, 0.2% and 0.2%.

On 27 June 2012 phytoplankton biomass in the sequence of left bank, midstream, right bank was 2.2 mg/l, 2.7 mg/l and 2.2 mg/l, a-chlorophyll concentration 8.9 µg/l, 8.9 µg/l and 11.1 µg/l, corresponding to the 5 3 (oligo-mesotrophic) grade at the left bank sampling site and midstream, and to the 4 (mesotrophic) grade on the right bank, on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (76.0%, 68.2% and 72.8%). Proportions of the diatom species in the Pennales order in the sequence of left bank, midstream, right bank were 0.2%, 0.2% and 0.8%, of the flagellate golden-brown algae (Chrysophyceae) 0.6%, 2.3% and 2.7%, of the grooved cryptomonads (Cryptophyta) 3.9%, 4.6% and 7.9%, and flagellates listed in the various taxonomic categories (Flagellates) 4.7%, 2.4% and 6.9%, green algae listed in the Volvocales-order 2.9%, 3.7% and 2.8%, green algae listed in the Chlorococcales-order 9.6%, 4.9% and 3.9%, respectively. The share of pico-algae in the sequence of left bank, midstream, right bank was 1.3%, 1.4% and 1.3%. Dinoflagellates were present only in the sample taken from midstream (Dinophyta: 11.3%).

On August 28 of 2012 phytoplankton biomass in the sequence of left bank, midstream, right bank was 9.7 mg/l, 11.1 mg/l and 3.3 mg/l, a-chlorophyll concentration 65.7 µg/l, 70.5 µg/l and 61.0 µg/l, corresponding to the 6 (eutrophic) grade on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) on all three sampling points [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (94.2%, 92.7% and 91.6%). Proportions of the diatom species in the Pennales order in the sequence of left bank, midstream, right bank were 0.7%, 0.1% and 0.6%, of the flagellate golden-brown algae (Chrysophyceae) 0.1%, 0.4% and 0.2%, of the grooved cryptomonads (Cryptophyta) 1.1%, 2.0% and 4.1%, and flagellates listed in the various taxonomic categories (Flagellates) 0.5%, 0.1% and 0.3%, green algae listed in the Volvocales-order 0.8%, 2.4% and 0.2%, green algae listed in the Chlorococcales-order 2.1%, 1.8% and 2.6%, respectively. The share of pico-algae in the sequence of left bank, midstream, right bank was 0.3%, 0.2% and 0.5%.

On 26 September 2012 phytoplankton biomass in the sequence of left bank, midstream, right bank was 0.2 mg/l, 0.3 mg/l and 0.2 mg/l, a-chlorophyll concentration 2.4 µg/l, 0.6 µg/l and 0.1 µg/l, corresponding to the 2 (oligotrophic) grade at the sampling point on the left bank, and 1 (ultra-oligotrophic) grade midstream and at the sampling point on the right bank, respectively, on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (53.0%, 81.6% and 64.6%). Proportions of the diatom species in the Pennales order in the sequence of left bank, midstream, right bank were 3.6%, 0.5% and 4.1%, of the flagellate golden-brown algae (Chrysophyceae) 0.0%, 0.0% and 1.9%, of the grooved cryptomonads (Cryptophyta) 9.9%, 5.7% and 10.2%, and flagellates listed in the various taxonomic categories (Flagellates) 0.0%, 0.6% and 0.5%, green algae listed in the Chlorococcales-order 28.9%, 4.6% and 10.5%, respectively. The share of pico-algae in the sequence of left bank, midstream, right bank was 4.2%, 3.1% and 3.1%.

On 14 November 2012 phytoplankton biomass in the sequence of left bank, midstream, right bank was 0.2 mg/l, 0.4 mg/l and 0.2 mg/l, a-chlorophyll concentration 0.6 µg/l, 1.8 µg/l and 2.4 µg/l, corresponding to the 1 (ultra-oligotrophic) grade at the sampling point on the left bank, and 2 (oligotrophic) grade midstream and at the sampling point on the right bank, respectively, on the ten grade Felföldy (1987)-type (0-9) trophity scale [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the orders Centrales and Pennales. Their respective proportions in the sequence of left bank, midstream, right bank were 13.7%, 53.0% and 30.6%, as well as 53.1%, 10.7% and 8.9%, respectively. The share of the flagellate golden-brown algae was (Chrysophyceae) 1.5%, 10.9% and 0.0%, of the grooved cryptomonads (Cryptophyta) 24.7%, 7.8% and 16.9%, and flagellates listed in the various taxonomic categories (Flagellates) 1.6%, 11.4% and 9.0%, green algae listed in the Volvocales-order 0.1%, 0.0% and 2.9%, green algae listed in the Chlorococcales-order 1.8%, 3.3% and 3.1%, respectively. The share of pico-algae in the sequence of left bank, midstream, right bank was 3.2%, 2.0% and 4.0%.

Sampling results downstream reflected a status a great extent similar to the upstream status.

(1) Components of phytoplankton biomass in the highest ratio included diatom species from the order Centrales all times.

(2) Biomass levels indicate seasonal trends.

(3) The period characterised by the highest biomass level is March and August, while the lowest biomass levels were found in the months September and November.

CLASSIFICATION OF THE NEAR DOWNSTREAM SECTION IN ACCORDANCE WITH THE WFD ON THE BASIS OF THE PHYTOPLANKTON

The table below summarises the EQR values obtained in the near downstream section from the three sampling units in each the mouth of the hot water canal, Nagysarkantyú and Uszód samples profiles, as well as the outcome of the ecological status assessment of the near downstream section.

Sampling unit	23.12.2012		27.06.2012		28.08.2012		26.09.2012		14.11.2012	
	EQR	Ecological status (based on HRPI)	EQR	Ecological status (based on HRPI)	EQR	Ecological status (based on HRPI)	EQR	Ecological status (based on HRPI)	EQR	Ecological status (based on HRPI)
PLDFP22	0.707	good	0.739	good	0.574	moderate	0.829	high	0.810	high
PLDFP23	0.702	good	0.763	good	0.523	moderate	0.881	high	0.874	high
PLDFP21	0.711	good	0.770	good	0.574	moderate	0.880	high	0.775	good
PLDFP32	0.705	good	0.780	good	0.560	moderate	0.878	high	0.852	high
PLDFP33	0.708	good	0.765	good	0.519	moderate	0.870	high	0.822	high
PLDFP31	0.702	good	0.777	good	0.555	moderate	0.886	high	0.853	high
PLDFP42	0.699	good	0.775	good	0.312	poor	0.815	high	0.909	high
PLDFP43	0.695	good	0.747	good	0.266	poor	0.864	high	0.843	high
PLDFP41	0.697	good	0.757	good	0.352	poor	0.844	high	0.762	good
average season	**0.703**	**good**	**0.764**	**good**	**0.471**	**moderate**	**0.861**	**high**	**0.833**	**high**
Classification of tl section	**0.726**					**good**				

Table 12.3.2-8: Phytoplankton based classification of the near downstream-section according to the WFD

For the purposes of characterising the ecological status of the near downstream section the HRPI index taking into account the a-chlorophyll concentration proportional to the NQr and phytoplankton biomass calculated on the basis of the species composition was used. The ecological status of the near downstream section according to the assessment of the phytoplankton and based on the average of the EQR values on the sampling sites indicated a good status in March and June, and high status in September and November. The lowest EQR levels were obtained during the August sampling season. In this period the ecological status was moderate. The seasonal fluctuations on the near downstream section are entirely in line with the experiences gained on the upstream section. Values characterising the statuses per season – and hence, on an annual basis – are identical with the results measured on the upstream section.

The ecological status of the near downstream section based on the phytoplankton was good.

12.3.2.3 Phytobenthos

The near downstream section consists of the sampling points at the hot water canal mouth profile (PLDFB21), Nagy-sarkantyú (PLDFP32, PLDFP31), as well as Uszód (PLDFP42, PLDFP41) profiles. Phytobenthos samples were taken in the near downstream section profiles during the year 2012 twice, on August 28 and on 26 September at two sampling points each (left bank, right bank). No samples were taken on the left bank of the hot water canal mouth profile because no suitable substrate was found at this area.

TAXONS	PLDFB21	PLDFB32	PLDFB31	PLDFB42	PLDFB41
	Paks hot water	Nagysarkantyú		Uszód	
	right	left	right	left	right
	28.08.2012	28.08.2012	28.08.2012	28.08.2012	28.08.2012
	Relative abundance (%)				
CENTRALES					
SUM Centrales	32.3	24.0	48.6	25.4	47.4
PENNALES					
SUM Fragilariaceae	3.9	1.2	4.4	3.1	0.0
SUM Eunotiaceae	0.2	0.0	0.0	0.0	0.0
SUM Achnanthaceae	4.3	1.7	3.2	9.3	3.8
SUM Naviculaceae	40.3	61.6	33.5	47.8	36.9
SUM Bacillariaceae	17.8	10.7	8.8	11.7	10.6
SUM Epithemiaceae	0.0	0.0	0.0	0.0	0.0
SUM Surirellaceae	0.9	0.0	0.4	0.5	0.6
SUM Pennales spp. (other)	0.2	0.8	1.2	2.2	0.6
SUM	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
IPS index	**8.91**	**12.78**	**9.08**	**14.67**	**9.05**

Table 12.3.2-9: Summary table of the phytobenthos taxons identified on the near downstream section during the summer sampling season

TAXONS	PLDFB21	PLDFB32	PLDFB31	PLDFB42	PLDFB41
	Paks hot water	Nagysarkantyú		Uszód	
	right	left	right	left	right
	26.09.2012	26.09.2012	26.09.2012	26.09.2012	26.09.2012
	Relative abundance (%)				
CENTRALES					
SUM Centrales	14.0	4.4	12.2	25.5	15.0
PENNALES					
SUM Fragilariaceae	1.3	0.3	1.0	5.0	0.7
SUM Achnanthaceae	5.3	0.8	4.9	6.6	5.8
SUM Naviculaceae	61.8	36.8	58.7	50.7	37.0
SUM Bacillariaceae	17.1	56.5	21.9	9.3	40.9
SUM Surirellaceae	0.0	0.3	0.0	1.3	0.2
SUM Pennales spp. (other)	0.4	0.8	1.4	1.7	0.5
SUM	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
IPS index	**7.54**	**11.03**	**7.81**	**11.18**	**5.35**

Table 12.3.2-10. Summary table of the phytobenthos taxons identified on the near downstream section during the summer sampling season

At the right bank at the sampling point of the **hot water canal mouth profile** *on August 28 of 2012* 32.3 % of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, of which relative abundance of Cyclotella meneghiniana was 5.2%. The share of Stephanodiscus hantzschii was 2.5%. The components in the highest rate of the Pennales-diatom stock were the taxons in the Naviculaceae-family, of which the relative abundance projected to the individuals counted was 40.3%. The species with the highest level of relative abundance in the Naviculaceae family included Navicula viridula var. rostellata (8.4%), Navicula recens (4.8%), Navicula tripunctata (1.4%), Navicula menisculus var. menisculus (2.1%), Navicula erifuga (1.1%), Navicula cryptocephala (1.8%), Amphora pediculus (1.4%), Amphora libyca (0.4%), Amphora ovalis (0.2%), Gyrosigma acuminatum (2.5%), as well as Gomphonema-species (2.5%). The share of the Achnanthaceae family was 7.8%. The Achnanthaceae-family was represented by Achnanthidium minutissimum (=Achnanthes minutissima) (2.3%), Achnanthes-species (0.2%) and Cocconeis placentula (1.8%). The share of the Bacillariaceae family represented by only the Nitzschia species was 17.8%. Dominant taxons of the Bacillariaceae-family included Nitzschia palea, Nitzschia (Lanceolatae)-species, as well as Nitzschia levidensis var. levidensis. Their relative abundance was 11.4%, 4.4% and 1.6%. Fragilaria construens (2.1%) and other Fragilaria-species (1.1%), as well as Diatoma ehrenbergii (0.2%), Diatoma mesodon (0.2%), Diatoma vulgaris (0.2%) and Asterionella formosa (0.4%), respectively. The share of the Fragilariaceae-family represented by was 4.4%.

At the right bank at the sampling point of the hot water canal mouth profile *on 26 September 2012* 14.0 % of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, of which relative abundance of Cyclotella meneghiniana was 0.4%, of other Cyclotella-species 2.2%. The share of Stephanodiscus hantzschii was 1.8%, the other Stephanodiscus-species 0.4%. The components in the highest rate of the Pennales-diatom stock were the taxons in the Naviculaceae-family, of which the relative abundance projected to the individuals counted was 61.8%. The species with the highest level of relative abundance in the Naviculaceae family included Navicula recens (13.2%), Navicula present form (8.8%), Navicula viridula var. rostellata (11.0%), Navicula erifuga (7.9%), Navicula veneta (1.8%), Navicula halophila (1.3%), Navicula trivialis (1.3%), and other Navicula-species (14.9%). The share of the Bacillariaceae family represented by only the Nitzschia species was 17.1%. The species with the highest level of relative abundance in the Bacillariaceae family included Nitzschia palea (13.2%), Nitzschia recta (1.3%) and Nitzschia (Lanceolatae) spp. (1.8%). The share of the Achnanthaceae family was 5.3%. The Achnanthaceae-family was represented by Achnanthidium minutissimum (=Achnanthes minutissima) (3.5%), Achnanthes-species (0.4%), and Cocconeis placentula (1.3%). The share of the Fragilariaceae-family represented by Fragilaria-species only was 1.3%.

At the left bank sampling point of the Nagysarkantyú profile *on August 28 of 2012* 24.0 % of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, of which relative abundance of Cyclotella meneghiniana was 2.1%. The relative abundance of Melosira varians 9.5%, that of Skeletonema spp. was 3.7%. The components in the highest rate of the Pennales-diatom stock were the taxons in the Naviculaceae-family, of which the relative abundance projected to the individuals counted was 61.6%. The species with the highest level of relative abundance in the Naviculaceae family included Navicula recens (28.9%), Navicula present form (4.5%), Navicula tripunctata (6.6%), Cymbella helvetica (5.0%), Cymbella tumida (1.7%), and Caloneis bacillum (2.5%). The share of the Achnanthaceae family was 1.7%. The Achnanthaceae-family was represented by Achnanthidium minutissimum (=Achnanthes minutissima) (0.8%) and Cocconeis placentula (0.8%). The share of the Bacillariaceae family represented by only the Nitzschia species was 17.8%. Dominant taxons of the Bacillariaceae-family included Nitzschia dissipata, as well as Nitzschia (Lanceolatae)-species. Their relative abundance was 5.4% and 4.9%. The share of the Fragilariaceae-family represented by Fragilaria-species only was 1.2%.

At the left bank sampling point of the Nagysarkantyú profile *on 26 September 2012* 4.4 % of the individuals counted in the diatom population of the benthos constituted from Centrales-diatom species settled from the plankton, and 95.6% of it from Pennales-diatom species. The components in the highest rate of the Pennales-diatom stock were the taxons in the Bacillariaceae- family, of which the relative abundance projected to the individuals counted was 56.5%. The species with the highest level of relative abundance in the Bacillariaceae family included Nitzschia palea (27.7%), Nitzschia dissipata (16.3%) and Nitzschia (Lanceolatae) spp. (10.8%). Naviculaceae-family had a share of 36.8%. The species with the highest level of relative abundance in the Naviculaceae family included Navicula recens (18.0%), Navicula present form (2.8%), Navicula menisculus var. grunowii (2.5%), Navicula subminuscula (5.8%), Navicula (Minusculae) spp. (1.1%) and other Navicula-species (3.6%). The share of the Achnanthaceae family was 5.3%.

At the right bank sampling point of the Nagysarkantyú profile *on August 28 of 2012* 48.6 % of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, of which relative abundance of Cyclotella meneghiniana was 6.0%. The share of Stephanodiscus hantzschii was 4.8%. The components in the highest rate of the Pennales-diatom stock were the taxons in the Naviculaceae-family, of which the relative abundance projected to the individuals counted was 33.5%. The species with the highest level of relative abundance in the Naviculaceae family included Navicula recens (8.4%), Navicula present form (2.0%), Navicula viridula var. rostellata (2.8%), Navicula lanceolata (2.4%), Navicula menisculus var. menisculus (1.6%), Cymbella silesiaca (1.6%), as well as Gyrosigma spp. (3.2%). The share of the Achnanthaceae family was 3.2%. The Achnanthaceae-family was represented by Achnanthidium minutissimum (=Achnanthes minutissima) (1.6%) and Cocconeis placentula (1.6%). The share of the Bacillariaceae family represented by only the Nitzschia species was 8.8%. Dominant taxons of the Bacillariaceae-family included Nitzschia (Lanceolatae)-species and Nitzschia palea. Their relative abundance was 3.6% and 3.2%. The share of the Fragilariaceae-family represented by Fragilaria construens (2.0%) and other Fragilaria-species (1.2%), as well as Diatoma moniliformis (0.4%), Diatoma vulgaris (0.4%) and Asterionella formosa (0.4%) was 4.4%.

At the right bank sampling point of the Nagysarkantyú profile *on 26 September 2012* 12.2 % of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, of which a Cyclotella atomus relative abundance 2.4%, of other Cyclotella-species 2.7%. The components in the highest rate of the Pennales-diatom stock were the taxons in the Naviculaceae-family, of which the relative abundance projected to the individuals counted was 58.7%. The species with the highest level of relative abundance in the Naviculaceae family included Navicula erifuga (7.6%), Navicula recens (6.6%), Navicula present form (6.6%), Navicula viridula var. rostellata (4.9%), Navicula cryptocephala (4.5%), Navicula veneta (2.4%), Navicula goeppertiana (2.1%), Navicula cryptotenella (1.4%), Navicula trivialis (1.4%), Navicula lanceolata (1.0%), Navicula menisculus var. menisculus (1.0%) and other Navicula-species (15.3%). The share of the Bacillariaceae family represented by only the Nitzschia species was 21.9%.Dominant taxons of the Bacillariaceae-family included Nitzschia palea, Nitzschia (Lanceolatae)-species and Nitzschia dissipata. Their relative abundance was 12.6%, 6.3% and 1.0%. The share of the Achnanthaceae family was 4.9%. The Achnanthaceae-family was represented by Achnanthidium minutissimum (=Achnanthes minutissima) (4.5%) and Cocconeis placentula (0.3%). The share of the Fragilariaceae-family represented by Fragilaria- and Diatoma-species was 1.0%.

At the left bank sampling point of the U**szód profile of the Danube** *on August 28 of 2012* 25.4 % of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, of which relative abundance of Cyclotella meneghiniana was 1.7%. The share of Stephanodiscus hantzschii was 2.2%. The components in the highest rate of the Pennales-diatom stock were the taxons in the Naviculaceae-family, of which the relative abundance projected to the individuals counted was 47.0%. The species with the highest level of relative abundance in the Naviculaceae family included Navicula tripunctata (14.4%), Navicula lanceolata (3.6%), Navicula menisculus var. menisculus (1.9%), Navicula recens (1.9%), Navicula present form (1.0%) and other Navicula-species (9.1%), as well as Gyrosigma acuminatum (6.7%) and other Gyrosigma species (2.2%), furthermore Cymbella- and Gomphonema-species (1.9% and 1.2%) and Amphora pediculus (1.4%). The share of the Achnanthaceae family was 3.2%. The Achnanthaceae-family was represented by Achnanthidium minutissimum (=Achnanthes minutissima) (4.1%), Achnanthes lanceolata (1.0%) and Cocconeis placentula (4.3%). The share of the Bacillariaceae family represented by only the Nitzschia species was 11.7%. Dominant taxons of the Bacillariaceae-family included Nitzschia dissipata, and Nitzschia (Lanceolatae)-species. Their relative abundance was 4.1% and 4.3%. The share of the Fragilariaceae-family represented by Fragilaria ulna var. ulna (0.7%) and other Fragilaria-species (1.4%), as well as Diatoma moniliformis (0.2%), Diatoma vulgaris (0.7%) was 3.1%.

At the left bank sampling point of the Uszód profile of the Danube *on 26 September* 25.5 % of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, of which the share of Stephanodiscus hantzschii was 4.0%. The components in the highest rate of the Pennales-diatom stock were the taxons in the Naviculaceae-family, of which the relative abundance projected to the individuals counted was 50.7%. The species with the highest level of relative abundance in the Naviculaceae family included Navicula viridula var. rostellata (9.9%), %), Navicula recens (5.0%), Navicula present form (2.6%), Navicula cryptocephala (2.3%), Navicula erifuga (2.0%), Navicula menisculus var. menisculus (1.3%), Navicula (Minusculae) spp. (1.3%) and other Navicula-species (12.6%), as well as Gomphonema- (1.7%) and Gyrosigma species (1.0%), furthermore Amphora pediculus (5.3%), Amphora montana (2.6%) and Amphora libyca (1.0%). The share of the Bacillariaceae family represented by only the Nitzschia species was 9.3%. Dominant taxons of the Bacillariaceae-family included Nitzschia (Lanceolatae)-species, Nitzschia palea, and Nitzschia dissipata. Their relative abundance was 3.0%, 2.3% and 2.0%. The share of the Achnanthaceae family was 6.6%. The Achnanthaceae-family was represented by Achnanthidium minutissimum (=Achnanthes minutissima) (3.3%), Achnanthes lanceolata (1.0%) and Cocconeis placentula (2.3%). The share of the Fragilariaceae-family represented by Fragilaria pinnata (1.3%), Fragilaria construens (1.0%), Fragilaria ulna var. ulna (0.7%) Fragilaria arcus (0.3%), as well as Asterionella formosa (0.7%), Diatoma moniliformis (0.7%) and a Tetracyclus cf. rupestris (0.3%) was 5.0%.

At the right bank sampling point of the Uszód profile of the Danube on *August 28 of 2012* 47.4 % of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, of which relative abundance of Cyclotella meneghiniana was 7.4%, of other Cyclotella-species 18.9%. The share of Stephanodiscus hantzschii was 0.6%. The components in the highest rate of the Pennales-diatom stock were the taxons in the Naviculaceae-family, of which the relative abundance projected to the individuals counted was 36.9%. The species with the highest level of relative abundance in the Naviculaceae family included Navicula recens (9.6%), Navicula present form (7.4%), Navicula viridula var. rostellata (7.4%), Navicula lanceolata (1.3%), Navicula menisculus var. grunowii (1.0%), a Gomphonema spp. (1.9%), Gyrosigma spp. (1.3%), as well as Amphora pediculus (1.0%). The share of the Achnanthaceae family was 3.2%. The Achnanthaceae-family was represented by Achnanthidium minutissimum (=Achnanthes minutissima) (1.6%) and Cocconeis placentula (1.6%). The share of the Bacillariaceae family represented by only the Nitzschia species was 8.8%. Dominant taxons of the Bacillariaceae-family included Nitzschia palea, Nitzschia (Lanceolatae)-species, as well as Nitzschia palea. Their relative abundance was 3.6% and 3.2%. The share of the Fragilariaceae-family represented by Fragilaria construens (2.0%) and other Fragilaria-species (1.2%), as well as Diatoma moniliformis (0.4%), Diatoma vulgaris (0.4%) and Asterionella formosa (0.4%) was 4.4%.

At the right bank sampling point of the Uszód profile of the Danube *on 26 September 2012* 15.0 % of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, of which Cyclotella meneghiniana relative abundance of the 1.2%, of other Cyclotella-species 6.2%, the share of Stephanodiscus hantzschii was 0.2%. The components in the highest rate of the Pennales-diatom stock were the taxons in the Bacillariaceae-family, of which the relative abundance projected to the individuals counted was 40.9%. Dominant taxons of the Bacillariaceae-family included Nitzschia palea and Nitzschia (Lanceolatae)-species. Their relative abundance was 34.6% and 4.2%. The share of the Naviculaceae-family was 37.0%. The species with the highest level of relative abundance in the Naviculaceae family included Navicula recens (8.8%), Navicula present form (3.5%), Navicula viridula var. rostellata (6.5%), Navicula cryptocephala (2.1%), Navicula erifuga (1.6%), Navicula trivialis (1.4%), Navicula halophila (1.2%) and other Navicula-species (9.5%). The share of the Achnanthaceae family was 5.8%. The Achnanthaceae-family was represented by Achnanthidium minutissimum (=Achnanthes minutissima) (3.9%), Achnanthes lanceolata (0.5%) and other Achnanthes-species (0.5%), as well as Cocconeis placentula (0.9%). A Diatoma vulgaris (0.5%) and Asterionella formosa (0.2%) The share of the Fragilariaceae-family was 0.7%.

CLASSIFICATION OF THE NEAR DOWNSTREAM SECTION IN ACCORDANCE WITH THE WFD ON THE BASIS OF THE PHYTOBENTHOS

The table below summarises the summer and autumn findings of the phytobenthos obtained in the near downstream section from the three sampling units in each the mouth of the hot water canal, Nagysarkantyú and Uszód samples profiles used for the ecological status assessment according to the WFD.

Sampling unit	EQR	Ecological status (based on EQR)	EQR	Ecological status (based on EQR)
	28.08.2012		26.09.2012	
PLDFB21	0.390	poor	0.317	poor
PLDFB32	0.594	moderate	0.502	moderate
PLDFB31	0.399	poor	0.331	poor
PLDFB42	0.694	good	0.509	moderate
PLDFB41	0.397	poor	0.202	poor
average season	**0.495**	**moderate**	**0.372**	**poor**
Classification of the section	**0.434**		**moderate**	

Table 12.3.2-11: Phytobenthos based ecological classification of the near downstream-section according to the WFD

Based on the assessment carried out in 2012 average EQR values in the summer period were EQR=0.495, during the autumn season EQR=0.372, corresponding to moderate and poor ecological status, respectively. At least one grade difference was found between the right and left sampling units for all sampling efforts. EQR of the sampling units effected by the discharge of hot water has a tendency to show lower values. However, a similar picture is drawn up by the autumn sampling from the upstream section at the Paks/ferry profile. The low - moderate – grade falls in line with the results of the assessments made earlier on (c.f. Table 12.1.5-4). The overall status grade matches that of the upstream section.

When data from both periods are considered together, an average value of EQR=0.434 is given, corresponding to a moderate ecological status.

12.3.2.4 Macrophyte

Macrophyte sampling was made on the near downstream section in 2012 during two periods, in summer and autumn. This section was designated only six sampling units with respect to macrophytes as well, the furthest point of which can be found approximately 3.7 kilometres downstream from the discharge point. Thus a total of 6 sampling units in a length of 100 metres each were assessed in a total length of 600 metres. Sampling covered areas on both the right and the left bank. Sampling units included both natural and pebbled bottoms. Sampling units on the left bank are not affected by hot water. Sampling units are identical during the summer and autumn sampling seasons. A total of 51 macrophyte species were found in the six sampling units during the summer and autumn surveys.

Scientific name	English name	PLDMF1.1	PLDMF 1.2	PLDMF 2.1	PLDMF 2.2	PLDMF 3.1	PLDMF 3.2
Phragmites australis	Common reed	1	1	1			
Salix purpurea	Purple willow	1	1		1		
Myosoton aquaticum	Water chickweed	1			1		
Rumex crispus	Curly dock	1			1		
Amorpha fruticosa	Desert false indigo	1				1	
Gnaphalium uliginosum	Marsh cudweed	1					
Lavathera thuringiaca	Tree mallow	1					
Carex gracilis	Slender tufted sedge	2	1				
Echinochloa crus-galli	Common barnyardgrass	2	1				
Acer negundo	Ash leaved maple	3	1			1	
Persicaria maculosa	Lady's thumb	3	2	1	2		
Aster lanceolatus agg.	Panicled aster	3	3	4	2	2	
Plantago media	Hoary plantain	3	3	4	2		
Salix alba	While willow	4	3	4	3	5	5
Rubus cf. caesius	Dewberry	4	4		2	3	
Fraxinus angustifolia subsp. pannonica	Hungarian narrow leafed ash	5	2	4	2	1	
Rorippa amphibia	Great yellowcress	5	6	6	7	6	3
Urtica dioica	Common nettle		1		1	1	
Lythrum salicaria	Purple loosestrife		1			1	
Alisma plantago-aquatica	Common water plantain		1				
Chrysanthemum vulgare	Tansy		1				
Dactylis glomerata	Orchardgrass		1				
Rumex conglomeratus	Sharp dock		1				
Chenopodium ambrosioides	Wormseed		2		3	1	
Solidago gigantea	Giant goldenrod		2		3	2	
Salix fragilis	Crack willow		2			3	
Agrostis alba	Redtop		3	2		3	
Populus canescens	Grey poplar		4				
Populus tremula	Common aspen			1		1	3
Equisetum arvense	Field horsetail			1			
Persicaria dubia	Tasteless water pepper			2			
Peplis portula	Spatulaleaf loosestrife				1	2	
Amaranthus retroflexus	Red-root pigweed				1		
Bidens tripartita	Three-lobe beggarticks				1		
Chenopodium album	Common lamb's quarters				1		
Cyperus fuscus	Brown galingale				1		
Fraxinus pennsylvanica	Green ash or red ash				1		
Morus alba	White mulberry				1		
Rumex obtusifolia	Broadleaf dock				1		
Setaria viridis	Green foxtail				1		
Solanum nigrum	European black nightshade				1		
Epilobium hirsutum	Great willowherb				2		
Chenopodium rubrum	Red goosefoot				3	2	
Acer pseudoplatanus	Sycamore maple					1	
Datura stramonium	Jimson weed					1	
Eragrostis pilosa	Indian lovegrass					1	

Scientific name	English name	PLDMF1.1	PLDMF 1.2	PLDMF 2.1	PLDMF 2.2	PLDMF 3.1	PLDMF 3.2
Phalaris arundinacea	Reed canary grass					2	3
Poa trivialis	Rough bluegrass					2	
Ulmus laevis	European white elm					2	
Populus nigra	Black poplar					3	1
Quercus robur	English or pedunculate oak						1
Number of species		**17**	**23**	**11**	**25**	**23**	**6**

Table 12.3.2-12: Macrophyte species found in the near downstream section and their estimated DAFOR quantities

None of the species found in the sampling profile was protected. Several species can be considered to be introduced (red ash, panicled aster), the abundance of which refers to the disturbed nature of the area. The section assessed is part of the SCI area identified as HUDD20023 Tolnai Danube. The indicator species of the area is the creeping marshwort (*Apium repens* (Jacq.) Lagesca) [12-46]. The species was not found along the sampling section.

CLASSIFICATION OF THE NEAR DOWNSTREAM SECTION IN ACCORDANCE WITH THE WFD ON THE BASIS OF THE MACROPHYTES

Ecological water quality of the section on the basis of macrophytes was carried out in accordance with the set of criteria of the WFD, based on the macrophyte method established in Hungary (Lukács et al. [12-28]). Aggregate data from the total length of 600 metres of the four sampling units were used for classification purposes.

	Aggregate DAFOR cubic value	Number of species
A (positive indicator species)	30	6
B (neutral species)	75	14
C (disturbance indicator species	62	6
SUM	167	26
Reference Index	-19.16	
EQR Value	0.40	
Classification	**moderate**	

Table 12.3.2-13: Results of the ecological status assessment on the near downstream section from summer and autumn macrophyte sampling

During the classification procedure, 26 species with indicator capabilities were identified. The outcome of the classification procedure for the near downstream section is identical with that for the upstream section.

Based on the findings of the assessment it can be stated that the ecological status of the near downstream section of the Danube according to the macrophyte analysis was moderate.

12.3.2.5 Macrozoobenthos

Sampling on the near downstream section – which means the area directly affected by the cooling water discharge – macroscopic aquatic invertebrates sampling was made in two seasons – summer and autumn – in 2012 at six sampling sites both on the right and the left bank of the Danube.

When the sites for sampling units were identified, the requirements provided, sampling sites of former assessments and the environmental conditions, suitability of the sampling site for carrying out the sampling procedure – determined during a field visit – were all taken into consideration. Sampling units were divided up to several subunits. The key consideration for the identification of the subunits included keeping an eye on the objective of the assessment and the representative nature of the sampling. Correspondingly, sampling sub units were assigned in areas with a number of different habitat types.

During the summer and autumn sampling seasons a total of 44 different macroscopic invertebrate taxons could be detected from the samples taken at six sampling sites (Table 12.3.2-14).

Taxons	PLDMZB 11	PLDMZB 12	PLDMZB 21	PLDMZB 22	PLDMZB 31	PLDMZB 32
Water worms (Oligochaeta)	3	4	3	18	4	3
Snails (Gastropoda)						

Taxons	PLDMZB 11	PLDMZB 12	PLDMZB 21	PLDMZB 22	PLDMZB 31	PLDMZB 32
Bithynia tentaculata (LINNAEUS, 1758)	4		2		14	
Galba truncatula (O. F. MÜLLER, 1774)	3					
Fagotia acicularis (FERRUSAC, 1823)					7	
Fagotia esperi (FERRUSAC, 1823)			1		9	
Lithoglyphus naticoides (C. PFEIFFER 1828)	25	759	60	684	68	228
Physella acuta (DRAPARNAUD, 1805)	1					
Potamopyrgus antipodarum (J. E. GRAY, 1843)	11				2	
Theodoxus fluviatilis (LINNAEUS 1758)	14		26	1	30	13
Valvata piscinalis (O.F. MÜLLER, 1774)			1	22		1
Valvata pulchella STUDER, 1820	1				1	
Viviparus acerosus (BOURGUIGNAT, 1862)	10		1		2	
Viviparus sp.	1					
Mussels (Bivalvia)						
Corbicula fluminalis (O.F. MÜLLER, 1774)	1		37		7	
Corbicula fluminea (O.F. MÜLLER, 1774)	96	21	712	8	336	77
Dreissena polymorpha (PALLAS, 1771)	5		15	4	25	5
Pisidium amnicum (O.F. MÜLLER, 1774)		2				
Pisidium pseudosphaerium FAVRE, 1927	1					
Sinanodonta woodiana (LEA, 1834)	4		6			
Unio sp.			2			
Unio tumidus RETZIUS, 1788		9	2	1		6
Crustaceans (Crustacea)						
Corophium curvispinum (SARS, 1895)	13	43	27	53	21	34
Dikerogammarus sp.	9	6	7	14	4	5
Dikerogammarus villosus (SOWINSKY, 1758)	102	2	33	28	24	17
Limnomysis benedeni CZERNIAVSKY, 1882	2	88	37	17	19	58
Obesogammarus obesus VIEUILLE, 1979	6	12	3	10	3	12
Orconectes limosus RAFINESQUE, 1872					1	1
Mayflies (Ephemeroptera)						
Heptagenia flava ROSTOCK, 1877		1				
Caenis pseudorivulorum KEFFERMÜLLER, 1960			1			
Dragonflies (Odonata)						
Calopteryx splendens (HARRIS, 1758)						1
Gomphus flavipes (CHARPENTIER, 1825)		2		1		
True bugs (Heteroptera)						
Gerridae	18		7			
Gerris sp.	3		3			
Sigara striata (LINNAEUS, 1758)				1		
Caddis flies (Trichoptera)						
Hydropsyche bulgaromanorum MALICKY, 1977						1
Hydropsyche contubernalis MACLACHLAN, 1865				1		
Beetles (Coleoptera)						
Hydrochara caraboides (LINNAEUS, 1758)		1				
Flies (Diptera)						
Chironomidae		87				
Chironominae	182	316	2	428	75	19
Glyptotendipes sp.						1
Orthocladiinae	48					
Procladius sp.	13	7	4	22	28	14
Tanypodinae	30	1		48		
Tanypus sp.			6		1	

Table 12.3.2-14: List of macroscopic invertebrates identified on the near downstream section

A substantial part of the macroscopic invertebrate taxons identified were invasive, intensively and aggressively penetrating introduced elements which are able to adapt to the changing environmental conditions at a rapid rate, have quick reproduction capabilities and a part of them may threaten the native, indigenous fauna. The zebra mussel, (*Dreissena polymorpha*), Chinese pond mussel (*Sinanodonta woodiana*), Asian clam (*Corbicula fluminea*) and a very aggressive species of a type of crab called *Dikerogammarus villosus*, which carries often the lifestyle of a predator and was found in great numbers in the profile drawn up directly beside the cooling water discharge can be highlighted from them.

A few individuals of the protected dragonfly species named *Gomphus flavipes* as well as the protected snail species *Fagotia acicularis* were identified on the near downstream section also. The thick shelled river mussel (*Unio crassus*), the macrozoobenthos species indicating the HUDD20023 SCI area, was not found during the sampling procedure.

The snail species called *Viviparus acerosus* as well as the crustacean *Dikerogammarus villosus* occurred in greater numbers near the hot water outlet (PLDMZB 11) compared to the other sampling points. The high number of individuals of the latter indicates that the species is able to adapt to the increased water temperature well, since it was samples in lower numbers on the further profiles of the section. Based on the assessment is seems that the other invasive taxons of macroscopic invertebrates did not prefer the increase of the water temperature at the hot water discharge. This is shown for instance by the number of individuals of the snail species *Lithoglyphus naticoides* and the crustacean *Corophium curvispinum* were increased at a distance further down from the hot water discharge and higher densities were observed mainly on the left bank, where the impact of the hot water could not be felt and the impact of the microhabitats formed by the bed load prevailed.

CLASSIFICATION OF THE NEAR DOWNSTREAM SECTION IN ACCORDANCE WITH THE WFD ON THE BASIS OF THE MACROZOOBENTHOS

Ecological status assessment was accomplished on the basis of a so called multimetric index, the HMMI (Hungarian Multimetric Macroinvertebrate Index) required by the WFD (Várbíró et al. [12-42], [12-43]), which passed the intercalibration process of the European Union and its five grade EQR (Ecological Quality Ratio) classification scale (1-5) proved to be well suited for the evaluation of the ecological status in watercourses (Table 12.3.2-15).

Near downstream section	Summer		Autumn	
	HMMI EQR	Classification	HMMI EQR	Classification
PLDMZB 11	0.65	good	0.52	moderate
PLDMZB 12	0.56	moderate	0.51	moderate
PLDMZB 21	0.69	good	0.37	poor
PLDMZB 22	0.5	moderate	0.38	poor
PLDMZB 31	0.61	good	0.44	moderate
PLDMZB 32	0.57	moderate	0.27	poor
average:	HMMI EQR		Classification	
	0.50		moderate	

Table 12.3.2-15: Ecological status assessment of the near downstream section based on summer and autumn macrozoobenthos samples

The seasonal difference can be observed in the multimetric ecological status assessment of the profiles, in other words the values in autumn samples are usually lower, which however did not cause any quality grade leap in this case. Summer values of the assessment indicate that the right bank sampling units affected by the discharge enjoy a good ecological status. It seems that mainly the channel bottom and the available microhabitats were responsible for the formation of the macroscopic invertebrate communities, but the impact of the hot water can also be assumed. The multimetric indicator developed (HMMI) is basically sensitive the an overall degradation of habitats, just like those used in the European Union, therefore, the detection of the quality based indexes available detection of the single impact from heat pollution is considerable doubtful. This is why a finer resolution ecological status assessment of the sections was also carried out (see Chapter 12.3.4.5). However, the evaluation grade matches that calculated for the upstream section.

Based on the findings of the assessment it can be stated that the ecological status of the near downstream section affected by hot water discharge according to the aquatic macroscopic invertebrate analysis was moderate (HMMI EQR: 0.50).

12.3.2.6 Fishes

Fish sampling was made in 2012 during two periods, in summer and autumn. This section was designated only six sampling units with respect to biological elements, including fishes, the furthest point of which can be found approximately 3.7 kilometres downstream from the discharge point. Thus on the section affected directly by the cooling water discharge (Halasi-Kovács [12-17], Kék Csermely [12-21]) a total of 6 sampling units in a length of 100 metres each were assessed in a total length of 600 metres. Sampling covered areas on both the right and the left bank. Sampling units included both natural and pebbled bottoms. Sampling units on the left bank are not affected by hot water. Sampling units are identical during the summer and autumn sampling seasons. (see Table 12.1.5-10).

A total of 3 679 individuals representing 51 species were found in the six sampling units during the summer and autumn surveys.

Scientific name	English name	PLHD11	PLHD12	PLHD21	PLHD22	PLHD31	PLHD32
Eudontomyzon mariae (Berg, 1931)	Ukrainian brook lamprey	0	1	0	1	1	1
Rutilus rutilus (Linnaeus, 1758)	Common roach	1	1	1	1	1	1
Leuciscus leuciscus (Linnaeus, 1758)	Common dace	0	0	0	0	1	0
Squalius cephalus (Linnaeus, 1758)	European chub	1	1	1	1	1	1
Leuciscus idus (Linnaeus, 1758)	Ide	1	1	1	1	1	1
Aspius aspius (Linnaeus, 1758)	Asp	1	1	1	1	1	1
Alburnus alburnus (Linnaeus, 1758)	Small river bleak	1	1	1	1	1	1
Blicca bjoerkna (Linnaeus, 1758)	Silver bream	1	1	1	1	1	1
Abramis brama (Linnaeus, 1758)	Bream	1	1	1	0	1	0
Ballerus sapa (Pallas, 1814)	Common dace	0	0	0	1	1	0
Pelecus cultratus (Linnaeus, 1758)	Sabre carp	1	0	0	0	0	0
Chondrostoma nasus (Linnaeus, 1758)	Nose-carp	1	0	1	0	1	0
Barbus barbus(Linnaeus, 1758)	Barbel	1	0	1	0	1	1
Romanogobio vladykovi (Fang, 1943)	Danube whitefin gudgeon	1	1	1	1	1	0
Rhodeus amarus (Bloch, 1782)	European bitterling	1	0	0	0	0	0
Carassius gibelio (Bloch, 1782)	Prussian carp	1	1	1	0	0	0
Cyprinus carpio (Linnaeus, 1758)	Carp	0	0	1	0	0	0
Sabanejewia balcanica (Karaman, 1922)	Golden loach	0	1	1	1	1	0
Silurus glanis Linnaeus, 1758	European wels	1	1	1	1	1	1
Esox lucius Linnaeus, 1758	Pike	0	0	1	1	1	1
Lota lota (Linnaeus, 1758)	Burbol	1	1	1	1	1	1
Lepomis gibbosus (Linnaeus, 1758)	Pumpkinseed sunfish	0	1	0	0	0	0
Perca fluviatilis Linnaeus, 1758	Perch	1	1	1	0	1	1
Gymnocephalus baloni Holčík & Hensel, 1974	Balon's ruffe	1	1	1	1	1	1
Gymnocephalus schraetser (Linnaeus, 1758)	Striped ruffe	1	1	1	1	1	0
Sander lucioperca (Linnaeus, 1758)	Zander	1	1	1	1	1	1
Sander volgensis (Gmelin, 1789)	Volga pikeperch	1	1	0	0	0	0
Zingel zingel (Linné, 1766)	Zingel	0	0	0	1	0	1
Proterorhinus semilunaris (Heckel, 1837)	Western tubenose goby	0	1	0	1	1	0
Neogobius fluviatilis (Pallas, 1814)	Monkey goby	1	1	1	0	1	0
Ponticola kessleri (Günther, 1861)	Bighead goby	1	1	1	1	1	1
Neogobius melanostomus (Pallas, 1814)	Round goby	1	1	1	1	1	1
Babka gymnotrachelus (Kessler, 1857)	Racer goby	1	1	1	1	1	1
Number of species		**24**	**24**	**24**	**21**	**26**	**18**

Table 12.3.2-16: Fish species found in the near downstream subsection

Five (*Romanogobio vladykovi, Rhodeus amarus, Sabanejewia balcanica, Gymnocephalus baloni, Gymnocephalus schraetser*) of the species identified during sampling were protected and two of them (*Eudontomyzon mariae, Zingel zingel*) strictly protected.

Indicator species of the SCI area marked HUDD 20023 identified in this section were as follows: *Eudontomyzon mariae, Aspius aspius, Gymnocephalus baloni, Gymnocephalus schraetser, Zingel zingel*.

Findings of earlier studies demonstrated unanimously that the diversity of the natural habitat as an environmental factor was a stronger influencing factor that hot water (SCIAP [12-37]). On the basis of the analysis of the species structure in the current sampling units it can be assumed that *Eudontomyzon mariae, Lota lota, Babka gymntrachelus* show a slight avoidance of hot water, while *Aspius aspius, Alburnus alburnus, Blicca bjoerkna, Chondrostoma nasus, Babrus barbus, Carassius gibelio, Perca fluviatilis, Neogobius melanostomus* prefer it. This result is in harmony with the findings of the 2010 studies.

Young individuals of 27 species were found in the samples. This means that 82 % of the species is present in the section in the form of progeny. This ratio is high, just like upstream.

Age group distribution of the individuals identified in the sampling units is presented on the following tables.

Summer	Adult (piece)	Offspring(piece)	Total (piece)
PLHD11	474	79	553
PLHD12	239	56	295
PLHD21	546	31	577
PLHD22	223	23	246
PLHD31	191	77	268
PLHD32	297	39	336

Table 12.3.2-17: Basic data from the catch efforts at the sampling units near downstream based on the summer sampling season

Autumn	Adult (piece)	Offspring(piece)	Total (piece)
PLHD11	244	47	291
PLHD12	96	38	134
PLHD21	204	54	258
PLHD22	131	21	152
PLHD31	193	97	290
PLHD32	143	136	279

Table 12.3.2-18: Basic data from the catch efforts at the sampling units near downstream based on the autumn sampling season

Total (adult plus offspring) catch per unit effort (CPUE) on the 100 metre units reflected a level of 93.2, the highest among the sections assessed in the sampling units on the right bank during the summer sampling season. At the same time CPUE values of the sampling units on the left bank, which is not exposed to hot water showed a high level of similarities with the values obtained from sampling units upstream. It can be seen from the table that CPUE values of sampling units from near downstream exposed to hot water show consistently higher levels compared to the levels in sampling units upstream and in non-affected downstream sections (Table 12.3.2-19).

Sample profiles	CPUE (100 m)
Upstream average based on the values in **Table 12.3.1-18**	59.0
„Hot water” 2002-2003 (Halasi-Kovács 2005)	88.9
„Hot water” 2009 (SCIAP Kft. 2010)	83.1
PLHD11+21+31 "units concerned"	93.2
PLHD12+22+32 " units not concerned "	58.5

Table 12.3.2-19: Comparison of the CPUE values with the former near downstream, as well as upstream findings

Based on the results from the near downstream sampling in 2012 it can be stated that the fish species setup of this Danube-section shows similarities to a large extent with both former assessment made with the same objective (Halasi-Kovács [12-14], SCIAP Kft. [12-37]), and with the findings upstream. New species compared to the upstream section included *Leuciscus leuciscus, Abramis sapa, Pelecus cultratus, Sabanejewia balcanica, Lepomis gibbosus, Sander volgensis*, but *Anguilla anguilla* was not found. However, these species were detected in the sections concerned in low numbers anyway.

Higher specimen numbers could be observed during the summer season, while the number of young individuals showed a slight increase in the samples taken in autumn. Yet, findings from the two sampling seasons demonstrated a high level of similarity. At any rate, it can be stated that even the sampling in autumn reflects rather the image of a summer status.

Findings of earlier studies demonstrated clearly that the diversity of the natural habitat as an environmental factor was a stronger influencing factor that hot water (SCIAP Kft. [12-37]). Findings of the current sampling efforts confirmed this fact. It can be seen from the results of the samples that *Eudontomyzon mariae, Lota lota, Babka gymntrachelus* show a slight avoidance of hot water, while *Aspius aspius, Alburnus alburnus, Blicca bjoerkna, Chondrostoma nasus, Babrus barbus, Carassius gibelio, Perca fluviatilis, Neogobius melanostomus* prefer it.

CLASSIFICATION OF THE NEAR DOWNSTREAM SECTION IN ACCORDANCE WITH THE WFD ON THE BASIS OF THE FISH COMMUNITY

Ecological water quality of the section on the basis of fish communities was carried out in accordance with the set of criteria of the WFD, based on the EQIHRF method established in Hungary (Halasi-Kovács et al. [12-17]). For the purposes of evaluation a sampling unit at least 2000 metres is needed. Correspondingly, right bank subunits were taken into account with higher weight in the course of the evaluation of the section (PLHD11, 21, 31), while only the data obtained from the uppermost left bank subunits (PLHD12) were considered both in the case of the summer and autumn samples. although summer sampling should be considered relevant on the basis of the EQIHRF protocol, classification was also made according to the autumn samples. The latter was for information purposes only

Near downstream section summer	Number of scores	Value
1. Relative abundance of the omnivorous species (%)	59.31	5
2. Relative abundance of the open water species	3	3
3. Relative abundance of the metaphyte species (%)	2.89	3
4. Number of benthic species (piece)	20.00	5
5. Number of litophile species (piece)	6	4
6. Relative abundance of the phytophile species (%)	1.99	4
7. Number of rheophilic species(piece)	12	4
8. Relative abundance of the stagnophile species (%)	0.14	2
9. Relative abundance of the specialist species (%)	40.00	5
10. Relative abundance of the indigenous species (%)	64.67	2
Total number of scores		**37**
Classification		**good**

Table 12.3.2-20: Results of the ecological status assessment along the near downstream section based on the summer sampling session

Near downstream section Autumn	Number of scores	Value
1. Relative abundance of the omnivorous species (%)	50.27	5
2. Relative abundance of the open water species	4	4
3. Relative abundance of the metaphyte species (%)	10.86	4
4. Number of benthic species (piece)	17	4
5. Number of litophile species (piece)	6	4
6. Relative abundance of the phytophile species (%)	2.82	4
7. Number of rheophilic species(piece)	11	4
8. Relative abundance of the stagnophile species (%)	2.01	5
9. Relative abundance of the specialist species (%)	49.73	5
10. Relative abundance of the indigenous species (%)	56.43	2
Total number of scores		**41**
Classification		**good**

Table 12.3.2-21: Results of the ecological status assessment along the near downstream section based on the autumn sampling session

The outcome of the near downstream classification concurs with the experiences gained upstream.

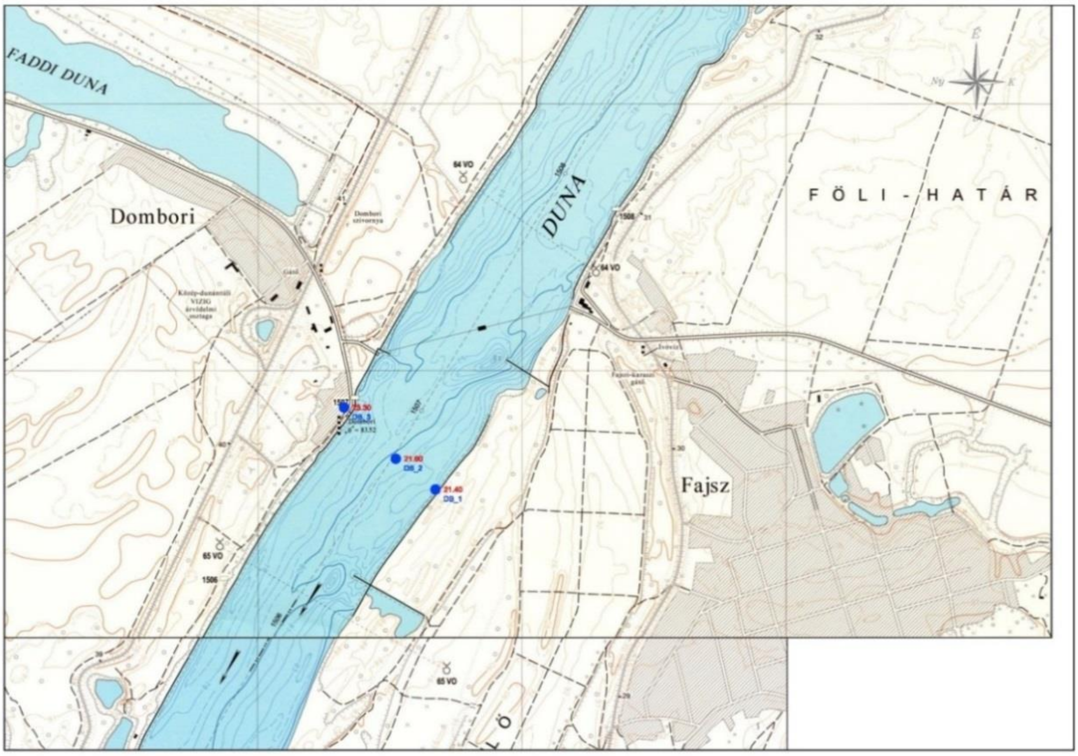
On the basis of the assessment the ecological status of the near downstream Danube-section on the basis of the fish community was good.

12.3.3 DISTANT DOWNSTREAM PROFILES OF THE DANUBE SECTION ASSESSED

12.3.3.1 Physico-chemical properties

Tests intended to determine the physico-chemical parameters were conducted once a month (in the case a total of Baja only twice) in the Danube profiles situated far away from the mouth of the hot water canal (1526 river km) in the second half of the year of 2013. The profiles to be assessed were placed into the group of distant downstream profiles. Fadd-

Dombori 1506.8 river km (Figure 12.3.3-1), Sió-South (Gemenc) 1496.0 river km (Figure 12.3.3-2), Baja (road bridge) 1481.5 river km (Figure 12.3.3-3).

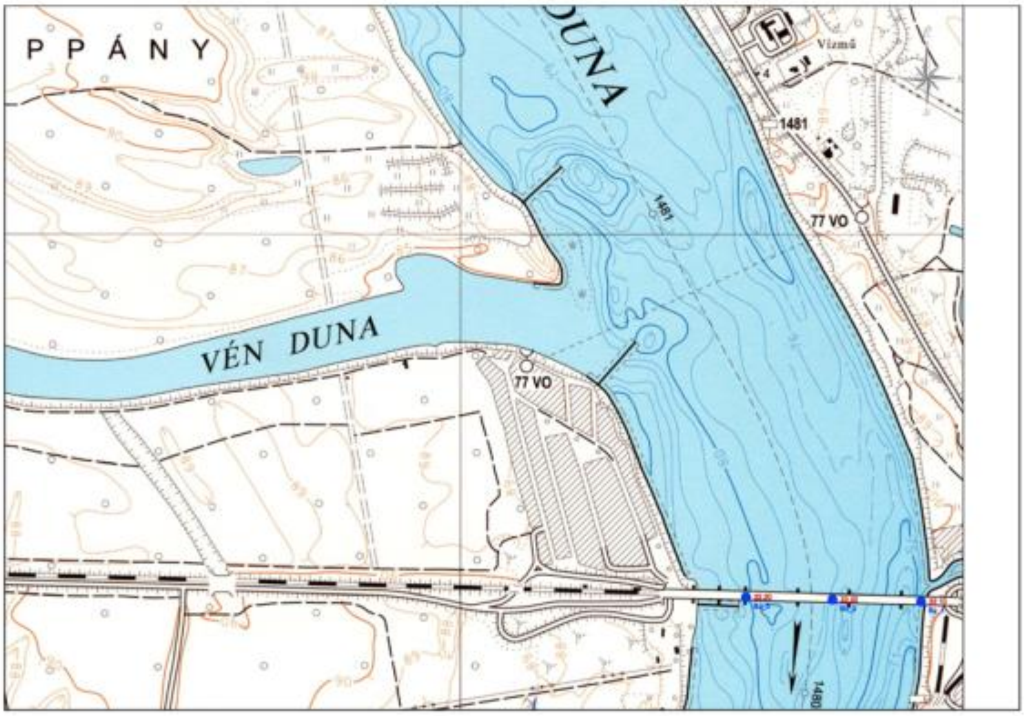


FÖLI-HATÁR – boundaries of the FÖLI region

Figure 12.3.3-1: General site map of study profile No 6 at Dombori 1506.8 river km

FELSŐ GEMENC – UPPER GEMENC

Figure 12.3.3-2: Sió South (1496 river km-Gemenc) – general site map of study profile No 7



VÉN DUNA – OLD DANUBE RIVER BRANCH

Figure 12.3.3-3: Baja 1481.5 river km (public road bridge) – general site map of study profile 8

The water quality table prepared on the basis of the 2013 assessments and also including the classification grade according to the Hungarian standard (MSZ) is attached as Table 12.3.3-1. Classification results in accordance with the WFD were summarised in Table 12.3.3-2. It should be noted that water quality testing of the Danube water is carried out in the Fadd-Dombori profile as part of the measurement under the National Core Network on the right and left bank, and in the main streamline. It is set forth in details in Chapter 12.2.1.

CLASSIFICATION OF THE DISTANT DOWNSTREAM DANUBE- SECTION BASED ON 2013 TESTS ACCORDING TO THE WFD

Elements	Unit of measurement	**Dombori_B _1506.8**	**Dombori_K _1506.8**	**Dombori_J _1506.8**	**Sió-D_B _1496**	**Sió-D_K _1496**	**Sió-D_J _1496**	**Baja_B _1481.5**	**Baja_K _1481.5**	**Baja_J _1481.5**	Dombori_1506.8 profile classification	Sió (south)_1496 profile classification	Baja_1481.5 profile classification	Average values of the Danube section specified by the profiles tested	
		average	average	average	average	average	average	average	average	average				MIN	MAX
pH		**8.17**	**8.18**	**8.14**	**8.18**	**8.16**	**8.11**	**8.20**	**8.15**	**8.11**	5	5	5	**8.06**	**8.21**
Acidification status											**5.0**	**5.0**	**5.0**		
Conductivity	µS/cm	**404**	**402**	**404**	**403**	**402**	**412**	**415**	**419**	**427**	5	5	5	**374**	**427**
Salinity											**5.0**	**5.0**	**5.0**		
Dissolved oxygen	mg/l	**11.0**	**11.1**	**10.2**	**11.2**	**11.0**	**10.5**	**9.4**	**9.3**	**8.9**	5	5	5	**8.9**	**12.1**
Oxygen saturation	%	**113.2**	**114.0**	**108.2**	**115.2**	**113.8**	**110.6**	**99.5**	**98.5**	**94.5**	4	4	5	**94.5**	**115.2**
BOD_5	mg/l	**3.4**	**3.3**	**2.9**	**4.0**	**3.7**	**3.6**	**2.8**	**3.0**	**3.2**	3	3	4	**2.8**	**4.0**
CODk	mg/l	**13.7**	**11.8**	**15.1**	**12.3**	**11.9**	**16.8**	**5.5**	**9.3**	**7.9**	3	3	5	**5.5**	**21.4**
Oxygenation conditions											**3.8**	**3.8**	**4.8**		
Ammonium-N (NH_4^+-N)	mg/l	**0.062**	**0.050**	**0.064**	**0.062**	**0.064**	**0.074**	**0.055**	**0.040**	**0.060**	5	5	5	**0.030**	**0.075**
Nitrite-N (NO_2^--N)	mg/l	**0.011**	**0.009**	**0.012**	**0.012**	**0.008**	**0.012**	**0.009**	**0.008**	**0.010**	4	4	5	**0.008**	**0.031**
Nitrate-N (NO_3^--N)	mg/l	**1.5**	**1.4**	**1.4**	**1.3**	**1.4**	**1.3**	**1.2**	**1.4**	**1.2**	4	4	4	**0.6**	**1.7**
Total nitrogen	mg/l	**2.6**	**2.8**	**2.6**	**2.6**	**2.4**	**2.9**	**2.4**	**4.7**	**2.6**	4	4	3	**2.3**	**4.7**
Orto-phosphate (PO_4-P)	µg/l	**41.0**	**45.6**	**40.2**	**41.0**	**41.6**	**44.8**	**38.5**	**42.0**	**42.5**	5	5	5	**38.5**	**55.4**
Total phosphorus	µg/l	**100**	**84**	**94**	**84**	**78**	**122**	**90**	**95**	**90**	5	4	5	**54**	**125**
Nutrient conditions											**4.5**	**4.3**	**4.5**		
Cd	µg/l	**0.017**	**0.006**	**0.008**	**0.008**	**0.006**	**0.009**	**0.015**	**0.008**	**0.008**	5	5	5	**0.005**	**0.020**
Hg	µg/l	**0.018**	**0.020**	**0.018**	**0.018**	**0.018**	**0.018**	**0.038**	**0.038**	**0.038**	5	5	5	**0.018**	**0.120**
Ni	µg/l	**1.68**	**2.10**	**1.67**	**1.61**	**1.64**	**1.65**	**2.25**	**2.69**	**2.93**	5	5	5	**1.61**	**2.93**
Pb	µg/l	**0.11**	**0.06**	**0.07**	**0.06**	**0.07**	**0.07**	**0.01**	**0.01**	**0.01**	5	5	5	**0.01**	**0.11**
Metals											**5.0**	**5.0**	**5.0**		
Zn	µg/l	**5.91**	**6.75**	**7.00**	**6.13**	**6.70**	**6.79**	**6.08**	**7.86**	**7.25**	5	5	5		
Cu	µg/l	**1.69**	**1.72**	**1.59**	**1.75**	**1.87**	**1.99**	**2.12**	**2.73**	**1.96**	5	5			
Cr	µg/l	**0.41**	**1.30**	**0.42**	**0.40**	**0.39**	**0.41**	**0.91**	**1.24**	**2.24**	5	5	5		
As	µg/l	**1.49**	**1.45**	**1.45**	**1.47**	**1.47**	**1.50**	**1.44**	**1.38**	**1.44**	5	5	5		
Specific pollutants (hazardous chemical elements)											**5.0**	**5.0**	**5.0**		
Danube (HURWAEP444 WATER BODY) section's physico-chemical parameters, ecological status assessment according to the WFD											**good status**	**good status**	**good status**	**good status**	

Table 12.3.3-1: Classification tabel of the water quality tests according to the WFD carried out on the distant downstream Danube Section (1506.8-1481.5 river km)

DOMBORI 1506.8 RIVER KM PROFILE CLASSIFICATION ACCORDING TO THE WFD

- The **acidification status** can be deemed to be of **high status** on the basis of the 5.0 semi-annual average.
- The **salinity** status can be deemed to be of high status on the basis of the 5.0 semi-annual average.
- The average of **oxygenation conditions status** per class is 3.8. It is deemed to be of **good status** based on the WFD requirements.
- The average of **nutrients** status per class is 4.5. Based on the methodology specified by the WFD it is deemed to be in good ecological status.
- The semi annual average of **metals** status per class is 5.0. Based on the methodology specified by the WFD it is deemed to be in high ecological status.

The Danube section at Dombor (1506.8 river km) can be deemed to be of good status from the ecological perspective and good, appropriate status from the specific pollutants (hazardous chemical elements) perspective on the basis of the semi-annual water quality testing procedures carried out in the year of 2012.

SIÓ SOUTH 1496 RIVER KM PROFILE CLASSIFICATION ACCORDING TO THE WFD

- The **acidification status** can be deemed to be of **high status** on the basis of the 5.0 semi-annual average.
- The salinity status can be deemed to be of high status on the basis of the 5.0 semi-annual average.
- The average of **oxygenation conditions status** per class is 3.8. It is deemed to be of **good status** based on the WFD requirements.
- The average of **nutrients** status per class is 4.3. Based on the methodology specified by the WFD it is deemed to be in good ecological status.
- The semi annual average of **metals** status per class is 5.0. Based on the methodology specified by the WFD it is deemed to be in high ecological status.

The Danube section at Sió South (1496 river km) can be deemed to be of good status from the ecological perspective and good, appropriate status from the specific pollutants (hazardous chemical elements) perspective on the basis of the semi-annual water quality testing procedures carried out in the year of 2013.

BAJA 1481.5 RIVER KM PROFILE CLASSIFICATION ACCORDING TO THE WFD

- The **acidification status** can be deemed to be of **high status** on the basis of the 5.0 semi-annual average.
- The salinity status can be deemed to be of high status on the basis of the 5.0 semi-annual average.
- The average of **oxygenation conditions** status per class is 4.8. It is deemed to be of **high status** based on the WFD requirements.
- The average of **nutrients** status per class is 4.5. Based on the methodology specified by the WFD it is deemed to be in good ecological status.
- The semi annual average of **metals** status per class is 5.0. Based on the methodology specified by the WFD it is deemed to be in high ecological status.

The Danube section at Baja (1481.5 river km) can be deemed to be of good status from the ecological perspective and good, appropriate status from the specific pollutants (hazardous chemical elements) perspective on the basis of the two water quality testing procedures carried out in the year of 2013.

CLASSIFICATION OF THE DISTANT DOWNSTREAM DANUBE (1506,8-1481.5 RIVER KM) PROFILE

Dombori profile 1506.0 river km	**Class II**	**GOOD status**
Sió South (Gemenc) 1495 river km	**Class II**	**GOOD status**
Baja profile 1481.5 river km	**Class II**	**GOOD status**

Table 12.3.3-2: Distant downstream Danube Section (1506.8-1481.5 river km)

Based on the outcome of the classification pursuant to WFD the Danube (HURWAEP444 WATER BODY) 1506.8-1481.5 river km section belongs to good status in terms of physico-chemical parameters.

12.3.3.2 Phytoplankton

The distant downstream section was divided up into two subsections – midstream distant and distant, respectively, – for biological elements. Presentation of the results is also arranged accordingly below.

Findings on the midstream-distant downstream subsection

The midstream-distant downstream section consists of the sampling units taken in the Gerjen-Foktő (PLDFP52, PLDFP53, PLDFP51), as well as in the Dombori profiles (P50DFP22, P50DFP23, P50DFP21). The Gerjen-Foktő profile was sampled five times in 2012 (22.03; 27.06; 28.08; 26.09; 14.11), the Dombori profile twice in 2013 (28.08; 10.10).

TAXONS	**PLDFP52**	**PLDFP53**	**PLDFP51**
	Gerjen-Foktő		
	left	**midstream**	**right**
	23.12.2012	**23.12.2012**	**23.12.2012**
SUM pico	41	35	41
SUM nano	5	2	4
SUM Flagellates	256	217	92
SUM Chroococcales	6	0	1
SUM Oscillatoriales	1	3	21
SUM Nostocales	0	0	0
SUM Euglenophyta	6	0	0
SUM Cryptophyta	65	288	167
SUM Dinophyta	0	66	626
SUM Chrysophyceae	209	244	306
SUM Xanthophyceae	0	0	0
SUM Centrales	10790	13428	9208
SUM Pennales	294	345	152
SUM Volvocales	296	143	90
SUM Chlorococcales	31	20	40
SUM Ulothricales	3	1	1
SUM Desmidiales	0	0	0
SUM Zygnematales	0	0	0
SUM biomass (µg/l)	**12003**	**14792**	**10747**
a-chlorophyll concentration (µg/l)	**21.7**	**20.2**	**20.8**
a-chlorophyll contents of biomass (%)	**0.181**	**0.137**	**0.194**
degree of trophity	**5 (m-eu)**	**5 (m-eu)**	**5 (m-eu)**

Table 12.3.3-3: Phytoplankton biomass (µg/l) and a-chlorophyll concentration (µg/l) on the Danube midstream distant downstream section during the March sampling season

TAXONS	PLDFP52	PLDFP53	PLDFP51
	Gerjen-Foktő		
	left	midstream	right
	27.06.2012	27.06.2012	27.06.2012
SUM pico	19	32	25
SUM nano	14	9	21
SUM Flagellates	41	50	8
SUM Chroococcales	0	0	0
SUM Oscillatoriales	0	31	20
SUM Nostocales	50	0	0
SUM Euglenophyta	6	0	35
SUM Cryptophyta	101	80	115
SUM Dinophyta	0	0	0
SUM Chrysophyceae	8	0	15
SUM Xanthophyceae	0	0	0
SUM Centrales	2055	1996	1223
SUM Pennales	18	195	9
SUM Volvocales	34	18	10
SUM Chlorococcales	319	189	181
SUM Ulothricales	0	0	0
SUM Desmidiales	10	0	0
SUM Zygnematales	0	0	0
SUM biomass (µg/l)	**2675**	**2599**	**1662**
a-chlorophyll concentration (µg/l)	**9.6**	**9.6**	**9.6**
a-chlorophyll contents of biomass (%)	**0.359**	**0.369**	**0.578**
degree of trophity	**3 (o-m)**	**3 (o-m)**	**3 (o-m)**

Table 12.3.3-4: Phytoplankton biomass (µg/l) and a-chlorophyll concentration (µg/l) on the Danube midstream distant downstream section during the June sampling season

TAXONS	PLDFP52	PLDFP53	PLDFP51	P50DFP22	P50DFP23	P50DFP21
	Gerjen-Foktő			Dombori		
	left	midstream	right	left	midstream	right
	28.08.2012	28.08.2012	28.08.2012	28.08.2013	28.08.2013	28.08.2013
SUM pico	20	29	30	37	19	32
SUM nano	1	5	2	17	7	4
SUM Flagellates	9	45	67	21	442	24
SUM Chroococcales	0	0	0	12	0	0
SUM Oscillatoriales	1	0	3	0	2	0
SUM Nostocales	0	0	2	0	0	0
SUM Euglenophyta	4	0	0	0	0	0
SUM Cryptophyta	145	89	156	160	121	49
SUM Dinophyta	0	23	5	0	0	0
SUM Chrysophyceae	0	8	0	0	0	0
SUM Xanthophyceae	1	37	0	0	0	0
SUM Centrales	8550	10818	3685	3752	4355	2492
SUM Pennales	80	9	6	11	7	103
SUM Volvocales	151	74	69	21	42	0
SUM Chlorococcales	121	263	122	293	119	189
SUM Ulothricales	0	0	0	0	1	1
SUM Desmidiales	0	0	0	0	0	0
SUM biomass (µg/l)	**9082**	**11400**	**4147**	**4325**	**5116**	**2894**
a-chlorophyll concentration (µg/l)	**58.6**	**64.0**	**58.0**	**13.2**	**14.1**	**8.1**
a-chlorophyll contents of biomass (%)	**0.645**	**0.561**	**1.399**	**0.305**	**0.276**	**0.280**
degree of trophity	**6 (eu)**	**6 (eu)**	**6 (eu)**	**4 (m)**	**4 (m)**	**3 (o-m)**

Table 12.3.3-5: Phytoplankton biomass (µg/l) and a-chlorophyll concentration (µg/l) on the Danube midstream distant downstream section during the August sampling season

TAXONS	PLDFP52	PLDFP53	PLDFP51	P50DFP22	P50DFP23	P50DFP21
	Gerjen-Foktő			Dombori		
	left	midstream	right	left	midstream	right
	26.09.2012	26.09.2012	26.09.2012	10.10.2013	10.10.2013	10.10.2013
SUM pico	10	3	16	10	6	6
SUM nano	0	0	1	2	0	0
SUM Flagellates	0	3	6	6	4	3
SUM Chroococcales	0	0	0	0	0	0
SUM Oscillatoriales	1	0	1	0	1	0
SUM Nostocales	0	0	0	0	0	0
SUM Euglenophyta	0	0	0	0	0	0
SUM Cryptophyta	9	4	5	69	30	18
SUM Dinophyta	0	0	0	0	0	0
SUM Chrysophyceae	0	0	60	3	3	0
SUM Xanthophyceae	0	0	0	0	0	0
SUM Centrales	316	187	90	114	181	68
SUM Pennales	0	0	14	0	28	11
SUM Volvocales	0	7	0	0	0	0
SUM Chlorococcales	6	21	14	0	13	2
SUM Ulothricales	1	0	0	1	0	0
SUM Desmidiales	0	0	0	0	0	0
SUM biomass (µg/l)	**343**	**226**	**206**	**204**	**265**	**109**
a-chlorophyll concentration (µg/l)	**0.1**	**1.8**	**0.1**	**0.7**	**<0.1**	**<0.1**
a-chlorophyll contents of biomass (%)	**0.029**	**0.798**	**0.049**	**0.343**	**-**	**-**
degree of trophity	**1 (u-o)**	**2 (o)**	**1 (u-o)**	**4 (m)**	**4 (m)**	**3 (o-m)**

Table 12.3.3-6.: Phytoplankton biomass (µg/l) and a-chlorophyll concentration (µg/l) on the Danube midstream distant downstream section during the Autumn (September 2012, October 2013) sampling season

TAXONS	PLDFP52	PLDFP53	PLDFP51
	Gerjen-Foktő		
	left	midstream	right
	14.11.2012	14.11.2012	14.11.2012
SUM pico	10	6	13
SUM nano	4	2	2
SUM Flagellates	4	2	3
SUM Chroococcales	0	0	0
SUM Oscillatoriales	1	1	26
SUM Nostocales	0	0	0
SUM Euglenophyta	0	0	0
SUM Cryptophyta	33	0	10
SUM Dinophyta	0	0	0
SUM Chrysophyceae	0	0	0
SUM Xanthophyceae	0	0	1
SUM Centrales	44	67	62
SUM Pennales	17	22	43
SUM Volvocales	0	0	0
SUM Chlorococcales	3	6	11
SUM Ulothricales	0	0	0
SUM Desmidiales	0	0	0
SUM biomass (µg/l)	**115**	**107**	**171**
a-chlorophyll concentration (µg/l)	**1.8**	**1.2**	**1.8**
a-chlorophyll contents of biomass (%)	**1.560**	**1.126**	**1.055**
degree of trophity	**2 (o)**	**2 (o)**	**2 (o)**

Table 12.3.3-7: Phytoplankton biomass (µg/l) and a-chlorophyll concentration (µg/l) on the Danube midstream distant downstream section during the November sampling season

At the **Danube Gerjen-Foktő profile** *on 22 March 2012* phytoplankton biomass in the sequence of left bank, midstream, right bank was 13.9 mg/l, 12.0 mg/l and 14.8 mg/l, a-chlorophyll concentration 21.5 µg/l, 21.7 µg/l and 20.2 µg/l, corresponding to the 5 (meso-eutrophic) grade on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) on all three sampling points [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (88.9%, 89.9% and 90.8%). Proportions of the diatom species in the Pennales order in the sequence of left bank, midstream, right bank were 2.3%, 2.4% and 2.3%, of the flagellate golden-brown algae (Chrysophyceae) 1.5%, 1.7% and 1.6%, of the grooved cryptomonads (Cryptophyta) 1.6%, 0.5% and 1.9%, and flagellates listed in the various taxonomic categories (Flagellates) 2.3%, 2.1% and 1.5%, green algae listed in the

Volvocales-order 1.0%, 2.5% and 1.0%, green algae listed in the Chlorococcales-order 0.2%, 0.3% and 0.1%, respectively.

On 27 June 2012 phytoplankton biomass in the sequence of left bank, midstream, right bank was 2.7 mg/l, 2.6 mg/l and 1.7 mg/l, a-chlorophyll concentration 9.6 µg/l, 9.6 µg/l and 9.6 µg/l, corresponding to the 3(oligo-mesotrophic) grade on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) on all three sampling points [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (76.8%, 76.8% and 73.6%). Proportions of the diatom species in the Pennales order in the sequence of left bank, midstream, right bank were 0.7%, 7.5% and 0.5%, of the flagellate golden-brown algae (Chrysophyceae) 0.3%, 0.0% and 0.9%, of the grooved cryptomonads (Cryptophyta) 3.8%, 3.1% and 6.9%, and flagellates listed in the various taxonomic categories (Flagellates) 1.5%, 1.9% and 0.5%, green algae listed in the Volvocales-order 1.3%, 0.7% and 0.6%, green algae listed in the Chlorococcales-order 11.9%, 7.3% and 10.9%, respectively. The share of pico-algae in the sequence of left bank, midstream, right bank was 0.7%, 1.2% and 1.5%, respectively.

On August 28 of 2012 phytoplankton biomass in the sequence of left bank, midstream, right bank was 9.1 mg/l, 11.4 mg/l and 4.1 mg/l, a-chlorophyll concentration 58.6 µg/l, 64.0 µg/l and 58.0 µg/l, corresponding to the 6 (eutrophic) grade on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) on all three sampling points [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (94.1%, 94.9% and 88.9%). Proportions of the diatom species in the Pennales order in the sequence of left bank, midstream, right bank were 0.9%, 0.1% and 0.1%, of the flagellate golden-brown algae (Chrysophyceae) 0.0%, 0.1% and 0.0%, of the grooved cryptomonads (Cryptophyta) 1.6%, 0.8% and 3.8%, and flagellates listed in the various taxonomic categories (Flagellates) 0.1%, 0.4% and 1.6%, green algae listed in the Volvocales-order 1.7%, 0.7% and 1.7%, green algae listed in the Chlorococcales-order 1.3%, 2.3% and 2.9%, respectively. The share of pico-algae in the sequence of left bank, midstream, right bank was 0.2%, 0.3% and 0.7%, respectively.

At the Danube Gerjen-Foktő profile *on 26 September 2012* phytoplankton biomass in the sequence of left bank, midstream, right bank was 0.2 mg/l, 0.3 mg/l and 0.2 mg/l, a-chlorophyll concentration 2.4 µg/l, 0.6 µg/l and 0.1 µg/l, corresponding to the 2 (oligotrophic) at the sampling point midstream, and 1 (ultra-oligotrophic) grade on the riparian sampling points, respectively, on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (92.1%, 82.9% and 43.6%). Proportions of the diatom species in the Pennales order in the sequence of left bank, midstream, right bank were 0.0%, 0.0% and 6.7%, of the flagellate golden-brown algae (Chrysophyceae) 0.0%, 0.0% and 29.0%, of the grooved cryptomonads (Cryptophyta) 2.6%, 1.6% and 2.5%, and flagellates listed in the various taxonomic categories (Flagellates) 0.0%, 1.2% and 2.7%, green algae listed in the Volvocales-order 0.0%, 3.2% and 0.0%,green algae listed in the Chlorococcales-order 1.9%, 9.5% and 6.7%, respectively. The share of pico-algae in the sequence of left bank, midstream, right bank was 2.8%, 1.4% and 7.7%, respectively.

On 14 November 2012 phytoplankton biomass in the sequence of left bank, midstream, right bank was 0.1 mg/l, 0.1 mg/l and 0.2 mg/l, a-chlorophyll concentration 1.8 µg/l, 1.2 µg/l and 1.8 µg/l, corresponding to the 2 (oligotrophic) grade on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) on all three sampling points [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order and the Pennales-order. Their respective ratios in the sequence of left bank, midstream, right bank were 38.0%, 62.9% and 36.2% and 15.1%, 20.9% and 25.3%. The share of grooved cryptomonads (Cryptophyta) was 28.7%, 0.1% and 5.9%, and flagellates listed in the various taxonomic categories (Flagellates) 3.1%, 1.9% and 1.5%, green algae listed in the Chlorococcales-order 3.0%, 5.9% and 6.6%, respectively. The share of pico-algae in the sequence of left bank, midstream, right bank was 8.2%, 6.0% and 7.4%, respectively.

Dipped phytoplankton samples were taken from the upstream Danube section in the Dombori profile twice in 2013, on 28 August and 10 October, at three sampling points (left bank (P50DFP22), midstream (P50DFP23), right bank (P50DFP21).

At the Danube Dombori profile *on August 28 2013* phytoplankton biomass in the sequence of left bank, midstream, right bank was 4.33 mg/l, 5.12 mg/l and 2.89 mg/l, a-chlorophyll concentration 13.2 µg/l, 14.1 µg/l and 8.1 µg/l, corresponding to the 4 (mesotrophic), 4 (mesotrophic) and a 3 (oligo-mesotrophic) grades, respectively, on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (86.8%, 85.1% and 86.1%). Proportions of the grooved cryptomonads (Cryptophyta) represented mainly by Rhodomonas species in the sequence of left bank, midstream, right bank were 3.7%, 2.4% and 1.7%, green algae listed in the Chlorococcales-order 6.8%, 2.3% and 6.5%.

At the Danube Dombori profile *on 10 October 2013* phytoplankton biomass in the sequence of left bank, midstream, right bank was 0.204 mg/l, 0.265 mg/l and 0.109 mg/l, a-chlorophyll concentration on all three sampling points was lower than the detection level (<0.1mg/l), the latter corresponding to the 1 (ultra-oligotrophic) grade. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (55.7%, 68.1% and 62.3%). Proportions of the grooved cryptomonads (Cryptophyta) represented mainly by Rhodomonas species in the sequence of left bank, midstream, right bank were 33.6%, 11.1% and 16.3%, respectively.

Sampling results from the midstream-distant section show a status and tendency very similar to that on the near downstream section. The amounts of diatom species are dominant in phytoplankton biomass; the period characterised by the highest biomass level is March and August, while the lowest biomass levels were found in the months September and November. Biomass values from the 2012 samples are also higher in the same period than those measured in the year 2013, yet seasonal differences exceed year-to-year deviations.

CLASSIFICATION OF THE MIDSTREAM-DISTANT DOWNSTREAM SECTION IN ACCORDANCE WITH THE WFD ON THE BASIS OF THE PHYTOPLANKTON

All HRPI EQR values established for the left bank, right bank and midstream sampling points at the Gerjen-Foktő and Dombori-profiles were used for the ecological status assessment of the midstream-distant downstream section according to the WFD based on phytoplankton (Gerjen-Foktő: 22.03.2012, 27.06.2012, 28.08.2012, 26.09.2012, 14.11.2012; Dombori: 28.08.2013, 10.10.2013), which were summarised in the table below.

Sampling unit	23.12.2012		27.06.2012		28.08.2012; 27.08.2013		26.09.2012; 11.10.2013		14.11.2012	
	EQR	Ecological status (based on HRPI)	EQR	Ecological status (based on HRPI)	EQR	Ecological status (based on HRPI)	EQR	Ecological status (based on HRPI)	EQR	Ecological status (based on HRPI)
PLDFP52	0.697	good	0.764	good	0.376	poor	0.892	high	0.843	high
PLDFP53	0.715	good	0.784	good	0.327	poor	0.858	high	0.885	high
PLDFP51	0.693	good	0.768	good	0.370	poor	0.849	high	0.821	high
Average season 2012	**0.702**	**good**	**0.772**	**good**	**0.358**	**poor**	**0.866**	**high**	**0.850**	**high**
P50DFP22					0.760	good	0.890	high		
P50DFP23					0.744	good	0.880	high		
P50DFP21					0.817	high	0.880	high		
Average season 2013					**0.774**	**good**	**0.883**	**high**		
Average season 2012-2013	**0.702**	**good**	**0.772**	**good**	**0.566**	**moderate**	**0.875**	**high**	**0.850**	**high**
Classification of the section	**0.753**					**good**				

Table 12.3.3-8: Phytoplankton based ecological status assessment of the midstream-distant downstream-section according to the WFD

For the purposes of characterising the ecological status of the midstream-distant downstream section the HRPI index taking into account the a-chlorophyll concentration proportional to the NQr and phytoplankton biomass calculated on the basis of the species composition was used. In the case when a-chlorophyll content is not within the detectable concentration range, the variable takes automatically the highest (1) value. Based on the average EQR values of the sampling sites the ecological status of the midstream-distant downstream section indicates good status in March and June and high status in September and November, respectively. The lowest EQR values were obtained in the August sampling period. In this period the ecological status was moderate. The August findings during the two years showed two grade leaps while the same difference could not be detected in the early autumn period. The seasonal values – and hence, the annual values – are identical with the results measured on the upstream and near downstream section.

The ecological status of the midstream-distant downstream section based on the phytoplankton was good.

Findings on the distant downstream subsection, phytoplankton

The distant downstream section consists of three sampling points each at the Sió-South, (P50DFP32, P50DFP33, P50DFP31), as well as Baja (P50DFP42, P50DFP43, P50DFP41) profiles. Supplementary phytoplankton samples were taken in both profiles in 2013 twice, on 28 August and 10 October.

TAXONS	**P50DFP32**	**P50DFP33**	**P50DFP31**	**P50DFP42**	**P50DFP43**	**P50DFP41**
	Sió South, left	**Sió South, midstream**	**Sió South, right**	**Baja, left**	**Baja, midstream**	**Baja, right**
	28.08.2013	**28.08.2013**	**28.08.2013**	**27.08.2013**	**27.08.2013**	**27.08.2013**
SUM pico	32	29	16	39	38	41
SUM nano	62	75	2	36	431	47
SUM Flagellates	171	0	13	33	104	47
SUM Chroococcales	0	0	0	1	12	0
SUM Oscillatoriales	0	0	3	0	19	0
SUM Nostocales	0	0	0	0	0	0
SUM Euglenophyta	0	0	0	0	0	0
SUM Cryptophyta	454	242	84	683	109	236
SUM Dinophyta	0	34	0	0	0	0
SUM Chrysophyceae	281	144	2	0	129	47
SUM Xanthophyceae	0	0	0	9	0	3
SUM Centrales	6582	5024	2182	10258	3277	5695
SUM Pennales	16	80	29	58	189	23
SUM Volvocales	17	24	106	14	2	3
SUM Chlorococcales	223	525	150	425	483	442
SUM Ulothricales	1	0	0	4	30	0
SUM Desmidiales	0	1	0	0	0	0
SUM Zygnematales	1	0	0	0	0	0
SUM biomass (µg/l)	**7840**	**6178**	**2585**	**11559**	**4823**	**6585**
a-chlorophyll concentration (µg/l)	**1,5**	**17,8**	**8,9**	**28,9**	**22,2**	**23,7**
a-chlorophyll contents of biomass (%)	**0.019**	**0.288**	**0.344**	**0.250**	**0.460**	**0.360**
degree of trophity	**2 (o)**	**4 (m)**	**3 (o-m)**	**5 (m-eu)**	**5 (m-eu)**	**5 (m-eu)**

Table 12.3.3-9: Phytoplankton biomass (µg/l) and a-chlorophyll concentration (µg/l) on the Danube distant downstream section during the August sampling season

TAXONS	**P50DFP32**	**P50DFP33**	**P50DFP31**	**P50DFP42**	**P50DFP43**	**P50DFP41**
	Sió South, left	**Sió South, midstream**	**Sió South, right**	**Baja, left**	**Baja, midstream**	**Baja, right**
	10.10.2013	**10.10.2013**	**10.10.2013**	**11.10.2013**	**11.10.2013**	**11.10.2013**
SUM pico	3	6	10	3	10	19
SUM nano	0	0	0	0	0	1
SUM Flagellates	24	3	11	4	16	2
SUM Chroococcales	0	0	1	0	1	1
SUM Oscillatoriales	0	7	7	4	2	162
SUM Nostocales	0	0	0	0	0	0
SUM Euglenophyta	0	0	0	0	0	0
SUM Cryptophyta	17	37	15	66	49	54
SUM Dinophyta	0	9	0	0	0	0
SUM Chrysophyceae	5	1	0	2	29	46
SUM Xanthophyceae	0	0	0	0	0	0
SUM Centrales	181	244	252	179	207	278
SUM Pennales	6	0	0	0	19	9
SUM Volvocales	0	0	0	0	0	0
SUM Chlorococcales	4	3	60	4	62	32
SUM Ulothricales	0	1	0	0	0	0
SUM Desmidiales	0	0	0	0	0	0
SUM Zygnematales	0	0	0	0	0	0
SUM biomass (µg/l)	**241**	**311**	**356**	**263**	**395**	**604**
a-chlorophyll concentration (µg/l)	**<0.1**	**<0.1**	**0.6**	**<0.1**	**<0.1**	**0.6**
a-chlorophyll contents of biomass (%	**-**	**-**	**0.168**	**-**	**-**	**0.099**
degree of trophity	**-**	**-**	**1 (u-o)**	**-**	**-**	**1 (u-o)**

Table 12.3.3-10: Phytoplankton biomass (µg/l) and a-chlorophyll concentration (µg/l) on the Danube distant downstream section during the October sampling season

At the **Danube Sió South profile** *on August 28 2013* phytoplankton biomass in the sequence of left bank, midstream, right bank was 7.84 mg/l, 6.18 mg/l and 2.59 mg/l, a-chlorophyll concentration 1.5 μg/l, 17.8 μg/l and 8.9 μg/l, corresponding to the (oligotrophic), a 4 (mesotrophic) and a 3 (oligo-mesotrophic) grades, respectively, on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) a 2 [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (84.0%, 81.3% and 84.4%). Proportions of the grooved cryptomonads (Cryptophyta) represented mainly by Rhodomonas species in the sequence of left bank, midstream, right bank were 5.8%, 3.9% and 3.2%, green algae listed in the Chlorococcales-order 2.8%, 8.5% and 5.8%.

At the Danube Sió South profile *on 10 October 2013* the phytoplankton biomass in the sequence of left bank, midstream, right bank was 0.241 mg/l, 0.311 mg/l and 0.356 mg/l, a-chlorophyll concentration at the left bank and midstream sampling points was lower than the detection level (<0.1mg/l), on the right bank 0.6 mg/l, corresponding to the 1 (ultra-oligotrophic) grade. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (75.1%, 78.2% and 70.8%). Proportions of the grooved cryptomonads (Cryptophyta) represented mainly by Rhodomonas species in the sequence of left bank, midstream, right bank were 7.2%, 11.8% and 4.3%volt, respectively.

At the Danube Baja profile on *7 August 2013* phytoplankton biomass in the sequence of left bank, midstream, right bank was 11.6 mg/l, 4.8 mg/l and 6.6 mg/l, a-chlorophyll concentration 28.9 μg/l, 22.2 μg/l and 23.7 μg/l, corresponding to the 5 (meso-eutrophic) grade on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) [12-11], [12-31] in all three cases. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (88.0%, 68.0% and 86.5%). Proportions of the grooved cryptomonads (Cryptophyta) represented mainly by Rhodomonas species in the sequence of left bank, midstream and right bank were 5.9%, 2.3% and 3.6%, green algae listed in the Chlorococcales-order 3.7%, 10.0 and 6.7%, respectively.

At the Danube Baja profile on *11 October 2013* phytoplankton biomass in the sequence of left bank, midstream, right bank was 0.263 mg/l, 0.395 mg/l and 0.604 mg/l, a-chlorophyll concentration at the left bank and midstream sampling points was lower than the detection level (<0.1mg/l), on the right bank 0.6 mg/l, corresponding to the 1 (ultra-oligotrophic) grade. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (68.0%, 52.4% and 45.9%). Proportions of the grooved cryptomonads (Cryptophyta) represented mainly by Rhodomonas species in the sequence of left bank, midstream and right bank were 25.1%, 12.4% and 8.9%, respectively.

CLASSIFICATION OF THE DISTANT DOWNSTREAM SECTION IN ACCORDANCE WITH THE WFD ON THE BASIS OF THE PHYTOPLANKTON

For the purposes of ecological status assessment of the distant downstream section based on phytoplankton finding according to the WFD the summer and autumn results from the left bank, midstream and right bank sampling points of the Sió South and Baja-profiles were used (Sió South: 28.08.2013, 10.10.2013, Baja: 28.08.2013, 10.10.2013), which were duly summarised in the table below.

Sampling unit	28.08.2012; 27.08.2013		26.09.2012; 11.10.2013	
	EQR	Ecological status (based on HRPI)	EQR	Ecological status (based on HRPI)
P50DFP32	0.862	high	0.860	high
P50DFP33	0.716	good	0.880	high
P50DFP31	0.783	good	0.850	high
P50DFP42	0.631	good	0.870	high
P50DFP43	0.657	good	0.840	high
P50DFP41	0.670	good	0.790	good
Average season 2013	**0.720**	**good**	**0.848**	**high**
Classification of the section	**0.784**		**good**	

Table 12.3.3-11: Phytoplankton based ecological status assessment of the distant downstream section according to the WFD

For the purposes of characterising the ecological status of the distant downstream section the HRPI index taking into account the a-chlorophyll concentration proportional to the NQr and phytoplankton biomass calculated on the basis of the species composition was used. In the case when a-chlorophyll content is not within the detectable concentration range, the variable takes automatically the highest (1) value. Based on the average EQR values of the sampling sites the ecological status of the distant downstream section indicates good status summer and high status in autumn. Ecological status of the section was determined on the basis of the average from the summer and autumn findings. **The ecological status of the distant downstream section based on the phytoplankton was good.**

In summary it can be stated that no grade level changes were caused by the Paks Nuclear Power Plant hot water discharge in the phytoplankton downstream when compared to the status upstream.

12.3.3.3 Phytobenthos

Findings of the midstream-distant downstream subsection

Phytobenthos at the midstream-distant downstream section in the Gerjen-Foktő (PLDFB52, PLDFB51) and Dombori profile (P50DFB22, P50DFB21) on the left and right bank sampling points was tested in the summer and autumn period. The Gerjen-Foktő profile was sampled on 28 August 2012 and 26 September 2012, the Dombori profile on 28 August 2013 and 10 October 2013.

TAXONS	PLDFB52	PLDFB51	P50DFB22	P50DFB21
	Gerjen-Foktő		Dombori	
	left	right	left	right
	28.08.2012	28.08.2012	28.08.2013	28.08.2013
	Relative abundance (%)			
CENTRALES				
SUM Centrales	62.6	6.8	79.4	91.5
PENNALES				
SUM Fragilariaceae	5.9	1.4	0.5	0.0
SUM Eunotiaceae	0.0	0.0	0	0
SUM Achnanthaceae	11.9	21.6	3.4	3.1
SUM Naviculaceae	13.3	64.9	6.9	1.8
SUM Bacillariaceae	4.5	3.8	8.8	3.6
SUM Epithemiaceae	0.0	0.3	0	0
SUM Surirellaceae	0.3	0.0	0.0	0.0
SUM Pennales spp. (other)	1.4	1.4	1.0	0.0
SUM	**100.0**	**100.0**	**100.0**	**100.0**
IPS index	**13.69**	**15.07**	**8.09**	**6.48**

Table 12.3.3-12: Summary table of the phytobenthos taxons detected at the midstream-distant downstream section during the summer sampling season

TAXONS	PLDFB52	PLDFB51	P50DFB22	P50DFB21
	Gerjen-Foktő		Dombori	
	left	right	left	right
	26.09.2012	26.09.2012	10.10.2013	10.10.2013
	Relative abundance (%)			
CENTRALES				
SUM Centrales	59.9	15.6	37.1	26.5
PENNALES				
SUM Fragilariaceae	1.7	0.9	8.8	3.2
SUM Achnanthaceae	9.7	7.2	8.8	8.0
SUM Naviculaceae	19.0	65.6	28.7	35.7
SUM Bacillariaceae	9.1	10.0	16.0	24.9
SUM Surirellaceae	0.0	0.0	0.0	0.8
SUM Pennales spp. (other)	0.6	0.6	0.7	0.8
SUM	**100.0**	**100.0**	**100.0**	**100.0**
IPS index	**12.28**	**9.05**	**12.25**	**12.38**

Table 12.3.3-13 Summary table of the phytobenthos taxons detected at the midstream-distant downstream section during the autumn sampling season

At the **Danube Gerjen-Foktő profile** at the left bank sampling point *on August 28 of 2012* 62.6 % of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, of which relative abundance of Cyclotella meneghiniana was 3.5%, of other Cyclotella-species 10.1%. The share of Stephanodiscus hantzschii was 3.8%, the other Thalassiosiraceae-taxons 42.0%. The components in the highest rate of the Pennales-diatom stock were the taxons in the Naviculaceae-family, of which the relative abundance projected to the individuals counted was 13.3%. The species with the highest level of relative abundance in the Naviculaceae family included Navicula tripunctata (1.4%), Navicula lanceolata (1.0%) and other Navicula-species (3.5%), a Gomphonema spp. (3.1%), Cymbella silesiaca (1.7%), as well as Amphora pediculus (1.0%). The share of the Achnanthaceae family was 11.9%. The Achnanthaceae-family was represented by Achnanthidium minutissimum (=Achnanthes minutissima) (4.5%), Achnanthes lanceolata (0.7%) and Cocconeis placentula (6.6%). The share of the Bacillariaceae family represented by only the Nitzschia species was 8.8%. Dominant taxons of the Bacillariaceae-family included Nitzschia (Lanceolatae)-species, as well as Nitzschia dissipata. Their relative abundance was 2.4% and 0.7%. The share of the Fragilariaceae-family represented by Fragilaria-species (2.3%), as well as Diatoma ehrenbergii (1.7%), Diatoma moniliformis (0.7%), Diatoma mesodon (0.3%) and Asterionella formosa (0.7%) was 5.9%.

At the Danube Gerjen-Foktő profile at the left bank sampling point *on 26 September 2012* 59.9 % of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, of which relative abundance of the Cyclotella meneghiniana 1.5%, of other Cyclotella-species 8.3%, the share of Stephanodiscus hantzschii 5.3%, of the other Thalassiosiraceae-taxons 38.0%. The components in the highest rate of the Pennales-diatom stock were the taxons in the Naviculaceae-family, of which the relative abundance projected to the individuals counted was 19.0%. The species with the highest level of relative abundance in the Naviculaceae family included Navicula (Lineolatae)- (4.6%) and Navicula (Minusculae)-species (1.7%), as well as other Navicula-species (4.8%). The share of the Bacillariaceae-family was 9.1%. Dominant taxons of the Bacillariaceae-family included Nitzschia inconspicuous and Nitzschia (Lanceolatae)-species. Their relative abundance was 5.5% and 1.5%. The share of the Achnanthaceae family was 9.7%. The Achnanthaceae-family was represented by Achnanthidium minutissimum (=Achnanthes minutissima) (7.2%), Achnanthes lanceolata (0.8%) and other Achnanthes-species (0.2%), as well as Cocconeis placentula (1.5%). The share of the Fragilariaceae-family represented by Fragilaria- and Diatoma-species was 1.7%.

At the Danube Gerjen-Foktő profile at the right bank sampling point *on August 28 of 2012* 6.8 % of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, of which relative abundance of Cyclotella meneghiniana was 0.8%, of other Cyclotella-species 1.7%. The share of Stephanodiscus hantzschii was 0.8%, the other Thalassiosiraceae-talons 3.5%. The components in the highest rate of the Pennales-diatom stock were the taxons in the Naviculaceae-family, of which the relative abundance projected to the individuals counted was 64.9%. The species with the highest level of relative abundance in the Naviculaceae family included Navicula tripunctata (27.0%), Navicula recens (4.1%), Navicula present form (1.4%), Navicula cryptotenella (1.1%), Navicula menisculus var. menisculus (1.1%), and other Navicula-species (4.1%), a Gomphonema spp. (2.4%), Gyrosigma acuminatum (8.4%), Gyrosigma spp. (2.4%), Caloneis bacillum (3.0%), a Rhoicosphaenia abbreviata (1.9%), a Reimeria sinuata (1.1%), as well as Amphora pediculus (1.4%). The share of the Achnanthaceae family was 21.6%. The Achnanthaceae-family was represented by Achnanthidium minutissimum (=Achnanthes minutissima) (1.4%) and Cocconeis placentula (20.3%). The share of the Bacillariaceae family represented by only the Nitzschia species was 3.8%. Dominant taxons of the Bacillariaceae-family included Nitzschia (Lanceolatae)-species, Nitzschia dissipata, as well as Nitzschia palea. Their relative abundance was 1.6%, 1.1% and 0.5%. The share of the Fragilariaceae-family represented by Fragilaria-species (0.8/%), Diatoma moniliformis (0.3%), as well as a Tetracyclus cf. rupestris (0.3%) was 1.4%.

At the Danube Gerjen-Foktő profile at the right bank sampling point *on 26 September 2012* 15.6 % of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, of which relative abundance of Cyclotella meneghiniana was 0.9%, of other Cyclotella-species 4.6%. The share of Stephanodiscus hantzschii was 0.9%, the other Thalassiosiraceae-taxons 8.4%. The components in the highest rate of the Pennales-diatom stock were the taxons in the Naviculaceae-family, of which the relative abundance projected to the individuals counted was 65.6%. The species with the highest level of relative abundance in the Naviculaceae family included Navicula recens (31.3%), Navicula present form (6.3%), Navicula erifuga (5.3%), Navicula viridula var. rostellata (5.3%), Navicula cryptocephala (2.2%), Navicula lanceolata (1.6%), and other Navicula-species (10.0%), Amphora pediculus (2.2%), as well as Gomphonema-species (0.9%), and Gyrosigma scalproides (0.3%). The share of the Achnanthaceae family was 7.2%. The Achnanthaceae-family was represented by Achnanthidium minutissimum (=Achnanthes minutissima) (6.3%) and Cocconeis placentula (0.9%). The share of the Bacillariaceae family represented by only the Nitzschia species was 10.0%. Dominant taxons of the Bacillariaceae-family included Nitzschia palea, Nitzschia (Lanceolatae)-species, as well as Nitzschia dissipata. Their relative abundance was 6.6%, 1.6% and 0.9%. The share of the Fragilariaceae-family represented by Asterionella formosa (0.3%), Fragilaria brevistriata (0.3%) and Diatoma moniliformis (0.3%) was 0.9%.

At the **Danube Dombori profile at** the left bank sampling point *on August 28 2013* 79.4% of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, of which relative abundance of Cyclotella meneghiniana was 29.4%. The share of the diatom species in the order Pennales was 20.6%. The highest ratio components of the Pennales-diatom populations included the Bacillariaceae-family and Naviculaceae-family (8.8% and 6.9%).

At the left bank sampling point of the Danube Dombori profile *on 10 October 2013* 37.1% of the diatom species belonged to the order Centrales, 62.9% of them belonged to diatom species in the order Pennales. Of those in the Centrales-diatom species relative abundance of Cyclotella meneghiniana was 9.8%. The highest ratio components of the Pennales-diatom populations (28.7%) included the Naviculaceae- family. The share of the Bacillariaceae-family was 16.0% volt, of which the share of Nitzschia dissipata was 7.5%.

At the right bank sampling point of the Danube Dombori profile *on 7 August 2013* 91.5% of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, of which relative abundance of Cyclotella meneghiniana was 44.6%. The share of the diatom species in the order Pennales was 8.5%. The highest number of the Pennales-diatom species populations (3.8%) was part of the Bacillariaceae-family, of which the share of Nitzschia palea was 2.2%. The Naviculaceae-family was represented by (1.8%) Gomphonema- and Navicula species.

At the right bank sampling point of the Danube Dombori profile on *11 October 2013* 26.5% of the individuals counted in the diatom population of the benthos constituted in a major part from the order Centrales, 73.5% of them belonged to diatom species in the order Pennales. The highest ratio components of the Pennales-diatom populations (35.7%) included Naviculaceae-taxons represented by the Amphora-, Gomphonema- and Navicula-species. The share of the Bacillariaceae-family was 24.9% within them relative abundance of Nitzschia dissipata ranged up to 10.4%.

CLASSIFICATION OF THE MIDSTREAM-DISTANT DOWNSTREAM SECTION IN ACCORDANCE WITH THE WFD ON THE BASIS OF THE PHYTOBENTHOS

For purposes of phytobenthos based ecological status assessment of the midstream-distant downstream section in the Gerjen-Foktő and Dombori profile findings of the left and right bank sampling points in the summer and autumn period were used (Gerjen-Foktő: 28.08.2012, 26.09.2012, Dombori: 28.08.2013, 10.10.2013), which were duly summarised in the table below.

Sampling unit	EQR	Ecological status (based on EQR)	EQR	Ecological status (based on EQR)
	28.08.2012; 27.08.2013		26.09.2012; 2012.10.11	
PLDFB52	0.642	good	0.568	moderate
PLDFB51	0.715	good	0.397	poor
Average season 2012	**0.679**	**good**	**0.4825**	**moderate**
P50DFB22	0.346	poor	0.566	moderate
P50DFB21	0.262	poor	0.573	moderate
Average season 2013	**0.304**	**poor**	**0.570**	**moderate**
Average season 2012-2013	**0.491**	**moderate**	**0.526**	**moderate**
Classification of the section	**0.509**		**moderate**	

Table 12.3.3-14: Phytobenthos based ecological status assessment of the distant downstream section according to the WFD

For the purposes of ecological status assessment the IPS based EQR value was used calculated based on the diatom species composition of the phytobenthos.

Based on the results it can be stated that the status was moderate both in the summer and autumn period. The classification status of the Gerjen-Foktő profile in the summer sampling period in 2012 was two grades higher than the profile sampled in the same period in 2013 at Dombori. Findings of the autumn samples were homogeneous. Ecological status assessment results of the section reflect a similar picture as both the upstream and near downstream section. Tendencies in classification statuses concur with the experiences gained on the upper sections.

Taking data from both periods into account together an average EQR value of EQR=0.509 is obtained which corresponds to a moderate ecological status

Findings on the distant downstream subsection, phytobenthos

Supplementary phytobenthos samples were taken from the distant downstream section at the Sió-South, (P50DFP32, P50DFP31), as well as Baja (P50DFP42, P50DFP41) profiles from the left and right bank, summer and repeatedly in autumn in 2013. Summer samples were taken on 28 August 2013 and autumn samples on 10 October.

TAXONS	P50DFB32	P50DFB31	P50DFB42	P50DFB41
	Sió South		Baja	
	left	right	left	right
	28.08.2013	28.08.2013	27.08.2013	27.08.2013
	Relative abundance (%)			
CENTRALES				
SUM Centrales	83,3	89,4	88,1	90.0
PENNALES				
SUM Fragilariaceae	2,3	0.4	1,3	0.8
SUM Eunotiaceae	0	0	0	0
SUM Achnanthaceae	1,6	2,7	0.4	0.8
SUM Naviculaceae	2,3	3,1	3,1	2,9
SUM Bacillariaceae	10.5	4,4	7,1	4,6
SUM Epithemiaceae	0	0	0	0
SUM Surirellaceae	0.0	0.0	0.0	0.8
SUM Pennales spp. (other)	0.0	0.0	0.0	0.0
SUM	**100.0**	**100.0**	**100.0**	**100.0**
IPS index	**6,82**	**7,14**	**6,34**	**6,36**

Table 12.3.3-15: Summary table of phytobenthos taxons detected on the distant downstream section during the summer sampling season

TAXONS	P50DFB32	P50DFB31	P50DFB42	P50DFB41
	Sió South		Baja	
	left	right	left	right
	10.10.2013	10.10.2013	11.10.2013	11.10.2013
	Relative abundance (%)			
CENTRALES				
SUM Centrales	10.8	29.5	35.4	16.4
PENNALES				
SUM Fragilariaceae	0.0	1.8	5.7	0.3
SUM Achnanthaceae	1.3	5.5	3.5	0.3
SUM Naviculaceae	29.6	43.1	17.8	30.2
SUM Bacillariaceae	57.5	19.4	36.0	49.8
SUM Surirellaceae	0.4	0.3	0.3	2.6
SUM Pennales spp. (other)	0.4	0.3	1.3	0.3
SUM	**100.0**	**100.0**	**100.0**	**100.0**
IPS index	**13.92**	**9.64**	**12.02**	**14.42**

Table 12.3.3-16. táblázat: Summary table of phytobenthos taxons detected on the distant downstream section during the autumn sampling season

At the **Danube Sió South profile** at the left bank sampling point *on August 28 2013* 83.3% of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, of which relative abundance of Cyclotella meneghiniana was 38.8%. The share of the diatom species in the order Pennales was 20.6%. The highest ratio components of the Pennales-diatom populations included the Bacillariaceae family and Naviculaceae-family (10.5% and 2.3%).

At the Danube Sió South profile left bank sampling point *on 10 October 2013* 10.8% of the individuals counted in the diatom population of the benthos constituted in a major part from the order Centrales-, 89.2% of them belonged to diatom species in the order Pennales. Relative abundance of Cyclotella meneghiniana which has a Vi=2 indicator value among the Centrales-diatom species was 3.8%. The highest ratio components of the Pennales-diatom populations (57.5%) were from the Bacillariaceae- family, of which the share of Nitzschia dissipata was 41.7%. The share of the Naviculaceae-family represented by the Cymbella-, Gomphonema- and Navicula-species was 29.6%.

At the Danube Sió South profile right bank sampling point on *August 28 2013* 89.4% of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, the relative abundance of which Cyclotella meneghiniana was 44.2%. The share of the diatom species in the order Pennales was 10.6%. The highest ratio components of the Pennales-diatom populations included the Bacillariaceae family and Naviculaceae-family (4.4% and 3.1%).

A Danube Sió South profile right bank at the sampling point on *11 October 2013* 29.5% of the individuals counted in the diatom population of the benthos belonged to the order Centrales, 70.5% of them belonged to diatom species in the order Pennales. Relative abundance of Cyclotella meneghiniana from the order Centrales was 9.2%. The highest ratio components of the Pennales-diatom populations (43.1%) included Naviculaceae-taxons represented by Amphora-, Gomphonema- and Navicula-species. The share of the Bacillariaceae-family was 19.4%, of which the relative abundance of Vi=4. indicator value Nitzschia dissipata was 7.4%.

At the **Danube Baja profile** left bank sampling point on *7 August 2013* 88.1% of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, of which Cyclotella meneghiniana relative abundance was 46.5%. The share of the diatom species in the order Pennales was 11.9%. The highest ratio components of the Pennales-diatom populations included the Bacillariaceae family and Naviculaceae-family (7.1% and 3.1%).

At the Danube Baja profile left bank sampling point on 11 October *2013* 35.4% of the individuals counted in the diatom population of the benthos constituted of the order Centrales, 64.6% of them belonged to diatom species in the order Pennales. Of the Centrales-diatom species relative abundance of Cyclotella meneghiniana was 15.6%. The highest ratio components of the Pennales-diatom populations (36.0%) included the Bacillariaceae- family, of which the share of Nitzschia dissipata was 21.3%. The share of the Naviculaceae-family represented by Amphora-, Cymbella-, Gomphonema- and Navicula-species was 17.8%.

At the Danube Baja profile right bank sampling point on *7 August 2013* 90.0% of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, of which relative abundance of Cyclotella meneghiniana was 41.8%. The share of the diatom species in the order Pennales was 10.0%. The highest ratio components of the Pennales-diatom populations included the Bacillariaceae family and Naviculaceae-family (4.6% and 2.9%).

At the Danube Baja profile right bank sampling point on 11 October *2013* 16.4% of the individuals counted in the diatom population of the benthos belonged to the order Centrales, 83.6% of them belonged to diatom species in the order Pennales. Relative abundance of Cyclotella meneghiniana from the order Centrales was 4.2%. The highest ratio components of the Pennales-diatom populations (30.2%) included Naviculaceae-taxons represented by Caloneis-, and Navicula-species. The share of the Bacillariaceae-family was 49.8% within them relative abundance of Nitzschia dissipata ranged up to 38.6%.

CLASSIFICATION OF THE DISTANT DOWNSTREAM SECTION IN ACCORDANCE WITH THE WFD ON THE BASIS OF THE PHYTOBENTHOS

For purposes of phytobenthos based ecological status assessment of the distant downstream section in the Sió-South and Baja profile findings of the left and right bank sampling points in the summer and autumn period were used (Sió South: 28.08.2013, 10.10.2013, Baja: 28.08.2013, 10.10.2013), which were duly summarised in the table below.

Sampling unit	EQR	Ecological status (based on EQR)	EQR	Ecological status (based on EQR)
	27.08.2013-28		2012.10.11	
P50DFB32	0.279	poor	0.654	good
P50DFB31	0.296	poor	0.428	moderate
P50DFB42	0.254	poor	0.554	moderate
P50DFB41	0.255	poor	0.681	good
Average season 2013	**0.271**	**poor**	**0.579**	**moderate**
Classification of the section	**0.425**		**moderate**	

Table 12.3.3-17: Phytobenthos based ecological status assesment of the distant downstream-section according to the WFD

For the purposes of ecological status assessment the IPS based EQR value was used calculated based on the diatom species composition of the phytobenthos. Average values of EQR=0.271 in summer and EQR=0.579 in autumn indicated poor and moderate statuses, respectively.

Taking data from both periods into account together an average EQR value of EQR=0.425 is obtained which corresponds to a moderate ecological status.

In summary it can be stated that no grade level changes were caused by the Paks Nuclear Power Plant hot water discharge in the phytobenthos downstream when compared to the status upstream.

12.3.3.4 Macrophyte

The distant downstream section was divided up into two subsections – midstream distant and distant, respectively, – for biological elements, including macrophytes. Presentation of the results is also arranged accordingly below.

Findings on the midstream distant downstream subsection

The midstream-distant downstream section consists of sampling units taken from the Gerjen Foktő and Dombori profiles (PLDMF41; PLDMF42; P50DMF21; P50DMF22). Macrophyte sampling was made in two seasons – summer and autumn – in 2012 at Gerjen-Foktő and in 2013 at Dombori. Four sampling units in a length of 100 metres each and 400 metres altogether were tested on both the right and the left bank area. Various habitat types were included among the sampling units. Sampling subunits were identical in the summer and autumn sampling seasons.

A total of 31 species were identified during the summer and autumn sampling operations in the four sampling units designated along the midstream-distant subsection.

Scientific name	English name	PLDMF4.1	PLDMF4.2	P50DMF2.1	P50DMF2.2
Salix fragilis	Crack willow	1	1	5	
Fraxinus pennsylvanica	Red ash	1	1		1
Rorippa amphibia	Great yellowcress	1	6		
Salix alba	While willow	5	5	2	3
Salix purpurea	Purple willow		1		
Carex gracilis	Slender tufted sedge		1		
Echinochloa crus-galli	Common barnyardgrass		1		
Plantago media	Hoary plantain		1		
Rumex conglomeratus	Sharp dock		1		
Populus canescens	Grey poplar		1		
Artemisia vulgaris	Common wormwood		1		
Rumex patientia	Garden patience		1		
Torilis japonica	Erect hedgeparsley		1		
Aster lanceolatus agg.	Panicled aster		2	1	2
Chenopodium ambrosioides	Wormseed		2		
Verbena officinalis	Common verbena		2		
Lolium perenne	Perennial ryegrass		5		
Rorippa sylvestris	Creeping yellowcress			1	1
Populus nigra	Black poplar			1	
Carex riparia	Greater pond sedge			1	
Juncus compressus	Compressed rush			1	
Bolboschoenus maritimus	Bulrush			2	
Lysimachia vulgaris	Yellow loosestrife			2	

Scientific name	English name	PLDMF4.1	PLDMF4.2	P50DMF2.1	P50DMF2.2
Amorpha fruticosa	Desert false indigo				1
Acer negundo	Ash leaved maple				1
Rubus cf. Caesius	Dewberry				1
Peplis portula	Spatulaleaf loosestrife				1
Rumex obtusifolia	Broadleaf dock				1
Ceratophyllum demersum	Rigid hornwort				1
Robinia pseudo-acacia	Honey locust				2
Populus tremula	Common aspen				5
Number of species:		**4**	**17**	**9**	**12**

Table 12.3.3-18: Macrophyte species found in the midstream distant downstream section and their estimated DAFOR quantities

None of the species found in the sampling profile was protected. Several species can be considered to be introduced (red ash, panicled aster), the abundance of which refers to the disturbed nature of the area.

The section assessed is part of the SCI area identified as HUDD20023 Tolnai Danube. The indicator species of the area is the creeping marshwort (*Apium repens* (Jacq.) Lagesca) [12-46]. The species was not found along the sampling section.

CLASSIFICATION OF THE MIDSTREAM-DISTANT DOWNSTREAM SECTION IN ACCORDANCE WITH THE WFD ON THE BASIS OF THE MACROPHYTES

Ecological water quality of the section on the basis of macrophytes was carried out in accordance with the set of criteria of the WFD, based on the macrophyte method established in Hungary (Lukács et al. [12-28]). Aggregate data from the total length of 400 metres of the four sampling units were used for classification purposes.

The outcome of the status assessment on the near downstream section is identical with the results obtained upstream and near downstream.

Based on the findings of the assessment it can be stated that the ecological status of the midstream-distant downstream section of the Danube according to the macrophyte analysis was moderate.

	Aggregate DAFOR cubic value	Number of species
A (positive indicator species)	2	2
B (neutral species)	34	10
C (disturbance indicator species)	7	2
SUM	43	14
Reference Index	-11,62	
EQR Value	0.44	
Classification	**moderate**	

Table 12.3.3-19: Results of the ecological status assessment along the midstream-distant downstream section based on the data on macrophytes from the summer and autumn sampling session

Finding of the distant downstream subsection, macrophyte

The distant downstream section consists of sampling units taken from the Sió South and Baja profiles (P50DMF31; P50DMF32; P50DMF41; P50DMF42). Macrophyte sampling was made in two seasons – summer and autumn – in 2013. Four sampling units in a length of 100 metres each and 400 metres altogether were tested on both the right and the left bank area. Various habitat types were included among the sampling units. Sampling subunits were identical in the summer and autumn sampling seasons.

Scientific name	English name	P50DMF3.1	P50DMF3.2	P50DMF4.1	P50DMF4.2
Rorippa sylvestris	Creeping yellowcress	1	1	1	
Echinochloa crus-galli	Common barnyardgrass	1			
Peplis portula	Spatulaleaf loosestrife	1			
Bolboschoenus maritimus	Bulrush	2		3	
Carex riparia	Greater pond sedge	3	1	5	
Salix alba	While willow	5	5	5	7
Salix alba (sapling)	While willow	5			
Juncus compressus	Compressed rush		1	1	
Populus nigra	Black poplar		1	3	
Lolium perenne	Perennial ryegrass		1		
Lysimachia vulgaris	Yellow loosestrife		1		
Cyperus fuscus	Brown galingale		1		
Rubus cf. Caesius	Dewberry		2		3
Fraxinus angustifolia subsp. Pannonic	Hungarian narrow leafed as		2		
Aster lanceolatus agg.	Panicled aster		5		2
Acer negundo	Ash leaved maple			1	
Robinia pseudo-acacia	Honey locust			1	
Populus alba	White poplar			2	
Ceratophyllum demersum	Rigid hornwort				1
Fraxinus pennsylvanica	Red ash				2
Number of species:		**7**	**11**	**9**	**5**

Table 12.3.3-20: Macrophyte species found in the distant downstream section and their estimated DAFOR quantities

During the summer and autumn surveys a total of 19 species were found in the distant downstream subsection in the four sampling units.

None of the species found in the sampling profile was protected. Several species can be considered to be introduced (red ash, panicled aster), the abundance of which refers to the disturbed nature of the area.

The section assessed is part of the SCI area identified as HUDD20023 Tolnai Danube. The indicator species of the area is the creeping marshwort (*Apium repens* (Jacq.) Lagesca) [12-46]. The species was not found along the sampling section.

CLASSIFICATION OF THE DISTANT DOWNSTREAM SECTION IN ACCORDANCE WITH THE WFD ON THE BASIS OF THE MACROPHYTES

Ecological status assessment according to the criteria laid down in the WFD was completed for the distant subsection (Lukács et al. [12-28]). Classification was made on the basis of the sample units No P50DMF31; P50DMF32, P50DMF41, P50DMF42, in a total length of 400 metres.

Based on the findings of the assessment it can be stated that the ecological status of the distant downstream section of the Danube according to the macrophyte analysis was moderate

	Aggregate DAFOR cubic value	Number of species
A (positive indicator species)	51	1
B (neutral species)	41	7
C (disturbance indicator species)	67.5	2
SUM	159.5	10
Reference Index	-10.34	
EQR Value	0.44	
Classification	**moderate**	

Table 12.3.3-21: Results of the ecological status assessment on the distant downstream section in summer and autumn based on macrophyte analysis

Based on the findings of the assessment it can be stated that the ecological status of the distant downstream section of the Danube according to the macrophyte analysis was moderate.

As a summary, it can be stated that hot water discharge from the Paks Nuclear Power Plant does not cause any grade change in the downstream section.

12.3.3.5 Macrozoobenthos

The distant downstream section was divided up into two subsections – midstream distant and distant, respectively, – for biological elements, including aquatic macroscopic invertebrates. Presentation of the results is also arranged accordingly below.

Findings of the midstream-distant downstream subsection

When the sites for sampling units were identified, the requirements provided, sampling sites of former assessments and the environmental conditions, suitability of the sampling site for carrying out the sampling procedure – determined during a field visit – were all taken into consideration. Sampling units were divided up to several subunits. The key consideration for the identification of the subunits included keeping an eye on the objective of the assessment and the representative nature of the sampling. Correspondingly, sampling sub units were assigned in areas with a number of different habitat types.

The midstream-distant downstream section contains macroscopic invertebrate sampling units for the Gerjen Foktő (PLDMZB41; PLDMZB42) and Dombori (P50DMZB21 and P50DMZB22) profiles. Macrozoobenthos sampling was made in two seasons – summer and autumn – in 2012 at Gerjen-Foktő and in 2013 at Dombori. Summer and autumn samples had identical sampling subunits.

During the summer and autumn sampling seasons a total of 42 different macroscopic invertebrate taxons could be detected from the samples taken at the midstream-distant downstream section (Table 12.3.3-22).

Taxons	PLDMZB 41	PLDMZB 42	P50DMZB 21	P50DMZB 22
Water worms (Oligochaeta)	12	5	13	6
Brittle worms (Polychaeta)				
Hypania invalida (GRUBE, 1860)			2	
Snails (Gastropoda)				
Bithynia tentaculata (LINNAEUS, 1758)		1		
Gyraulus albus (O.F. MÜLLER, 1774)		1		1
Fagotia acicularis (FERRUSAC, 1823)	1			
Fagotia esperi (FERRUSAC, 1823)	1			
Lithoglyphus naticoides (C. PFEIFFER 1828)	222	1035	372	58
Physella acuta (DRAPARNAUD, 1805)		1		
Planorbis planorbis (LINNAEUS, 1758)		1		
Potamopyrgus antipodarum (J. E. GRAY, 1843)	1			1
Theodoxus fluviatilis (LINNAEUS 1758)	8	7	1	
Valvata piscinalis (O.F. MÜLLER, 1774)	1	75		4
Mussels (Bivalvia)				
Corbicula fluminalis (O.F. MÜLLER, 1774)		3		
Corbicula fluminea (O.F. MÜLLER, 1774)	11	97	7	2
Corbicula sp.			1	6
Dreissena bugensis (ANDRUSOV, 1897)	2			
Dreissena polymorpha (PALLAS, 1771)		3	1	1
Pisidium amnicum (O.F. MÜLLER, 1774)		4		
Pisidium henslowanum (SHEPPARD, 1823)				1
Pisidium pseudosphaerium FAVRE, 1927		1		1
Pisidium supinum A.SCHMIDT, 1851		1		
Sinanodonta woodiana (LEA, 1834)			1	
Unio tumidus RETZIUS, 1788	2	3		
Crustaceans (Crustacea)				
Corophium curvispinum (SARS, 1895)	28	2	1	3
Dikerogammarus sp.	31	2	4	2
Dikerogammarus haemobaphes (EICHWALD, 1841)	10			
Dikerogammarus villosus (SOWINSKY, 1758)	67	23	7	10
Jaera istri VIEUILLE, 1979	1			
Limnomysis benedeni CZERNIAVSKY, 1882	14	74	44	6
Obesogammarus obesus VIEUILLE, 1979			1	1
Orconectes limosus RAFINESQUE, 1872	1			
Mayflies (Ephemeroptera)				
Procloeon bifidum (BENGTSSON, 1912)		1		
Potamanthus luteus (LINNAEUS, 1767)			1	
Heptagenia flava ROSTOCK, 1877	1			1
Dragonflies (Odonata)				
Gomphus flavipes (CHARPENTIER, 1825)		3	2	1
True bugs (Heteroptera)				

Taxons	PLDMZB 41	PLDMZB 42	P50DMZB 21	P50DMZB 22
Gerris sp.		1		
Beetles (Coleoptera)				
Chrysomelidae		1		
Flies (Diptera)				
Chironomidae	3	114		
Chironominae	146	41	33	7
Orthocladiinae		2		
Tanypus sp.	3	3		
Tanytarsini	2			

Table 12.3.3-22: List of macroscopic invertebrate taxons identified in the midstream-distant downstream section

The presence of the invasive taxons detected in the previous sections could be confirmed in this section as well, in particular the snail species *Lithoglyphus naticoides* which comes in great numbers. The presence of the brittle worm species named *Hypania invalida* and a kind of mussel, known in this country only from a few places so far, *Dreissena bugensis* should be noted (this is the only location where the latter was found). Both Ponto-Caspian species should be considered as invasive and they slowly start to spread over in our major rivers. Note that a few individuals of the protected dragonfly species called *Gomphus flavipes*, as well as the protected snail species named *Fagotia acicularis* were also included in the samples and specimens of mayflies (*Procloeon bifidum, Potamanthus luteus, Heptagenia flava*) were collected from several sites, which otherwise do not tolerate sudden and substantial increases in the temperature of water (such as the one experienced in the neighbourhood of the cooling water discharge). The indicator macrozoobenthos species of the SCI area marked HUDD20023, thick shelled river mussel (*Unio crassus*) was never found in the samples.

CLASSIFICATION OF THE MIDSTREAM-DISTANT DOWNSTREAM SECTION IN ACCORDANCE WITH THE WFD ON THE BASIS OF THE MACROZOOBENTHOS

In a similar manner like the other sections upstream, ecological status assessment of the section on the basis of the sampling sites was made using the HMMI (Hungarian Macroinvertebrate Multimetric Index) method (Várbíró et al. [12-42], [12-43]). The status classification grade was defined as an average of summer and autumn samples.

Midstream distant downstream section	Summer		Autumn	
	HMMI EQR	Classification	HMMI EQR	Classification
PLDMZB 41	0.66	good	0.41	moderate
PLDMZB 42	0.64	good	0.43	moderate
P50DMZB 21	0.42	moderate	0.38	poor
P50DMZB 22	0.46	moderate	0.48	moderate
average:	**HMMI EQR**		**Classification**	
	0.48		**moderate**	

Table 12.3.3-23: Ecological status assessment of the midstream distant downstream section based on summer and autumn macrozoobenthos samples

The classification status of the midstream-distant section corresponds to that recorded upstream and near downstream. **Based on the macroscopic invertebrate communities in the samples taken during the two sampling sessions each the ecological status of the midstream-distant downstream section was moderate (HMMI EQR: 0.48).**

Findings of the distant downstream subsection, macrozoobenthos

The distant downstream section contains macroscopic invertebrate sampling units for the Sió South and Baja profiles. Macrozoobenthos sampling was made in two seasons – summer and autumn – in 2013.

When the sites for sampling units were identified, the requirements provided, sampling sites of former assessments and the environmental conditions, suitability of the sampling site for carrying out the sampling procedure – determined during a field visit – were all taken into consideration. Sampling units were divided up to several subunits. The key consideration for the identification of the subunits included keeping an eye on the objective of the assessment and the representative nature of the sampling. Correspondingly, sampling sub units were assigned in areas with a number of different habitat types. Summer and autumn samples had identical sampling subunits.

During the summer and autumn sampling seasons a total of 37 different macroscopic invertebrate taxons could be detected from the samples taken at the distant downstream section (Table 12.3.3-24).

Taxons	P50DMZB 31	P50DMZB 32	P50DMZB 41	P50DMZB 42
Water worms (Oligochaeta)	4	56	49	7
Brittle worms (Polychaeta)				
Hypania invalida (GRUBE, 1860)	1	3	1	
Snails (Gastropoda)				
Borysthenia naticina (MENKE, 1845)	6		44	
Lithoglyphus naticoides (C. PFEIFFER 1828)	1370	835	1583	977
Physella acuta (DRAPARNAUD, 1805)	2			1
Theodoxus fluviatilis (LINNAEUS 1758)	3		1	
Valvata piscinalis (O.F. MÜLLER, 1774)	3			21
Viviparus acerosus (BOURGUIGNAT, 1862)		1	1	1
Mussels (Bivalvia)				
Anodonta anatina (LINNAEUS, 1758)	1			
Anodonta sp.			2	
Corbicula fluminalis (O.F. MÜLLER, 1774)	8			
Corbicula fluminea (O.F. MÜLLER, 1774)	23	27	6	6
Corbicula sp.	13	46	9	1
Dreissena polymorpha (PALLAS, 1771)	16	3	3	
Pisidium amnicum (O.F. MÜLLER, 1774)	2			2
Pisidium henslowanum (SHEPPARD, 1823)	1			
Pisidium pseudosphaerium FAVRE, 1927	1			
Sinanodonta woodiana (LEA, 1834)	1			
Sphaerium corneum (LINNAEUS, 1758)	6		4	
Sphaerium rivicola (LAMARCK, 1818)			3	1
Unio sp.		1		
Unio tumidus RETZIUS, 1788	13	6		
Crustaceans (Crustacea)				
Corophium curvispinum (SARS, 1895)	58	20	9	39
Dikerogammarus sp.	12	8	5	3
Dikerogammarus villosus (SOWINSKY, 1758)	21	11		25
Limnomysis benedeni CZERNIAVSKY, 1882	107	100	11	21
Obesogammarus obesus VIEUILLE, 1979	8	2		2
Mayflies (Ephemeroptera)				
Heptagenia flava ROSTOCK, 1877				1
Dragonflies (Odonata)				
Gomphus flavipes (CHARPENTIER, 1825)	8	1	1	2
True bugs (Heteroptera)				
Aquarius paludum (FABRICIUS, 1794)		3		
Ranatra linearis (LINNAEUS, 1758)	1			
Caddisflies (Trichoptera)				
Hydropsyche bulgaromanorum MALICKY, 1977				1
Hydropsyche sp.	2	1		
Setodes punctatus (FABRICIUS, 1793)	1			
Beetles (Coleoptera)				
Platambus maculatus (LINNAEUS, 1758)		1		
Flies (Diptera)				
Chironominae	10	32	9	6
Tanypus punctipennis MEIGEN, 1818	1		1	

Table 12.3.3-24: List of macroscopic invertebrate taxons detected on the distant downstream section

The presence of the invasive taxons detected in the previous sections could be confirmed in this section as well, in particular the snail species *Lithoglyphus naticoides* which comes in great numbers. The presence of the brittle worm species named *Hypania invalida* and another brittle worm, *Hypania invalida* as well as the great number of individuals *Limnomysis benedeni* (Pontus) should be noted. Note that a few individuals of the protected dragonfly species called *Gomphus flavipes* were also collected. A few specimen of the mussel *Unio tumidus* were found in this section, which was only sporadically encountered elsewhere. It is important to note that a some of the species could get into the samples in such great numbers because the sampling session took place at low water stage when you can wade into the water farther away and for instance mussels living in the looser sediment of the channel bottom in a distance from the shore can not be collected at times of high water. The presence of the *Setodes punctatus* caddis fly is also important which is a typical species of major rivers, indicating good water quality and which was caught only in this section. The indicator macrozoobenthos species of the SCI area marked HUDD20023, thick shelled river mussel (*Unio crassus*) was never found in the samples.

CLASSIFICATION OF THE DISTANT DOWNSTREAM SECTION IN ACCORDANCE WITH THE WFD ON THE BASIS OF THE MACROZOOBENTHOS

In a similar manner like the other sections upstream, ecological status assessment of the section on the basis of the sampling sites was made using the HMMI (Hungarian Macroinvertebrate Multimetric Index) method (Várbíró et al. [12-42], [12-43]). The status classification grade was defined as an average of summer and autumn samples.(Table 12.3.3-25).

Distant downstream section	Summer		Autumn	
	HMMI EQR	Classification	HMMI EQR	Classification
P50DMZB 31	0.64	good	0.59	moderate
P50DMZB 32	0.57	moderate	0.38	poor
P50DMZB 41	0.36	poor	0.28	poor
P50DMZB 42	0.46	moderate	0.37	poor
average:	**HMMI EQR**		**Classification**	
	0.45		**moderate**	

Table 12.3.3-25: Ecological status assessment of the distant downstream section based on summer and autumn macrozoobenthos samples

Based on the findings of the aquatic macroscopic invertebrate community it can be stated that the ecological status of the distant downstream section was moderate (HMMI EQR: 0.45).
In summary, it can be stated that hot water discharge from the Paks Nuclear Power Plant did not cause any change to an extent of a grade leap downstream compared to upstream.

12.3.3.6 Fishes

The distant downstream section was divided up into two subsections – midstream distant and distant, respectively, – for biological elements, including fishes. Presentation of the results is also arranged accordingly below.

Findings on the midstream-distant downstream subsection

The midstream-distant downstream section consists of the sampling units taken in the Gerjen-Foktő, as well as in the Dombori profiles (PLHD4; P50DH2). Sampling of the fish community in the Gerjen profile and in the Dombori profile was accomplished in 2012 and 2013, respectively, in two periods – one in summer and one in autumn – each. Two sampling units in the two profiles each in a length of 500 metres each and 2000 metres altogether were tested on both the right and the left bank area. Sampling subunits included both natural and paved bottom profiles (see Table 12.1.5-10). Summer and autumn samples had identical sampling subunits.

A total of 3 367 individuals of 34 species were identified during the summer and autumn sampling operations in the four sampling units designated along the midstream-distant subsection.

Scientific name	English name	PLHD41	PLHD42	P50DH21	P50DH22
Eudontomyzon mariae (Berg, 1931)	Ukrainian brook lamprey	0	1	0	0
Anguilla anguilla (Linnaeus, 1758)	Eel	0	1	0	0
Rutilus rutilus (Linnaeus, 1758)	Common roach	1	1	1	1
Rutilus virgo (Heckel, 1852)	Cactus roach	1	1	0	0
Scardinius erythrophthalmus (Linnaeus, 1758)	Common rudd	0	0	0	1
Leuciscus leuciscus (Linnaeus, 1758)	Common dace	0	0	1	1
Squalius cephalus (Linnaeus, 1758)	European chub	1	0	1	1
Leuciscus idus (Linnaeus, 1758)	Ide	1	1	1	1
Aspius aspius (Linnaeus, 1758)	Balin	1	1	1	1
Alburnus alburnus (Linnaeus, 1758)	Common bleak	1	1	1	1
Blicca bjoerkna (Linnaeus, 1758)	Silver bream	1	1	1	1
Abramis brama (Linnaeus, 1758)	Bream	1	1	0	1
Ballerus sapa (Pallas, 1814)	White eye bream	1	0	1	0
Chondrostoma nasus (Linnaeus, 1758)	Nose carp	0	1	0	1
Barbus barbus (Linnaeus, 1758)	Barbel	0	1	1	1
Romanogobio vladykovi (Fang, 1943)	Danube whitefin gudgeon	1	1	1	1
Rhodeus amarus (Bloch, 1782)	European bitterling	0	0	1	0
Carassius gibelio (Bloch, 1782)	Prussian carp	0	0	1	0
Cyprinus carpio (Linnaeus, 1758)	Carp	0	0	1	0
Silurus glanis Linnaeus, 1758	European wels	1	1	1	1
Ameiurus melas (Rafinesque, 1820)	Black bullhead	1	0	0	0
Esox lucius Linnaeus, 1758	Pike	1	1	1	1

Scientific name	English name	PLHD41	PLHD42	P50DH21	P50DH22
Lota lota (Linnaeus, 1758)	Burbol	1	1	1	1
Perca fluviatilis Linnaeus, 1758	Perch	1	1	1	1
Gymnocephalus baloni Holčík & Hensel, 1974	Balon's ruffle	1	1	1	1
Gymnocephalus schraetser (Linnaeus, 1758)	Striped ruffle	0	1	1	1
Sander lucioperca (Linnaeus, 1758)	Zander	1	1	1	0
Sander volgensis (Gmelin, 1789)	Volga pikeperch	1	1	0	0
Zingel zingel (Linné, 1766)	Zingel	1	1	1	1
Proterorhinus semilunaris (Heckel, 1837)	Western tubenose goby	0	0	1	1
Neogobius fluviatilis (Pallas, 1814)	Monkey goby	1	0	1	1
Ponticola kessleri (Günther, 1861)	Bighead goby	1	1	1	1
Neogobius melanostomus (Pallas, 1814)	Round goby	1	1	1	1
Babka gymnotrachelus (Kessler, 1857)	Racer goby	1	1	1	1
Number of species:		**23**	**24**	**26**	**24**

Table 12.3.3-26: Fish species found in the midstream-distant downstream subsection

Five *(Rutilus virgo, Romanogobio vladykovi, Rhodeus amarus, Gymnocephalus baloni, Gymnocephalus schraetser)*of the species identified during sampling were protected and two of them (*Eudontomyzon mariae, Zingel zingel*) strictly protected.

Indicator species of the SCI area marked HUDD 20023 identified in this section were as follows: *Eudontomyzon mariae, Rutilus virgo, Aspius aspius, Gymnocephalus baloni, Gymnocephalus schraetser, Zingel zingel*.

Young individuals of 27 species were found in the samples. This means that 79 % of the species is present in the section in the form of progeny. This ratio is similar to the other section upstream and can also be considered a very high level.

Age group distribution of the individuals identified in the sampling units is presented on the following tables.

Summer	Adult (piece)	Offspring(piece)	Total (piece)
PLHD41	388	49	437
PLHD42	268	50	318
P50DH21	318	225	543
P50DH22	361	134	495
Autumn	**Adult (piece)**	**Offspring(piece)**	**Total (piece)**
PLHD41	482	252	734
PLHD42	217	73	290
P50DH21	231	107	338
P50DH22	118	94	212

Table 12.3.3-27: Basic data from the catch efforts at the sampling units in the midstream-distant downstream based on the summer and autumn sampling season

Total (adult plus offspring) catch per unit effort (CPUE) on the 100 metre units reflected an average level of 98 in the sampling units on the right bank during the summer sampling season, which is higher than the CPUE value of the near downstream section effected by hot water discharge. At the same time CPUE values of the sampling units on the left bank, which is not exposed to hot water showed a somewhat lower level, similar to those sampling units which were affected by the hot water.

Sample profiles	CPUE (100 m)
Upstream average based on values in **Table 12.3.1-18**	59.0
Near downstream units (affected) average based on values in **Table 12.3.2-19**	88.4
Near downstream units (non affected) average based on values in **Table 12.3.2-19**	58.5
Average of mid-distance, affected (right side) sampling units (PLHD41; P50DH21)	98.0
Average of mid-distance, non affected (left side) (PLHD42; P50DH22)	81.3

Table 12.3.3-28: Comparison of the CPUE values with the former near downstream, as well as upstream findings

Based on the 2012 and 2013 years' findings it can be stated that the species composition of the midstream-distant section did not show much deviations compared to the upper sections and the fish species structure of the sections assessed is uniform. However, the number of individuals per unit length shows a strong growth again on the midstream-distant section, the values of which exceed near downstream section levels. On one hand this result concurs with the experiences of 2009 to a great extent (SCIAP 2010), and on the other, the phenomenon does not show any changes which would correlated with the impact of the hot water. It should be noted in this context that the spawning season in 2013 was successful, as demonstrated by the high ratio of species with offspring and the high number of young individuals. This applies to all profiles assessed. In 2013 the lower water levels and lower water temperature in the autumn season – reflecting a true autumnal aspect of the river – resulted in a more homogeneous mass of data than the summer aspect, assisting lower scale analysis effectively. All in all, the outcome of the sampling efforts carried out in both seasons resulted an appropriate data set for the purposes of water quality classification according to the WFD requirements.

CLASSIFICATION OF THE MIDSTREAM-DISTANT DOWNSTREAM SECTION IN ACCORDANCE WITH THE WFD ON THE BASIS OF THE FISH COMMUNITY

Ecological status assessment was completed for the midstream-distant section in accordance with the WFD criteria (Halasi-Kovács et al. [12-17]). Classification was completed on the basis of the sampling units PLHD41; PLHD42, P50DH21, P50DH22, the total length of a 2 000 metres long profile. Although summer sampling should be considered relevant on the basis of the EQIHRF protocol, classification was also made according to the autumn samples. However, for the purposes of the outcomes, the summer results were accepted as relevant.

Mid-distance downstream section summer	Number of scores	Value
1. Relative abundance of the omnivorous species (%)	72.03	4
2. Relative abundance of the open water species	4.00	4
3. Relative abundance of the metaphyte species (%)	7.94	5
4. Number of benthic species (piece)	19.00	4
5. Number of litophile species (piece)	8.00	5
6. Relative abundance of the phytophile species (%)	1.26	3
7. Number of rheophilic species(piece)	12.00	4
8. Relative abundance of the stagnophile species (%)	0.45	3
9. Relative abundance of the specialist species (%)	31.82	4
10. Relative abundance of the indigenous species (%)	76.04	2
Total number of scores		**38**
Classification		**good**

Table 12.3.3-29: Results of the ecological status assessment based on the summer sampling season on the midstream-distant section

Mid-distance downstream section Autumn	Number of scores	Value
1. Relative abundance of the omnivorous species (%)	41.03	4
2. Relative abundance of the open water species	3.00	3
3. Relative abundance of the metaphyte species (%)	6.93	5
4. Number of benthic species (piece)	20.00	5
5. Number of litophile species (piece)	6.00	4
6. Relative abundance of the phytophile species (%)	2.28	4
7. Number of rheophilic species(piece)	10.00	4
8. Relative abundance of the stagnophile species (%)	1.42	4
9. Relative abundance of the specialist species (%)	56.79	5
10. Relative abundance of the indigenous species (%)	49.19	1
Total number of scores		**39**
Classification		**good**

Table 12.3.3-30: Results of the ecological status assessment along the midstream-distant downstream section based on the data from the autumn sampling session

The ecological status of the midstream-distant section equals with that of the upstream, as well as the near downstream section.

Based on the findings of the assessment it can be stated that the ecological status of the midstream-distant downstream section of the Danube according to the fish community analysis was good.

Findings of the distant downstream subsection, fishes

The midstream-distant downstream section consists of the sampling units taken in the Sió South profile. Sampling of the fish community was accomplished in 2013, in two periods – one in summer and one in autumn – each. Two sampling units in the two profiles each in a length of 500 metres each and 2000 metres altogether were tested on both the right and the left bank area. Sampling subunits included both natural and paved bottom profiles (see Table 12.1.5-10). Summer and autumn samples had identical sampling subunits. A total of 4 151 individuals of 33 species were identified during the summer and autumn sampling operations in the four sampling units designated along the distant downstream subsection.

Scientific name	English name	P50DH31	P50DH32	P50DH41	P50DH42
Eudontomyzon mariae (Berg, 1931)	Ukrainian brook lamprey	0	0	0	1
Anguilla anguilla (Linnaeus, 1758)	Eel	0	1	1	0
Rutilus rutilus (Linnaeus, 1758)	Common roach	1	1	1	1
Rutilus virgo (Heckel, 1852)	Cactus roach	1	1	0	0
Scardinius erythrophthalmus (Linnaeus, 1758)	Common rudd	0	1	0	0
Squalius cephalus (Linnaeus, 1758)	European chub	1	1	1	1
Leuciscus idus (Linnaeus, 1758)	Ide	1	1	1	1
Aspius aspius (Linnaeus, 1758)	Balin	1	1	1	1
Alburnus alburnus (Linnaeus, 1758)	Common bleak	1	1	1	1
Blicca bjoerkna (Linnaeus, 1758)	Silver bream	1	1	1	1
Abramis brama (Linnaeus, 1758)	Bream	1	1	1	1
Ballerus sapa (Pallas, 1814)	White eye bream	0	0	1	1
Chondrostoma nasus (Linnaeus, 1758)	Nose carp	1	1	0	1
Barbus barbus (Linnaeus, 1758)	Barbel	1	0	0	1
Romanogobio vladykovi (Fang, 1943)	Danube whitefi gudgeon	1	1	1	1
Pseudorasbora parva (Temminck & Schlegel, 1846)	Stone morocco	0	0	1	0
Rhodeus amarus (Bloch, 1782)	European bitterling	0	1	1	1
Carassius gibelio (Bloch, 1782)	Prussian carp	1	1	1	1
Cyprinus carpio (Linnaeus, 1758)	Carp	1	0	0	0
Silurus glanis Linnaeus, 1758	European wels	1	1	1	0
Esox lucius Linnaeus, 1758	Pike	1	1	1	1
Lota lota (Linnaeus, 1758)	Burbol	1	1	1	1
Perca fluviatilis Linnaeus, 1758	Perch	1	1	1	1
Gymnocephalus baloni Holčík & Hensel, 1974	Balon's ruffle	1	1	1	1
Gymnocephalus schraetser (Linnaeus, 1758)	Striped ruffle	1	1	1	1
Sander lucioperca (Linnaeus, 1758)	Zander	1	1	1	1
Sander volgensis (Gmelin, 1789)	Volga pikeperch	1	0	0	0
Zingel zingel (Linné, 1766)	Zingel	1	1	0	1
Proterorhinus semilunaris (Heckel, 1837)	Western tubenose goby	0	1	1	1
Neogobius fluviatilis (Pallas, 1814)	Monkey goby	1	1	1	1
Ponticola kessleri (Günther, 1861)	Bighead goby	1	1	1	1
Neogobius melanostomus (Pallas, 1814)	Round goby	1	1	1	1
Babka gymnotrachelus (Kessler, 1857)	Racer goby	1	1	1	1
Number of species:		**26**	**27**	**25**	**26**

Table 12.3.3-31: Fish species found in the distant downstream subsection

Five *(Rutilus virgo, Romanogobio vladykovi, Rhodeus amarus, Gymnocephalus baloni, Gymnocephalus schraetser)*of the species identified during sampling were protected and two of them (*Eudontomyzon mariae, Zingel zingel*) strictly protected.

Indicator species of the SCI area marked HUDD 20023 identified in this section were as follows: *Eudontomyzon mariae, Rutilus virgo, Aspius aspius, Gymnocephalus baloni, Gymnocephalus schraetser, Zingel zingel*.

Young individuals of 27 species were found in the samples. This means that 79 % of the species is present in the section in the form of progeny. This ratio is similar to the other section upstream and can also be considered a very high level.

Age group distribution of the individuals identified in the sampling units is presented on the following tables.

Summer	Adult (piece)	Offspring(piece)	Total (piece)
P50DH31	198	179	377
P50DH32	205	489	694
P50DH41	279	274	553
P50DH42	328	607	935
Autumn	**Adult (piece)**	**Offspring(piece)**	**Total (piece)**
P50DH31	333	191	524
P50DH32	162	123	285
P50DH41	256	183	439
P50DH42	159	185	344

Table 12.3.3-32 Basic data from the catch efforts at the sampling units on the distant downstream section

Total (adult plus offspring) catch per unit effort (CPUE) on the 100 metre units reflected an average level of 93 in the sampling units on the right bank during the summer sampling season, which is higher than the CPUE value of the near downstream section effected by hot water discharge. At the same time CPUE values of the sampling units on the left bank, which is not exposed to hot water showed are extremely high, which is caused by the high number of young individuals. This observation clearly refers to the offspring discharge of the Gemenc branch system of the river.

Sample profiles	CPUE (100 m)
Upstream average based on values in Table 12.3.1-18	59.0
Near-downstream units (affected) average based on values in Table 12.3.2-19	58.5
Mid-downstream units (non affected) average based on values in Table 12.3.3-28	81.3
Near-downstream units (affected) average based on values in Table 12.3.2-19	88.4
Mid-downstream units (affected) average based on values in Table 12.3.3-28	98.0
Average of distant, affected (right side) sampling units (P50DH31; P50DH41)	93.0
Average of distant, non affected (left side) (P50DH32; P50DH42)	162.9

Table 12.3.3-33: Comparison of the CPUE values with the downstream, as well as upstream findings

Based on the results it can be stated that the species inventory in the distant downstream section, and in the downstream sections as such, reflects a lot of similarities to the upstream sections. In other words, the hot water discharge of the Paks Nuclear Power Plant does not cause any changes. No species disappears or appears as an effect thereof.

At the same time changes can be observed in the levels of abundance. Number of individuals on the distant section in unit length exceeded that of the downstream section.

In 2013 the lower water levels and lower water temperature in the autumn season – reflecting a true autumnal aspect of the river – resulted in a more homogeneous mass of data than the summer aspect, assisting lower scale analysis effectively. All in all, the outcome of the sampling efforts carried out in both seasons resulted an appropriate data set for the purposes of water quality classification according to the WFD requirements.

CLASSIFICATION OF THE DISTANT DOWNSTREAM SECTION IN ACCORDANCE WITH THE WFD ON THE BASIS OF THE FISH COMMUNITY

Ecological status assessment was completed for the distant section in accordance with the WFD criteria (Halasi-Kovács et al. [12-17]). Classification was completed on the basis of the sampling units P50DH31, P50DH32, P50DH41, P50DH42, the total length of a 2 000 metres long profile. Although summer sampling should be considered relevant on the basis of the EQIHRF protocol, classification was also made according to the autumn samples. However, for the purposes of the outcomes, the summer results were accepted as relevant.

Distant downstream section summer	Number of scores	Value
1. Relative abundance of the omnivorous species (%)	66.04	4
2. Relative abundance of the open water species	3.00	3
3. Relative abundance of the metaphyte species (%)	14.17	4
4. Number of benthic species (piece)	18.00	4
5. Number of litophile species (piece)	7.00	4
6. Relative abundance of the phytophile species (%)	2.76	4
7. Number of rheophilic species(piece)	11.00	4
8. Relative abundance of the stagnophile species (%)	1.38	4
9. Relative abundance of the specialist species (%)	37.01	5
10. Relative abundance of the indigenous species (%	71.56	2
Total number of scores		**38**
Classification		**good**

Table 12.3.3-34: Results of the ecological status assessment along the distant downstream section based on the data from the summer sampling session

Distant downstream section Autumn	Number of scores	Value
1. Relative abundance of the omnivorous species (%)	51.47	5
2. Relative abundance of the open water species	3.00	3
3. Relative abundance of the metaphyte species (%)	4.03	4
4. Number of benthic species (piece)	19.00	4
5. Number of litophile species (piece)	7.00	4
6. Relative abundance of the phytophile species (%)	2.50	4
7. Number of rheophilic species(piece)	11.00	4
8. Relative abundance of the stagnophile species (%)	2.18	5
9. Relative abundance of the specialist species (%)	46.14	5
10. Relative abundance of the indigenous species (%	62.24	2
Total number of scores		**40**
Classification		**good**

Table 12.3.3-35: Results of the ecological status assessment along the distant downstream section based on the data from the autumn sampling session

Based on the findings of the assessment it can be stated that the ecological status of the distant downstream section of the Danube according to the fish community analysis was good.

In summary it can be stated that no grade level changes were caused by the Paks Nuclear Power Plant hot water discharge downstream when compared to the status upstream.

12.3.4 COMPREHENSIVE ASSESSMENT OF THE DANUBE SECTION BELONGING TO THE BODY OF WATER MARKED HURWAEP444 FROM THE WILDLIFE CONSERVATION AND WFD PERSPECTIVE

12.3.4.1 Physical and chemical parameters of the water

12.3.4.1.1 Classification of the assessed Danube sections according to the WFD on the basis of the 2012-2013 studies

Profile number	Name of section	Danube river km	Testing date	Profile status	Location of the Danube profile assessed
0	**Dunaföldvár (road bridge**	1560.	2013	**good status**	Distant **upstream** Danube study profile
1	**Paks (ferry)**	1534.	2012		Near **upstream** Danube study profile
2	**Paks hot water canal**	1526.	2012	**good status**	Direct **downstream** Danube study profile
3	**Nagysarkantyú**	1525.	2012		Direct **downstream** Danube study profile
4	**Uszód**	1524.	2012		Direct **downstream** Danube study profile
5	**Gerjen-Foktő**	1516.	2012		Direct **downstream** Danube study profile
6	**Fadd-Dombori**	1506.	2013	**good status**	Distant **downstream** Danube study profile
7	**Sió-South (Gemenc)**	1496.	2013		Distant **downstream** Danube study profile
8	**Baja (road bridge)**	1481.	2013		Distant **downstream** Danube study profile

Table 12.3.4-1: Classification of the Danube sections assessed (1560.6-1481.5 river km) according to the WFD

*A classification of the Danube section in accordance with the outcomes of the investigations carried out in 2012 and in the second half of 2013 from the ecological perspective, based on the physico-chemical parameters according to the WFD: **good status**.*

12.3.4.1.2 Theoretical impact of the warmed cooling water from Paks Nuclear Power Plant the assessed Danube sections

On the basis of the test results obtained from Core Network study profiles between 1979 and 2004 **it can be stated that water quality changes appear in the case of most elements more expressively as a function of time than as a function of the place**. Changes in the physico-chemical parameters are influenced by various processes in space and time, including the following key factors:

When the sampling points situated upstream and downstream of the Paks Nuclear Power Plant are taken into account, *water quality conditions showed a favourable tendency in terms of time* for most sampling sites and quality parameters. Quality at the sampling sites situated downstream of the Paks Nuclear Power Plant (Fajsz, Baja, Mohács, Hercegszántó) usually no difference could be detected in water quality compared to that upstream (Dunaföldvár). This means that **with respect to the elements assessed the Nuclear Plant did not play any significant role in the tendencies observed in the water quality of the Danube**.

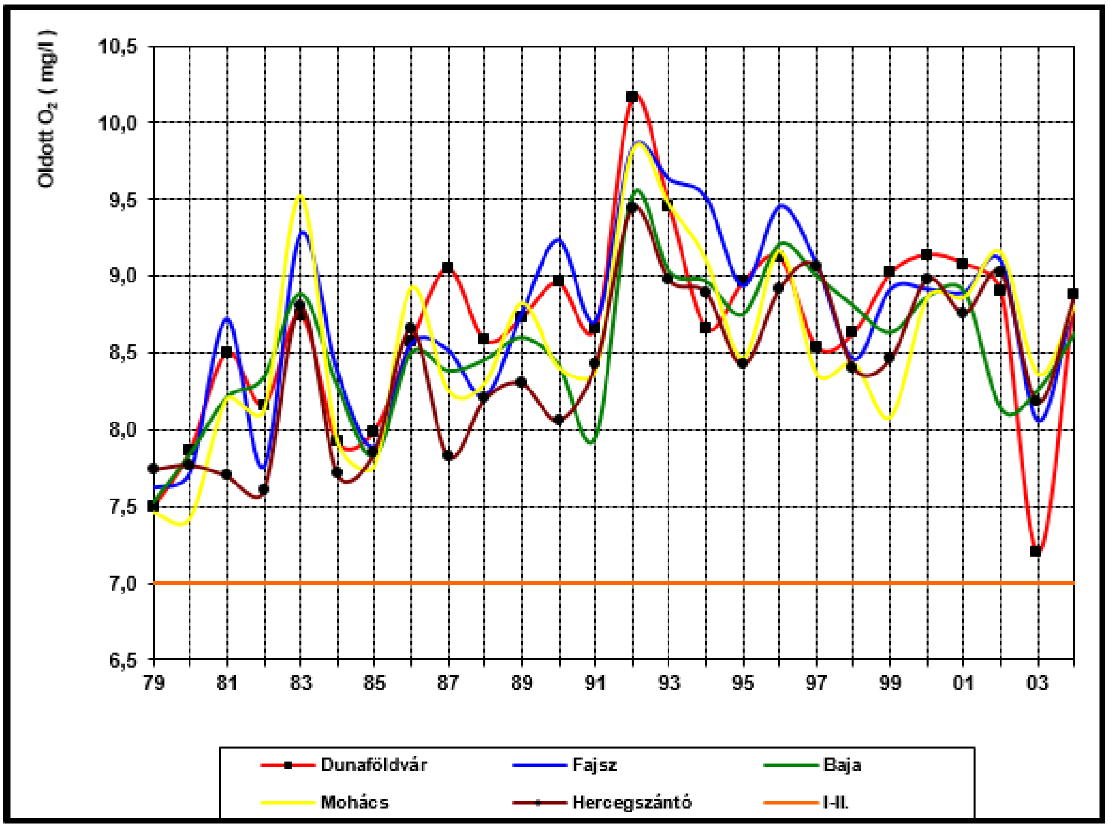
Calculations carried out with the help of linear trend analysis demonstrated that in terms of long term temporal tendency water quality reflected a tendency of impairment across the 26 years assessed only in terms of ***coliform counts, copper and water temperature*** (water temperature in August), the other parameters were characterised by improvement or a stagnant state. Limit values clearly reflected the water quality grade leaps which have occurred over time, which is strikingly unanimous for certain components and applies to almost all sampling sites. As it can be seen, changes over time during the period assessed was a lot more significant than the concentration change in the parameters tested with respect to the direction of the water flow.

In connection with the increases in water temperature it can be stated that it was not any higher Fajsz than at Dunaföldvár, clearly demonstrating that the Nuclear Power Plant has no detectable impact on the temperature regime of the Danube with respect to samples taken midstream. The warmed up cooling water is in fact Danube water from the right bank. Its quality is also influenced by the chemical composition of the treated municipal waste water from Madocsa community and the treated municipal waste water of Paks city, discharged into the main stream line about 500 metres upstream from the cold water canal.

In accordance with the evaluation with respect to the element groups specified by the Hungarian standard No MSZ 12749:1993 the **oxygenation conditions parameters** typical indicators for organic matter content (BOD_5, COD_{ps} and COD_{Cr}) reflected a standard declining trend. However, specific fluctuations can be seen in the annual averages. One of the reasons can be assumed as the changes in the water regime. ***Namely, the organic matter loads transported by the Danube water becomes concentrated during the dry periods lacking sufficient precipitation***. Dissolved oxygen content reacts sensitively to the symptoms of life taking place in the water. Oxygen for aquatic life can be derived from oxygen rich water inlets, diffusion from the atmosphere and from photosynthesis. Key processes consuming it include respiration, decay and mineralisation of organic mater and ventilation to the air in case of oversaturation. Organic contamination equals water pollution, the formula is self-explanatory: too much organic matter, too many micro-organisms, little oxygen, bad water quality. The aforementioned values practically never changed along the river section under consideration during the period assessed.

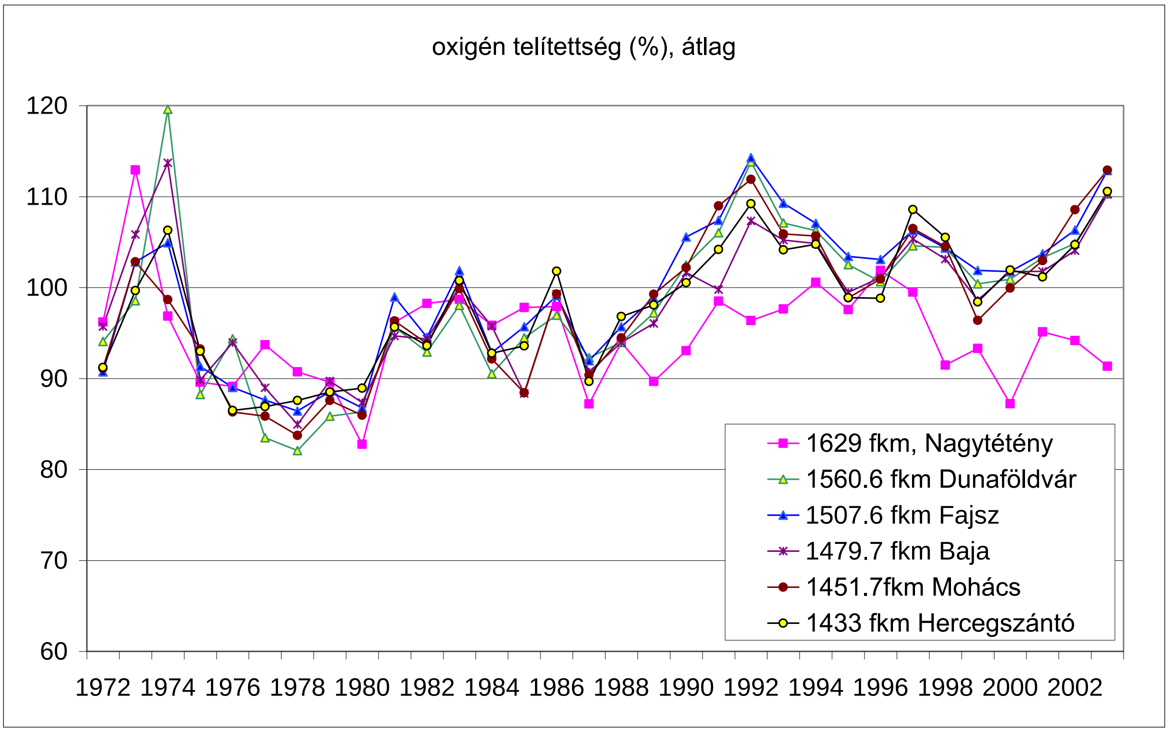
Namely, reduction of the biologically degradable organic matter content in the river takes place at a slower rate than the changes in the chemical oxygen demand. In other words, COD and BOD ratios are shifted in a characteristic manner. This happened basically due to the joint effect of two distinct processes. As a result of the waste water treatment plant programmes biologically degradable organic matter content of the river id continuously reduced, however, as a consequence of the plant nutrient loads which remained – otherwise also on a declining trend – algal production may be increased. Nevertheless, no substantial changes can be expected in the future in terms of the trends of the changes and of the values referred to above.

The studies investigating the temporal changes observable in water chemical parameters prepared on the basis of the Core Network data were analysed and processed in a graphic representation as part of the lifetime extension project of the Paks Nuclear Power Plant by VITUKI Kht. The findings of the graphic representations were described on the tables between Figure 12.3.4-1 and Figure 12.3.4-16.



Oldott - dissolved

Figure 12.3.4-1: Dissolved oxygen 90 % constancy in the Danube (Core Network measurements 1979-2004.)



oxigén telítettség – oxygen saturation
átlag - average

Figure 12.3.4-2: Changes in oxygen saturation in the Danube at the Bp.-Hercegszántó section (Core Network measurements annual average 1972-2003.)

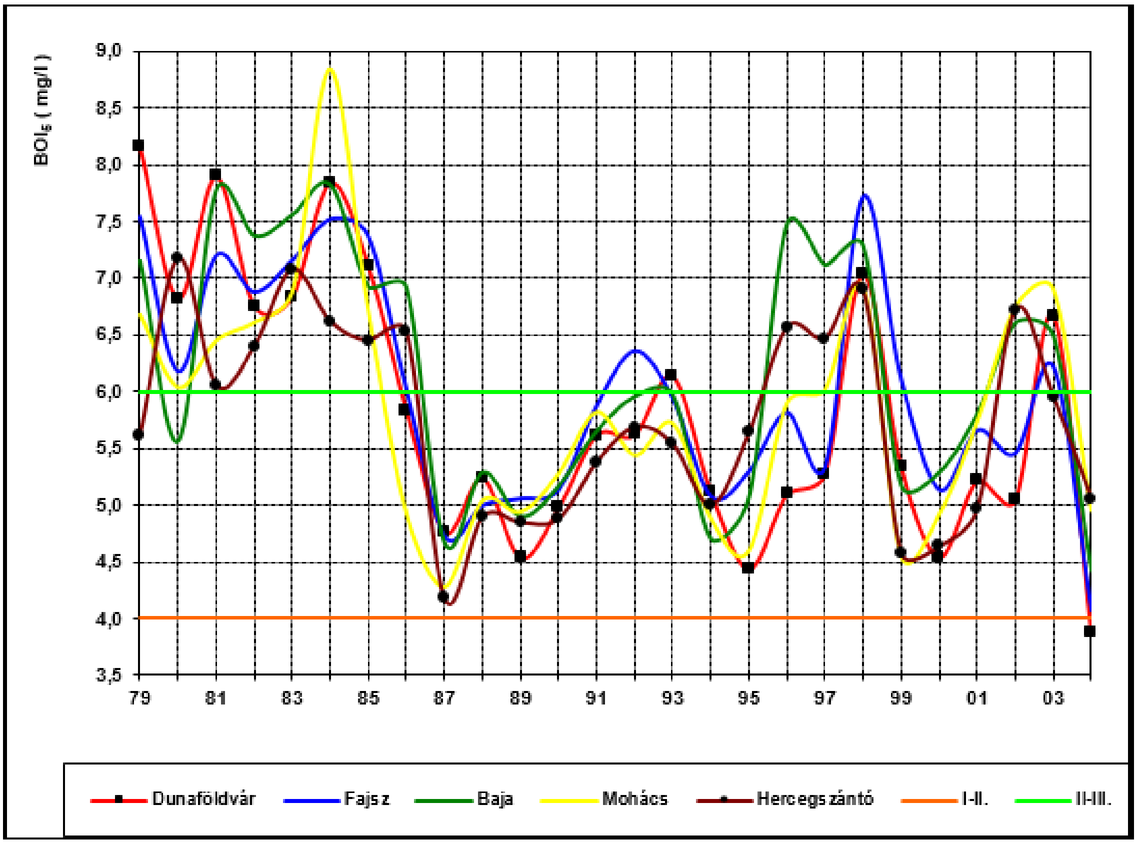
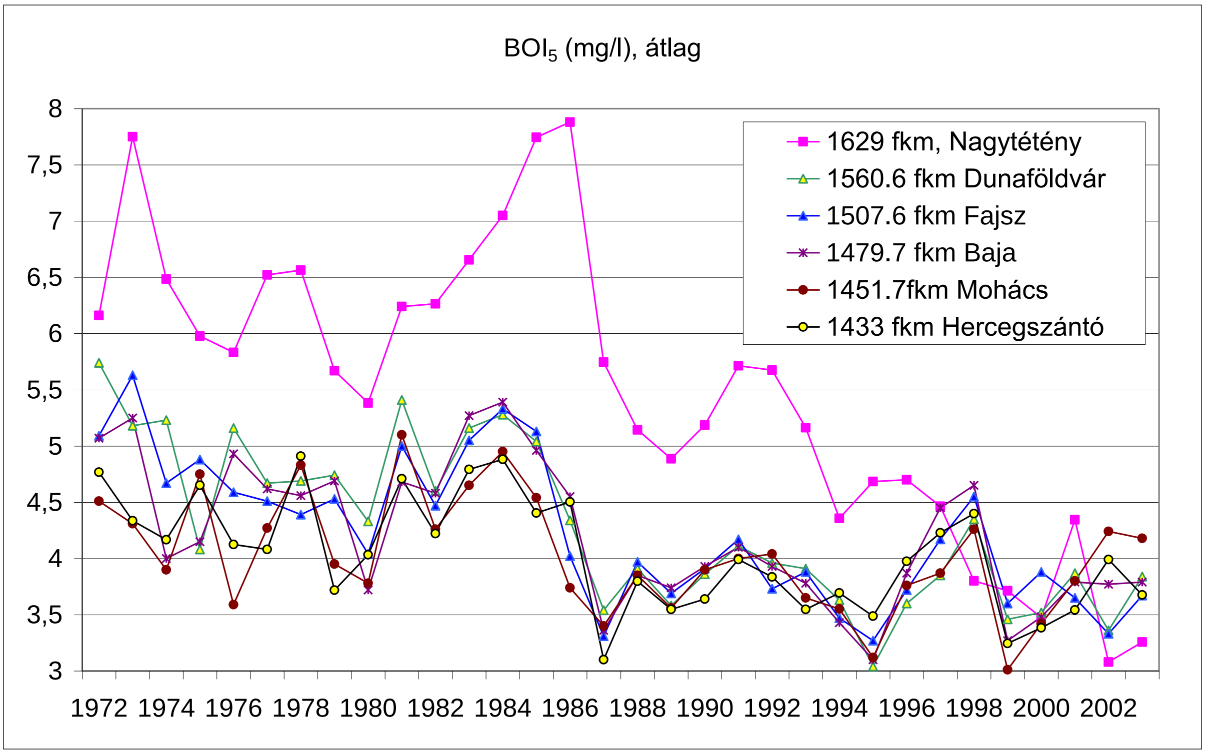


Figure 12.3.4-3: Danube BOD_5 90 % constancy values (Core Network measurements 1979-2004.)



átlag - average

Figure 12.3.4-4: Danube BOD_5 variations along the Bp.-Hercegszántó section (Core Network measurements annual average 1972-2003.)

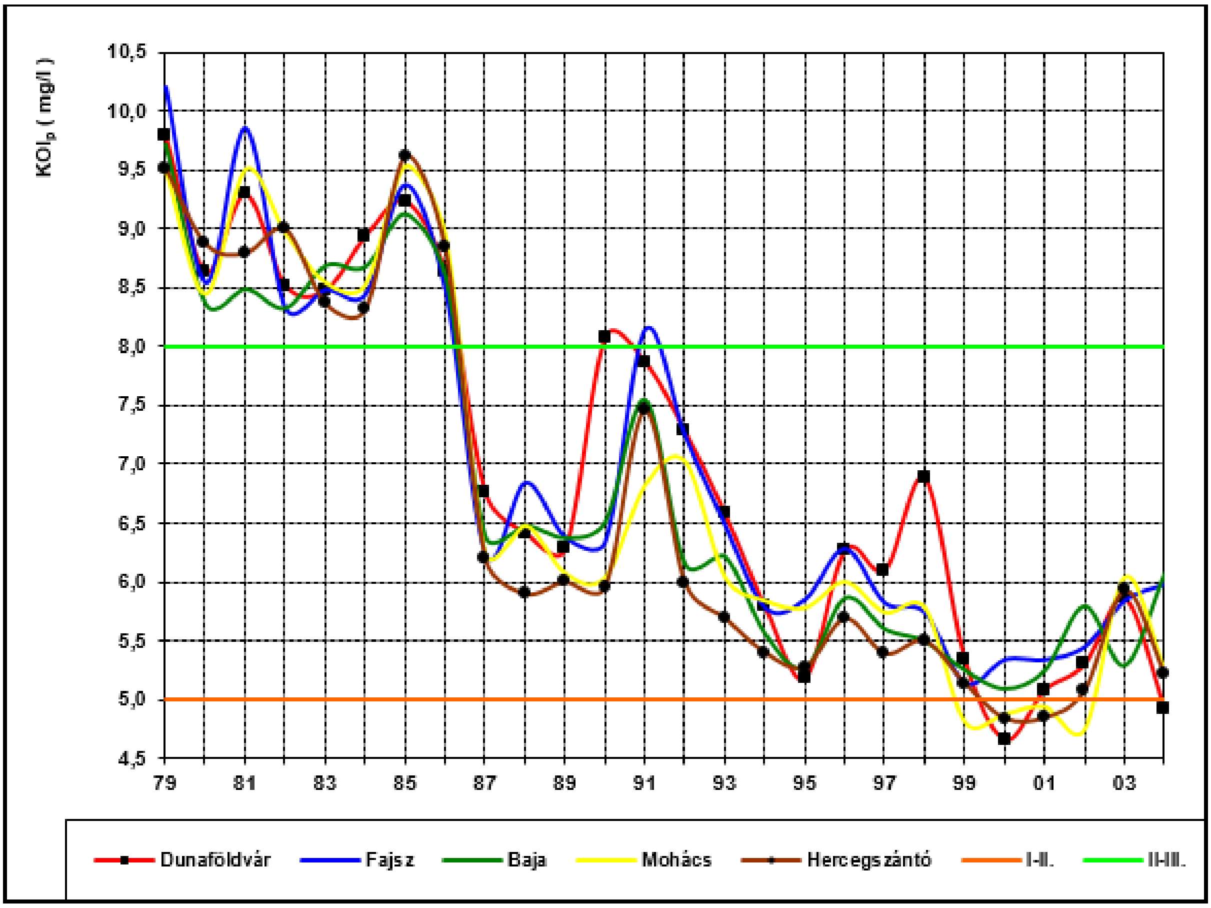


Figure 12.3.4-5: Dissolved CODp 90 % constancy values on the Danube (Core Network measurements 1979-2004.)

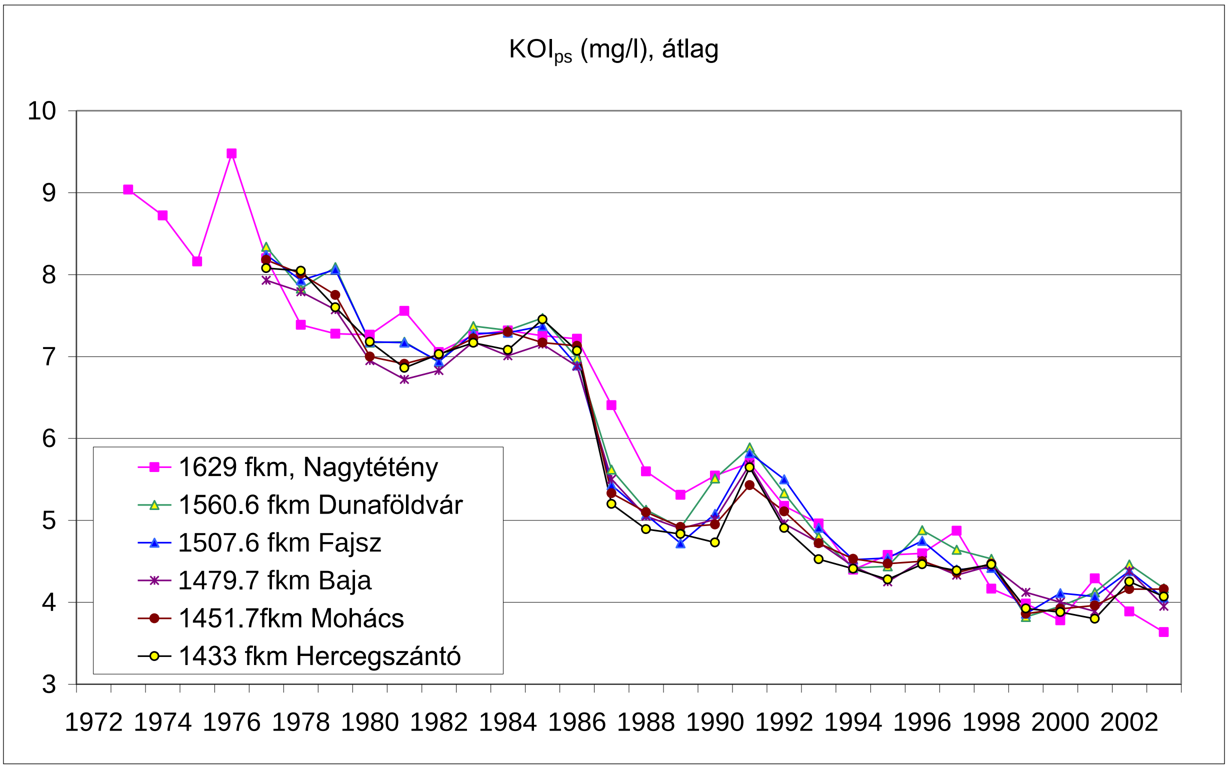


Figure 12.3.4-6: Danube CODps level changes, Bp.-Hercegszántó section (Core Network measurements annual average 1972-2003.)

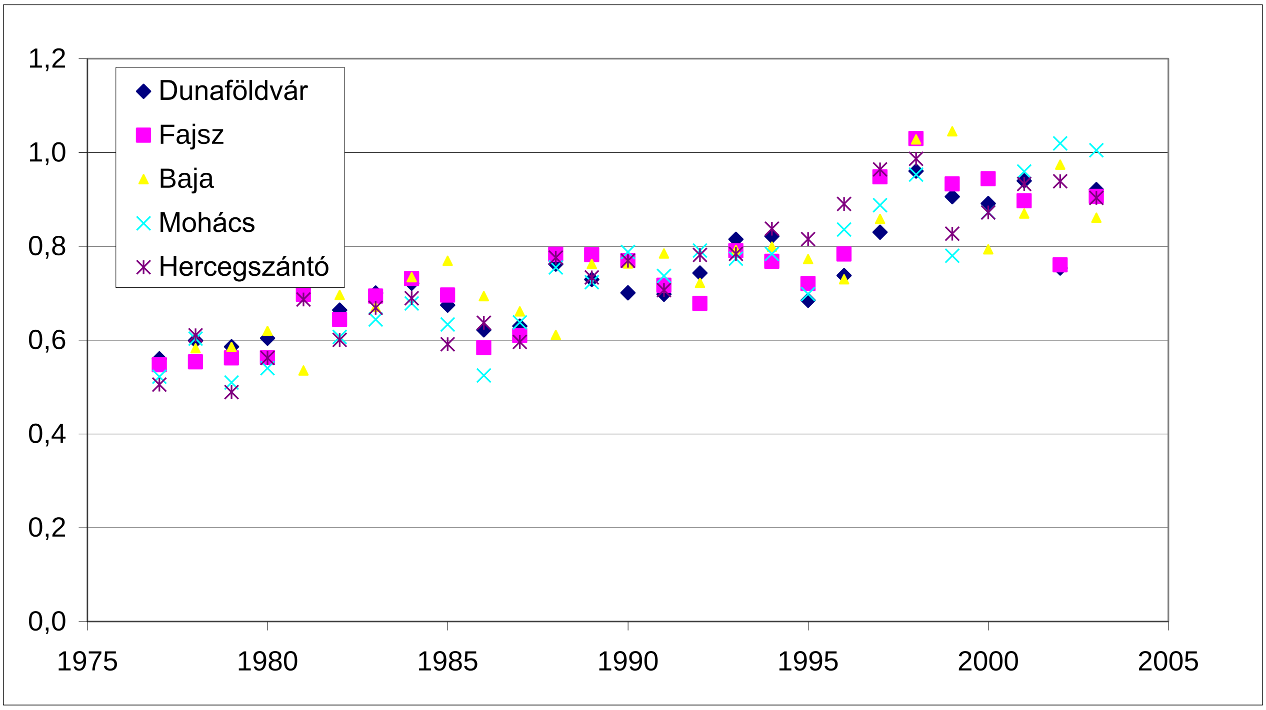


Figure 12.3.4-7: Changes in Danube BOD_5/CODps levels, Bp.-Hercegszántó section (Core Network measurements annual average 1972-2003.)

The other group of elements which might be exposed to changes due to the impact of warmed up cooling water included **plant nutrients**. The trends show a similarly encouraging picture, what is more, in certain cases even a more radical drop could be stated. One of the reasons is the supplementary treatment of waste water originating from point sources of pollution at the biological waste water treatment plants (nitrification, chemical precipitation of phosphorus), and the decrease of the amount of synthetic fertilisers washing off from agricultural areas by an order of magnitude. These processes in themselves are very complicated in themselves, and very little is known of their relative importance, but anyhow, they are influenced in the Paks Nuclear Power Plant area by the warmed up cooling water in addition to the natural purification processes of the river. ***The impact of the latter can be determined by comparing the water quality statuses upstream and downstream of the outlet***.

The quantity of **ammonia/ammonium, nitrite, nitrate ions, organic nitrogen and total nitrogen** is determined by the elemental nitrogen fixing activity of the bacteria and blue algae, but they can also be transported to the water in great quantities from waste waters by nitrification and denitrification. If untreated waste water containing organic matter is discharged into a watercourse, the level of nitrite, organic nitrogen and later total nitrogen contents in the water will grow dramatically. Highest values can be observed in periods of cold water.

When total nitrogen levels are high, this refers to an abundant external source, or vivid nitrogen fixing activity. Any major amount of nitrate may result in intensive algal growth and the associated eutrophication under favourable meteorological and hydrological conditions.

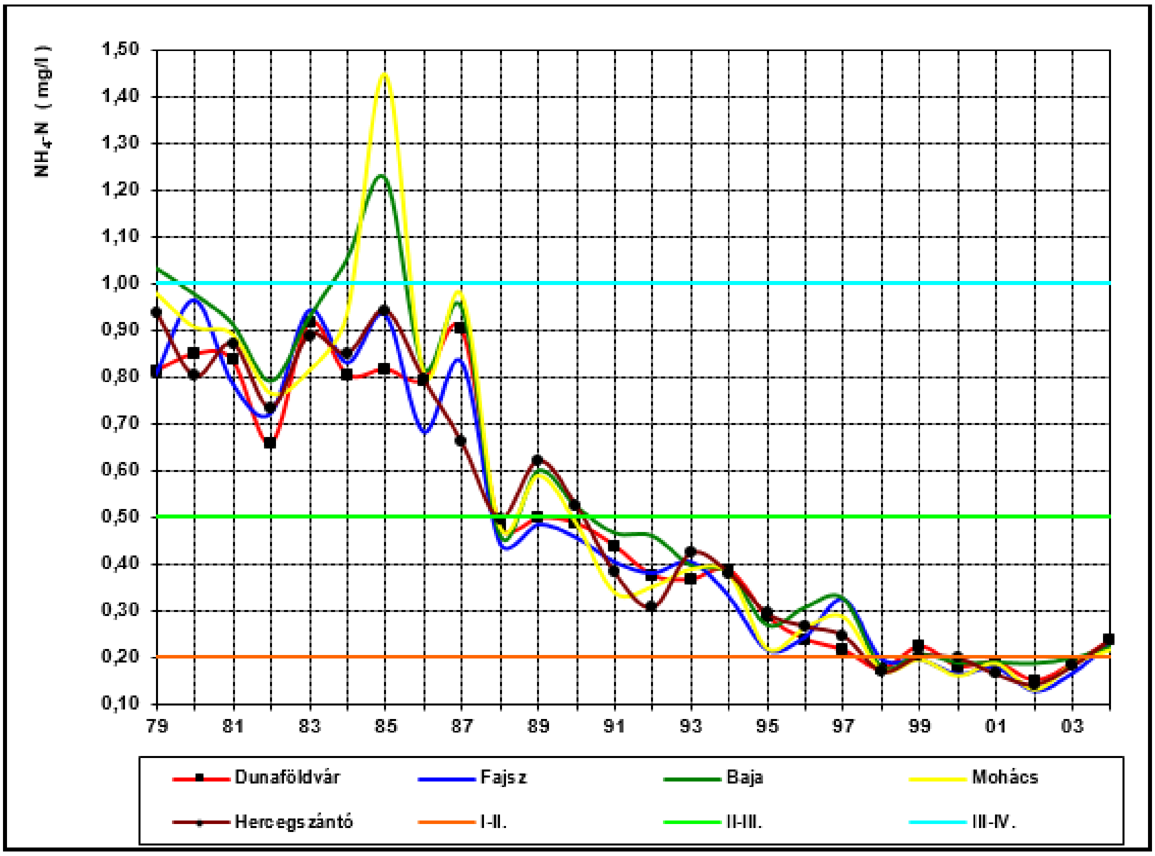
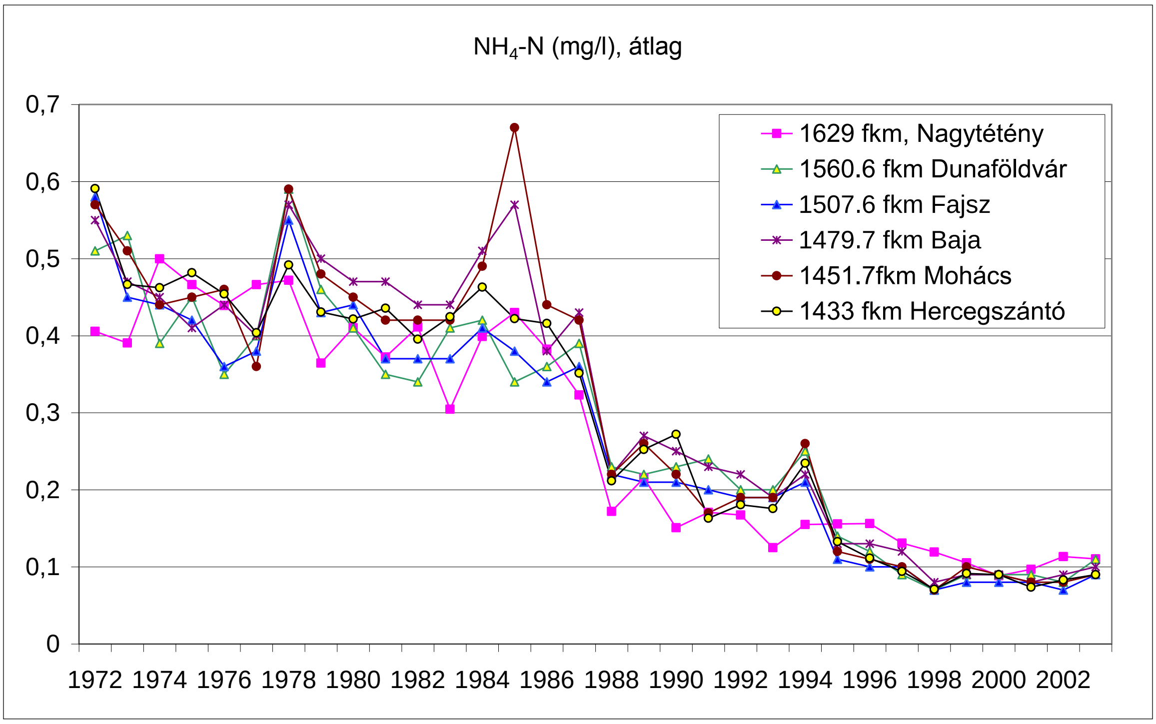


Figure 12.3.4-8: Dissolved NH_4-N 90 % constancy values in the Danube (Core Network measurements 1979-2004.)



átlag – average

Figure 12.3.4-9: Changes in the NH_4-N levesl on the Danube, Bp.-Hercegszántó section (Core Network measurements annual average 1972-2003.)

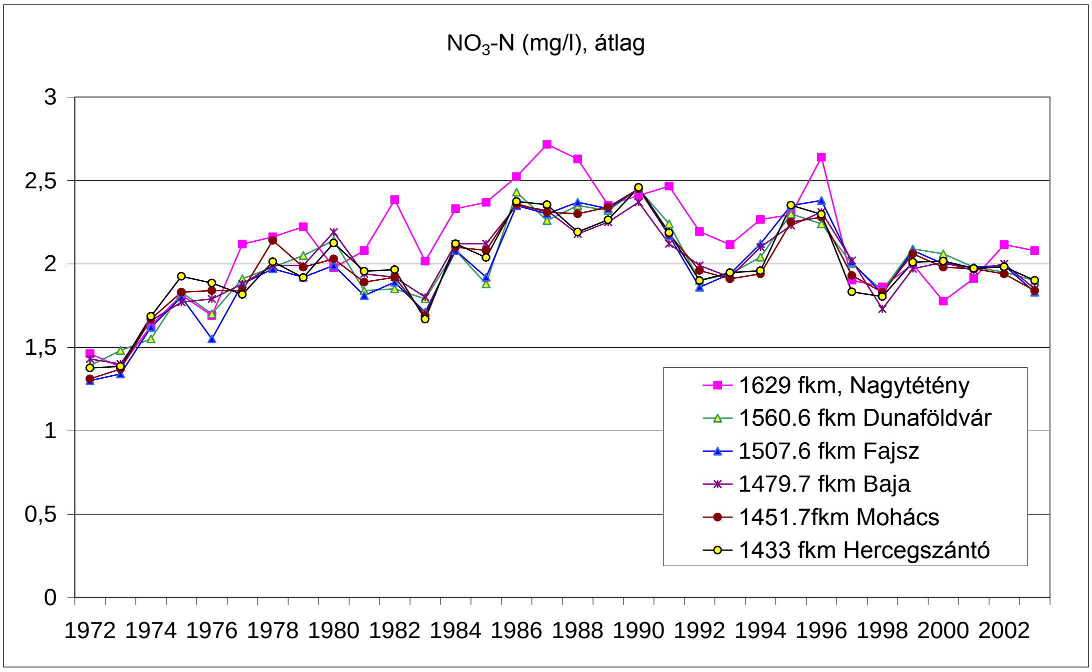


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Figure 12.3.4-10: Changes in the NO_3-N levels on the Danube, Bp.-Hercegszántó section (Core Network measurements annual average 1972-2003.)

From the perspective environmental physiology *one of the most important elements building up living organisms is phosphorus*, because its ratio – compared to the other biological elements – is a lot higher in the body of living organisms than in the environment. Phosphorus, present only in a very low level in surface waters as a default, *is one of the key factors in eutrophication*. Its most common forms include *orto-phosphate phosphorus and total phosphorus*. Waters receive it in a natural way from the soil or rocks as degradation products of organic matter, or by human intervention through artificial fertilisation. Algal growth in surface waters is determined primarily by the amount of dissolved reactive phosphorus.

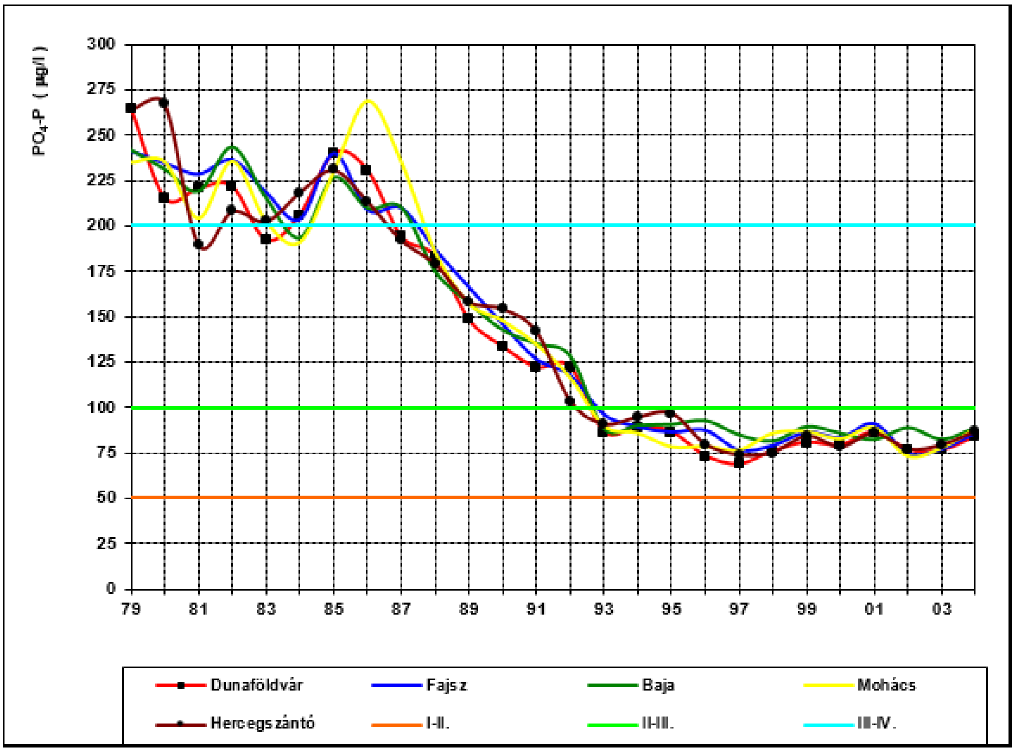
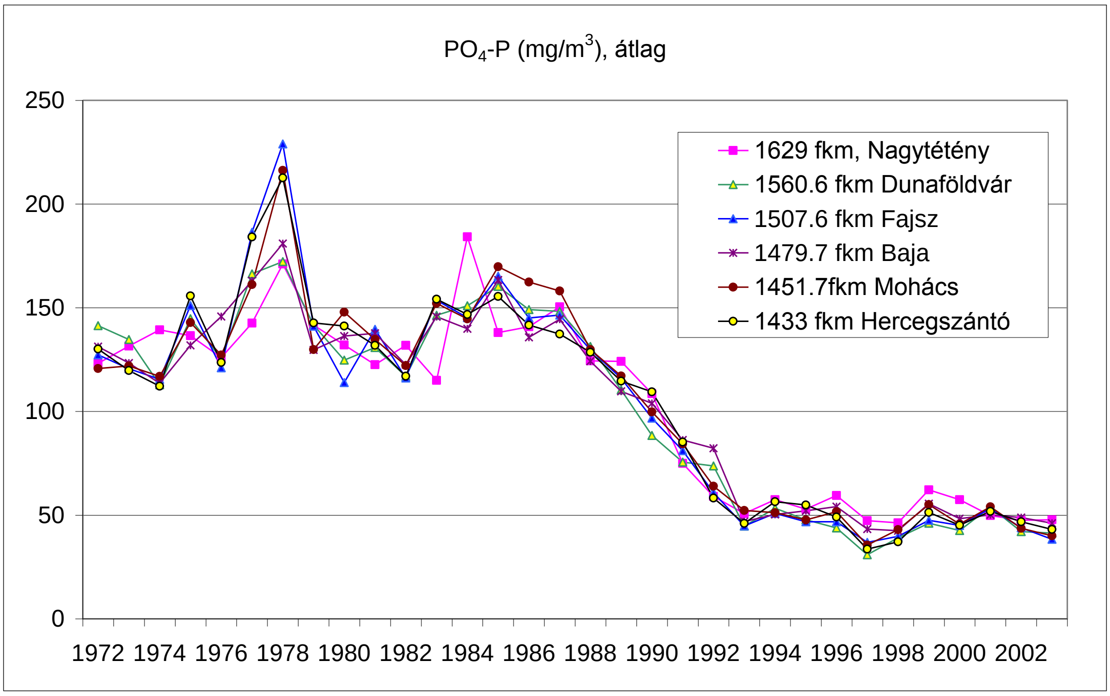


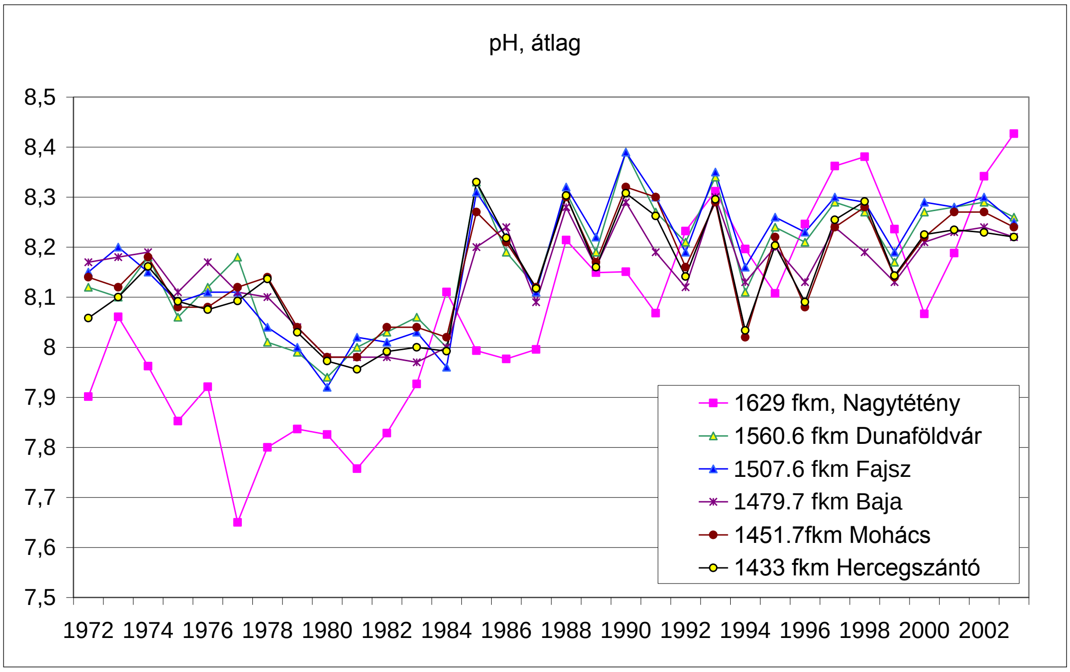
Figure 12.3.4-11: PO_4-P 90% constancy levels in the Danube (Core Network measurements 1979-2004.)



átlag – average

Figure 12.3.4-12: Changes in PO_4-P levels in the Danube, Bp.-Hercegszántó section (Core Network measurements annual average 1972-2003.)

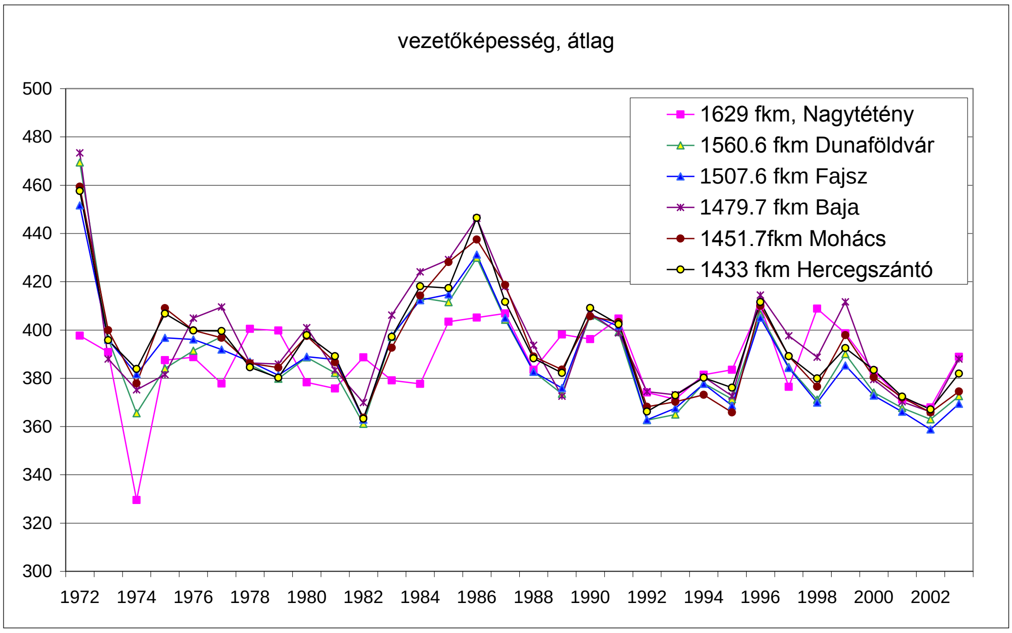
Of the other **indicators, pH** and **electrical conductivity** indicate the impacts of municipal waste water discharges into surface waters. Evaluation of the pH values assumes that certain more complex hydrobiological processes such as photosynthesis or degradation impact are taken into account. The former increase, the latter decrease pH in water, but temperature dependency of the processes of biodegradation may also change pH levels.



átlag – average

Figure 12.3.4-13: Changes of the pH in the Danube, Bp.-Hercegszántó section (Core Network measurements annual average 1972-2003.)

Specific electrical conductivity is a parameters suited to determine changes occurring in the quality of surface waters. In such cases however, composition of the dissolved inorganic substances in addition to their quantities is also a decisive factor, therefore the specification of the dominant anions and cations is also necessary. Their level is practically not influences by living organisms. Provided this section of the Danube is not exposed to any further pollution no additional pollution sources are identified, the levels will practically not change.



vezetőképesség, átlag – conductivity, average

Figure 12.3.4-14: Changes in specific conductivity (µS/cm) of the Danube, Bp.-Hercegszántó section (Core Network measurements annual average 1972-2003.)

A**-chlorophyll**, found in green plant cells, produces oxygen and organic matter with the help of the solar radiation energy of the Sun. You can conclude from its quantity to the amount of phytoplankton and photosynthetic capacity. In the event no major phytoplankton stocks are formed, the extent of intensification of eutrophication does not change along the longitudinal profile, and water quality does not change substantially, either. *Findings of the tests carried out in the area indicate that the current trends may only be changed by significant and permanent low water levels and the associated increase in temperature.*

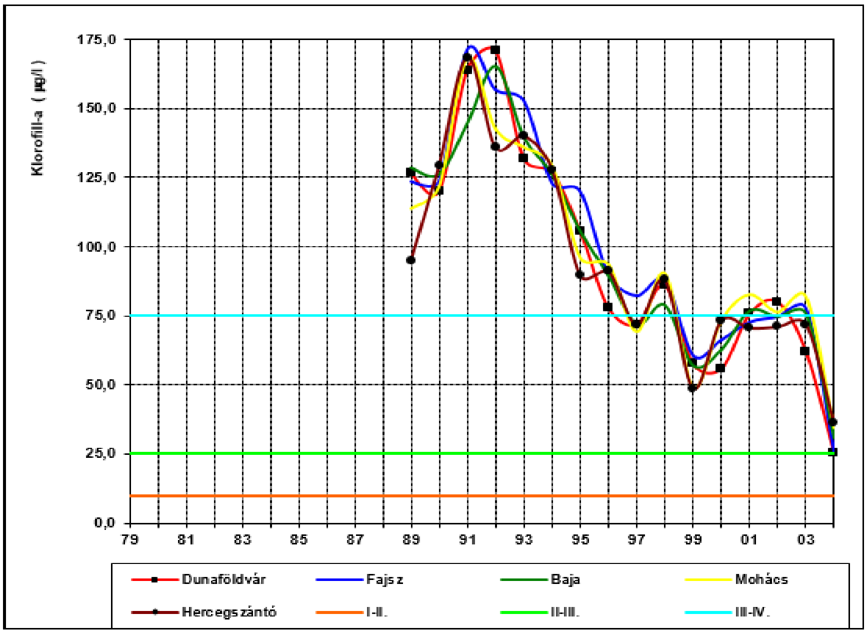


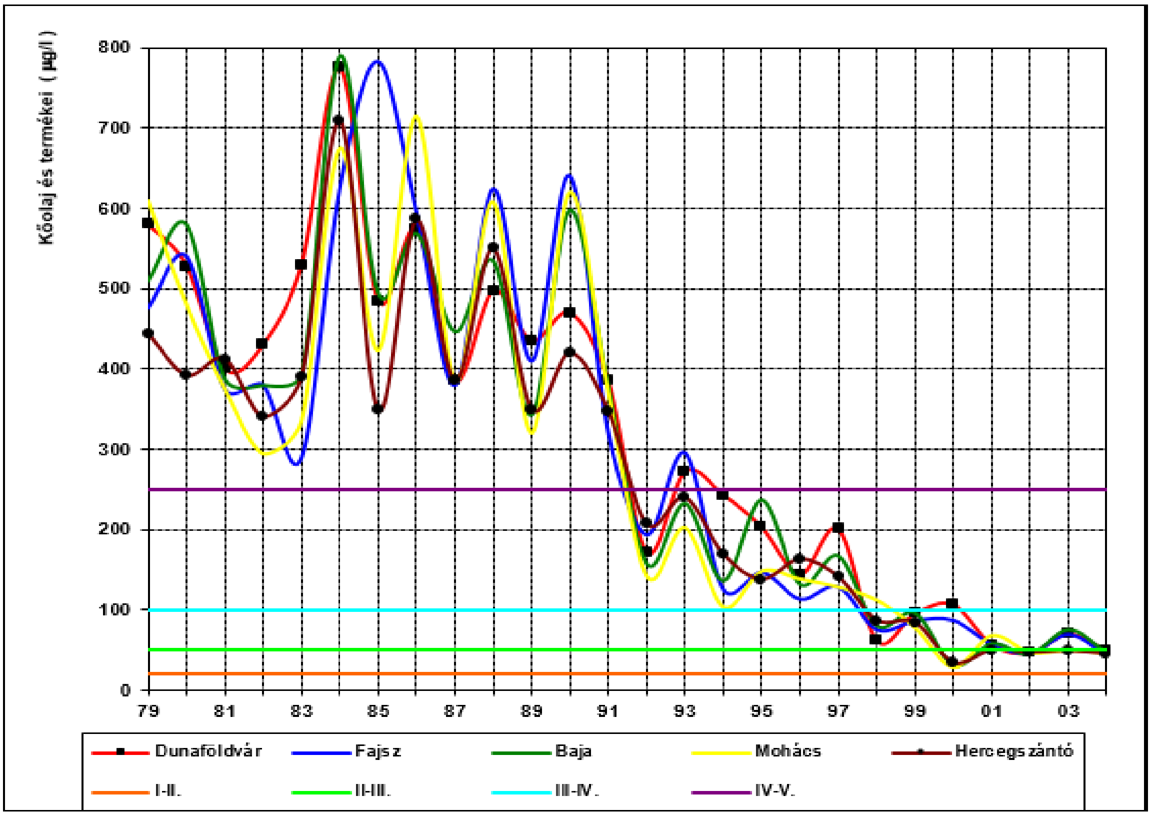
Figure 12.3.4-15: Danube chlorophyll-a 90 % constancy values (Core Network measurements 1979-2004.)

In summary it can be stated that the warmed up cooling water has no detectable or quantifiable impact on the nitrogen and phosphorus turnover indicators or on a-chlorophyll contents.

Other **parameters** of physico-chemical features include the so called transport components which are not subject to chemical changes in the water. They may get into the surface water from waters of different origin in terms of space and time. They usually appear in the upstream profiles along the Danube section assessed and minor changes in their concentration can be observed pending on the water stage or mixing. They include **total suspended** and **total dissolved matter**, the amount of which is higher in times of high water levels due to the stirred up sediment and silt. Higher **chloride, sulphate, sodium** and **potassium** levels referred to this phenomenon. Sodium, potassium and chloride may be originated from waste water discharges. Hydrogen carbonate and carbonate concentrations correlate with the water pH levels. In more alkaline water when phytoplankton biomass in the Danube is higher, carbonate levels are increased, while hydrogen-carbonate is decreased.

Discharge of the warmed up cooling water has no observable influencing effect on the parameters in this group.

Organic micro-pollutants include crude oil and crude mineral oil derivatives, TPH, polyaromatic hydrocarbons (PAH) and polychlorinated biphenyls (PCB). According to the analysis of the water samples the water of the Danube reflected appropriate level of purity in terms of these parameters. Slightly increased levels indicate some kind of a random contamination. Although the presence of residues of gas oil contamination (naphthalene, acenaphthene, anthracene, fenantrene), as well as traces of combustion products (fluoroanthene, pyrene, benzanthracene, benzophenanthrene) has been demonstrated from time to time, they were found only in very low concentrations. Any major amount of them is typically attributed to heating installations and traffic.



kőolaj és termékei –petroleum and its products

Figure 12.3.4-16: Crude oil and crude mineraloil derivatives 90 % constancy values on the Danube (Core Network measurements 1979-2004.)

Results of the Core Network measurements conducted in the 1979-2004 period indicated that concentrations of earlier pollution incidents were declining as a consequence of natural degradation on one hand and because they had no serious replenishment sources on the other. Provided the river is not exposed to any such contamination referred to above in the future, no major changes should be reckoned with.

Summary

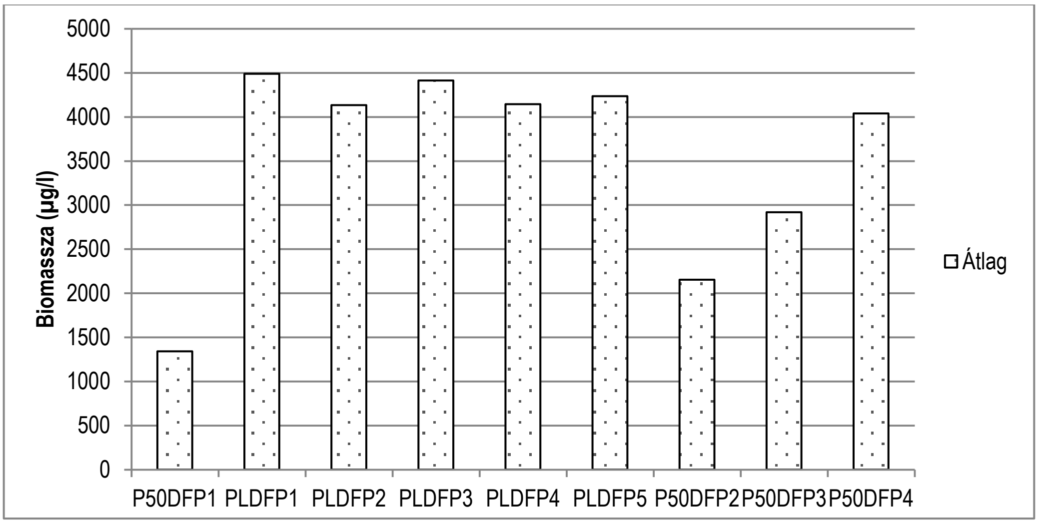
Of the parameters tested, warmed up cooling water may cause changes only in the dissolved oxygen contents of the Danube water. This may only happen in case of adverse hydrological and hydrometerorological events when water temperature at low water stage in summer reaches and permanently exceed 25 ^{0}C. At this time local mass algal production may be formed in a short river section downstream of the hot water canal, that result in a strong diurnal fluctuation of the dissolved oxygen content of the water, including a substantial decline during the night. The probability of occurrence of such a scenario is however considerably low, since dissolved oxygen contents measured in the Danube indicate low saturation levels below 60% only in very rate occasions. No substantial changes are caused by the warmed up cooling water of the Paks Nuclear Power Plant on the other water quality parameters.

12.3.4.2 Phytoplankton

12.3.4.2.1 Ecological status evaluation of the phytoplankton on the assessed Danube sections

In the course of the phytoplankton assessment studies you can obtain information not only about the taxonomic composition of the phytoplankton but their quantities as well. As result, you will get a lot more detailed picture on the impacts of a certain load. During ecological status assessment based on phytoplankton the index numbers used make an effort to quantify mainly the impact of plant nutrients (in the case of rivers, that of impoundment). Therefore the question emerges to which extent this group of organisms is fit for indicating the true impacts of heat loads. As opposed to benthic diatom species, the room to move is a lot wider in the case of phytoplankton since there is an opportunity to analyse quantitative data and also a much wider taxonomic spectrum is available for the researcher when the composition of the sample is defined. The temperature dependence of the index number based on the biomass – as one of the phytoplankton derived indexes – can not be questioned at stable light and nutrient conditions. The same applies to the taxonomic composition, because differences in tolerance and preference can be observed not only between species but at the level of divisions as well. Based on all these considerations it is thought that in the event the increase of the temperature has a significant impact on phytoplankton, it can be detected when the index numbers used in these assessment studies are taken into consideration.

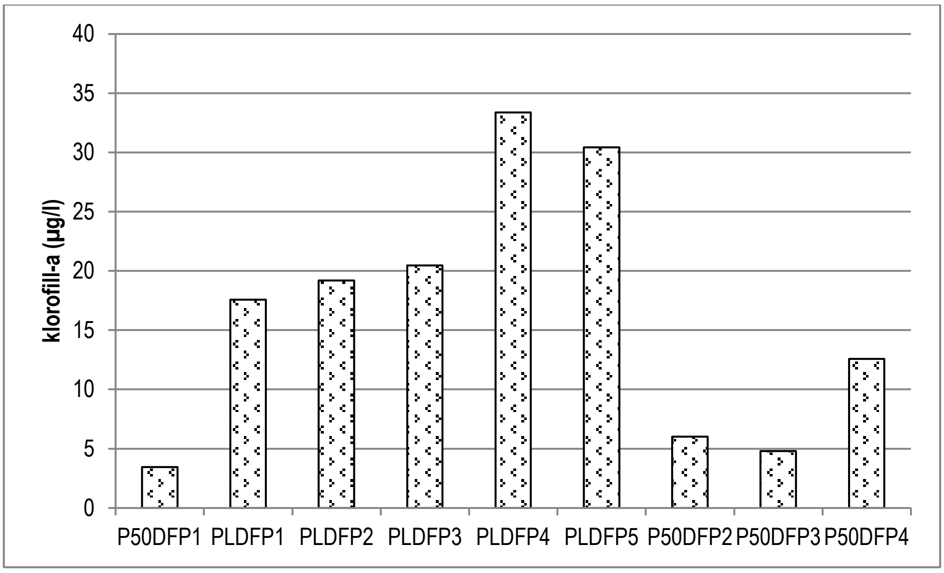
As a result of the phytoplankton sampling sessions conducted in the years 2012 and 2013, respectively, considerable differences could be identified in terms of phytoplankton biomass between the two years (Figure 12.3.4-17). In year 2012 biomass levels in samples taken both in the same seasons and the yearly average figures are higher. At the same time substantially more intensive changes could be recorded than the year-to-year differences when various seasons in the same year were considered (Figure 12.3.4-19 and Figure 12.3.4-20). This confirms the statement that test results from samples taken in two different years reinforce each other, and projected on a longer time horizon they provide adequate results.



átlag - average

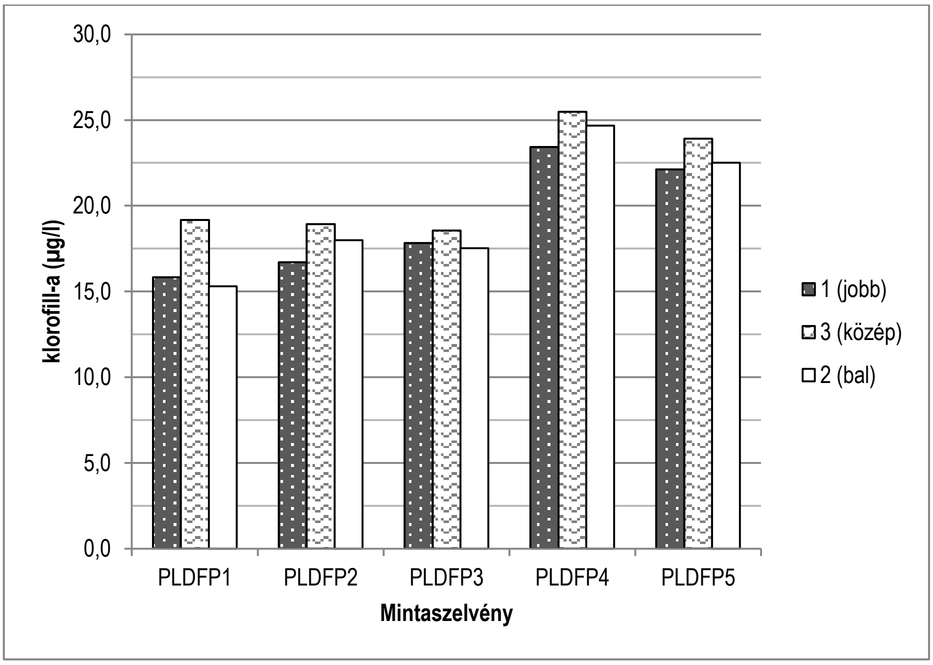
Figure 12.3.4-17: Changes in phytoplankton biomass (µg/l) in the individual sample profiles as an average derived from the sampling sessions in summer (August) and autumn (September/October)

Chlorophyll-a contents show a similar tendency to that of biomass (Figure 12.3.4-18). The results illustrated on the column diagrams indicate also that the discharge of hot water from the hot water canal of the Paks Nuclear Power Plant does not cause any detectable differences in terms of phytoplankton biomass or chlorophyll-a contents between the upstream and downstream profiles. Findings of the sampling units taken in the same year from the Paks/ferry upstream (PLDFP1), as well as the near downstream (PLDFP2; PLDFP3; PLDFP4) and mid-distant downstream (PLDFP5) sections' upstream and downstream profiles are presented a right bank, left bank, midstream breakdown in details (Figure 12.3.4-19; Figure 12.3.4-20; Figure 12.3.4-21; Figure 12.3.4-22). It is clearly seen from the column diagrams that both chlorophyll-a, and biomass levels reflect a similar tendency. The quantity of phytoplankton in the vegetation period (March, June, August, September sampling sessions) is considerably higher than in the late autumn (November) season. On the basis of the findings in the vegetation period the typical cross profile arrangement of rivers is clearly marked out. In all test profiles, higher levels are detected in the main current line for both biomass and chlorophyll-a. This also means that the flow of the watercourse can better be characterised by the samples taken midstream, while in the riparian areas major changes may eventually be observed due to natural reasons because of the great diversity of the hydromorphological conditions here. However, even in the event of these column diagrams, no anomaly to be associated with the discharge from the Paks Nuclear Power Plant can be demonstrated in any of the seasons.



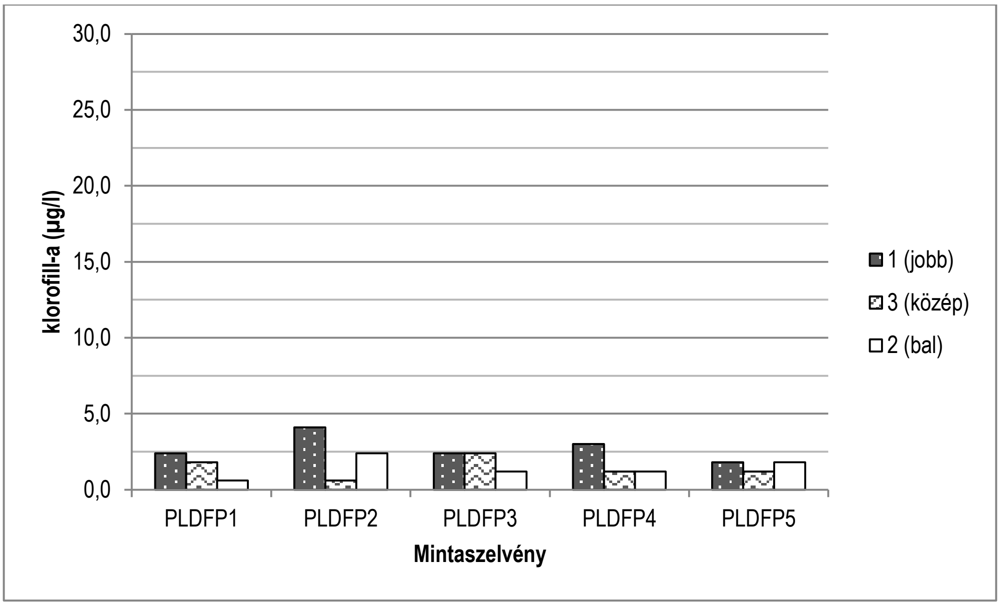
átlag szelvény – average profile

Figure 12.3.4-18: Changes in chlorophyll-a (µg/l) contents in the individual sample profiles as an average derived from the sampling sessions in summer (August) and autumn (September/October)



közép – medium
jobb – right
bal – left
mintaszelvény – sample profile

Figure 12.3.4-19: Chlorophyll-a contents of the phytoplankton (µg/l) in the 2012 March, June, August, September sampling average between the Paks ferry - Gerjen-Foktő profiles 1 (right) 2 (midstream) 3 (left)



jobb – right
közép – medium
bal - left

Figure 12.3.4-20: Chlorophyll-a contents of the phytoplankton (µg/l) in the 2012 November sample between the Paks ferry - Gerjen-Foktő profiles. 1 (right) 2 (midstream) 3 (left)

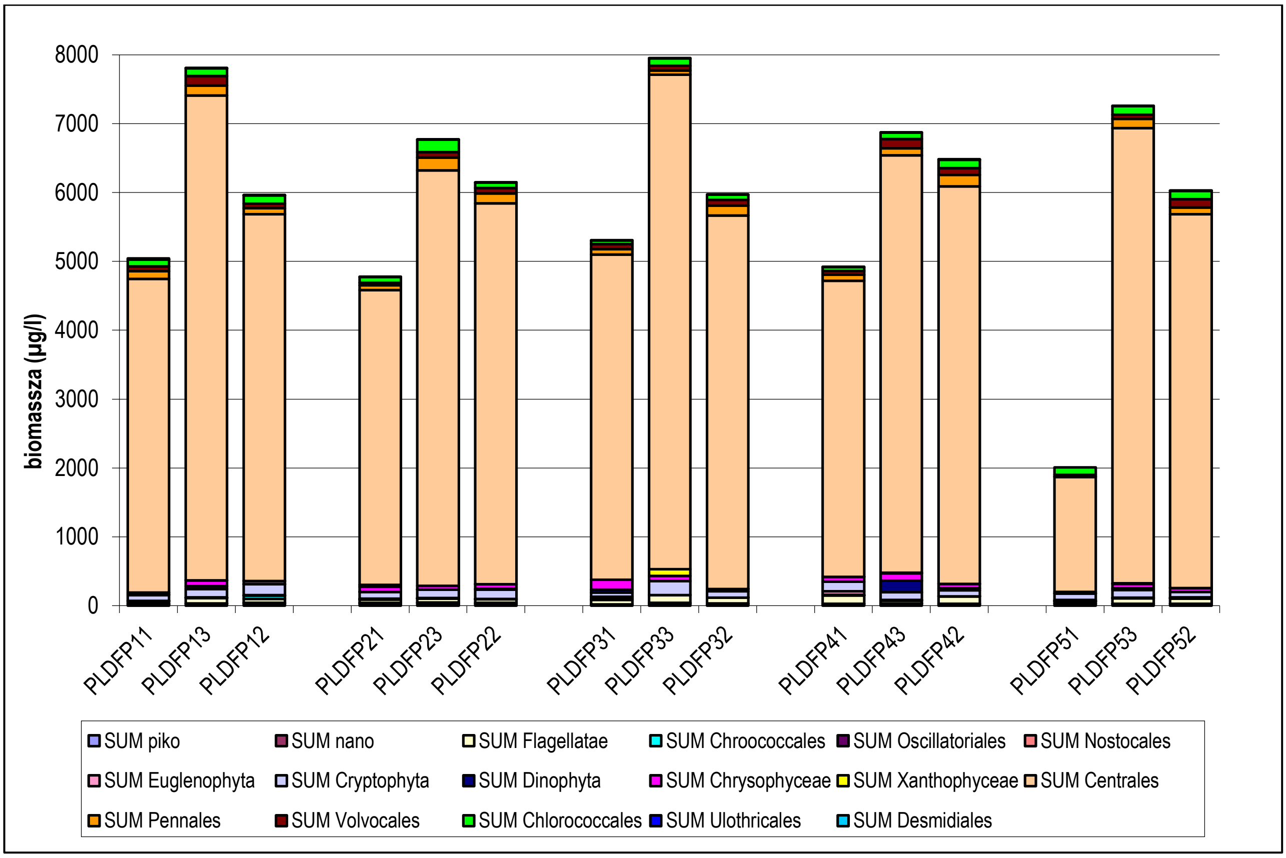
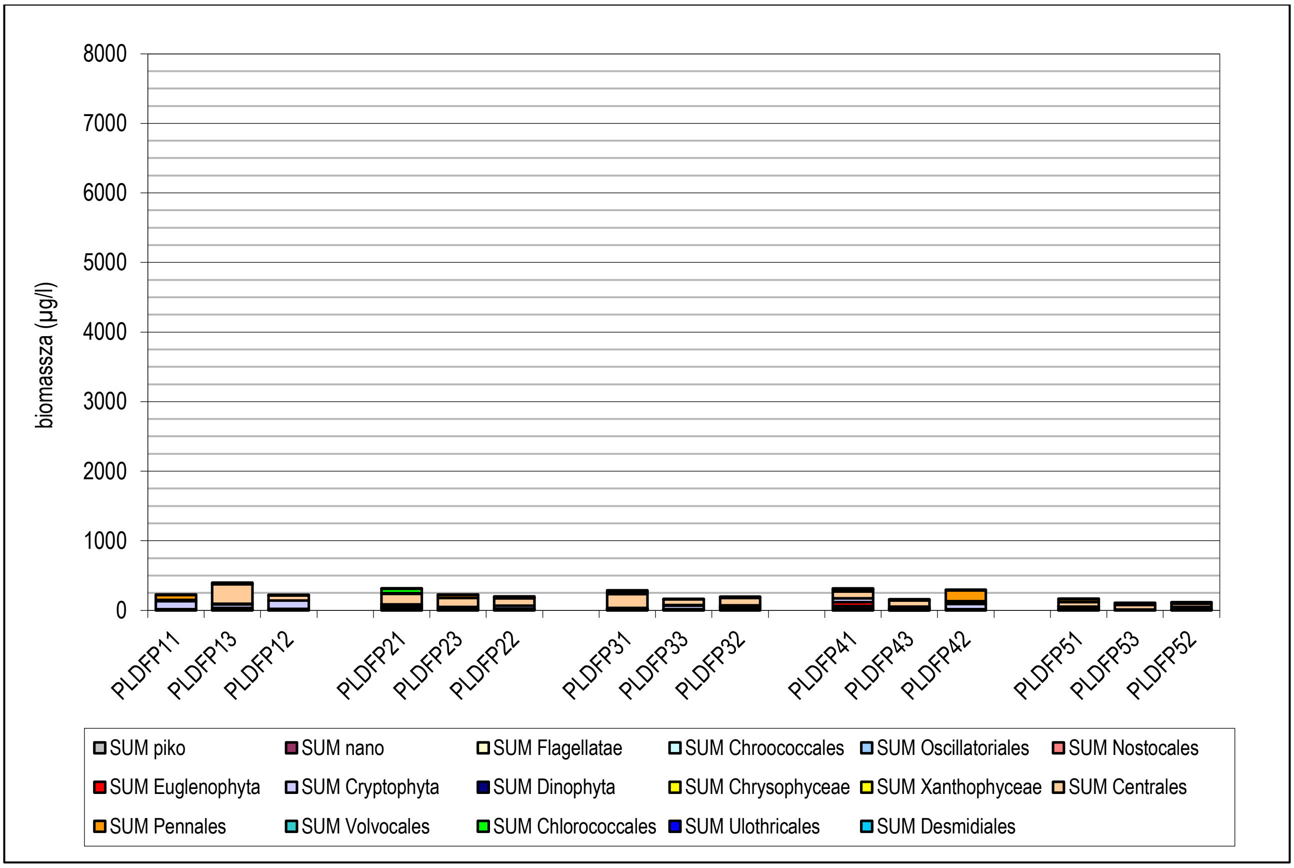


Figure 12.3.4-21: Phytoplankton biomass (µg/l) as an average of the March, June, August, September 2012 sampling seasons between the Paks ferry - Gerjen-Foktő profiles



biomassza - biomass

Figure 12.3.4-22: Phytoplankton biomass (µg/l) in the November 2012 sampling season between the Paks ferry - Gerjen-Foktő profiles

Biomass data obtained at the five sampling dates from the sampling units of upstream and near downstream sessions in 2012 were matched with the quantitative dissimilarity (distance) function by Bray-Curtis. For the purposes of the cluster analysis grouping was made based on the cluster averages. In periods characterised by low biomass levels no distinct group could be recognised on the basis of the composition of the phytoplankton. By then end of August phytoplankton biomass is high. In this season, two distinct and one transient clusters can be observed on the dendrogram. (1) Samples from midstream (PLDFP13; 23; 33; 43; 53), where average phytoplankton biomass levels are the highest and the relative abundance in terms of biomass of diatom species in the order Centrales is the highest. (2) Samples from the right bank (PLDFP11; 21; 31; 41; 51), where average phytoplankton biomass levels are the lowest and the relative abundance in terms of biomass of diatom species in the order Centrales is also the lowest. (3) Samples from the left bank, constituting a transient group between the two (PLDFP12; 22; 32; 42; 52), with a medium level biomass value. This arrangement can be associated with the hydromorphological specialities of the cross profiles along the sections assessed. It should be noted however, that earlier surveys found lower hot water phytoplankton biomass levels than that of the Danube water let into the cooling system of the plant, which is thought to be the consequence of the heat shock encountered during the trip across the cooling system. This may have a slight influence on the biomass levels in the right bank samples, but this assumption could not be confirmed in the present study (see Figure 12.3.4-21).

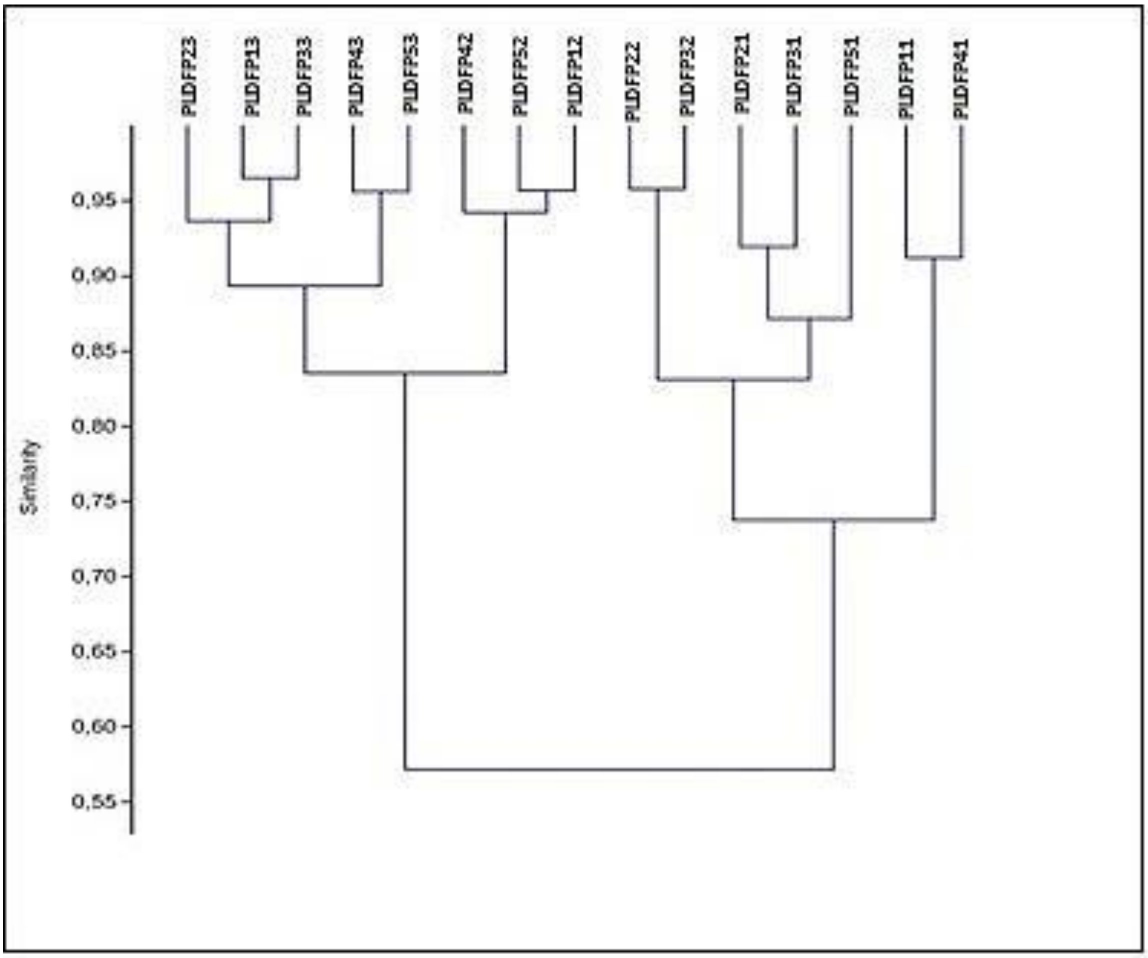


Figure 12.3.4-23: Dendrogramm prepared from the cluster analysis of the August 2012 phytoplankton biomass figures based on sampling units at Paks ferry upstream, near downstream and Gerjen-Foktő midstream distant downstream section

Additionally, the ordination analysis of the correlation between the environmental variables measured during the studies and the phytoplankton with the help of canonical correspondence analysis (CCA) for each sampling unit in the 2012-2013 summer and autumn. The sampling units on the ordination graph reflect the annual clustering described earlier on when the summer figures are taken into account. The outcome of the ordination process and of the variable selection did not show any correlation in the summer or autumn samples with the hot water discharge.

Based on the analyses carried out it can be stated as a whole that the discharge of the Paks Nuclear Power Plant into the Danube did not have any detectable impact on the quantitative or qualitative aspects of the phytoplankton.

12.3.4.2.2 Classification of the assessed Danube sections according to the WFD on the basis of the 2012-2013 phytoplankton studies

Phytoplankton Ecological status per section	EQR	Ecological status
Upstream section	0.766	good
Near downstream section	0.726	good
Mid distant downstream section	0.753	good
Distant downstream section	0.784	good

Table 12.3.4-2: Ecological status of the Danube sections assessed on the basis of the phytoplankton

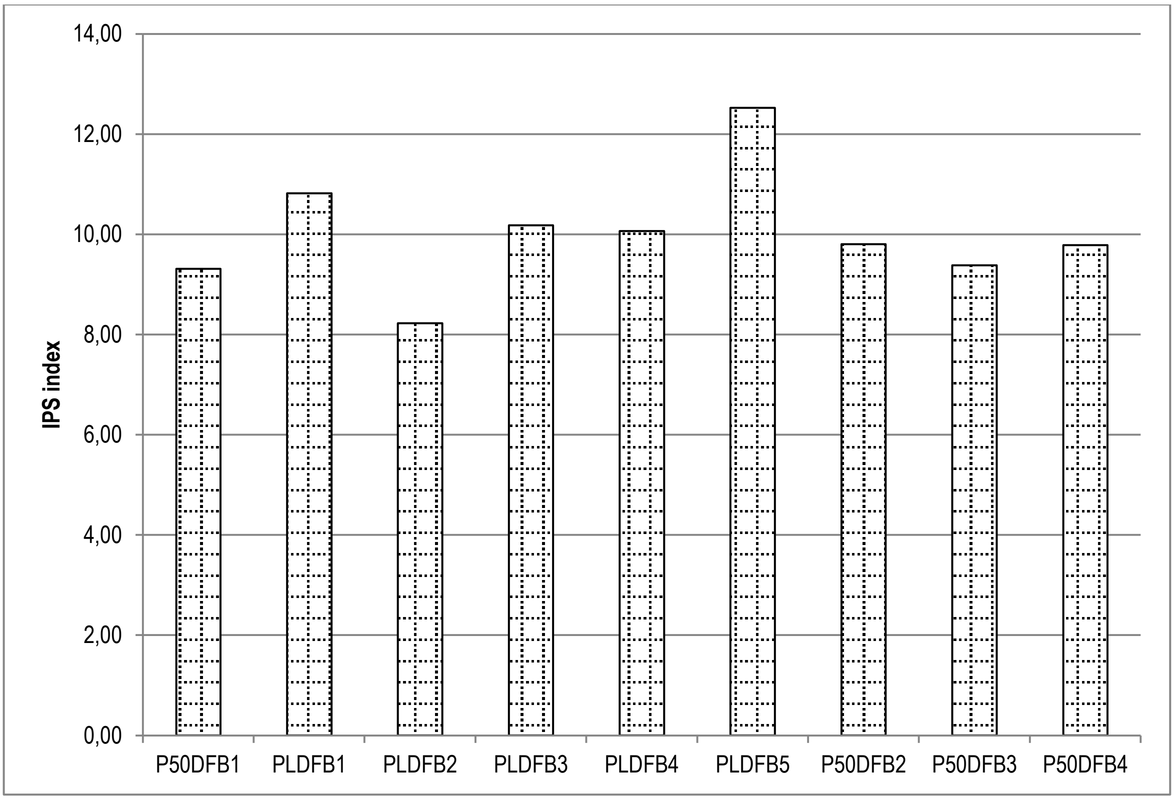
*The ecological status of the Danube section assessed based on the phytoplankton and with a view to the findings of the assessments carried out in 2012 and 2013 was harmonious, in the classification grade of **good** according to the WFD. Discharge from the Paks Nuclear Power Plant does not cause any changes in the classification value, either.*

12.3.4.3 Phytobenthos

12.3.4.3.1 Ecological status evaluation of the phytobenthos on the assessed Danube sections

During the ecological status assessment carried out on the basis of benthic diatom species a so called IPS index (Coste in Cemagref 1982) was calculated once the composition of the diatom flora was known. This index was basically developed for detecting organic and inorganic exposures. The index may take values ranging from 0 to 20. The issue may be raised during the assessment efforts whether an index developed for detecting contamination by organic and inorganic matter would be fit for indicating the ecological effects of heat loads. Two arguments can be cited for the application of IPS based metrics. One is, that a higher temperature favours decomposition processes, which entails the growth of saprobity rates. Therefore in an indirect manner the increase of temperature may be reflected in the value of the index. The second is that taxons tolerant to organic and inorganic pollutants usually have a wide tolerance range, and hence show high level of tolerance to other ecological background variables. As a consequence, their relative abundance in the samples will grow which will be associated with a decline in the index value.

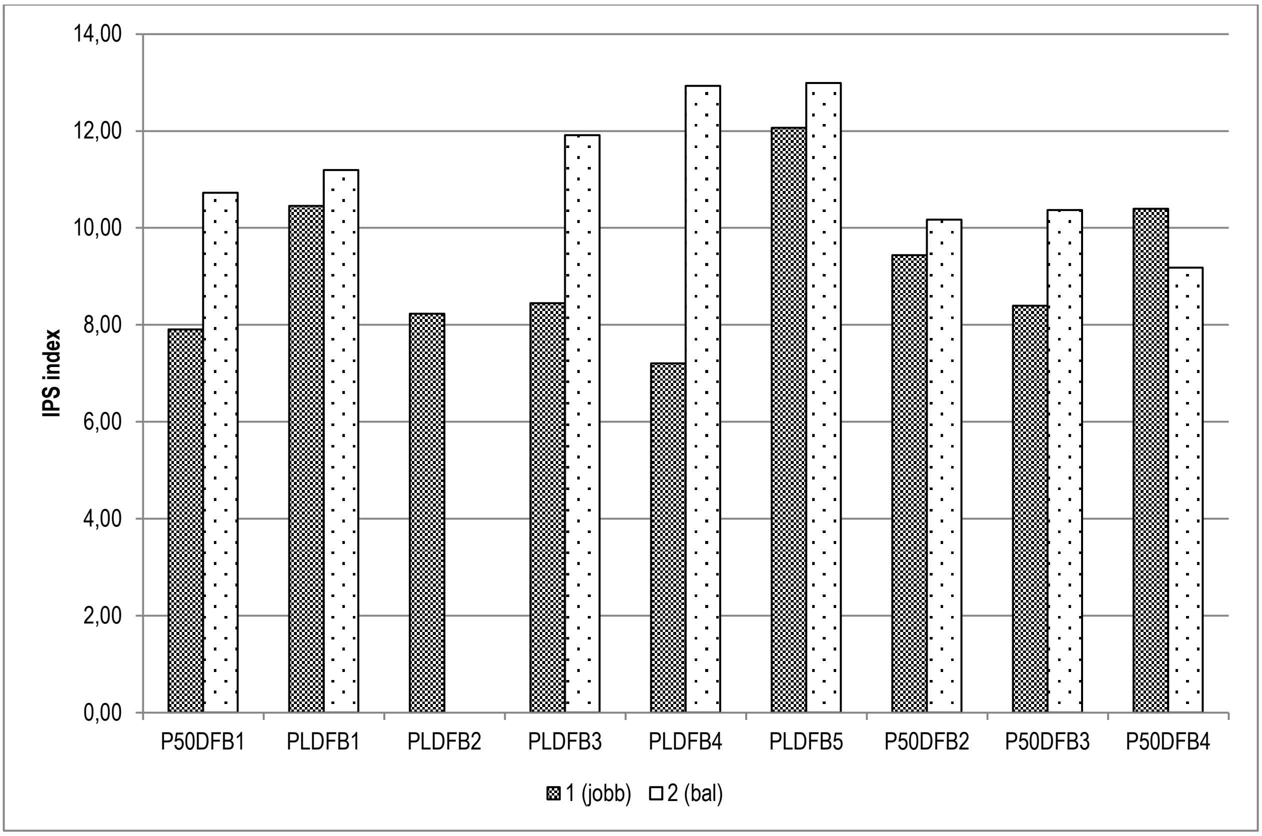
Benthic diatom communities are sensitive to changes in the physical parameters of the medium (flow rate, light climate). Due to these disturbing effects the composition of the diatom community varies which is reflected in sometimes significant deviations in the calculated indexes. In order to reduce uncertainties arising from this circumstance, it is necessary to collect multiple samples in the vegetation period and to take an average of the calculated index values. The figure below illustrates well what was explained above when showing fluctuations in the index value along the river sections assessed.



Sorozatok – trends

Figure 12.3.4-24: Trends in phytobenthos IPS index values in the assessed Danube profiles as an averqge of summer and autumn as well as right and left bank samples, respectively

Based on the analysis of the diatom data it can be stated that not detectable difference exists between the years on the basis of the IPS index, as opposed to the experiences gained with the phytoplankton; larger differences can be observed in the samples from each profile and right and left bank samples, respectively, within any one year. The lowest index value was calculated for the discharge point (PLDFB2). The bar chart (Figure 12.3.4-25) shows that indexes in the right bank samples are typically lower, in other words they reflect a poorer status than those from the left. Since this is true for the upstream sample profiles as well, this condition may be correlated with the hydromorphological nature of the river and/or other exposures – most probably of organic origin – independent from the Paks Nuclear Power Plant. Since however the lowest index values were calculated for the section downstream of the discharge, the impact of the Paks Nuclear Power Plant can not be excluded to the status of the phytobenthos diatom flora can not be excluded.



bal – left
jobb – right

Figure 12.3.4-25: IPS index values calculated from the diatom flora as seasonal averages in the right and left bank samples on the assessed Danube profiles

In order to decide in the issue additional statistical analysis was carried out. Comparison of the relative abundance levels specified from the 2012 phytobenthos samples – like it was explained for the phytoplankton – was completed with the help of cluster analysis (Figure 12.3.4-26). Data were matched with the quantitative dissimilarity (distance) function by Bray-Curtis, while for the purposes of the cluster analysis grouping was made based on the cluster averages. Findings of the autumn samples did not show any ecologically sensible clusters.

Based on the data from the summer sampling session samples from the upstream and near downstream section right bank indicated a kind of clustering. This confirms the outcome of the IPS index analysis shown on the bar chart, but still does not prove the impact of the spent water discharged from the hot water canal of the Paks Nuclear Power Plant clearly, since the same cluster also contains the set of data from the right bank on the upstream section. Thus when a conservative approach is taken, the impact of the water discharged from the hot water canal of the Paks Nuclear Power Plant on the benthic diatom populations can not be fully excluded on the basis of the cluster analysis data. However, even this assumed impact could not be detected any more below the Uszód sampling profile.

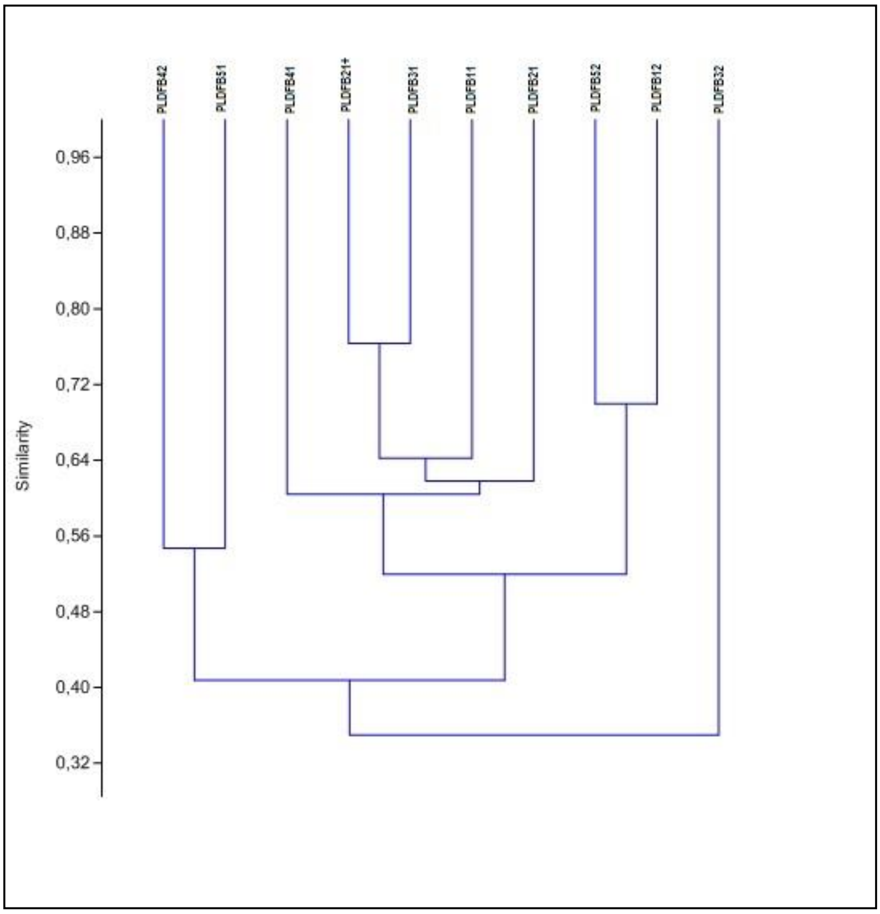
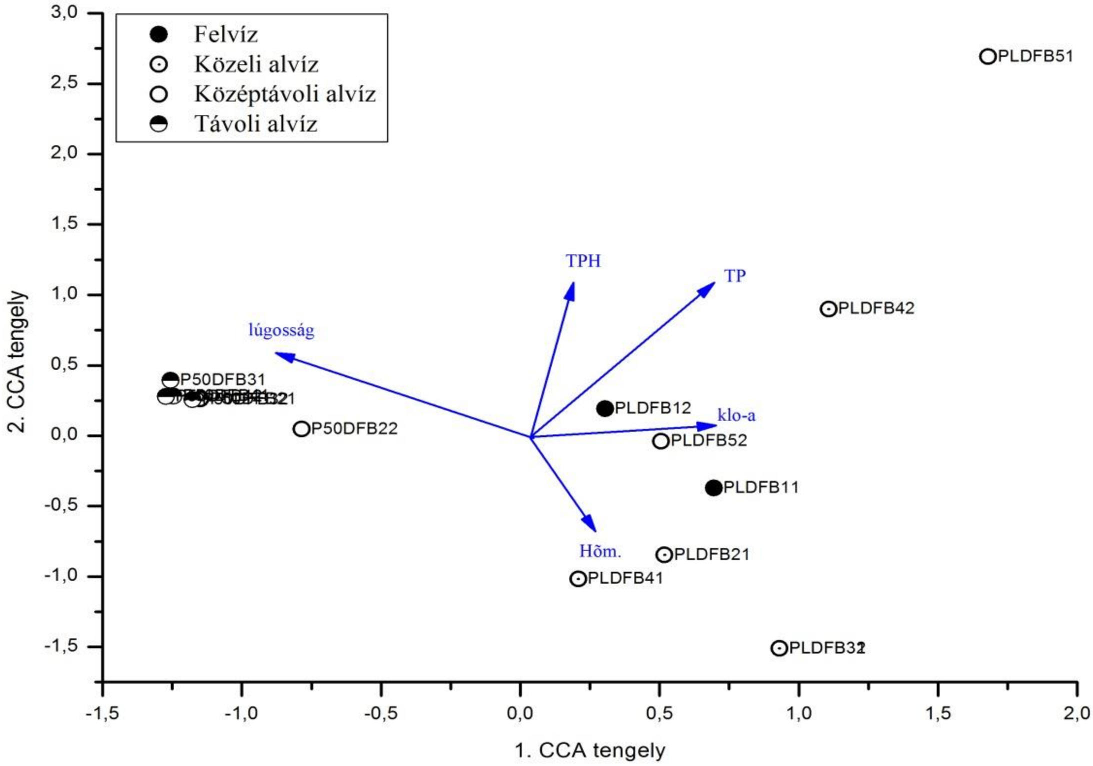


Figure 12.3.4-26: Dendrogran prepared from the cluster analysis of the relative abundance of phytobenthos taxons in August 2012 based on the sampling units at the Paks ferry upstream, near downstream and Gerjen-Foktő midstream distant downstream section

Additionally, the canonical correspondence analysis (CCA) was also carried out for the phytobenthos community based on the summer and autumn sampling sessions. The outcome of the ordination process and of the variable selection did not show any detectable clustering or correlation with the hot water discharge from the Paks Nuclear Power Plant in the summer or autumn samples.

Taking into account the diatom findings in summer it can be stated on the basis of the ordination that the near downstream sampling units affected by hot water (PLDFB21; PLDFB31; PLDFB41) constitute a relatively independent group, which concurs with the findings of the cluster analysis. Yet, based on CCA ordination, the same cluster includes the near downstream sampling unit PLDFB32 as well, which is not affected by hot water discharges. On the basis of the statistics samples taken in two difference years are separated in distinct clusters. The first and second axis of the ordination figure together cover 53.6% of the total variance in species inventory and environmental variables. This indicates a medium level of correlation between the phytobenthos community an the environmental variables tested, which can be effectively evaluated and analysed from the practical point of view, showing cause and effect relationships. On the basis of the variable selection, total phosphorus (TP), as well as chlorophyll-a contents (Chl-a) of the assessed physico-chemical factors of the water (water temperature, pH, dissolved oxygen, alkalinity, chemical oxygen demand, biological oxygen demand, ammonium, nitrate, organic nitrogen, total nitrogen, orto-phosphate, total phosphorus, chlorophyll-a, TPH) can be regarded as true and significant environmental factors on the diatom community of the profiles under consideration at the probability level of 95%. Additionally, the value of temperature difference (Δt) is seen as a strong – albeit not significant at the 95% probability level – environmental impact on the near downstream section for the sampling units affected. This variable is the difference between the average of the water temperature levels on the upstream and unaffected sampling units and the water temperature of the sampling unit concerned on the day under investigation.

Based on the statistical analyses the impact of the spent water discharged from the hot water canal of the Paks Nuclear Power Plant on the diatom communities can not be excluded or proved, alternatively, beyond doubt. The impact *assumed by the conservative approach is felt only in the (late) summer period, in the right bank profile affected by hot water discharge, up to the level of the Uszód Nagysarkantyú, in a length of approximately 2 km.*



Note:
Dots represent sampling units.
Arrows show key environmental variables obtained in the variable selection (Monte-Carlo permutation test) process.
Legend:

Hőm. - difference in water temperature (Δt);
TP - Total phosphorus;
TPH - Total Petroleum Hydrocarbon;
klo-a - chlorophyll-a
tengely – axis
lúgosság – basicity
felvíz – upstream section
közeli alvíz – nearby downstream section
középtávoli alvíz – medium distant downstream section
távoli alvíz – distant downstream section

Figure 12.3.4-27: Ordination of the relative abundance figures of the phytobenthos in the Danube sections assessed derived by canonical correspondence analysis (CCA).

12.3.4.3.2 Classification of the assessed Danube sections according to the WFD on the basis of the 2012-2013 phytobenthos studies

Phytobenthos Ecological status per section	EQR	Ecological status
Upstream section	0.451	moderate
Near downstream section	0.434	moderate
Mid distant downstream section	0.509	moderate
Distant downstream section	0.425	moderate

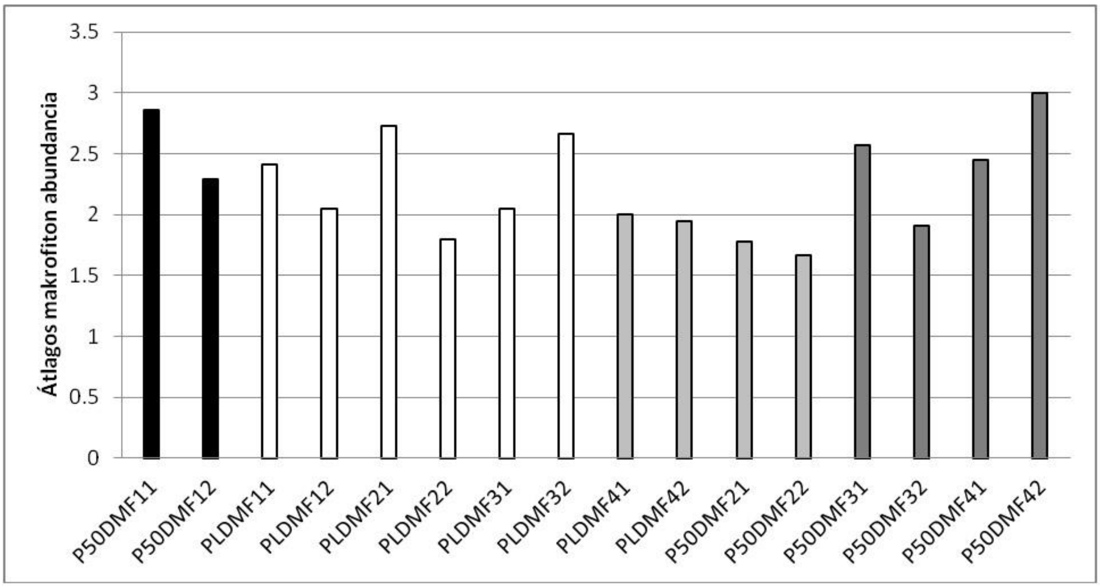
Table 12.3.4-3: Ecological status of the assessed Danube section on the basis of phytobenthos

*The ecological status of the Danube section assessed based on the phytobenthos and with a view to the findings of the assessments carried out in 2012 and 2013 was harmonious, in the classification grade of **moderate** according to the WFD.*
Discharge from the Paks Nuclear Power Plant does not cause any grade level changes in the classification value, either.

12.3.4.4 Macrophyte

12.3.4.4.1 Evaluation of the macrophyte communities on the assessed Danube sections according to the wildlife conservation perspective

Abundance values of the sampling units were represented in the column diagram based on the macrophyte sampling sessions conducted in 2012 and 2013 (Figure 12.3.4-28).



átlagos makrofiton abundancia – average abundance values of the macrophyte communities

Figure 12.3.4-28: Average abundance (DAFOR) values of the macrophyte communities in the sampling section on the Danube during the summer and autumn seasons

Right and left bank are shown separately (black: upstream section; white: near downstream section; light grey: midstream-distant downstream section; dark grey: distant downstream section.)

Based on the column diagram it can be stated that the cooling water of the Paks Nuclear Power Plant has no effect on the quantity of macrophyte communities along the Danube-section concerned.

Compared to upstream and unaffected downstream sampling units the average abundance levels of macrophytes vary in an irregular pattern. The highest abundance levels were found in the upstream section and in the distant downstream section. With a few exception, left bank average abundance figures – not affected by the heat plume – reflected a lower level. This might be attributed to the different morphological characteristics and disturbance level on the respective banks of the river.

Similarities and dissimilarities of the macrophyte species inventory on the sampling sites was analysed by an ordination procedure derived from a Bray-Curtis function (principal coordinate analysis, PCoA) and a hierarchic classification method (cluster analysis). Ordination created with the help of the principal coordinate analysis showed a somewhat different result than the abundance data (Figure 12.3.4-29).

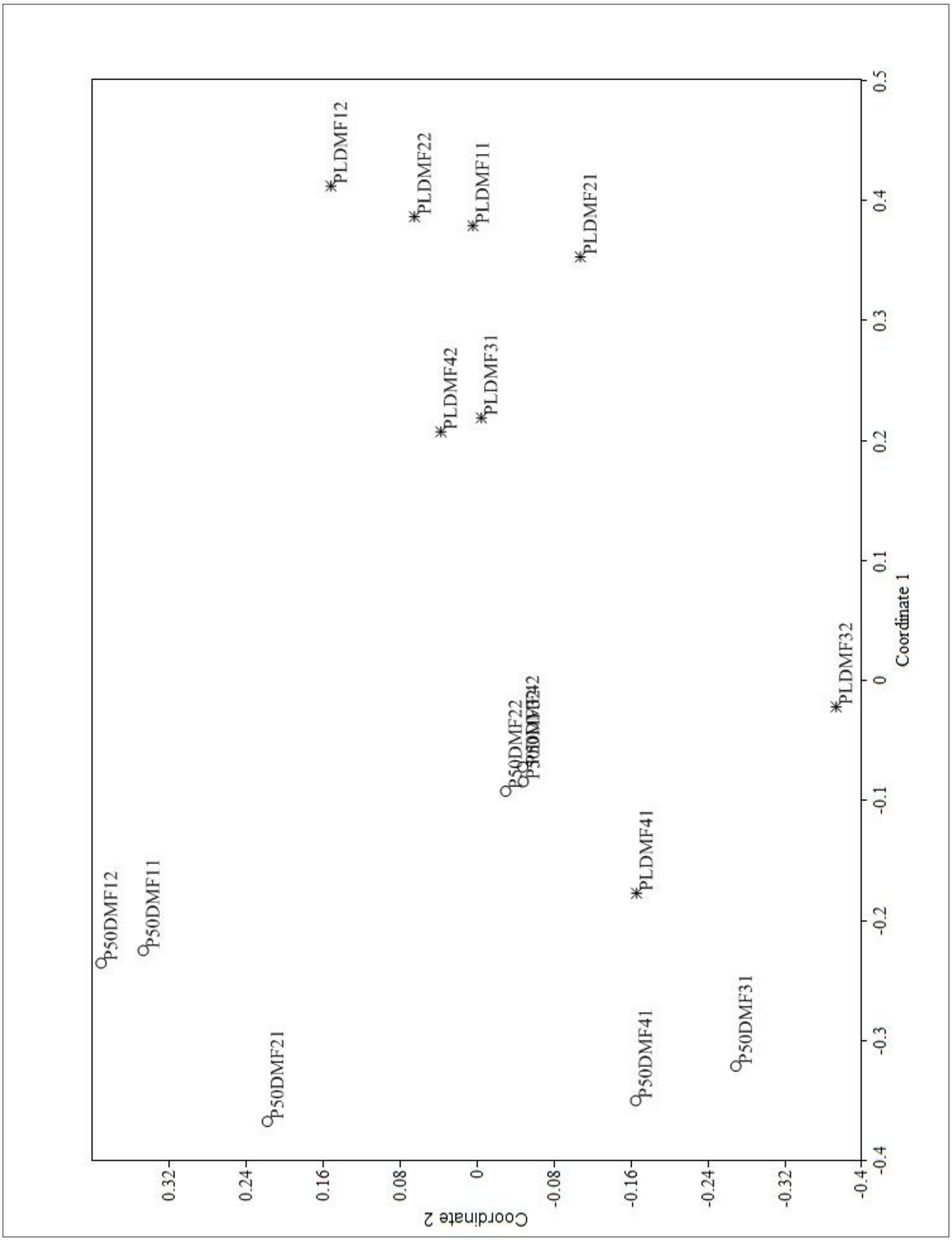
Three sets of dots can be differentiated on the basis of similarities in species inventory. The three sets can be distinguished on the basis of their relative distance from the hot water discharge point:

(1) dots on the right edge of the figure come from the samples taken in 2012 at Paks, in other words the profile closest to the hot water inlet.

(2) dots on the lower quarter of the figure are the sampling points of the profiles situated the furthest away from the hot water discharge point, in other words 2012 samples from the Gerjen, 2013 samples from the Dombori, from the downstream Sió-channel and from the Baja profiles.

(3) In the upper left corner of the figure sampling points from profiles upstream from the hot water discharge point and the right side sampling site of the Dombori profile.

However, correlation between the units from the near downstream section affected and not affected by hot water, respectively, reinforces the differences in terms of habitats.



Note:
Handling right and left side points of the profiles separately
Legend:
*: 2012 sampling sites;

○ : 2013 sampling sites

Figure 12.3.4-29: Principal coordinate analysis of the Danube sampling units based on consolidated summer and autumn sampling sessions in 2012 and 2013 for macrophytes

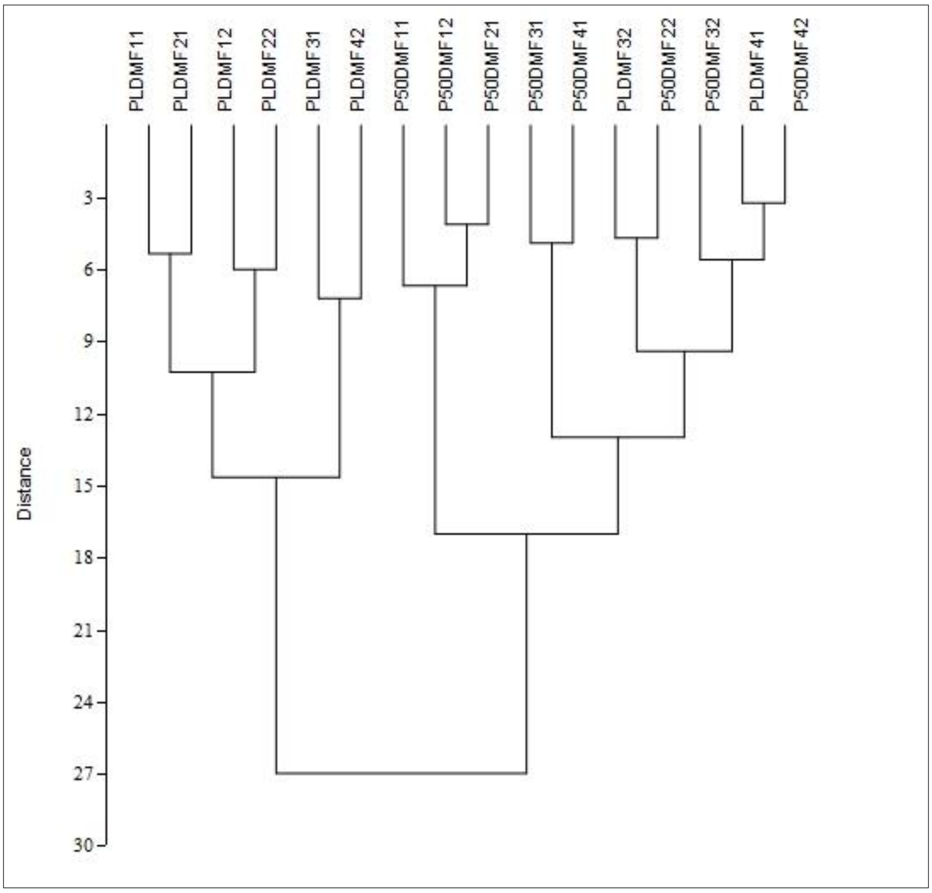


Figure 12.3.4-30: Clusters of the macrophyte stands at the Danube sampling sites derived by the Ward method based on consolidated summer and autumn sampling sessions in 2012 and 2013

The results of the cluster analysis confirm and make more illustrative the findings of the principal coordinate analysis. The upstream, near downstream and distant downstream sections were differentiated from the Danube section assessed. The midstream-distant downstream section was grouped in the same cluster branch as the sampling points from the distant downstream section. The hot water discharge point is situated within the near downstream section.

Since the sampling points were clustered according to the sections and since the left bank sampling sites which were not affected by the heat plume did not separate, either, the conclusion can be drawn from the cluster analysis that hot water has no influence on the macrophyte populations and they are a lot more determined by the channel bottom morphology and other environmental factors section by section environmental factors.

Alkalinity, chlorophyll-a contents, concentrations of various nitrogen forms (ammonium, total nitrogen), and phosphorus forms (orto-phosphate, total-phosphorus) and TPH as well as water temperature were found by the canonical correspondence analysis (CCA) and the associated variable selection found that as the decisive environmental factors of the parameters tested. These environmental factors have the largest influence on the similarities and dissimilarities of the macrophyte populations along the Danube sampling sections. The first and second axis of the ordination figure together cover 53.6% of the total variance in species inventory and environmental variables. This value is below average, in other words the correlation between the sampling site featured on the CCA figure and the environmental variables are poor (and not significant in any of the cases). The upstream and near downstream sampling sections can be clearly distinguished on the ordination graph of the CCA analysis. Mid-distant- and distant downstream points also separate from the above and constitute dot sets overlapping each other, that is macrophyte populations of these sampling sections have a similar species composition. Findings of the CCA analysis concur with the data from the literature investigating and characterising the environmental needs of various plant species [12-3]. Based on them the spread of macrophyte species in the watercourses is mostly determined by the plant nutrients (forms of nitrogen and phosphorus) and the flow rate of the water. Even in this context the findings of the analysis show no correlation with the spent water discharge from the Paks Nuclear Power Plant.

12.3.4.4.2 Classification of the assessed Danube sections according to the WFD on the basis of the 2012-2013 macrophyte studies

Macrophyte Ecological status per section	EQR	Ecological status
Upstream section	0.50	moderate
Near downstream section	0.40	moderate
Mid distant downstream section	0.44	moderate
Distant downstream section	0.44	moderate

Table 12.3.4-4: Ecological status of the assessed Danube section on the basis of the macrophyte community

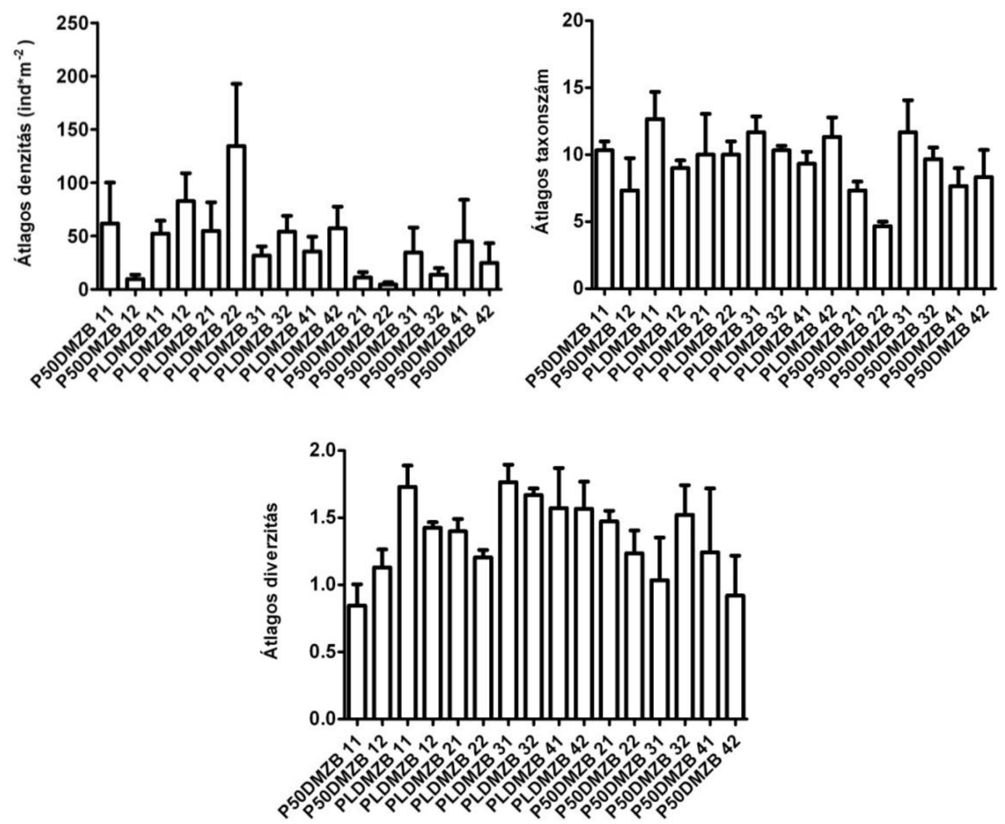
The ecological status of the Danube section assessed based on the macrophyte community and with a view to the findings of the assessments carried out in 2012 and 2013 was harmonious, in the classification grade of ***moderate*** *according to the WFD.*

Discharge from the Paks Nuclear Power Plant does not cause any changes in the classification value, either.

12.3.4.5 Macrozoobenthos

12.3.4.5.1 Evaluation of the macrozoobenthos on the assessed Danube sections according to the wildlife conservation perspective

Quantitative analyses of the macroscopic invertebrate samples taken in eight Danube profiles in 2012-2013 were carried out on the basis of the summer and autumn data alike. Analysing the macrozoobenthos densities (numbers of individuals) of the samples taken during the summer sampling season (Kruskal-Wallis H- test) statistically significant differences were observed ($H = 87.36$; $p < 0.0001$). Examining the average numbers of taxons no detectable difference was seen ($H = 20.48$.; $p = 0.1542$), just like in the case of the Shannon diversity values which did not deviate significantly, either ($H = 23.88$; $p = 0.0671$) (Figure 12.3.4-31).



átlagos denzitás – average density
átlagos taxonszám – average number of taxons
átlagos diverzitás – average diversity

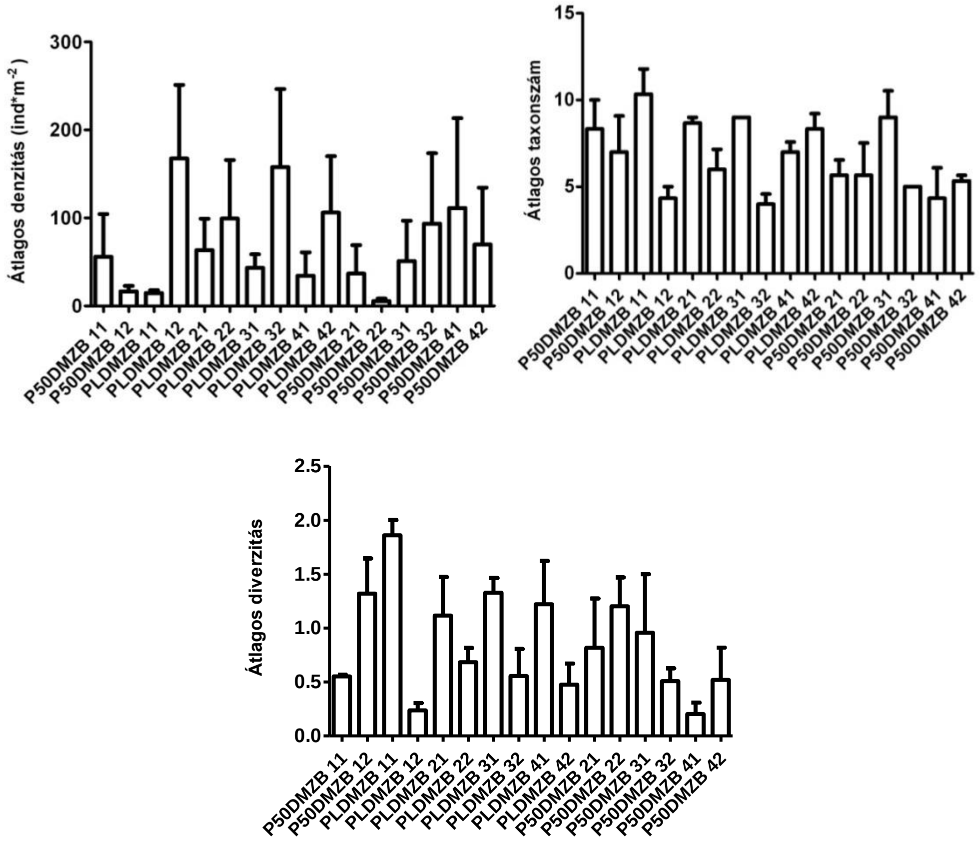
Figure 12.3.4-31: Average number of individuals, taxons and diversity of macrozoobenthos in the 2012-2013 period in the summer samples

Numbers of individuals in the control, upstream profile (P50DMZB 11) macrozoobenthos samples was somewhat higher compared to the density of samples taken at the near downstream sections right bank (that is, where the sampling units directly exposed to hot water impact were found: PLDMZB 11, PLDMZB 21 and PLDMZB 31). When individual sampling units were compared in pairs, difference between the average numbers of individuals between the right and left bank could be detected in a statistically significant manner. The average number of individuals was lower in the samples taken from the near downstream section on the right bank of the Danube compared to that on the left bank, which might be attributed to the direct impact of the hot water (lower number of individuals) and different channel bottom material, and hence a difference in the number of microhabitats.

Average density values in the near downstream section samples differed significantly from average numbers of individuals detected on the midstream-distant and distant downstream sections, and on the latter higher density values were seen on the right bank, most probably determined by the water level and the number of habitats available to sampling. The number of taxons identified in the samples showed a very diverse picture. Even though no statistically significant differences could be experienced, some deviation is visible still between taxon numbers of individual sampling units. You can see that the average number of taxons in the section indirect contact with hot water (PLDMZB 11) is higher than that of the control section, since a number of invasive species (taxons) are able to adapt to the extreme environmental conditions created as an impact of the hot water which could not be found in the upstream and midstream and distant downstream units.

Diversity indexes are basically values based on the relationship between the number of individuals and the number of taxons, that is where density is high but only a few taxons can be found (dominance), diversity is usually lower. According to the studies the hot causes an increase in local diversity in the direct (PLDMZB 11) and indirect near downstream profiles, but it should be emphasised that this was caused with a great degree of probability by the high number of invasive taxons which is not desirable in any way. A statistically significant difference could be experienced when samples taken during the autumn sampling were tested for macrozoobenthos density (number of individuals)

(Kruskal-Wallis H- test) (H = 48.58; p < 0.0001). Significant differences could be detected with respect to the average numbers of taxons (H = 27.93.; p = 0.022), just like in the case of the Shannon diversity values which differed from each other significantly (H = 25.39; p = 0.045) (Figure 12.3.4-32).



átlagos denzitás – average density
átlagos taxonszám – average number of taxons
átlagos diverzitás – average diversity

Figure 12.3.4-32: Average number of individuals, number of taxons and diversity of macrozoobenthos in the 2012-2013 period based on the autumn samples

When individual sampling units were compared in pairs difference between the average numbers of individuals between near downstream (PLDMZB31) and midstream distant and distant downstream (P50DMZB22, 31, 42) sections could be detected in a statistically significant manner. The levels of number of individuals on the near downstream section left bank, that is in the sampling units not directly exposed to the impact of the hot water was higher, then this ratio was reversed on the distant downstream section and macroscopic invertebrate density was higher on the right bank. This may be in correlation with the vanishing impact of the hot water (which has a local impact according to former research along an approximately 2 km long section on the right bank), which might possibly be attributed to the differences in the channel bottom material and the different number of the habitats available.

The number of taxons detected in the samples showed a strongly varied picture. In the statistical sense only between PLDMZB11 and PLDMZB32 was there any difference when the sampling units were compared in a pairwise manner. It can be seen that the average number of taxons directly exposed to hot water (PLDMZB 11) was the highest during the autumn sampling seasons, most probably for similar reasons that was experiences in the summer samples, since a number of invasive species (taxons) are able to adapt to the extreme environmental conditions created as an impact of the hot water which could not be found in the upstream and midstream and distant downstream units.

Diversity indexes are basically values based on the relationship between the number of individuals and the number of taxons, that is where density is high but only a few taxons can be found (dominance), diversity is usually lower. According to the studies the hot causes an increase in local diversity in the direct (PLDMZB 11) and indirect near downstream profiles, but it should be emphasised that this was caused with a great degree of probability by the high number of invasive taxons which is not desirable in any way. The tendency was apparent that the density levels on the near downstream section left bank, that is in the sampling units not directly exposed to the impact of the hot water was higher, then this ratio was reversed on the distant downstream section and macroscopic invertebrate density was higher on the right bank.

Similarities and dissimilarities of the quantitative samples (sampling sites, units) were analysed by cluster analysis derived from a Bray-Curtis function in order to decide to which extent individual sections can be differentiated in terms of macrozoobenthos when quantitative (number of individuals) data are taken into account. (Binary) analysis of quantitative data was carried out on the basis of the cluster derived with the help of the Rogers-Tanimoto similarity function, and only the presence or absence of the taxons was considered at the sampling sites concerned instead of quantitative data. Multiple variable analyses were carried out for the quantitative data from the 2012-2013 summer and autumn seasons.

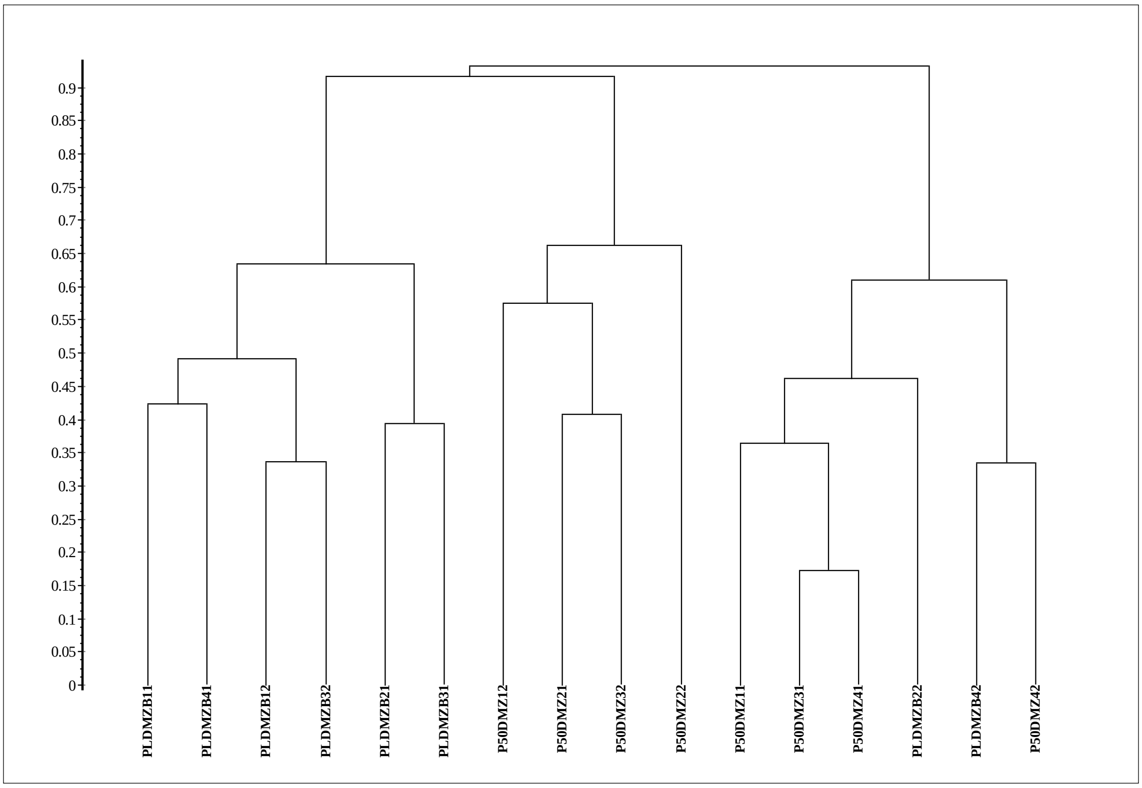


Figure 12.3.4-33: The cluste of sampling sites based on the number of individuals and derived from the Bray-Curtis similarity function in the 2012-2013 summer samples

Based on the cluster it can be seen that the profile No PLMZB 11 (directly adjacent to the hot water discharge) stands out clearly from the other profiles on the basis of the large numbers of individuals (*Dikerogammarus villosus, Sinanodonta woodiana, Viviparus acerosus*) and numbers of taxons. It is apparent furthermore that the six branches of the cluster on the left side of the diagram indicate the near downstream section, while the units of the control – i.e. upstream – can be found in the middle and of the midstream-distant and distant sections on the right hand side. It was important that one point on the upstream section (P50DMZB11) showed a great degree of similarity to the distant downstream sections when quantitative data were taken into account. The fact that the control section was put into this quarter on the cluster on the basis of the sample composition and quantitative features indicates that the impact of the hot water is not felt on those sections and the community structure experienced upstream is reset. Beside all these factors, however, the tendencies in the community might be exposed to a great extent to the microhabitat conditions defined by the channel bottom material.

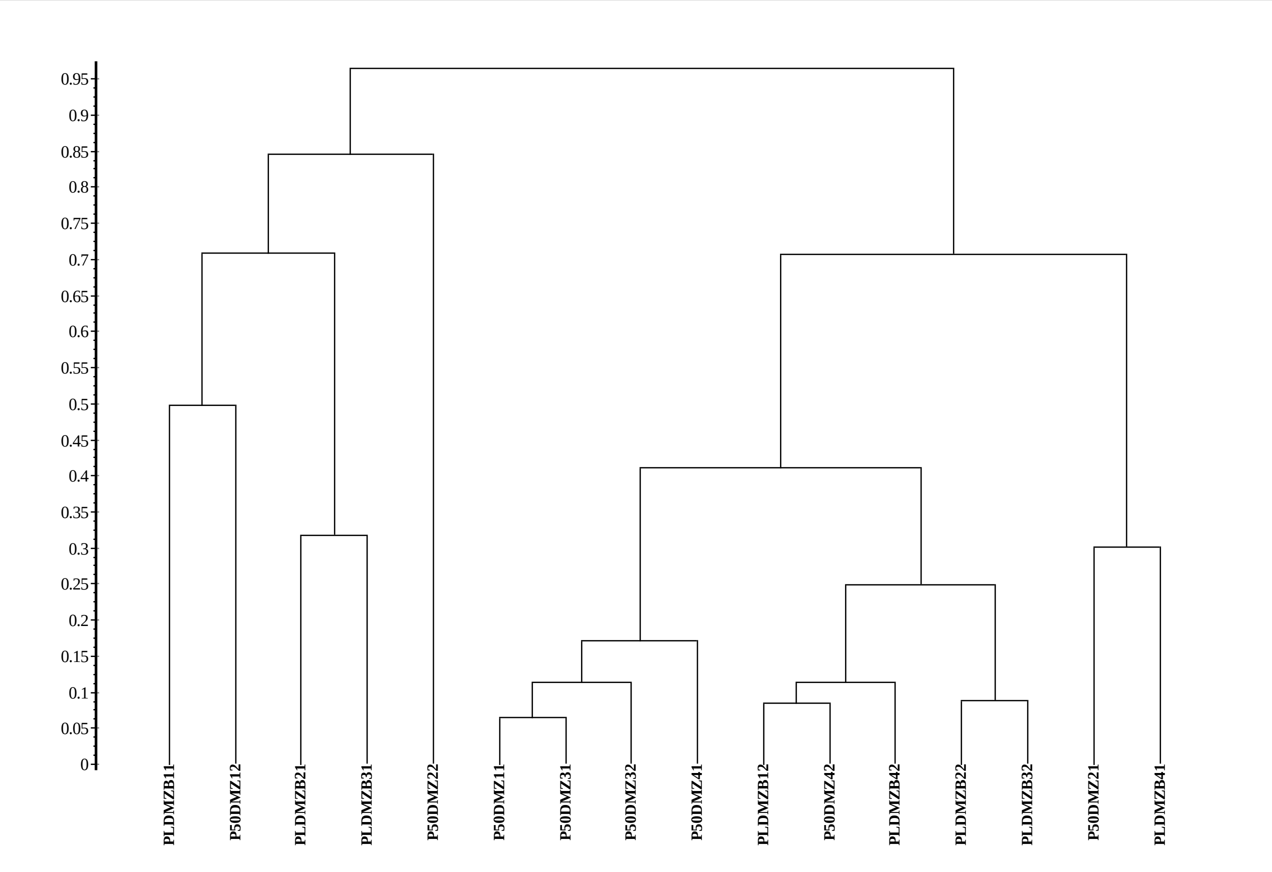


Figure 12.3.4-34: The cluste of sampling sites based on the number of individuals and derived from the Bray-Curtis similarity function in the 2012-2013 autumn samples

During the autumn sampling session the level of water was lower than in the summer and therefore the number of habitats subject to sampling differed from the case in summer, which is seen on the shaping of the cluster. The site in the direct neighbourhood of the hot water discharge (PLDMZB11) stands out from the other sites and the control upstream P50DMZB11 was put to a separate branches again, the near downstream sampling sites separate less spectacularly, only the two last (PDMZB21 and PLDMZB41) midstream distant section units and the two near downstream units before them (PLDMZB22 and PLDMZB32) on the right hand side of the cluster separate clearly from the other sections. The differences between the right and left bank was seen earlier on in sampling during low water stages and it was confirmed again, demonstrated by the cluster. This could probably be caused by the two different kinds of channel bottom surfaces available for colonisation found in the two banks.

Only the presence or absence of the taxons was considered in the samples when the composition of the macroscopic invertebrate community was tested, quantitative data were not considered in this analysis.

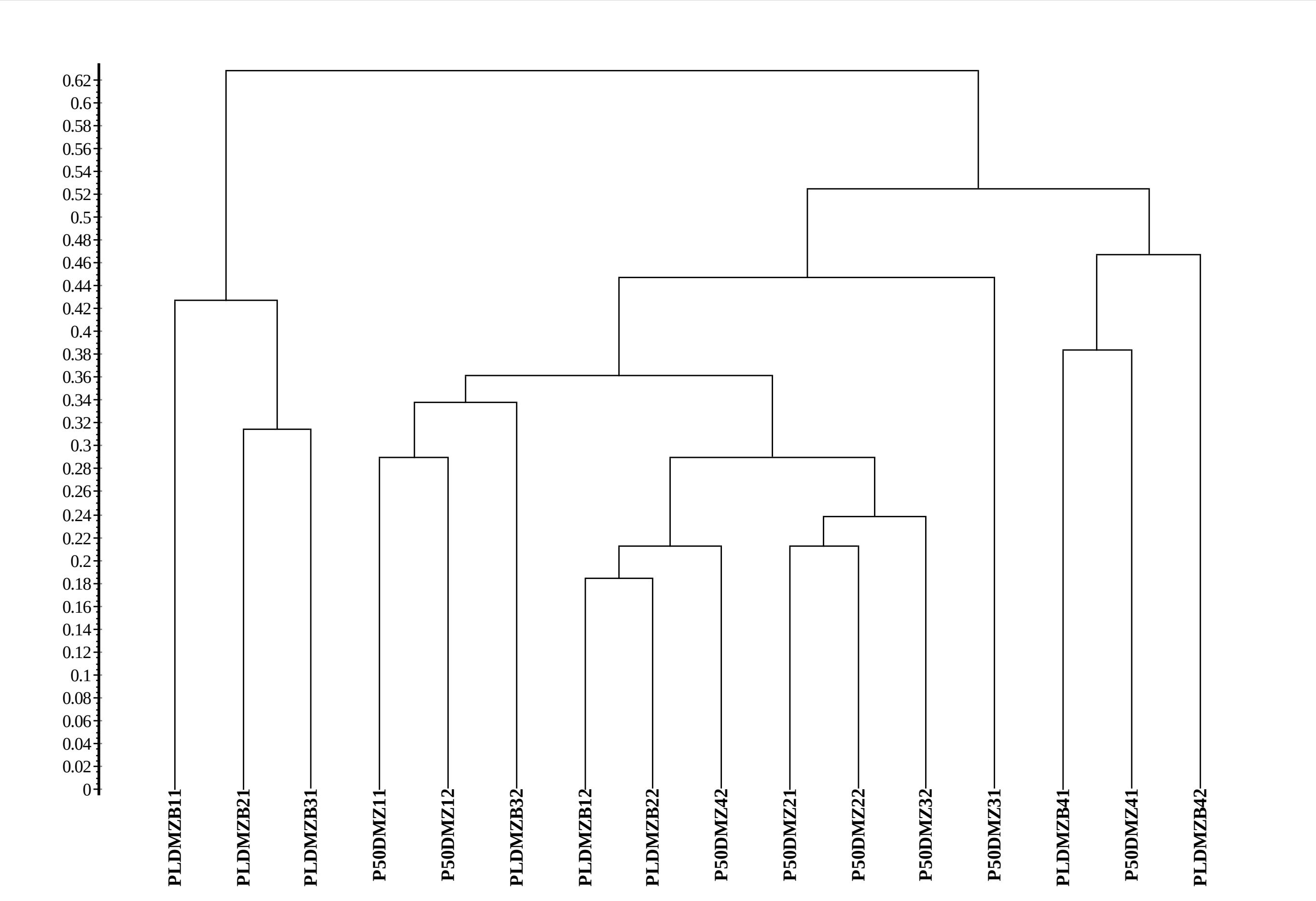


Figure 12.3.4-35: Cluster diagram of the sampling sites based on the presence or absence of macroscopic invertebrate organisms derived using the Rogers-Tanimoto similariy function for autumn samples

In the analysis of the similarities in the summer taxon composition of the macrozoobenthos community the near downstream units (left hand side branches), the control, upstream, as well as the midstream distant and distant downstream sections can be clearly distinguished. Based on taxon composition the two Dombori profiles (P50DMZB21 and 22), reflected a great degree of similarity and the Sió South (P50DMZB31) section was put to an entirely different branch, in other words the taxon inventory was different from the others, due to the presence of *Setodes punctatus and Hydropsyche sp*. caddis fly taxons which were identified only here.

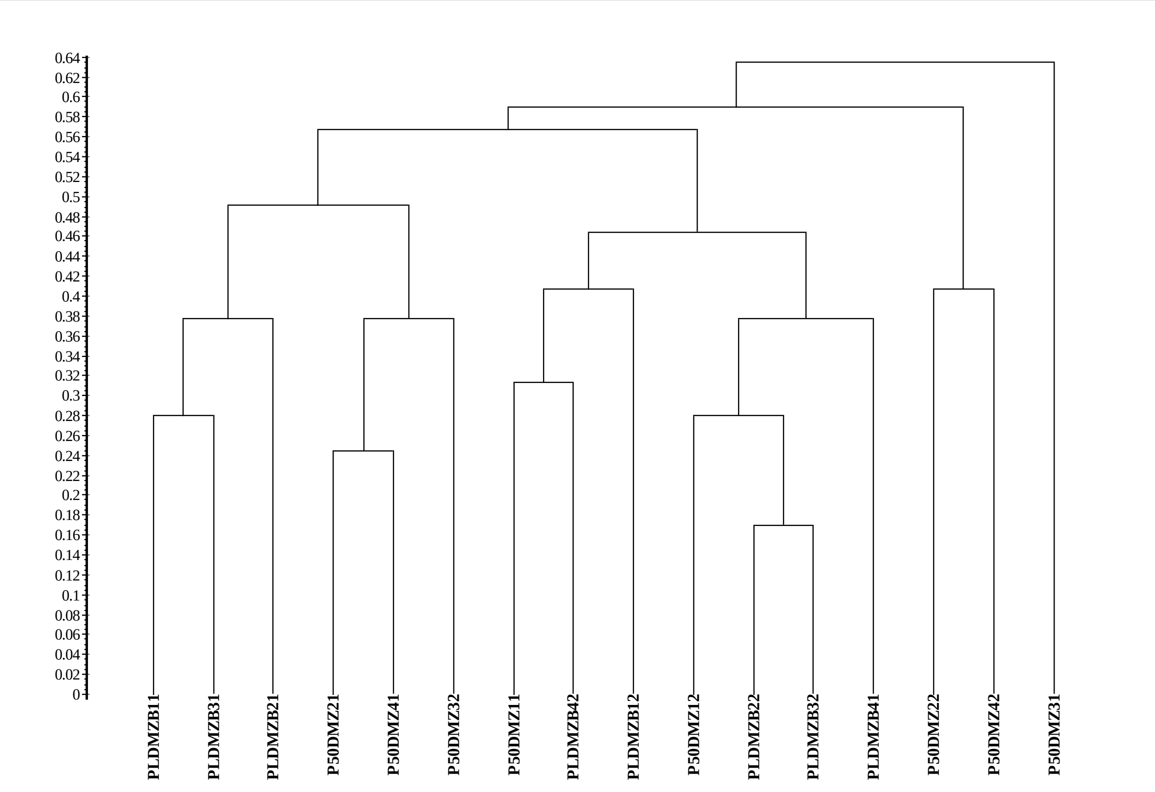


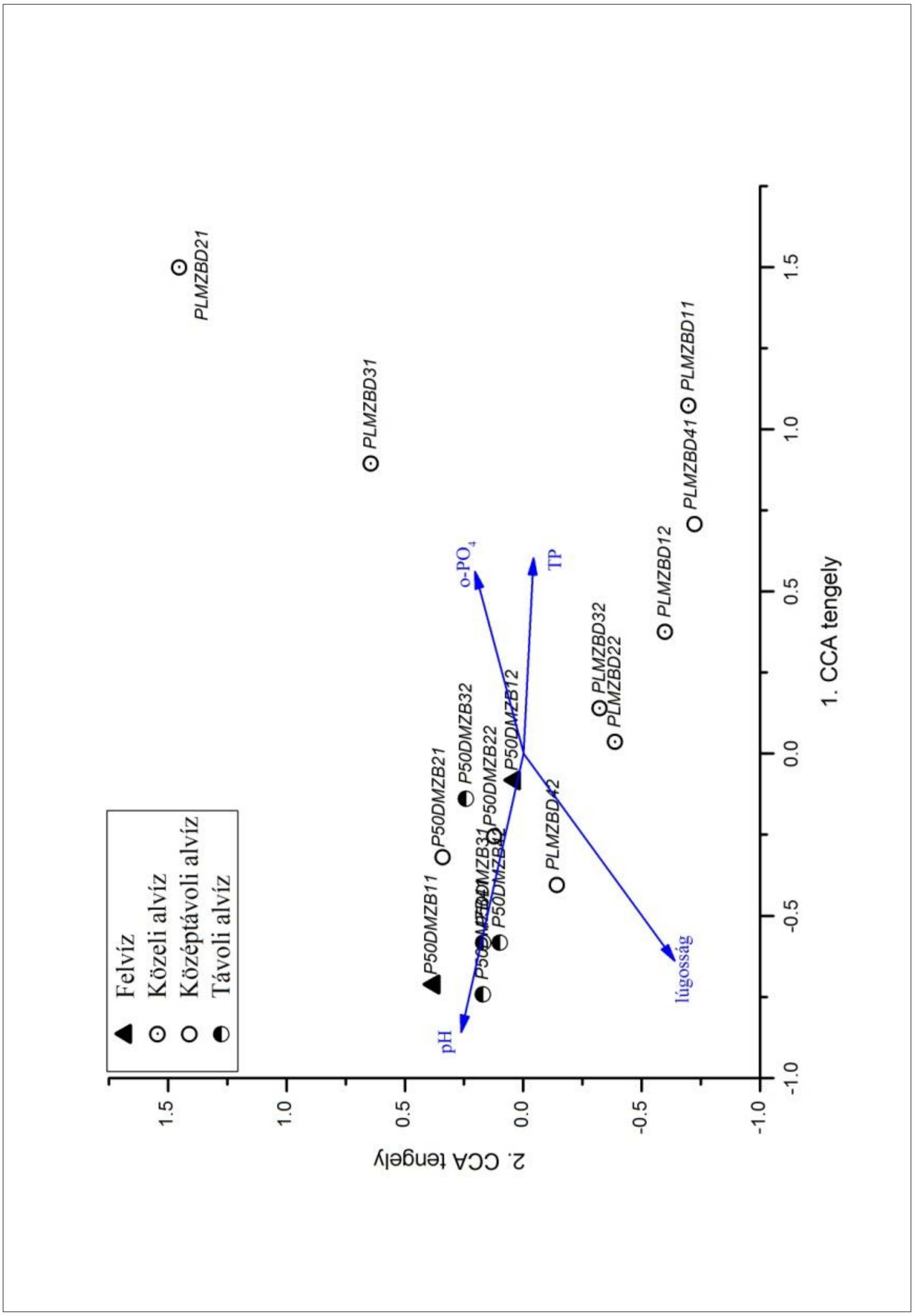
Figure 12.3.4-36: Cluster diagram of the sampling sites based on the presence or absence of macroscopic invertebrate organisms derived using the Rogers-Tanimoto similariy function for autumn samples

In the autumn samples the units of the near downstream section (left side branches) are clearly distinguished on the basis of the macroscopic invertebrate community, but units of the control section sampling also showed right and left bank differences, which difference can be demonstrated in the case of midstream distant and distant downstream sites as well, due to the low water stage referred to earlier on. The great degree of similarities between the upstream P50DMZB11 and the midstream distant downstream (PLDMZB42) points also confirms the claim that the impact of hot water most probably does not prevail on that section and the composition of the macrozoobenthos communities return to the structure encountered upstream. Additionally, beside all these factors, however, the tendencies in the community might be exposed to a great extent to the microhabitat conditions defined by the channel bottom material, in particular in the periods of low water stages.

Ordination analysis of the relationship between the environmental variables and the macroscopic invertebrate community was carried out for both the summer and the autumn samples taken in 2012-2013. In the ordination analysis the sampling units defined by the biotic data and the effective environmental variables were plotted on the ordination graph of the canonical correspondence analysis (CCA).

Taking into account the macroscopic invertebrate data from the summer it can be stated that based on the ordination process the sampling units on the near downstream section affected by the hot water are situated relatively far away from each other. No change attributable to the discharge of the Paks Nuclear Power Plant can be experienced, of the environmental variables tested (water temperature, pH, dissolved oxygen, alkalinity, chemical oxygen demand, biological oxygen demand, ammonium, nitrate, organic nitrogen, total nitrogen, orto-phosphate, total phosphorus, chlorophyll-a, TPH) the impact of the water temperature data was not significant. The first and second axis of the ordination figure together cover 51.1% of the total variance in species inventory and environmental variables. This indicates a medium level of correlation between sampling sites indicated on the CCA graph and the environmental variables tested.

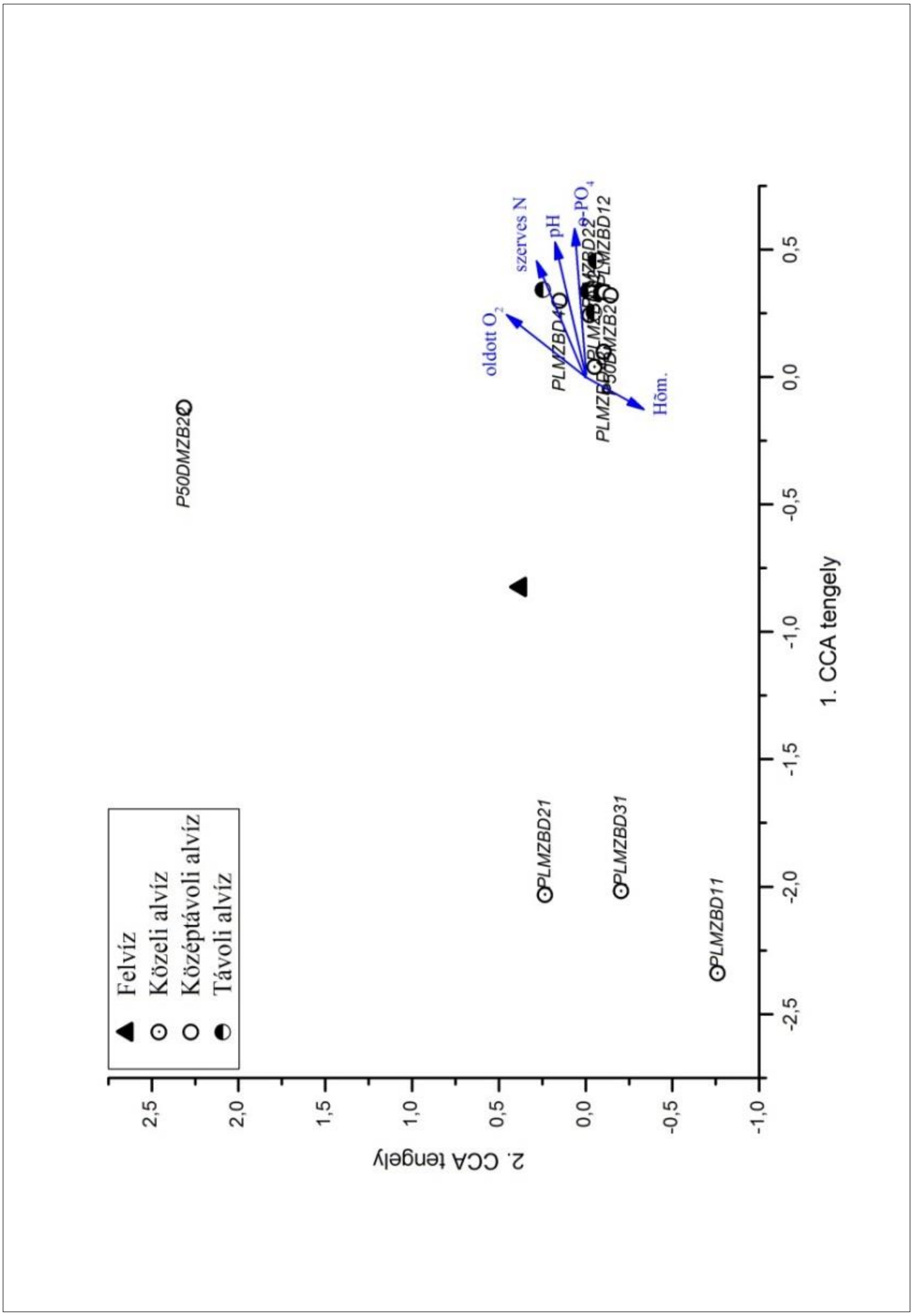
The analysis of the autumn data provides a picture to comprehend more easily – the first and second axis of the ordination figure together cover 66.3% of the total variance in species inventory and environmental variables – which marks the separation of the near downstream section strongly. Of the environmental variables the water temperature gradient can be considered a true environmental factor. Beside and in conjunction with the hydromorphological features of the water chemistry parameters the composition and structure of the macroscopic invertebrate community on the upstream, midstream-distant, and distant downstream sections is influenced most during the autumn period by the nutrient contents of the water, the pH and the concentrations of dissolved oxygen. The stronger impact on autumn samples can be explained by the fact that in the period with lower water coverage more homogeneous habitats could be samples, in other words the modifying effect of the microhabitats could be felt less.



<u>Legend:</u>

o-PO4 - orto-phosphate;
TP - Total phosphorus
felvíz – upstream section
közeli alvíz – nearby downstream section
középtávoli alvíz – medium distant downstream section
távoli alvíz – distant downstream section
tengely – axis

Figure 12.3.4-37: Ordination of effective water chemistry parameters and sampling sites using CCA on summer samples



Legend:

Hőm.: water temperature difference (Δt);
oldott O_2: dissolved oxygen;
o-PO_4: orto-phosphate; organic
N: organic nitrogen;
felvíz – upstream section
közeli alvíz – nearby downstream section
középtávoli alvíz – medium distant downstream section
távoli alvíz – distant downstream
tengely – axis

Figure 12.3.4-38: Ordination of effective water chemistry parameters and sampling sites using CCA on autumn samples

Based on the analysis it can be stated as a summary that the discharge from the Paks Nuclear Power Plant exerts an impact on the macrozoobenthos organisms of the affected side on the near downstream section due to the heat loads. According to the analysis this fact is indicated basically by the increase in the number of taxons and the diversity, meaning clearly a disturbance. The impact can be detected in an approximately 2 km long section corresponding to a value of 2.5 °C Δt.

From the ecological perspective, the dangers associated with the discharge of hot water mean that for the newly introduced invasive species – based on the sampling results in particular Dreissena polymorpha, Sinanodonta woodiana, Corbicula fluminea, Corbicula fluminalis, Dikerogammarus villosus, Orconectes limosus – the downstream section of the inlet functions as an invasion hub as a result of the hot water impact; changes in the habitat conditions encourage further expansion of these species on the downstream section. The ecological structure of the natural community is changed this way, which finally enhances vulnerability of the habitat from the biological point of view.

12.3.4.5.2 Classification of the assessed Danube sections according to the WFD on the basis of the 2012-2013 macrozoobenthos studies

Macrozoobenthos ecological status per section	EQR	Ecological status
Upstream section	0.53	moderate
Near downstream section	0.50	moderate
Mid distant downstream section	0.48	moderate
Distant downstream section	0.45	moderate

Table 12.3.4-5: Ecological status of the assessed Danube section on the basis of the macrozoobenthos

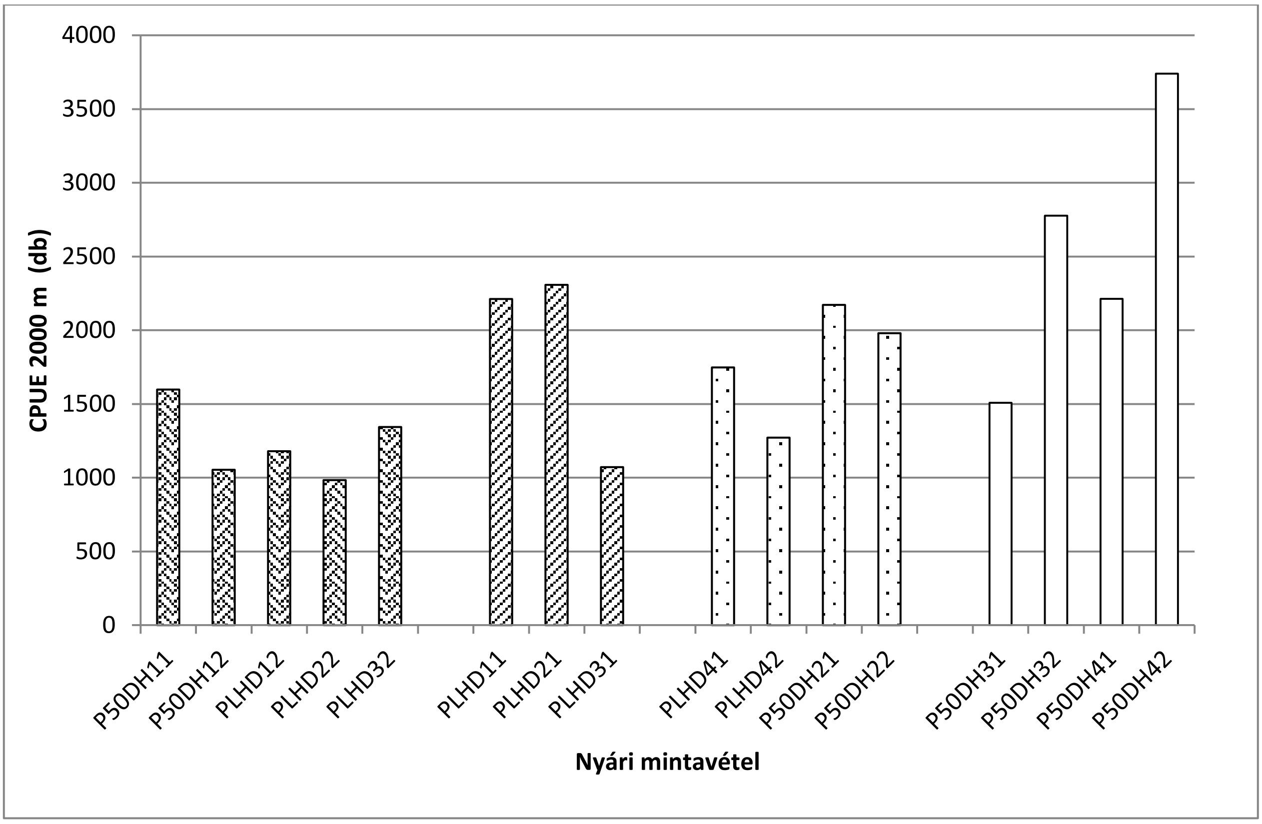
The ecological status of the Danube section assessed based on the macrozoobenthos community and with a view to the findings of the assessments carried out in 2012 and 2013 was harmonious, in the classification grade of ***moderate*** *according to the WFD.*

Discharge from the Paks Nuclear Power Plant does not cause any grade level changes in the classification value, either.

12.3.4.6 Fishes

12.3.4.6.1 Evaluation of the fish communities on the assessed Danube sections according to the wildlife conservation perspective

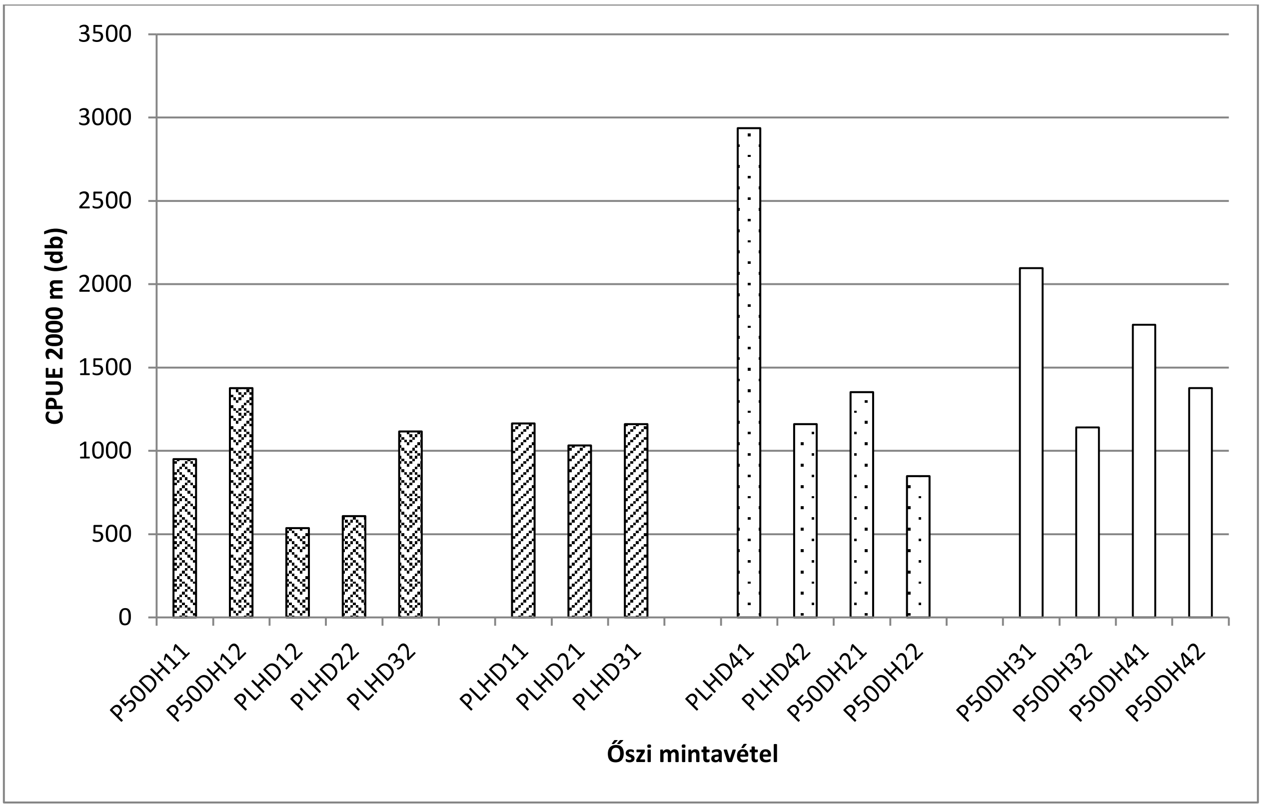
Findings of the analysis carried out on the bases of finer resolution sampling sessions made earlier on proved unanimously that the cooling water of the Paks Nuclear Power Plant caused an increase of the number of individuals in the fish community locally along an approximately 2 km long affected Danube-section. In downstream direction the abundance values returned again to the levels typical for the upstream section and the areas not affected by the hot water. Statistical analysis of the sampling units from pebbled surface bottom providing homogeneous environmental conditions showed significant differences in the abundance levels of the fish community in the 2 km long section affected by hot water (Halasi-Kovács [12-14], SCIAP [12-37]). In addition to this fact the findings of the 2009 study indicated also that at the Gerjen profile another – albeit less dominant – growth in abundance could be experienced. Abundance levels derived from the adult + offspring data of the 2012-2013 summer and autumn sampling were presented on column diagrams below (Figure 12.3.4-39,Figure 12.3.4-40).



Nyári mintavétel – Sampling during Summer
sorozatok - trends

Figure 12.3.4-39: CPUE values of fish communities on the Danube sampling sections during the summer sampling

The figures of the catch per unit efforts on the 2000 metres length in the summer sampling session (CPUE) substantiated the findings of former research. Following the homogeneously low values of the upstream section as well as of the near downstream section not affected by the hot water a quantum leap is seen in the number of individuals on the near downstream section in sampling units taken from the right bank, which does not show any difference compared to upstream levels any more after the profile of the third unit, i.e. in a distance of approximately 2 000 metres from the hot water discharge. Units of the midstream-distant downstream section – like in earlier sampling efforts – grow again, abundance figures here exceed those encountered in the upstream sample profiles. Sampling units on the left hand side, which is not affected by the heat plume reflected lower levels, but they still exceed the upstream data. The highest abundance levels are seen in the results of the distant downstream section. They exceed even the levels measured at the discharge point. It should be noted that in this section the highest scores were achieved by the left side sampling units. Statistical evaluation of the findings plotted on the bar charts was accomplished by the non parametric Kruskal-Wallis test. As a result of the assessment it can be stated that no significant difference exists across sections at 95% probability level (χ^2=7.328; p=0.062).



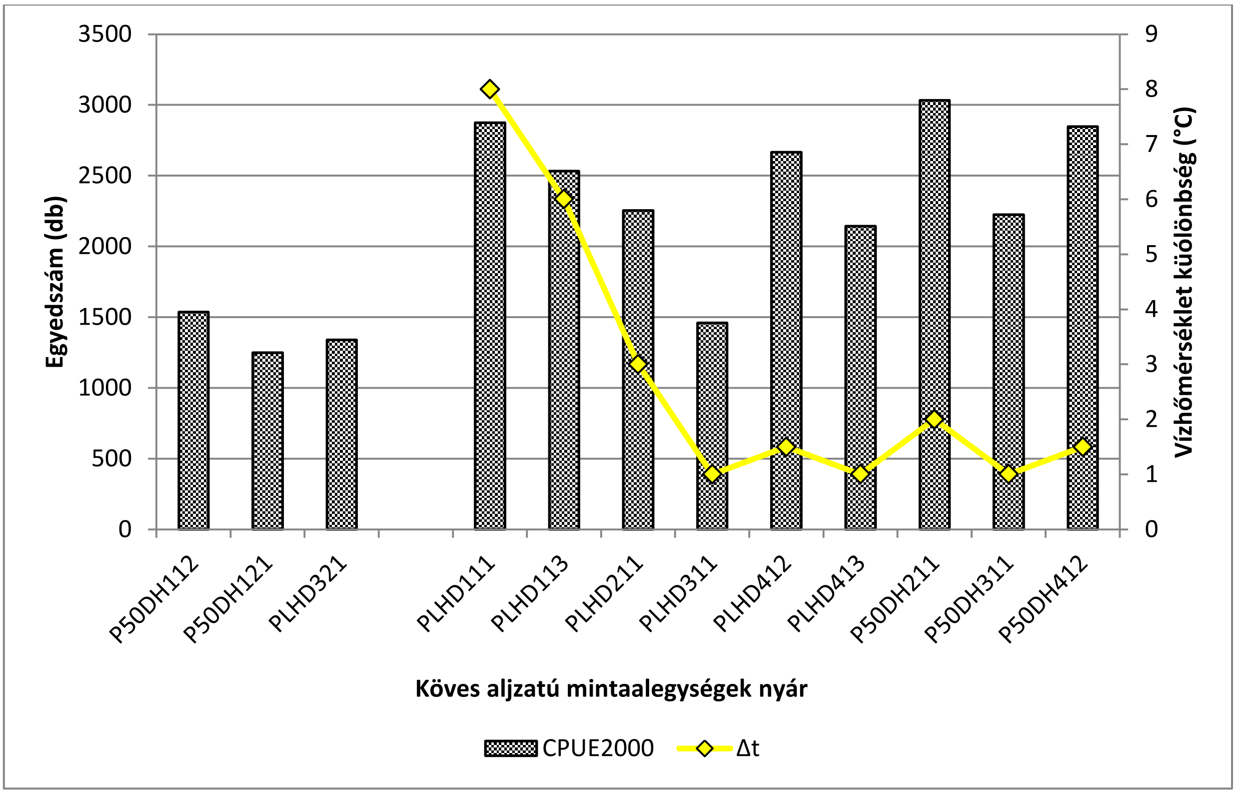
Őszi mintavétel – Sampling in Autumn
Sorozatok – trends

Figure 12.3.4-40: CPUE values of fish communities on the Danube sampling sections during the autumn sampling

Findings of the autumn sampling provided a lot more homogeneous picture than that in summer. Similarly to earlier survey results, no higher abundance levels could be detected even at the discharge site. At the same time it is remarkable that results of the midstream-distant and distant sections exceed both the upstream and near downstream levels in the autumn period as well.

Based on the evaluation results in summary it can be said that – taking into account the changes of the abundance levels in the longitudinal direction from upstream towards distant downstream – that hot water discharge can be demonstrated to cause detectable increase in the number of individuals in a length of 2 000 metres. At the same time, the extent of increase in the number of individuals caused locally by the discharge is may be exceeded by natural and other artificial environmental impacts not to be associated with the operation of the Paks Nuclear Power Plant. In addition to the microhabitat level varieties represented by the diversity of the natural bottom such environmental factors include the offspring discharge effect of the Gemenc river branch system and the organic nutrient load originating from the Sió.

In order to reduce the disturbing effects emerging during the statistical assessment of the habitat heterogeneity (Halasi-Kovács [12-14]) abundance data from the sample subsections taken on pebbled surface samples were analysed separately from the summer sampling session. beside abundance levels of adult + young individuals the Δt value calculated from the temperature data measured on the surface at the time of sampling relative to the upstream measurement results.



Köves aljzatú mintaalegységek nyár – pebbled surface bottom sampling subunits in Summer
Egyedszám (db) – number of individuals
Vízhőmérséklet különbség – water temperature difference

Figure 12.3.4-41: CPUE values of the fish community in the pebbled surface bottom sampling subunits on the upstream and downstream sections

The column diagram confirms and at the same highlights the results referred to above. Values on the upstream sampling units are steady and lower. An abrupt high abundance level characterises the discharge site which returns to the value typical for the upstream section gradually, after approximately 2 km at the PLHD311 sample subunit profile. From the sample subunit numbered PLHD412 higher abundance level appear again which continue up to the end of the distant downstream section. Comparison of the upstream and downstream pebbled surface bottom sampling sites was carried out using the two samples non-parametric Mann-Whitney test. The first cluster consists of the upstream (P50DH112, P50DH121) and left side downstream – surely not affected by the hot water discharge – pebbled surface bottom sampling subunits (PLHD321). Pebbled surface bottom sampling units affected by the hot water plume on the right hand side were ranked in the second group (PLHD111, PLHD113, PLHD211, PLHD311, PLHD412, PLHD413, P50DH211, P50DH311, P50DH412). As a result of the significance tests it can be stated that significant differences could be confirmed between the two groups at 95% probability level ($p=0.0182$).

Data on the column diagram indicate that the decrease of the temperature was not even on the right hand side area, that is where the heat plume had an effect. At the same time the substantial increases in abundance levels can not be explained by the slight temperature increase or fluctuations alone. This phenomenon can not be associated with the discharge from the Paks Nuclear Power Plant but confirms the fact that variations in the natural conditions may be able to create changes in the abundance patterns which exceed the impact of the discharge.

The similarity of the sampling units was defined using the quantitative Euclidean distance function, and the cluster analysis computed with the Ward method. Added up the basic data contain the number of adult and young individuals in summer from samples taken on pebbled bottom (Figure 12.3.4-42).

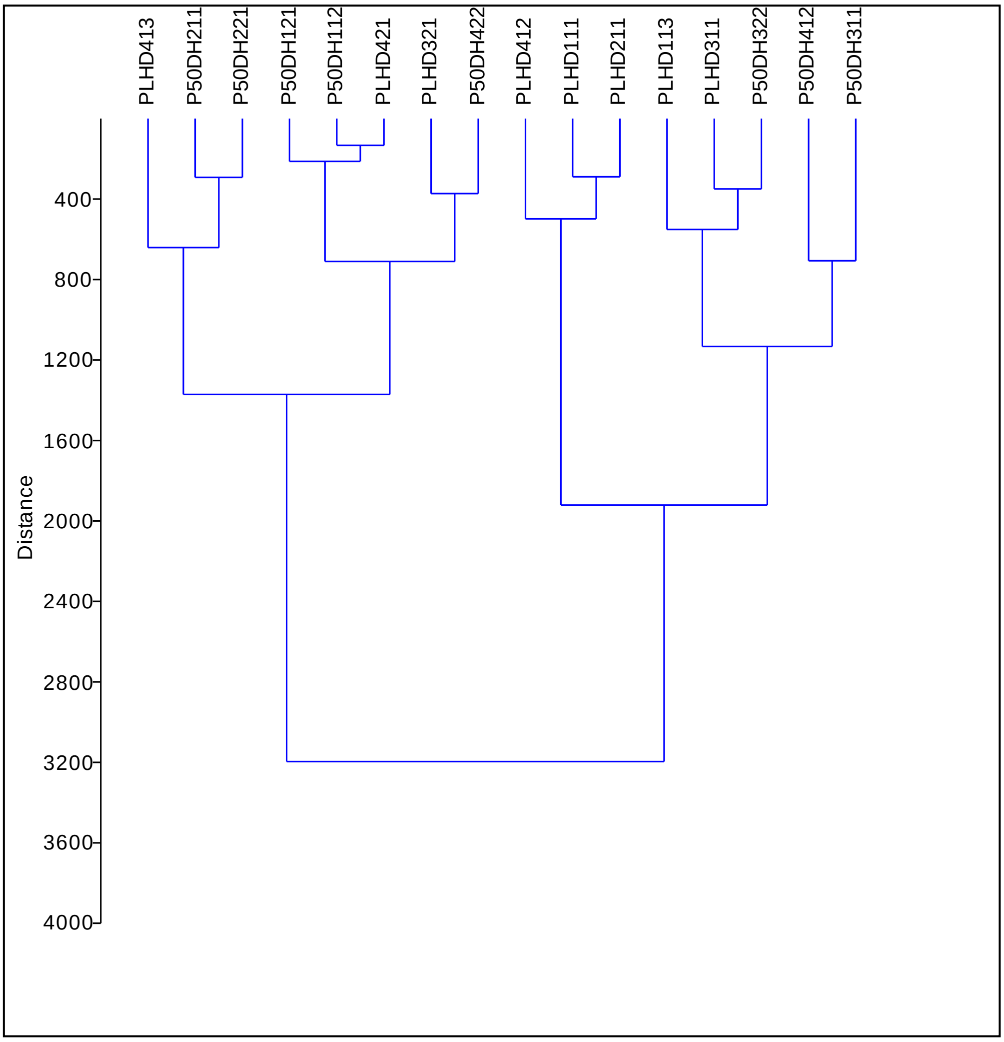
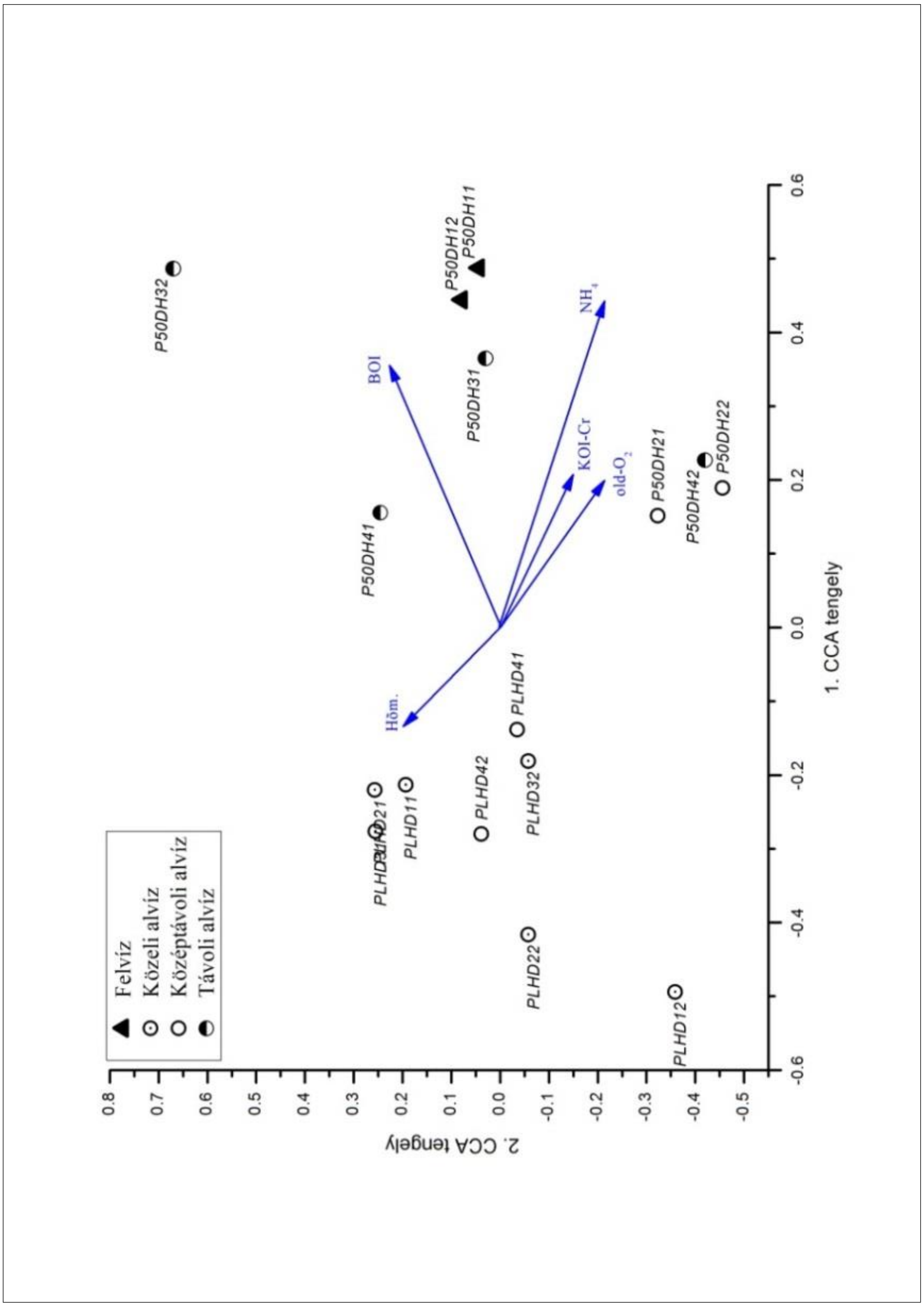


Figure 12.3.4-42: Dendrogram of the pebbled bottom sampling subunits in the Danube

The findings of the cluster analysis confirms the evaluation results of the abundance features illustrated on the column diagrams. The dendrogram consists of two major groups which can be interpreted from the ecological perspective. Areas of the upstream (P50DH112, P50DH121) section, as well those of the near downstream section (PLHD111, PLHD113, PLHD211, PLHD311) which are exposed to the discharge constitute two clearly distinct clusters, confirming the direct impact of the Paks Nuclear Power Plant hot water discharge on the structure of the fish assembly. However, no patterns which could be directly associated with the discharge can be detected on the midstream-distant and distant sections and the changes observed to not arrange to become a gradient.

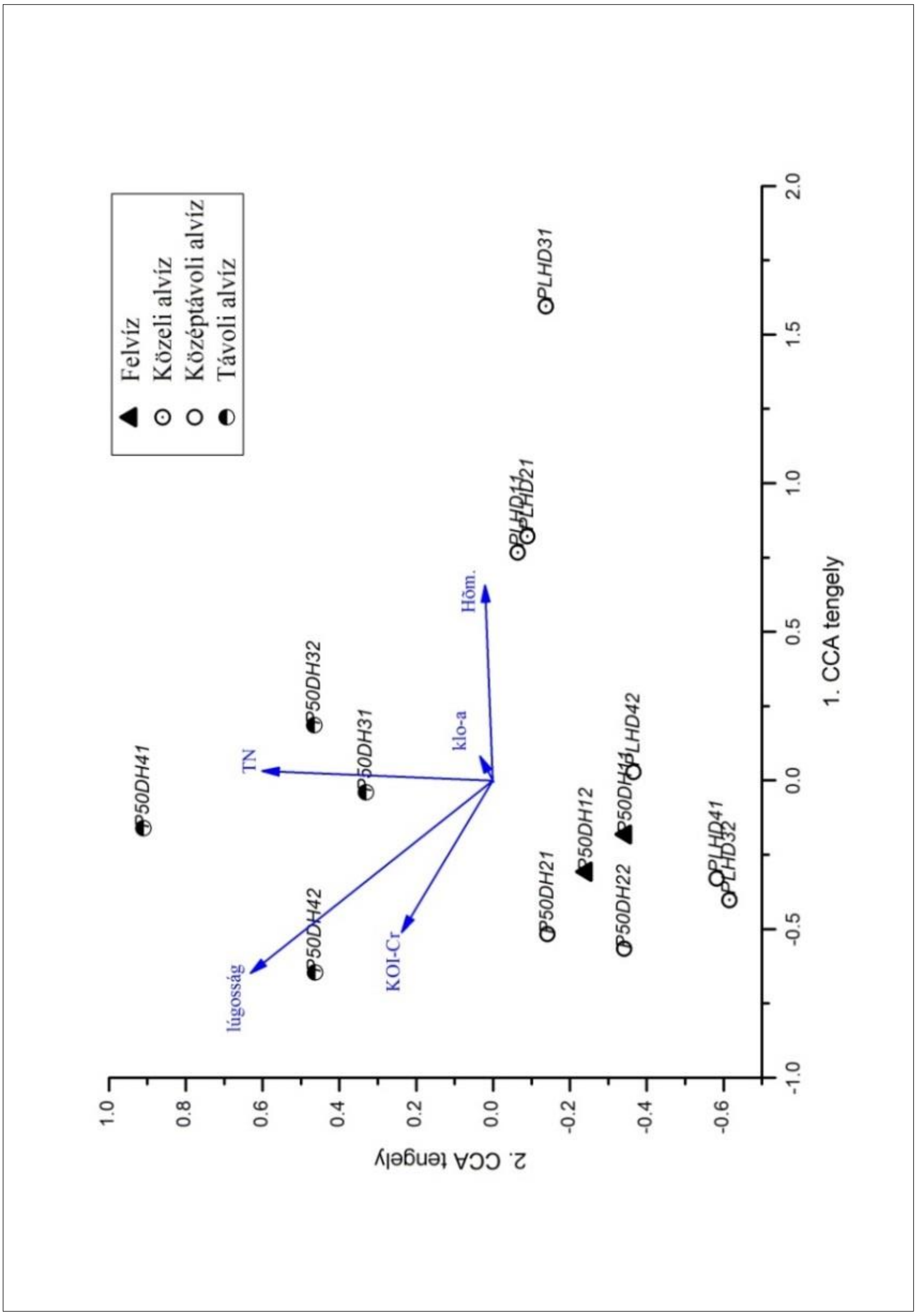
Correlations between the fish community and certain abiotic environmental variables was analysed using the canonical correspondence analysis. In the case of biotic data – based on the analysis above – figures from the summer sampling of the adult age group, as well as summer sampling data on adult and young individuals of pebbled bottom sampling units were used. The range of abiotic environmental variables consisted in this test those physical and chemical parameters of the water which indicated (any kind of) trend type changes from the direction of the upstream section towards the downstream sections (water temperature, pH, dissolved oxygen, alkalinity, chemical oxygen demand, biological oxygen demand, ammonium, nitrate, organic nitrogen, total nitrogen, orto-phosphate, total phosphorus, chlorophyll-a, TPH). Correlation of the biotic and abiotic variables was of medium level (41.8% for adult individuals and 54% in the event of sampling sites with paved, pebbled bottom).



Legend:

BOD: biological oxygen demand;
Hőm.: water temperature difference (Δt);
COD-Cr: chromate chemical oxygen demand;
NH_4: ammonium;
old-O_2: dissolved oxygen;
tengely – axis
felvíz – upstream section
közeli alvíz – nearby downstream section
középtávoli alvíz – medium distant downstream section
távoli alvíz – distant downstream section

Figure 12.3.4-43: Diagram of the canonical correspondence analysis (CCA) diagramja; Danube, summer sampling, adult individuals



Legend:

Hőm.: water temperature difference (Δt);
COD-Cr: chromates chemical oxygen demand;
klo-a: chlorophyll-a;
TN: Total nitrogen;
tengely – axis
felvíz – upstream section
közeli alvíz – nearby downstream section
középtávoli alvíz – medium distant downstream section
távoli alvíz – distant downstream section

Figure 12.3.4-44: Diagram of the canonical correspondence analysis (CCA); Danube, pebbled bottom, summer-autumn sampling, adult and young individuals

The outcome of the two analyses is identical and confirms the results of the analyses referred to above. On the other hand, it also provides additional information on the loads exerted by the Paks Nuclear Power Plant on the wildlife of the Danube river. **On this basis it can be declared that the discharge from the Paks Nuclear Power Plant has an impact on the fish community structure due to the heat loads. Such impact can be detected up to a distance of approximately 2 km, which corresponds to a Δt value of 2.5 °C based on our own measurements. At the same time the ordination diagram provides evidence that the waters discharged from the Paks Nuclear Power Plant do not cause any detectable effect on the Danube fish community in terms of either nutrient or TPH concentrations.** The image of the diagram makes it clearly visible that nutrients have a serious community organisation power, the exposure can be detected below the Sió mouth and on the Gemenc branch system profile, that is at the distant downstream section, while the lack of it on the upstream section and parts of the near downstream section not affected by the discharge.

Beside the impact revealed it is an important fact that due to the effect of the hot water discharge nodes of several invasive, mainly pioneer fish species may appear mainly in the areas of the backwater river branches where water flow is less intensive. This may just as well extend local impact of the hot water to a significant extent. Such species include potentially – based on the study findings – primarily *Carassius gibelio*, as well as *Neogobius melanostomus*.

On the other hand, statistical analyses pointed out the fact indicated earlier on unanimously that habitat features and conditions as environmental factors cover up the impacts of the power plant discharge to a significant extent. In order to detect finer impact mechanisms this fact has to be taken into account when longer term assessment programmes are planned. For this reason it seems to be advisable to set up a monitoring plan where it is taken into account that due to the assumed local impact of the discharge the effects on the fish community can only be demonstrated by serial samples taken in small units and executed in an accurate manner. Additionally the assessment must also include a supplementary test in the channel bottom as the most homogeneous habitat, in addition to the current method.

12.3.4.6.2 Classification of the assessed Danube sections according to the WFD on the basis of the 2012-2013 fish community studies

Ecological status of fish communities per section	Number of scores	Ecological status
Upstream section	38	good
Near downstream section	37	good
Mid-distance downstream section	38	good
Distant downstream section	38	good

Table 12.3.4-6: Ecological status of the assessed Danube section on the basis of the fish community

*The ecological status of the Danube section assessed based on the fish community and with a view to the findings of the assessments carried out in 2012 and 2013 was harmonious, in the classification grade of **good** according to the WFD.*

Discharge from the Paks Nuclear Power Plant does not cause any grade level changes in the classification value, either.

12.3.4.7 Comprehensive ecological status classification of the assessed Danube sections belonging to the body of water marked HURWAEP444 according to the WFD

When the Danube section assessed was evaluated, basically the fundamental principles included in the ECOSTAT guidance document no. 13. (ECOSTAT 2005: Common Implementation Strategy for the Water Framework Directive (2000/60/EC) were taken into consideration, as well as the domestic national guidance specified in the course of the planning process of the national river basin management plan in 2008.

During the assessment of the Danube in accordance with WFD the classification principle of "one bad means all bad" formulated in the Water Framework Directive was taken into account at the level of qualitative elements and groups of elements.

The findings of the macrophyte classification process is given only for information, it was not taken into account for classification purposes.

A summary of the classification results of the Danube water body marked HURWAEP444, between Szob and Baja in accordance with the individual elements assessed pursuant to the WFD is shown on the table below per section studied.

Danube sections	Physico-chemical properties	Phytoplankton	Phytobenthos	Macrophyte	Macrozoobenthos	Fishes
Upstream	good	good	moderate	moderate	moderate	good
Near downstream	good	good	moderate	moderate	moderate	good
Distant downstream	good	good	moderate	moderate	moderate	good
		good	moderate	moderate	moderate	good

Table 12.3.4-7: WFD classification of the assessed Danube section (HURWAEP444) per section and per element tested

Based on the evaluation results of the water quality assessment pursuant to the requirements laid down in the WFD carried out in 2012 and 2013 the ecological status of the water body marked Danube HURWAEP444 between Szob and Baja was moderate.

The outcome of the current study is in line with the status grade based on the available historical data.

It can be stated that the discharge of the Paks Nuclear Power Plant into the Danube does not cause grade level changes in any of the study groups.

However, the finer resolution analysis of the data points out that the discharge does have impacts on the structure of the wildlife communities downstream, and that the WFD basede classification method in itself is therefore not suited to judge the exact impacts of the power plant discharge. Therefore we find it of paramount importance that during the additional studies the design of the sampling sessions remained on the basis of the WFD, the classification be completed, but at the same time the design and execution of the sampling procedure should allow the implementation of finer resolution ecological analysis, and hence the more accurate evaluation of the ecological impacts the discharge may cause.

12.4 BASE STATE OF THE OTHER SURFACE BODIES OF WATER IN THE NEIGHBOURHOOD

Lakes surveys in the surrounding of the site

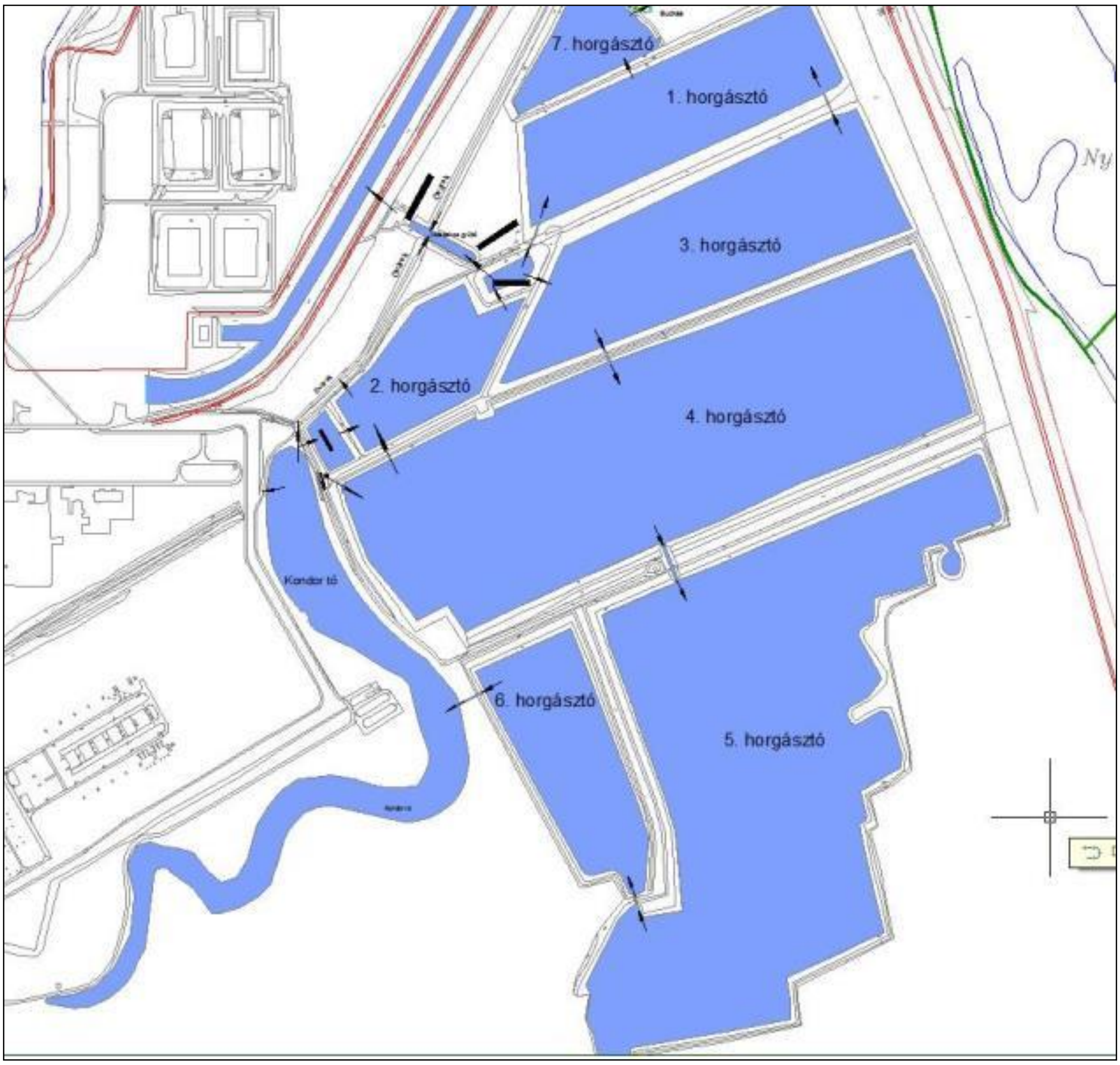
- Kondor Lake, Fishing Ponds (HULWAIH005 water body)
- Dead Danube of Fadd (HULWAIH066 water body)
- Tolnai-Dead-Danube (HULWAIH136)
- Sió canal downstream section (HURWAEP959)

12.4.1 KONDOR LAKE AND THE FISHING PONDS (HULWAIH005)

12.4.1.1 Physico-chemical results of water testing

Tests concerning the determination of the physico-chemical parameters were carried out in the former Dead-Danube branch situated directly at the southern edge of the site – now maintained by artificial water replenishment – four times in 2012. Classification of the lake was made according to these tests.

The layout of the lakes is shown on Figure 12.4.1-1.



tó – pond
horgásztó – fishing pond

Figure 12.4.1-1: Test site: Kondor Lake and the Angler Ponds

Classification based on the assessments in 2012 according to the WFD was accomplished in Chapter 12.4.1 and the results summarised in Table 12.4.1-1.

CLASSIFICATION OF THE KONDOR LAKE AND THE FISHING PONDS ACCORDING TO THE WFD

Based on the WFD classification method it can be seen that the acidification status of the water body was good, salinity status high, oxygenation conditions are short of good, and nutrients also fall short of the good status.

Thus, Kondor Lake (HULWAIH005 water body) did not reach good status based on physico-chemical parameters when classified according to the WFD.

Only one point sample was tested at the discharge sluice of the Fishing Ponds in 2012, therefore no status grade can be determined for this artificial water body according to the Decree. Since Kondor Lake and the Fishing Ponds should be seen as a single water body due to their artificial connection, the latter test can be regarded as a fifth test in addition to the existing four samples from the Kondor Lake, and the Fishing Ponds were therefore evaluated in conjunction with the Kondor Lake.

Findings on the 2012 physico-chemical testing of the lakes are provided in Table 12.4.2-1.

Groups and elements evaluating the physico-chemical status of the water body	Calculated average grade	Rounded average grade	
Acidification status (pH)	**4.5**	**4**	
Salinity (conductivity)	**5.0**	**5**	
conductivity	5.0		
Oxygenation conditions: (dissolved O_2, oxygen saturation, BOD_5, COD_{cr})	**2.8**	**3**	
Dissolved O_2	4.0		
BOD_5	0.0		
COD_{cr}	4.5		
Nutrient conditions: (NH_4-N, NO_3-N, TP, PO_4-P, TN, a-Chlorophyll)	**2.0**	**2**	
NH_4-N	2.5		
NO_3-N	0.0		
TP	2.0		
PO_4-P	2.5		
TN	5.0		
a-chlorophyll	0.0		
Classification of the Kondor Lake and the Fishing Ponds (HULWAIH005 water body) according to the WFD		**2**	**Did not reach good status**

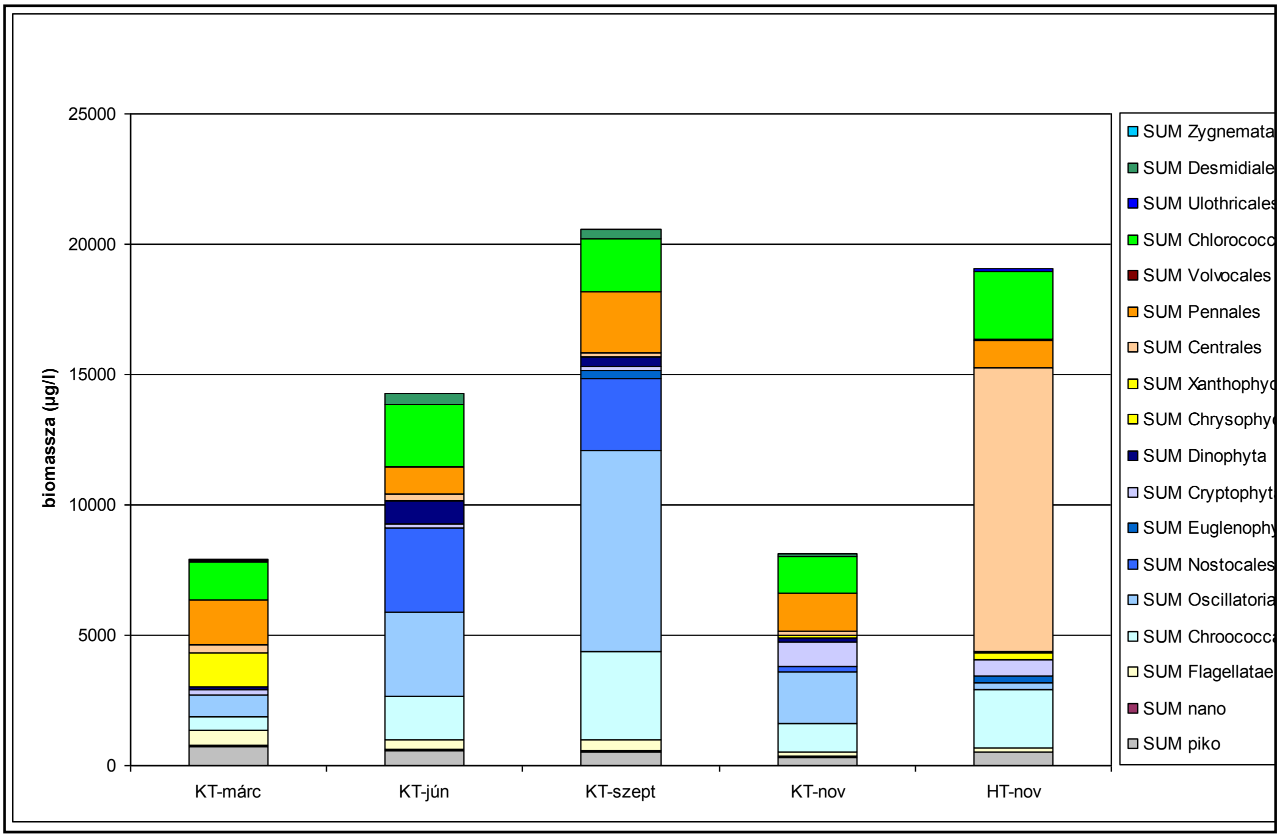
Table 12.4.1-1: Classification of the physico-chemical status of the Kondor Lake and Fishing Ponds water body according to the WFD

12.4.1.2 Phytoplankton

Phytoplankton sampling of the Kondor Lake was carried out in four repetitions while the Fishing Ponds were sampled at their drainage (16.11.2012) below the draining structure.

TAXONS	Sampling sites and dates				
	Kondor Lake				Fishing Ponds discharge canal
	PLKTFP	PLKTFP	PLKTFP	PLKTFP	PLHTFP
	23.12.2012	27.06.2012	26.09.2012	14.11.2012	16.11.2012
SUM pico	733	561	542	330	514
SUM nano	43	46	13	27	28
SUM Flagellates	555	400	433	159	156
SUM Chroococcales	546	1662	3372	1077	2204
SUM Oscillatoriales	823	3224	7742	2004	301
SUM Nostocales	7	3203	2748	188	0
SUM Euglenophyta	0	39	283	7	213
SUM Cryptophyta	235	125	201	950	650
SUM Dinophyta	58	896	341	134	0
SUM Chrysophyceae	1315	6	1	145	237
SUM Xanthophyceae	0	0	0	0	72
SUM Centrales	296	239	134	134	10906
SUM Pennales	1734	1041	2382	1442	1044
SUM Volvocales	0	0	0	0	38
SUM Chlorococcales	1452	2433	2022	1417	2574
SUM Ulothricales	68	2	0	1	128
SUM Desmidiales	30	410	360	105	0
SUM Zygnematales	0	0	0	0	0
SUM	**7894**	**14287**	**20573**	**8119**	**19064**
a-chlorophyll concentration (µg/l)	**10.2**	**55.0**	**98.3**	**33.2**	**73.0**
a-chlorophyll contents of biomass (%)	**0.129**	**0.385**	**0.478**	**0.409**	**0.383**
degree of trophity	**4 (m)**	**6 (eu)**	**6 (eu)**	**5 (m-eu)**	**6 (eu)**

Table 12.4.1-2: Phytoplankton biomass (µg/l) and a-chlorophyll concentration (µg/l) on the Kondor-lake and the discharge canal of the Angler Ponds



biomassza – biomass

Figure 12.4.1-2: Phytoplankton biomass and composition on the Kondor-lake and the discharge canal of trhe Fishing Ponds

The biomass of the Paks **Kondor Lake** phytoplankton *on 22 March 2012* was 7.6 mg/l, calculated a-chlorophyll concentration 29.0 µg/l, corresponding to the 5 (meso-eutrophic) grade and Water Quality class III. Components of phytoplankton biomass in the highest ratio included diatom species from the order Pennales (22.6%), of the flagellate golden-brown algae (Chrysophyceae: 17.2%), green algae in the order Chlorococcales (14.3%) and blue algae in the order Oscillatoriales (10.9%).

The number of taxons N=80. The value of the Shannon-diversity was H'=4.88, smoothness J=0.77.

The HLPI EQR value calculated on the basis of the phytoplankton composition according to the WFD was 0.737, corresponding to a good ecological status.

The biomass of the Paks Kondor Lake phytoplankton *on 27 June 2012* was approximately twice the March value, 14.3 mg/l, a-chlorophyll concentration 55.0 µg/l, corresponding to the 6 (eutrophic) grade and Water Quality class III. Components of phytoplankton biomass in the highest ratio included blue algae in the orders Oscillatoriales, Nostocales and Chroococcales (22.6%, 22.4% and 11.6%), as well as green algae in the order Chlorococcales (17.0%) and diatom species in the order Pennales (7.3%).

The number of taxons found ranged up to N=77, the value of the Shannon-diversity was H'=4,98, that of homogeneity J=0.79.

The HLPI EQR value calculated on the basis of the phytoplankton composition according to the WFD was 0.607 corresponding to a good ecological status.

The biomass of the Paks Kondor Lake phytoplankton *on 26 September 2012* was approximately one and a half of the June value, 20.6 mg/l, a-chlorophyll concentration 98.3 µg/l, corresponding to the 6 (eutrophic) grade and Water Quality class III. Components of phytoplankton biomass in the highest ratio included blue algae in the orders Oscillatoriales-, Chroococcales- and Nostocales (37.6%, 16.4%, and 13.4%, respectively), as well as diatom species in the order Pennales (11.6%) and green algae in the order Chlorococcales (9.8%).

The number of taxons found ranged up to N=67, the value of the Shannon-diversity was H'=4,57, that of homogeneity J=0.75.

The HLPI value calculated on the basis of the phytoplankton composition and taking into account a-chlorophyll concentration as well was HLPI=0.482 corresponding to a moderate ecological status.

The biomass of the Paks Kondor Lake phytoplankton *on 14 November 2012* was approximately 40% of the June value, 8.1 mg/l, a-chlorophyll concentration 33.2 µg/l, corresponding to the 5 (meso-eutrophic) grade and Water Quality class II. Components of phytoplankton biomass in the highest ratio included blue algae in the order Oscillatoriales-, Chroococcales- and Nostocales (24.7%, 13.3%, and 2.3%, respectively), as well as diatom species in the Pennales order (17.8%), green algae from the Chlorococcales order (17.5%) and grooved cryptomonads (Cryptophyta: 11.7%).

The number of taxons found ranged up to N=63, the value of the Shannon-diversity was H'=4,83, that of homogeneity J=0.81.

The HLPI value calculated on the basis of the phytoplankton composition was 0.698, corresponding to a good ecological status.

In the drainage canal of the **Fishing Ponds** on *November 16 2012* the planktonic algal community included a large proportion of the Aulacoseira-species thought to be stirred up from the sediment layer, therefore the interpretation of these findings is questionable and the evaluation is provided for your information only.

Biomass of the algal community in the water space was 19.1 mg/l, and the calculated a-chlorophyll concentration 73.0 µg/l, corresponding to the 6 (eutrophic) grade and Water Quality class III. Components of phytoplankton biomass in the highest ratio (57.2%) included mainly Centrales-diatom species represented by Aulacoseira-species. The share of the green algae belonging to the order Chlorococcales was 13,5%), that of blue algae in the order Chroococcales 11,6%, and of the diatom species in the order Pennales 5.5%.

The number of taxons found ranged up to N=66, the value of the Shannon-diversity was H'=3,52, that of homogeneity J=0.58.

The HLPI value calculated on the basis of the phytoplankton composition and taking into account a-chlorophyll concentration as well was HLPI=0.697 corresponding to a good ecological status.

Sampling unit	EQR	Ecological status (based on EQR)
Kondor Lake March	0.737	good
Kondor Lake June	0.607	good
Kondor Lake September	0.482	moderate
Kondor Lake November	0.698	good
average value:	**0.631**	**good**
Fishing Ponds:	**0.697**	**good**

Table 12.4.1-3: Ecological status of the water body marked (HULWAIH005) – Kondor Lake, as well as Fishing Ponds – based on phytoplankton, according to the WFD classification method

*Based on the findings of the assessment it can be stated that the ecological status of both the Kondor Lake, mind the Fishing Ponds according to the phytoplankton analysis was **good**.*

The phytoplankton structure of the water body is basically defined not by the discharge from the Paks Nuclear Power Plant, much rather the still water habit of the area and – at least in an equal weight – intensive utilisation as an angler and fishing lake. This is substantiated by the historical data which suggest that the algal biomass was able to assume extreme levels periodically. The historical data confirmed also that phytoplankton biomass in the cooling water passing the Paks Nuclear Power Plant cooling system expressed a lower level due to the heat shock than that in the Danube water at the intake. Subsequently, the phytoplankton structure seasonally characterising the lakes is then developed gradually.

12.4.1.3 Phytobenthos

Phytobenthos in the Kondor Lake was sampled on 27 June 2012 and on 26 September. Samples for phytobenthos were taken from the Fishing Ponds drainage canal on 16 November when the water from the lakes was drained.

TAXONS	Kondor Lake: Paks		Fishing Ponds discharge canal
	27.06.2012	26.09.2012	16.11.2012
	pi (%)	pi (%)	pi (%)
CENTRALES			
SUM Centrales	0.0	0.0	86,9
PENNALES			
SUM Fragilariaceae	78,7	60.0	4,9
SUM Achnanthaceae	11,4	33,6	4,6
SUM Naviculaceae	2,3	3,4	1,6
SUM Bacillariaceae	7,2	2,5	1,6
SUM Epithemiaceae	0.0	0.2	0.0
SUM Surirellaceae	0.0	0.0	0.3
SUM Pennales spp. (other)	0.4	0.2	0.0
SUM	**100.0**	**100.0**	**100.0**

Table 12.4.1-4: Composition of the diatom inventory of the phytobenthos in the Kondor Lake and in the Fishing Ponds discharge canal, 2012

In the Paks **Kondor Lake** *on 27 June 2012* the diatom population of the benthos was constituted entirely from taxons belonging to the order Pennales. The components in the highest rate of the Pennales-diatom stock were the taxons in the Fragilariaceae, Achnanthaceae and Bacillariaceae-family, of which the relative abundance projected to the individuals counted was 78.7%, 11.4% and 7.2%. Taxons of the Fragilariaceae-family with the highest relative abundance included Fragilaria berolinensis (62.1%), Fragilaria pinnata (8.7%) and Fragilaria cf. nanana (5.2%). Fragilaria berolinensis, a species abundant in the plankton as well, represents a typical diatom of the Kondor Lake. It is known in this country only from a small number of habitats. This species in not included in the list of indicator taxons provided for the purposes of calculating the TDIL-index (Stenger-Kovács et al. [12-39]), therefore in the present paper the Vi and Si values specified for the calculation of the IPS-index were used and the same approach was followed in the case of a number of other taxons. The Achnanthaceae-family was represented by Achnanthidium minutissimum (=Achnanthes minutissima) (11.2%), and Achnanthes lanceolata. The share of the Bacillariaceae-family was 7.2%. The Bacillariaceae-family was represented by Nitzschia dissipata, Nitzschia angustatula, as well as other Nitzschia (Lanceolatae) species. The share of the Naviculaceae-family was 2.3%. The Naviculaceae-family was represented by sporadically encountered Navicula-, Cymbella- and Gomphonema species.

The number of taxons found ranged up to N=21, the value of the Shannon-diversity was H'=2.07, that of homogeneity J=0.47. The low level diversity and homogeneity is a consequence of the outstanding high abundance of Fragilaria berolinensis. The EQR value of the lake diatom-index is NTDIL(1-20)=0.61 corresponding to a good ecological status.

In the Paks Kondor Lake *on 26 September 2012* the diatom population of the benthos was constituted entirely from taxons belonging to the order Pennales. The components in the highest rate of the Pennales-diatom stock were the taxons in the Fragilariaceae-, and Achnanthaceae family, of which the relative abundance projected to the individuals counted was 60.0% and 33.6%. Taxons of the Fragilariaceae-family with the highest relative abundance included Fragilaria berolinensis (45.8%) and Fragilaria pinnata (10.5%). The Achnanthaceae-family was represented only by Achnanthidium minutissimum (=Achnanthes minutissima) (33.6%). The share of the Naviculaceae-family was 3.4%. The Naviculaceae-family was represented by the sporadically encountered Navicula- and Cymbella species. The share of the Bacillariaceae-family was 2.5%. The Bacillariaceae-family was represented by Nitzschia palea and other Nitzschia (Lanceolatae) species.

The number of taxons found ranged up to N=18, the value of the Shannon-diversity was H'=2.08, that of homogeneity J=0.50 volt. The low level diversity and homogeneity is a consequence of the outstanding high abundance of Fragilaria berolinensis, just like in the case of the summer results. The EQR value of the lake diatom-index is NTDIL(1-20)=0.62 corresponding to a good ecological status.

In the drainage canal of the Paks **Fishing Ponds** on *16 November 2012* both the benthic and the planktonic algal community included a large proportion of the Aulacoseira-species thought to be stirred up from the sediment layer, therefore the diatom community surveyed can not be really considered to be a representative benthic sample. The interpretation of these findings is questionable and the evaluation is provided for your information only.

Diatom populations of the benthic algal community consisted in 86.9% of taxons belonging to the orders Centrales, 13.1% in the order Pennales. The components in the highest rate of the Centrales-diatom stock were the taxons in the Aulacoseira-genus, of which the relative abundance projected to the individuals counted was 74.3%, dominant taxons included Aulacoseira ambigua (48.9%), Aulacoseira cf. subarctica f. spiralis (12.0%), Aulacoseira granulata (3.0%) and other Aulacoseira-species (5.7%). Taxons in the Thalassiosiraceae-family (Cyclostephanos dubius, Cyclotella atomus, C. meneghiniana, C. pseudostelligera, Cyclotella spp.) had a share of 12.6%. The components in the highest rate of the Pennales-diatom stock were the taxons in the Fragilariaceae- and Achnanthaceae-family, of which the relative abundance projected to the individuals counted was 4.9% and 4.6%. Taxons of the Fragilariaceae-family with the highest relative abundance included Fragilaria berolinensis (4.1%). The Achnanthaceae-family was only represented by Achnanthidium minutissimum (=Achnanthes minutissima) (4.6%). The share of the Naviculaceae-family was 1.6%. The Naviculaceae-family was represented by Navicula cryptotenella, Navicula spp. and Amphora pediculus. The share of the Bacillariaceae-family was 1.6%. The Bacillariaceae-family was represented by Nitzschia palea, Nitzschia angustatula and other Nitzschia (Lanceolatae) species.

The number of taxons found ranged up to N=26, the value of the Shannon-diversity was H'=2.92, that of homogeneity J=0.62 volt. The EQR value of the lake diatom index was NTDIL(1-20)=0.61 corresponding to a good ecological status.

Sampling unit	EQR	Ecological status (based on EQR)
Kondor Lake June	0.61	good
Kondor Lake September	0.62	good
Average value:	**0.615**	**good**
Fishing Ponds:	**0.61**	**good**

Table 12.4.1-5: Ecological status of the water body marked (HULWAIH005) – Kondor Lake, as well as Fishing Ponds – based on phytobenthos, according to the WFD classification method

Based on the findings of the assessment it can be stated that the ecological status of both the Kondor Lake, mind the Fishing Ponds according to the phytobenthos analysis was ***good****. Just like the statement made in the case of the phytoplankton tests, phytobenthos structure of the water body is basically determined by the still water habit of the area and intensive utilisation as an angler and fishing pond.*

The discharge from the Paks Nuclear Power Plant has no detectable impact on the phytobenthos of the water body.

12.4.1.4 Macrophyte

Floristic and ecological status assessment of the Kondor Lake and the Fishing Ponds

Sampling in 2012 was accomplished in two and five (4 and 5 evaluated in aggregate) sampling units in a 100 metres long section each on the Kondor-Lake and on the Angler Ponds, respectively, during summer and repeated in the autumn season.

Scientific name	English name	PLKTMF	PLHTMF
Agrostis alba	Redtop		1
Alisma lanceolata	Narrow leaved water plantain		
Alnus glutinosa	Common alder	3	
Amorpha fruticosa	Desert false indigo		1
Berula erecta	Water parsnip		1
Bidens tripartita	Three-lobe beggarticks	2	6
Calystegia sepium	Larger bindweed	1	
Carex gracilis	Slender tufted sedge	3	
Carex vulpina	True fox-sedge	1	
Dactylis glomerata	Orchardgrass		1
Echinochloa crus-galli	Common barnyardgrass		1
Eleocharis palustris	Common spike brush		2

Scientific name	English name	PLKTMF	PLHTMF
Epilobium tetragonum	Square stalked willow-herb		1
Euphorbia salicifolia	Willow leaved spurge	1	
Glyceria maxima	Reed sweetgrass		1
Humulus lupulus	Common hop	2	
Juncus articulatus	Jointleaf rush	2	
Lolium perenne	Perennial ryegrass	3	
Lycopus europaeus	Gypsywort		1
Lysimachia vulgaris	Yellow loosestrife	1	
Lythrum salicaria	Purple loosestrife	1	
Phalaroides arundinacea	Reed canarygrass		1
Phragmites australis	Common reed	3	18
Polygonum mite	Tasteless water pepper		4
Populus alba	White poplar	2	
Populus nigra	Black poplar	1	
Potamogeton crispus	Curly-leaf pondweed		1
Potamogeton nodosus	Longleaf pondweed		4
Potamogeton pectinatus	Sago pondweed		1
Ranunculus repens	Creeping buttercup	1	6
Rumex conglomeratus	Sharp dock		1
Rumex crispus	Curly dock		1
Salix caprea	Pussy willow	1	
Salix fragilis	Crack willow	2	6
Salix purpurea	Purple willow		2
Scirpus sylvaticus	Wood club-rush	1	
Solidago gigantea	Giant goldenrod	2	4
Sonchus asper	Spiky sow thistle	2	2
Sonchus oleraceus	Common sow thistle		1
Spirodela polyrhiza	Common duckweed		1
Ulmus laevis	European white elm	1	
Urtica dioica	Nettle	1	
Utricularia vulgaris	Greater bladderwort		
Verbena officinalis	Common verbena	1	
Veronica anagallis-aquatica	Water speedwell	2	

Table 12.4.1-6: Macrophyte species identitfied on the Kondor-lake (PLKTMF), as well as on the Fishing Ponds (PLHTMF)

During sampling 23 and 22 species were found in the Kondor Lake and the Angler Ponds, respectively. No protected or Natura 2000 indicator species occurred. Litorial vegetation on the Kondor Lake shore is less disturbed, more trees and shrubs grow on it. On the contrary, the shoreline of the Fishing Ponds is strongly degraded and in must cases (PLHT1, 2, 3) fully mowed. The litorial zone of the fishing lakes was constituted of a narrow band of continuous reeds at sampling point PLHT4 (*Phragmites australis*). Quantitative surveys mainly involved common weeds and tolerant species but a number of other species represent intensively and aggressively spreading introduced elements. They are able to adapt to the changing environmental conditions very quickly, possess rapid reproduction capabilities and a part of them may threaten elements of the native vegetation in a serious manner.

The data matrix obtained from the processing of the samples (quantitative data) was subjected to a hierarchic classification method (cluster analysis). The Bray-Curtis similarity function was used for the calculations on the basis of the aggregated summer and autumn sampling data (Figure 12.4.1-3).

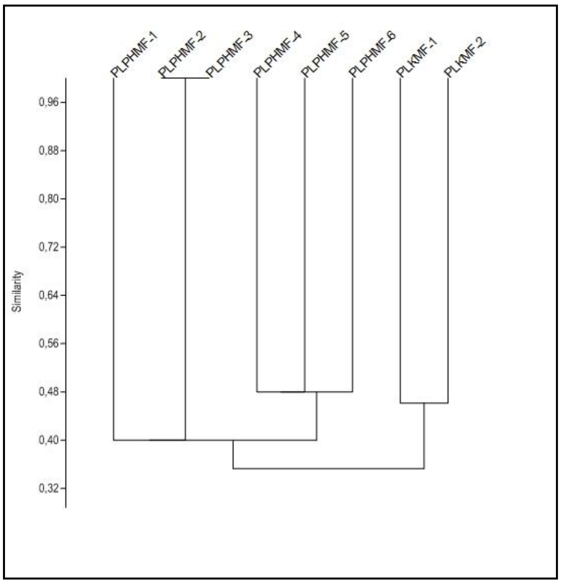


Figure 12.4.1-3: Cluster of the macrophyte populations at the Kondor-Lake and Angler Pond sampling sites (summer and autumn sampling)

As a result of the cluster analysis Fishing Ponds sampling points separated from the Kondor Lake sampling points. The main cause of the separation is the different level of disturbance on the shoreline of the lakes. Compared to that of the Fishing Ponds the lakeside of the Kondor Lake is less disturbed, and is betted shaded as a result of the extensive woody vegetation. Correspondingly, less species and lower quantities of hair-weeds were found in the water.

CLASSIFICATION OF THE KONDOR LAKE, AS WELL AS THE FISHING PONDS IN ACCORDANCE WITH THE REQUIREMENTS OF THE WFD

During the classification process the two lakes are assessed as a whole on the basis of the data sets of the sampling sites on them. The statuses are provided as the aggregate summer and autumn data, for the Fishing Ponds as an average of the sampling units. (Table 12.4.1-7).

PLKTMF	Aggregate DAFOR cubic value	Number of species
A (indicator species)	1	1
B (neutral species)	131	13
C (disturbance indicator species	4,4	1
SUM	136,4	15
Reference Index	-2,47	
EQR Value	0.48	
Classification:	**moderate**	

Table 12.4.1-7: Ecological status assessment of the sampling sites on the Kondor Lake based on macrophyte communities

	PLPHMF-I		PLPHMF-II		PLPHMF-III		PLPHMF-IV	
	Aggregate DAFOR cubic value	Number of species	Aggregate DAFOR cubic value	Number of species	Aggregate DAFOR cubic value	Number of species	Aggregate DAFOR cubic value	Number of species
A (indicator species)	10	2	0	0	0	0	8	2
B (neutral species)	252,7	12	125	1	125	1	267	14
C (disturbance indicator species)	8	1	0	0	0	0	73	3
SUM	270	13	125		125		348	21
Reference Index	0.73		0		0		-18,67	
EQR Value	0.58		0.5		0.5		0.45	
Classification	**good**		**moderate**		**moderate**		**moderate**	

Table 12.4.1-8: Ecological status assessment of the sampling sites on the Kondor Lake based on macrophyte communities

*Based on the findings of the assessment it can be stated that the ecological status of both the Kondor Lake, mind the Fishing Ponds according to the macrophyte analysis was **moderate**. Water quality clearly indicates the intensive use of the lakes for angling and fishing.*

The discharge from the Paks Nuclear Power Plant has no detectable impact on the macrophyte populations of the lakes.

12.4.1.5 Macrozoobenthos

Faunistic and ecological evaluation of the Kondor Lake and Fishing Ponds findings

Macrozoobenthos populations were tested on the Kondor-Lake and the Fishing Ponds in 2012 in two sampling sessions (Summer, Autumn) and one sampling unit each.

During sampling 24 and 33 different macroscopic invertebrate taxons were collected in the Kondor Lake and the Angler Ponds, respectively. (Table 12.4.1-9).

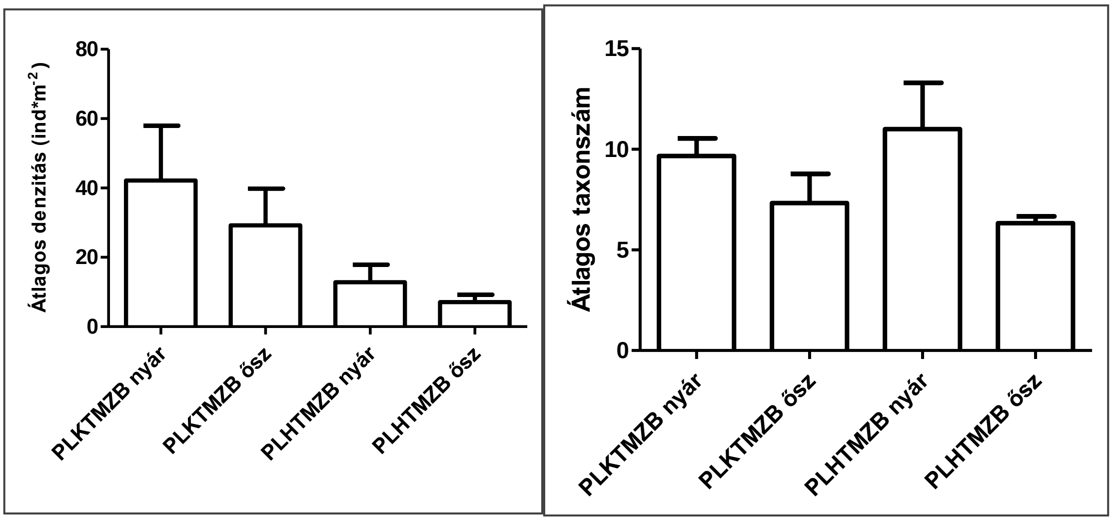
Taxons	PLHTMZB	PLKTMZB
Water worms (Oligochaeta)	1	1
Leeches (Hirudinea)		
Piscicola geometra (LINNAEUS, 1761)		1
Snails (Gastropoda)		
Anisus spirorbis (LINNAEUS, 1758)	1	
Bithynia tentaculata (LINNAEUS, 1758)	1	
Gyraulus albus (O. F. MÜLLER, 1774)	1	
Galba truncatula (O.F. MÜLLER, 1774)	12	
Physa fontinalis (LINNAEUS, 1758)	1	
Physella acuta (DRAPARNAUD, 1805)	1	14
Radix balthica (LINNAEUS, 1758)	1	1
Segmentina nitida (O.F.MÜLLER, 1774)		1
Mussels (Bivalvia)		
Corbicula fluminea (O.F. MÜLLER, 1774)	2	
Dreissena polymorpha (PALLAS, 1771)	1	
Crustaceans (Crustacea)		
Corophium curvispinum		3
Limnomysis benedeni CZERNIAVSKY, 1901	5	394
Orconectes limosus RAFINESQUE, 1872	2	
Mayflies (Ephemeroptera)		
Caenis robusta EATON, 1884		1
Cloeon dipterum (LINNAEUS, 1761)	5	7
Dragonflies (Odonata)		
Anax parthenope (SÉLYS, 1839)		2
Coenagrion puella/pulchellum group of species	3	2
Coenagrion puella (LINNAEUS, 1758)		22
Coenagrion sp.	1	4
Ischnura elegans (VANDER LINDEN, 1820)	16	61
Orthetrum albistylum (SELYS, 1848)	1	
Platycnemis pennipes (PALLAS, 1771)		3
True bugs (Heteroptera)		
Gerridae		1
Gerris lacustris	1	
Gerris sp.	1	12
Micronecta scholtzi (FIEBER, 1860)	81	
Nepa cinerea LINNAEUS, 1758		3
Notonecta glauca LINNAEUS, 1758	1	

Taxons	PLHTMZB	PLKTMZB
Ranatra linearis (LINNAEUS, 1758)	4	4
Sigara lateralis (LEACH, 1817)	2	
Caddisflies (Trichoptera)		
Ecnomus tenellus RAMBUR, 1842		5
Beetles (Coleoptera)		
Chrysomelidae	1	
Cybister lateralimarginalis (DE GEER, 1774)	2	
Helochares obscurus (O.F.MÜLLER, 1776)	1	
Laccophilus sp.		1
Noterus clavicornis (DE GEER, 1774)		1
Flies (Diptera)		
Anopheles maculipennis group of species	1	
Chironominae	27	33
Dolichopodidae	1	
Glyptotendipes sp.	2	43
Orthocladiinae	1	
Tanypodinae	1	
Tanypus punctipennis MEIGEN, 1818	1	

Table 12.4.1-9: List of macroscopic invertebrate taxons on the Kondor Lake (PLKTMZB) and the Fishing Ponds (PLHTMZB)

Almost all the taxons detected are typical lenitic, stagnant organisms, the majority of which basically associated with aquatic plants (for instance *Cloeon dipterum, mayfly; Ecnomus tenellus, caddis fly*). At the same time other invasive species found in the Danube as well also occur here (for instance the amphipod *Corophium curvispinum*; the Ponto-Caspian mysid, *Limnomysis benedeni* and zebra mussel, *Dreissena polymorpha*, or the Eastern crayfish, *Orconectes limosus*).

No seasonal difference or differences across the sampling units were revealed by the analysis of the density and number of taxons in the summer and autumn samples. (Figure 12.4.1-4).



Átlagos denzitás – average density
Átlagos taxonszám – average number of taxons
nyár – summer
ősz - autumn

Figure 12.4.1-4: Density and number of taxons of macroscopic invertebrates collected in the Kondor Lake and Fishing Ponds sampling units

Although statistically no serious differences existed between the community structure indicators, some deviations can be seen on the diagrams nevertheless. Differences in density might be caused by the fact that water of both lakes experienced significant and advanced level of eutrofication by autumn, which is not tolerated by a number of macroscopic invertebrate organisms (lack of oxygen). Similar reasons can be attributed to the differences in the number of taxons, which is associated with the condition that a number species can not be collected in autumn because they fly out from the water space concerned (for instance caddis flies). It should be noted furthermore that the litorial zone of the Kondor Lake is considerably artificial, and hence, not rich in habitats, as opposed to the fishing lakes which had a more natural appearance (hair weed, reeds).

WFD SAMPLING POINTS OF THE KONDOR LAKE AND THE ANGLER PONDS

Having regard to the fact that no multimetric method is available for the purposes of ecological status assessment of stagnant water using macroscopic invertebrates, classification was made on the basis of the Hungarian macrozoobenthos family scoring system (MMCP) [12-7] which is used internationally as well.

Ecological status of the two water spaces were defined as the average of the summer and autumn samples (Table 12.4.1-10).

HULWAIH005 water body	Summer			Autumn		
	MMCP	TÁP	Classification	MMCP	TÁP	Classification
PLHTMZB	58	3.87	good	52	3.47	medium
Aggregate classification:	**good**					
PLKTMZB	56	4.00	good	38	3.45	medium
Aggregate classification:	**good**					

Table 12.4.1-10: Ecological status assessment of the Kondor Lake and the Fishing Ponds

*The ecological status defined on the basis of the summer sampling was good, and moderate in autumn. The somewhat poorer outcome of the classification on the basis of the autumn samples can be attributed to the fact that a number of insect species can not be collected any more in this season of the year (fenological/lifecylce features), although they play a role in the classification method and hence their lack may result in poorer status assignment. However, based on the aggregate classification results the ecological status of the water body based on macrozoobenthos was **good**.*

All in all, the macrozoobenthos fauna of the water body consisting of isolated water spaces and areas with different utilisation schemes reflects a basically stagnant lenitic state, but Danube associated species appear as well, indicating connectivity. At the same time based on this set of organisms the conclusion can be drawn again that the ecological status of the lakes is mostly determined by the way and intensity of use in addition to the environmental determinant factors.

The impact of the Paks Nuclear Power Plant can not be detected.

12.4.1.6 Fishes

Faunistic and ecological evaluation of the Kondor Lake and Fishing Ponds findings

Fish sampling in the Kondor Lake and the discharge canal of the Fishing Ponds took place twice (summer, autumn) in 2012, in one sampling unit each.

During the summer and autumn survey a total of 24 species and one hybrid *(Carassius carassius x gibelio)* and 1 472 individuals could be identified and counted in the two sampling units of the two sites. The presence of 23 and 19 species was recorded in the Kondor Lake and in the Angler Ponds, respectively. Young individuals of 12 species were detected in the samples, 11 and 7 on the Kondor- lake and Angler Pond, respectively. One of the species found was protected *(Rutilus virgo)*. Protected species of Community importance under Annex No II of the Habitat directive included *Rutilus virgo* and *Aspius aspius*.

Species name	PLKTH	PLHTH
Rutilus rutilus	1	1
Rutilus virgo	0	1
Ctenopharyngodon idella	1	1
Scardinius erythrophthalmus	1	1
Leuciscus idus	1	1
Aspius aspius	1	1
Alburnus alburnus	1	1
Blicca bjoerkna	1	1
Abramis brama	1	1
Ballerus sapa	1	0
Pseudorasbora parva	1	1
Carassius carassius x gibeli	1	0
Carassius gibelio	1	1
Cyprinus carpio	1	1
Silurus glanis	1	1
Ameiurus melas	1	0
Esox lucius	1	1
Lepomis gibbosus	1	1
Perca fluviatilis	1	0
Sander lucioperca	1	1
Sander volgensis	1	0
Proterorhinus semilunaris	1	1
Neogobius fluviatilis	1	0
Ponticola kessleri	1	0
Neogobius melanostomus	1	1
Babka gymnotrachelus	0	1

Table 12.4.1-11: Fish species found in the samples

Based on the species structure drawn up by the summer and autumn sampling the Kondor-Lake is characterised by a relatively high number of taxons considering its isolation. However, the species composition as such is close to the one which is natural in this type of water spaces. The majority of the Kondor Lake species is able to sustain self-sustaining populations, as proved by the presence of the offspring. However, the large quantity of fishes introduced into the lakes as a result of the intensive fishing practices defines not only the structure of the fish community, but the plankton metabolic turnover developing in the backwater and observed permanently in the times of sampling in a substantial way as well.

The sampling site at the angler lake was the drainage canal of the water spaces consisting several lake beds isolated from each other by embankments and used partly for angling and partly for aquaculture. No settling in takes place here but the water can be drained by the pump situated at the end of the canal in order to assist fish production in the managed ponds. Correspondingly, individuals found in the sampling site are refugees from the ponds. On the other hand, several, mainly small sized fish species constitute a self-sustaining fish community in the pond. In this fish community the pioneer species, mainly invasive ones, play the dominant role. The species structure proves that connectivity with the Danube fish community exists at least periodically, but certainly with a certain kind of regularity.

Relative abundance of the number of individuals on the 2 000 metres long section expressed a high level in the Kondor-lake (CPUE2000=3117 ind/2000m), which is higher than that experienced, for instance, on the Dead Danube of Fadd. This can be decisively interpreted as the result of the impact originating from the intensive stocking with carps which booms the nutrient turnover. High number of species is also a result of the fish stocking and the associated random introduction of other species.

The high abundance level observed in the Fishing Ponds (CPUE2000=3580 ind/2000m) is also influenced by the different (wading) sampling method, by which catches in a unit area are more efficient compared to the boat based method. The number of species and the number of individuals here is essentially determined by the number of fishes getting in and getting out, in other words the water management practices.

The ecological analysis and their functional characteristics for the Kondor Lake and the Angler Pond fish community were provided after (Halasi-Kovács and Tóthmérész [12-18]) (Table 12.4.1-12 and Table 12.4.1-13).

Functional features	PLKTH summer	PLKTH Autumn
Feeding grounds		
Open water	37.25	46.88
Metaphytic	34.64	34.12
Benthic	28.10	18.99
Flow rate		
Stagnofil	7.84	10.39
Eurytop	89.87	87.54
Rheofilic	2.29	2.08
Origin		
Introduced	23.86	27.60
Indigenous	76.14	72.40

Table 12.4.1-12: Selected functional characteristics of the Kondor Lake fish community

Functional features	PLHTH summer	PLHTH Autumn
Feeding grounds		
Open water	71.60	50.75
Metaphytic	19.82	39.20
Benthic	8.58	10.05
Flow rate		
Stagnofil	14.50	20.60
Eurytop	81.66	75.88
Rheofilic	3.85	3.52
Origin		
Introduced	24.56	41.21
Indigenous	75.44	58.79

Table 12.4.1-13: Selected functional characteristics of the Angler Pond fish community

The composition of the Kondor Lake fish community substantiates the statement made above on the decisive role of stocking by fishes. This is justified by the high relative abundance rates of the open water and eurytop species. On the other hand, the high level of benthic species demonstrates the proper oxygen supply of the backwater bottom. The presence of rheofilic species can be correlated partly with the connectivity with the Danube and partly with the stocking operations.

The functional characteristics data of the fish community in the Fishing Ponds indicate a fundamentally disturbed status. However, while this was formed on the Kondor Lake as a result of deliberate colonisation, it can be explained here by the random introduction of the fishes and by the water governance practices. The presence of rheofilic species refers to the connectivity with the Danube.

WFD SAMPLING POINTS OF THE KONDOR LAKE AND THE ANGLER PONDS

No WFD based classification method exists in Hungary at the time being for lakes. Halasi-Kovács et al. [12-17] made a recommendation on the classification method for stagnant water bodies in the course of the river basin management planning process. In this work the assessment was made on this basis.

During the assessment process results from both the summer and autumn sampling were taken into consideration in a way by which the final classification values were determined as the arithmetic means of the base values according to the rules of rounding.

Classification criteria	PLKTH1		PLHTH1	
	Value	Value index	Value	Value index
Expert judgement	2	1	1	1
Specialist species, relative abundance	11.90	1	8.12	1
Indigenous species, relative abundance	74.24	3	67.12	3
Classification result		1.66		1.66
WFD Classification value indexa		poor (2)		poor (2)

Table 12.4.1-14: Ecological status assessment of the Kondor Lake and Fishing Ponds according to the fish community

*The ecological status of the water body on the basis of the fish communities in aggregate is **poor**.*

Based on the assessment of the fish community in the water body and evaluation pursuant to the WFD criteria the following claims can be made:

Species composition of the Kondor Lake in aggregate is very close to that which can be considered as natural for this type of water space. Most of the species is able to support a self-sustaining population. The high level of benthic species demonstrates the proper oxygen supply of the backwater bottom.

The typical fish community on the Kondor-lake can be decisively interpreted as the result of the impact originating from the stocking procedure and from the intensive stocking with carps which booms the nutrient turnover. The large quantity of fishes introduced into the lakes as a result of the intensive fishing practices defines not only the structure of the fish community, but the plankton metabolic turnover developing in the backwater and observed permanently in the times of sampling in a substantial way as well.

Based on the structure of the fish community connectivity with the Danube can be demonstrated in the case of the Kondor Lake, allowing swapping of fish species at least in a limited manner.

The Angler ponds sampling site is disturbed water space in ecological terms where no permanent fish community can be formed as a result of the water governance operations. Fishes found here are partly specimens escaping from the Angler Ponds. On the other hand, several, mainly small sized fish species constitute a self-sustaining fish community in the pond. In this fish community the pioneer species, mainly invasive ones, play the dominant role.

The species structure proves that connectivity with the Danube fish community exists at least periodically, but certainly with a certain kind of regularity.

The water body marked HULWAIH005 can be ranked in the poor status on the basis of the ecological assessment pursuant to the WFD. However, it should be noted that ecological water classification of water spaces used for fish production in accordance with the WFD criteria is not thought to be appropriate.

No detectable impact was found with regard to the discharge from the Paks Nuclear Power Plant. The structure of the fish community is basically determined by the way of utilisation. With respect to the partly heavily modified water space (Kondor Lake), and partly with respect to the entirely artificial lakes (Angler Ponds) the impact of the nuclear plant emerges rather in a way that the continuous and controllable water replenishment which is necessary for their operation is provided by the spent water itself, discharged from the Paks Nuclear Power Plant.

12.4.1.7 Comprehensive ecological status classification of the body of water marked HULWAIH005 named Paks Fishing Ponds according to the WFD

For the purposes of evaluation, basically the fundamental principles included in the ECOSTAT guidance document No. 13. (ECOSTAT 2005: Common Implementation Strategy for the Water Framework Directive (2000/60/EC) were taken into consideration, as well as the domestic national guidance specified in the course of the planning process of the national river basin management plan in 2008.

During the assessment of the water body in accordance with the Water Framework Directive the classification principle of "one bad means all bad" was followed.

Though no WFD based classification method exists for lakes with respect to macrozoobenthos and fish community, due to the reliability of the sampling and evaluation of these biological elements the classification results carried out on the basis of these two biological elements were taken into account with full weight.

The fundamental principle, determined upon the establishment of the river basin management plan (VGT) requiring one class higher grades for heavily modified and artificial water bodies automatically, was not enforced partly due the fact that it was not endorsed in the professional international arena, and partly because it was not properly substantiated for this special body of water.

HULWAIH005	Physico-chemical properties	Phytoplankton	Phytobenthos	Macrophyte	Makro-zoobenton	Fishes
Kondor Lake	poor	good	good	moderate	good	poor
Angler Pond	bad	good	good	moderate	good	poor
HULWAIH005 water body	**Does not reach good status**	**good**	**good**	**moderate**	**good**	**poor**

Table 12.4.1-15: WFD based classification of the Paks Fishing Ponds (Kondor Lake and Angler Ponds) (HULWAIH005)

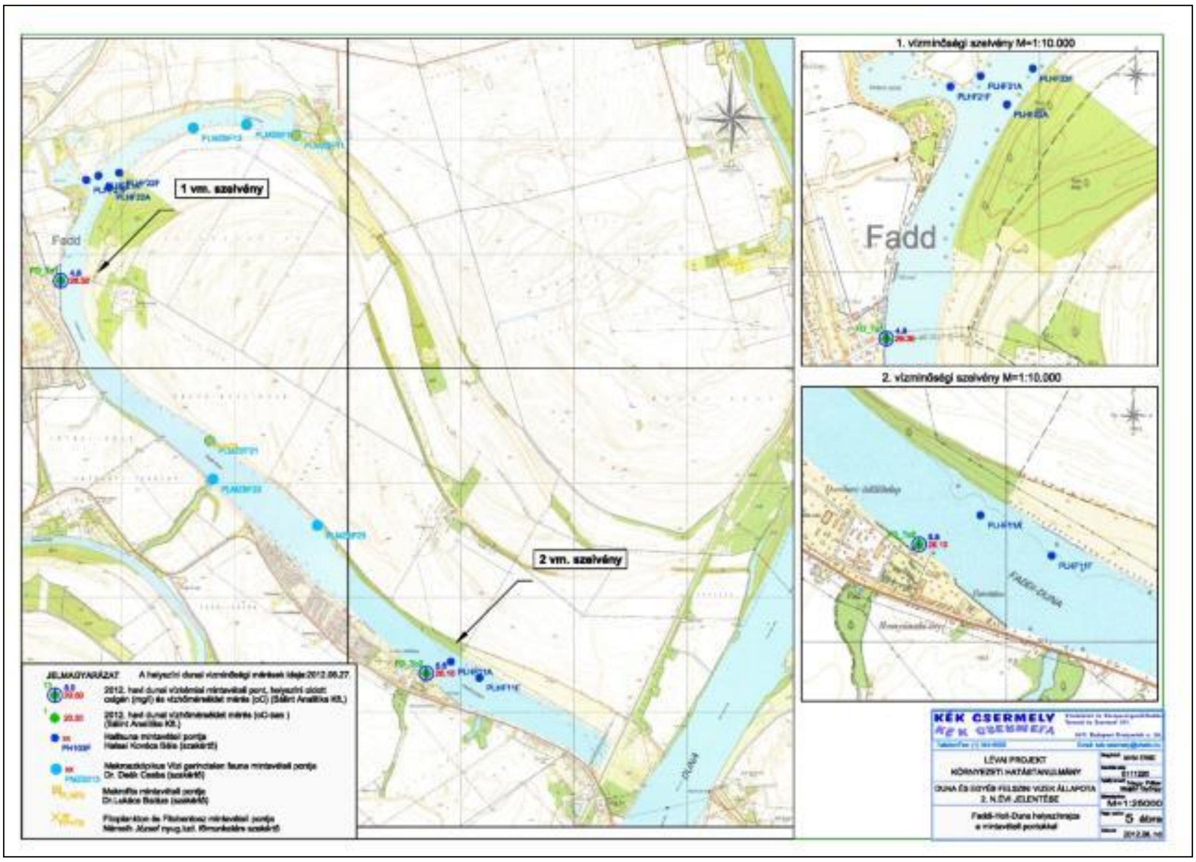
Based on the evaluation results of the water quality assessment pursuant to the requirements laid down in the WFD carried out in 2012 the ecological status of the water body marked HULWAIH005 was poor.

It can be stated furthermore that the discharge from the Paks Nuclear Power Plant has no detectable impact on any of the assessed groups.

12.4.2 DEAD DANUBE OF FADD (HULWAIH066)

12.4.2.1 Physico-chemical results of water testing

Tests concerning the determination of the physico-chemical parameters were carried out in the former Dead-Danube branch of Fadd situated some 20 km to the south from the site four times in 2012. The layout of the lakes is shown on Figure 12.4.2-1. Classification of the Dead-Danube was made according to these tests.



Jelmagyarázat: Legend
A helyszíni dunai vízminőség mérések ideje – Date of the water quality assessments of the River Danube at site
2012 év adott hó dunai vízkémiai mintavételi pont, helyszíni oldott oxigén (mg/l) és vízhőmérséklet (°C) mérés – measurement of dissolved oxygen (mg/l) and water temperature (°C) at the water chemistry sampling point of the River Danube in 2012
Halfauna mintavételi pontja – sampling point of the fish fauna
Makroszkópikus vízi gerinctelen fauna mintavételi pontja – sampling point of macroscopic invertebrate fauna
Szakértő – expert
Makrofita mintavételi pontja – sampling point of macrophytes
Fitoplankton és Fitoberitosz mintavételi pontja – sampling point of phytoplankton and Phytoberitos
Lévai Projekt Környezeti Hatástanulmány – Project Lévai Environmental Impact Assessment Study
Duna és egyéb felszíni vízek állapota 2. n.évi jelentése – Conditions of the River Danube and other surface waters – Quarterly Report of Quarter 2
Fadd- Holt - Duna helyszínrajza – site map of the Fadd Dead - Danube River section

Figure 12.4.2-1: Study area on the Dead Danube of Fadd

DEAD DANUBE OF FADD PROFILE CLASSIFICATION ACCORDING TO THE WFD

Based on the summary it can be seen that the acidification status of the water body was good, salinity status high, oxygenation conditions are short of good, and nutrients were in good status.

Based on the “one bad, all bad” principle the classification status is 3, moderate.

On the basis of the physico-chemical parameters selected by the WFD the Dead Danube of Fadd (HULWAIH066 WATER BODY) belongs to the worst class with a grade of 3, ***moderate****, and did not reach good status.*

Name of section	Water temperature	pH	Conductivity	Dissolved oxygen	Total alkalinity	CODk	BOD_5	Total nitrogen	Organic nitrogen	Nitrate-N	PO_4 -P	Total phosphorus	NH_4-N	Total cyanide	a-chlorophyll	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
	^{0}C		µS/cm	mg/l	mmol/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l
Fadd-backwater 1 (Fadd ferry)	18.0	8.42	535	9.84	4.60	35.1	6.77	1.47	1.18	0.32	<16.3	0.04	0.055	<10	25.1	2.46	0.02	0.16	0.92	0.03	1.78	0.02	3.78
Fadd-backwater 2 (Fadd beach)	17.8	8.80	552	9.95	4.38	30.0	5.27	1.97	1.48	0.60	<16.3	0.04	0.035	<10	20.9	2.91	0.01	0.27	0.91	0.03	1.70	0.35	4.32
Kondor -Lake (Foot bridge)	17.1	8.40	298	7.66	2.20	25.1	7.60	2.03	1.50	0.48	<16.3	0.04	0.045	<10	102.8	0.88	0.01	0.10	0.91	0.03	1.40	0.02	5.53
Fishing Ponds (discharge sluice)	8.9	7.59	410	10.40	3.20	12.0	5.10	3.42	1.55	0.68	81.50	0.08	1.15	<10	161.0	0.90	0.04	0.24	0.96	<0.01	2.37	0.03	4.49

Table 12.4.2-1: Findings of the water quality assessment tests for the lakes near the site, according to classification pursuant to the WFD

Groups and elements in the physico-chemical status assessment	Calculated average grade	Rounded class average	
Acidification status (pH)	**4.00**	**4**	
Salinity (conductivity)	**5.00**	**5**	
conductivity	5.0		
Oxygenation conditions (Dissolved O_2, Oxygen saturation, BOD_5, COD_{cr}	**2.67**	**3**	
Dissolved O_2	4.0		
BOD_5	0.0		
COD_{cr}	4.0		
Nutrient conditions: (NH_4-N, NO_3-N, TP, PO_4-P, TN, a-Chlorophyll)	**4.17**	**4**	
NH_4-N	5.0		
NO_3-N	2.0		
TP	4.0		
PO_4-P	5.0		
TN	5.0		
a-chlorophyll	4.0		
FADDI-HOLT-DANUBE (HULWAIH066 WATER BODY) according to the WFD		**3**	**Did not reach good status**

Table 12.4.2-2: Classification of the Dead Danube of Fadd physico-chemical staqtus according to the WFD

12.4.2.2 Phytoplankton

Phytoplankton sampling on the Dead Danube of Fadd was carried out in four sessions (22 March, 27 June, 26 September, and 14 November 2012), in two sampling units.

TAXONS	**Sampling sites and dates**							
	Dead Danube of Fadd: Fadd, ferry				**Dead Danube of Fadd: Dombori, beach**			
	PLFHDFP1	**PLFHDFP1**	**PLFHDFP1**	**PLFHDFP1**	**PLFHDFP2**	**PLFHDFP2**	**PLFHDFP2**	**PLFHDFP2**
	23.12.2012	**27.06.2012**	**26.09.2012**	**14.11.2012**	**23.12.2012**	**27.06.2012**	**26.09.2012**	**14.11.2012**
SUM pico	143	82	89	35	140	98	127	95
SUM nano	0	139	224	10	2	89	35	13
SUM Flagellates	682	439	342	66	364	413	28	78
SUM Chroococcales	23	738	798	67	184	1168	855	26
SUM Oscillatoriales	4978	475	1839	166	4519	349	8747	649
SUM Nostocales	0	1025	2175	0	0	553	4143	383
SUM Euglenophyta	0	0	161	0	0	0	0	0
SUM Cryptophyta	323	351	1751	4230	1565	164	61	308
SUM Dinophyta	0	249	564	228	1274	288	176	199
SUM Chrysophyceae	354	175	321	198	815	7	378	128
SUM Xanthophyceae	0	65	0	0	8	0	0	0
SUM Centrales	4070	213	2356	1389	2833	221	270	535
SUM Pennales	2888	465	695	57	673	195	196	139
SUM Volvocales	967	62	113	0	1961	19	0	0
SUM Chlorococcales	371	1175	987	365	854	1281	418	285
SUM Ulothricales	252	190	7	10	239	161	4	7
SUM Desmidiales	36	376	203	521	55	740	284	37
SUM Zygnematales	0	198	0	0	0	50	0	38
SUM	**15087**	**6418**	**12624**	**7344**	**15485**	**5795**	**15721**	**2919**
a-chlorophyll concentration (µg/l)	**21,0**	**23,0**	**35,5**	**20.7**	**18,3**	**16,3**	**36,1**	**13,0**
a-chlorophyll contents of biomass (%)	**0.139**	**0.358**	**0.281**	**0.282**	**0.118**	**0.281**	**0.230**	**0.445**
degree of trophity	**5 (m-eu)**	**5 (m-eu)**	**5 (m-eu)**	**5 (m-eu)**	**4 (m)**	**4 (m)**	**5 (m-eu)**	**4 (m)**

Table 12.4.2-3: Phytoplankton biomass (µg/l) and a-chlorophyll concentration (µg/l) levels on the Dead Danube of Fadd

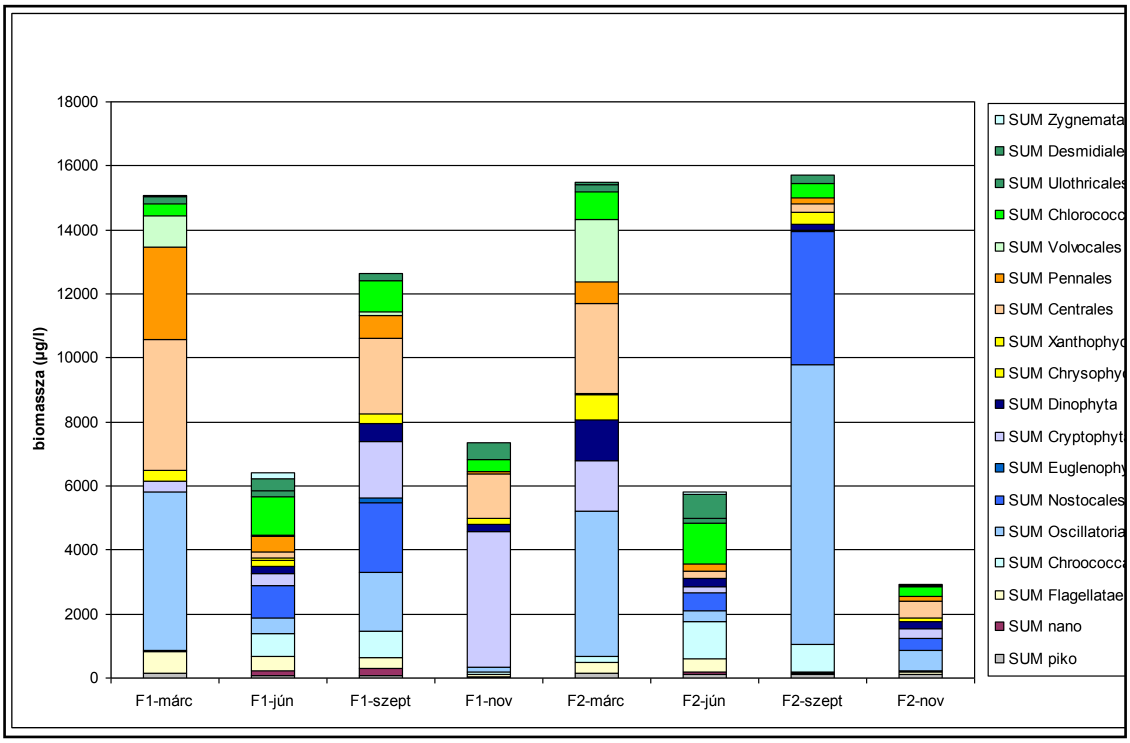


Figure 12.4.2-2: Phytoplankton biomass and composition on the Dead Danube of Fadd

At sampling point 1 of the **Dead Danube of Fadd** *on 22 March 2012* phytoplankton biomass was 15.2 mg/l, on sampling point 2 16.0 mg/l. The corresponding levels of a-chlorophyll concentration were 21.0 µg/l and 18.3 µg/l respectively, referring to 5 (meso-eutrophic) and 4 (mesotrophic) grades and Water Quality Class No II. The species composition of the phytoplankton showed significant differences between the two sampling sites. Components of phytoplankton biomass in the highest ratio at sampling point 1 included blue algae species from the order Oscillatoriales (32.8%), as well as diatom species from the orders Centrales and Pennales (26.8% and 19.05), at sampling point 2 blue algae in the order Oscillatoriales (28.0%), diatom species from the order Centrales (17.7%), as well as grooved cryptomonads (Cryptophyta: 9.0%).

At sampling point 1 the number of taxons were N=49, the value of the Shannon-diversity was H'=3.60, that of homogeneity J=0.64, At sampling point 2 these values ranged up to N=60. H'=3,83, J=0.65, respectively.

The HLPI EQR value calculated on the basis of the phytoplankton composition according to the WFD at sampling point 1 was HLPI=0.728, a t sampling point 2 HLPI=0.730, corresponding to a good ecological status.

At sampling point 1 of the Dead Danube of Fadd *on 27 June 2012* phytoplankton biomass was 6.4 mg/l, and 5.8 mg/l at sampling point 2. The corresponding levels of a-chlorophyll concentration were 23.0 µg/l and 16.3 µg/l respectively, referring to 5 (meso-eutrophic) and 4 (mesotrophic) grades and Water Quality Class No II. The species composition of the phytoplankton showed significant differences between the two sampling sites. Components of phytoplankton biomass in the highest ratio at sampling point 1 included green algae species from the order Chlorococcales (18.3%), blue algae in the orders Nostocales-, Chroococcales- and Oscillatoriales (16.0%, 11.5% and 6.0%), respectively, as well diatom species in the order Pennales (7.2%), at sampling point 2 green algae in the order Chlorococcales (22.1%), blue algae in the orders Chroococcales-, Nostocales-, and Oscillatoriales (20.2%, 9.5% and 7.4%, respectively), as well as green algae in the order Desmidiales (12,8%).

At sampling point 1 the number of taxons was N=67, the value of the Shannon-diversity was H'=5.14, that of homogeneity J=0.85, at sampling point 2 these values ranged up to N=64, H'=4.99 and J=0.83, respectively.

The HLPI EQR value calculated on the basis of the phytoplankton composition according to the WFD at sampling point 1 was HLPI=0.696, at sampling point 2 HRPI=0.712, corresponding to a good ecological status.

At sampling point 1 of the Dead Danube of Fadd *on 26 September 2012* phytoplankton biomass was 6.4 mg/l, and 5.8 mg/l at sampling point 2. The corresponding levels of a-chlorophyll concentration were 23.0 µg/l and 16.3 µg/l respectively, referring to 5 (meso-eutrophic) and 4 (mesotrophic) grades and Water Quality Class No II. The species composition of the phytoplankton showed significant differences between the two sampling sites. Components of phytoplankton biomass in the highest ratio at sampling point 1 included green algae species from the order (18.3%), blue algae in the order Nostocales-, Chroococcales- and Oscillatoriales (16.0%, 11.5% and 6.0%, respectively), as well as diatom species in the order Pennales (7.2%), at sampling point 2 green algae in the order Chlorococcales (22.1%), blue algae in the orders Chroococcales-, a Nostocales-, and Oscillatoriales (20.2%, 9.5% and 7.4%, respectively), as well as green algae in the order Desmidiales (12.8%).

At sampling point 1 on a number of taxons N=62, the value of the Shannon-diversity was H'=4.51, that of homogeneity J=0.76 volt, at sampling point 2 these values ranged up to N=47, H'=5.55 and J=0.49, respectively.

The HLPI EQR value calculated on the basis of the phytoplankton composition according to the WFD at sampling point 1 was HLPI=0.705, at sampling point 2 HLPI=0.610.This value corresponds to a good ecological status.

At sampling point 1 of the Dead Danube of Fadd *on 14 November 2012* phytoplankton biomass was 7.3 mg/l, and 2.9 mg/l at sampling point 2. The corresponding levels of a-chlorophyll concentration were 20.7 µg/l and 13.0 µg/l respectively, referring to 5 (meso-eutrophic) and 4 (mesotrophic) grades and Water Quality Class No II. The species composition of the phytoplankton showed significant differences between the two sampling sites. Components of phytoplankton biomass in the highest ratio at sampling point 1 (57.6%) included grooved cryptomonads (Cryptophyta). Relative abundance of the diatom species in the order Centrales was 18.9%, Desmidiales and green algae listed in the Chlorococcales-order 7.1% and 5.0%, respectively. Components of phytoplankton biomass in the highest ratio at sampling point 2 included blue algae in the orders Oscillatoriales- and Nostocales (22.2% and 13.1%, respectively), diatom species in the order Centrales (18.3%), grooved cryptomonads (Cryptophyta: 10.5%), as well as green algae in the order Chlorococcales (9.8%).

At sampling point 1 on a number of taxons N=45, the value of the Shannon-diversity was H'=3.12, that of homogeneity J=0.57, at sampling point 2 these values ranged up to N=49, H'=4.39 and J=0.78, respectively.

The HLPI EQR value calculated on the basis of the phytoplankton composition according to the WFD at sampling point 1 was HLPI=0.827 high; at sampling point 2 HLPI=0.748, corresponding to a good ecological status.

The HLPI value calculated on the basis of the phytoplankton composition and taking into account a-chlorophyll concentration as well was HLPI= corresponding to a good ecological status.

Sampling unit	EQR	Ecological status (based on EQR)
PLFHD1 March	0.728	good
PLFHD2 March	0.730	good
PLFHD1 June	0.696	good
PLFHD2 June	0.712	good
PLFHD1 September	0.705	good
PLFHD2 September	0.610	good
PLFHD1 November	0.827	high
PLFHD2 November	0.748	good
average value:	**0.720**	**good**

Table 12.4.2-4: Ecological status assessment based on phytoplankton of the body of water marked (HULWAIH066) and named Dead Danube of Fadd according to the criteria of the WFD

Based on the findings of the assessment it can be stated that the ecological status of the Dead Danube of Fadd according to the phytoplankton analysis was ***good****.*

Water replenishment to the Dead Danube of Fadd is ensured through the Paks-Fadd-main canal (HURWAEP868) as a result of the backwater reclamation carried out in the 1996-1998 period using a 12 kilometres long and supplemented with the cooling water of the Paks Nuclear Power Plant. Based on the results it can be claimed that the phytoplankton of the backwater channel is basically of stagnant nature and deviates fundamentally from the phytoplankton composition of the Danube.

Cooling water discharged from the Paks Nuclear Power Plant has no effect on the phytoplankton community in the Dead Danube of Fadd and such impact can not be expected in the future, either. Since this water replenishment route is controlled, it can be shut down in case of failure events.

12.4.2.3 Phytobenthos

Phytobenthos samples were taken in the Dead Danube of Fadd profiles during the year 2012 twice (summer and autumn) at two sampling points each.

TAXONS	Dead Danube of Fadd: Fadd, ferry (PLFHDFB1)		Dead Danube of Fadd: Dombori, beach (PLFHDFB2)	
	27.06.2012	26.09.2012	27.06.2012	26.09.2012
	pi (%)	pi (%)	pi (%)	pi (%)
CENTRALES				
SUM Centrales	0.0	23,6	1,8	16,2
PENNALES				
SUM Fragilariaceae	44.4	39.3	26.0	16.0
SUM Achnanthaceae	12.9	20.5	7.6	30.5
SUM Naviculaceae	30.8	10.9	53.8	21.9
SUM Bacillariaceae	5.0	5.2	4.0	2.0
SUM Epithemiaceae	5.4	0.5	4.0	12.9
SUM Surirellaceae	0.0	0.0	0.0	0.0
SUM Pennales spp. (other	1.4	0.0	2.7	0.5
SUM	**100.0**	**100.0**	**100.0**	**100.0**

Table 12.4.2-5: Composition of the benthic diatom populations in the Dead Danube of Fadd

In the upper (Fadd: ferry) profile of the **Dead Danube of Fadd** *on 27 June 2012* the benthic diatom populations consisted exclusively of taxons belonging to the order Pennales. The components in the highest rate of the Pennales-diatom stock were the taxons in the Fragilariaceae-, Naviculaceae- and Achnanthaceae family, of which the relative abundance projected to the individuals counted was 44.4%, 30.8% and 19.2%, respectively. Taxons of the Fragilariaceae-family with the highest relative abundance included Fragilaria capucina (25.8%) and Fragilaria ulna var. ulna (13.6%). The Naviculaceae-family was represented by Navicula-, Cymbella-, Gomphonema-, and Amphora-species, as well as Rhoicosphaenia abbreviata. The Achnanthaceae-family was represented by Achnanthidium minutissimum (=Achnanthes minutissima) (11.8%), Cocconeis pediculus, Cocconeis placentula, and Achnanthes species. The share of the Epithemiaceae family was 5.4%, that of the Bacillariaceae family 5.0%. The Epithemiaceae family was represented by the species Rhopalodia gibba and Epithemia sorex, Bacillariaceae family by Nitzschia amphibia, Nitzschia fonticola, as well as other Nitzschia (Lanceolatae) species.

The number of taxons found ranged up to N=37, the value of the Shannon-diversity was H'=4.18, that of homogeneity J=0.80. The EQR value of the lake diatom index was NTDIL(1-20)=0.62; corresponding to a good ecological status.

In the upper (Fadd: ferry) profile of the Dead Danube of Fadd *on 26 September 2012* 23.6% of the benthic diatom populations consisted of taxons belonging to the order Centrales, 76.4% of taxons in the order Pennales. Components of phytoplankton biomass in the highest ratio (22.7%) included mainly Centrales-diatom species represented by Cyclotella ocellata. Components of Pennales-diatom populations in the highest ratio were represented by Fragilariaceae-, Achnanthaceae and Naviculaceae-family, of which the relative abundance projected to the individuals counted was 39.3%, 20.5% and 10.9%, respectively. Taxons of the Fragilariaceae-family with the highest relative abundance included Fragilaria capucina (21.1%) and Fragilaria ulna var. acus (10.7%). The Achnanthaceae-family was represented by Achnanthidium minutissimum (=Achnanthes minutissima) (19.8%), Cocconeis placentula, and Achnanthes lanceolata. The Naviculaceae-family was represented by Navicula-, Cymbella-, Gomphonema-, and Amphora species. The share of the Bacillariaceae family was 5.2%, that of the Epithemiaceae family 0.5%. The Bacillariaceae-family was represented by Nitzschia palea, Nitzschia amphibia, Nitzschia dissipata and Nitzschia fonticola, as well as other Nitzschia (Lanceolatae)-species, the Epithemiaceae family was represented by Epithemia sorex.

The number of taxons found ranged up to N=33, the value of the Shannon-diversity was H'=3.62, that of homogeneity J=0.72 volt. The EQR value of the lake diatom index was NTDIL(1-20)=0.62, corresponding to a good ecological status.

In the lower (Dombori: beach) profile of the Dead Danube of Fadd *on 27 June 2012* 98.2% of the benthic diatom populations consisted of taxons belonging to the order Pennales. The components in the highest rate of the Pennales-diatom stock were the taxons in the Naviculaceae-, Fragilariaceae-, and Achnanthaceae family, of which the relative abundance projected to the individuals counted was 53.8%, 26.0% and 7.6%, respectively. The Naviculaceae-family was represented by Navicula-, Cymbella-, Gomphonema-, and Amphora-species, as well as Rhoicosphaenia abbreviata. Taxons of the Fragilariaceae-family with the highest relative abundance included Fragilaria ulna var. ulna (14.3%) and Fragilaria capucina (6.2%). The Achnanthaceae-family was represented by Achnanthidium minutissimum (=Achnanthes minutissima) (6.7%), and Cocconeis placentula. The respective share of the Bacillariaceae family and of the Epithemiaceae family was 4.0% for both. The Bacillariaceae-family was represented by Nitzschia dissipata, Nitzschia fonticola, as well as other Nitzschia (Lanceolatae)-species, and the Epithemiaceae family by Epithemia sorex and Rhopalodia gibba.

The number of taxons found ranged up to N=34, the value of the Shannon-diversity was H'=4.44, that of homogeneity J=0.87 volt. The EQR value of the lake diatom index was NTDIL(1-20)=0.62, corresponding to a good ecological status.

In the lower (Dombori: beach) profile of the Dead Danube of Fadd *on 26 September 2012* 16.2% of the benthic diatom populations consisted of taxons belonging to the order Centrales, 83.8% by taxons in the Pennales order. Components of Centrales-diatom populations in the highest ratio (15.7%) were represented by Cyclotella ocellata, like in the upper profile, a species abundant in the plankton as well. The components in the highest rate of the Pennales-diatom stock were the taxons in the Achnanthaceae, Naviculaceae-, Fragilariaceae-, and Epithemiaceae-family, of which the relative abundance projected to the individuals counted was 30.5%, 21.9%, 16.0% and 12.9%, respectively. The share of the Bacillariaceae-family was 2.0%. The Achnanthaceae-family was represented by Achnanthidium minutissimum (=Achnanthes minutissima) (29.2%), Cocconeis placentula and Achnanthes-species, the Naviculaceae family by Navicula-, Cymbella-, Gomphonema-, and Amphora-species, as well as a Rhoicosphaenia abbreviata. This was the time and place when and where the occurrence of the extremely rare species Mastogloia smithii of the Naviculaceae family was recorded. Mastogloia smithii var. lacustris is listed on the Red List of Hungarian Algae in the potentially threatened (VU: Vulnerable) category (NÉMETH 2005). Taxons of the Fragilariaceae-family with the highest relative abundance included Fragilaria brevistriata (5.3%), Fragilaria capucina (5.2%) and other, less abundant Fragilaria-species. The Epithemiaceae family was represented by Epithemia sorex (11.8%) and Rhopalodia gibba (1.1%), the Bacillariaceae family by Nitzschia amphibia and other Nitzschia (Lanceolatae) species.

The number of taxons found ranged up to N=35, the value of the Shannon-diversity was H'=3.64, that of homogeneity J=0.71 volt. The EQR value of the lake diatom index was NTDIL(1-20)=0.62, corresponding to a good ecological status.

The number of taxons found ranged up to N=26, the value of the Shannon-diversity was H'=2.92, that of homogeneity J=0.62 volt. The EQR value of the lake diatom index was NTDIL(1-20)=0.61 corresponding to a good ecological status.

Sampling unit	EQR	Ecological status (based on EQR)
PLFHD1 June	0.62	good
PLFHD2 June	0.62	good
PLFHD1 September	0.62	good
PLFHD2 September	0.62	good
average value:	**0.62**	**good**

Table 12.4.2-6: Ecological status assessment based on phytobenthos of the body of water marked (HULWAIH066) and named Dead Danube of Fadd according to the criteria of the WFD

*Based on the findings of the assessment it can be stated that the ecological status of the Dead Danube of Fadd according to the phytobenthos analysis was **good**. Just like in the case of the statement made with regard to the findings of the phytoplankton assessment, phytobenthos composition in this body of water is decisively of stagnant character.*

The discharge from the Paks Nuclear Power Plant has no detectable impact on the phytobenthos community of the water body and is not expected to have such effect following the completion of the proposed project, either.

12.4.2.4 Macrophyte

Floristic and ecological status assessment of the Dead Danube of Fadd findings

Macrophyte sampling of the Dead Danube of Fadd according to the WFD was accomplished in 2012 in a total of six sampling units in two sampling sessions (summer and autumn season) at two sampling sites.

The sampling revealed 35 species (Table 12.4.2-7). One of the species in the list (*Carex pseudocyperus*) enjoys protection under Hungarian law with an intrinsic value of HUF 2000. No Natura 2000 indicator species occurred. Quantitative surveys mainly involved common weeds and tolerant species but a number of other species represent intensively and aggressively spreading introduced elements. They are able to adapt to the changing environmental conditions very quickly, possess rapid reproduction capabilities and a part of them may threaten elements of the native vegetation in a serious manner.

Scientific name	English name	PLFHDMF
Agrostis alba	Redtop	2
Alisma plantago-aquatica	Common water plantai	1
Berula erecta	Water parsnip	1
Bidens tripartita	Three-lobe beggarticks	1
Calystegia sepium	Larger bindweed	2
Carex gracilis	Slender tufted sedge	2
Carex pseudocyperus	Cyperus sedge	1
Ceratophyllum demersum	Rigid hornwort	4
Chladophora sp.	Filament alga sp.	2
Eupatorium cannabinum	Hemp agrimony	1
Fraxinus pennsylvanica	Red ash	2
Galium palustre	Marsh bedstraw	2
Glyceria maxima	Reed sweetgrass	1
Hydrocharis morsus-ranae	Frogbit	1
Iris pseudacorus	Yellow flag	1
Lycopus europaeus	Gypsywort	1

Scientific name	English name	PLFHDMF
Lysimachia nummularia	Yellow loosestrife	1
Lythrum salicaria	Purple loosestrife	1
Mentha aquatica	Water mint	1
Myriophyllum verticillatum	Whorled water milfoil	3
Najas marina	Spiny water nymph	1
Peplis portula	Spatulaleaf loosestrife	1
Phragmites australis	Common reed	5
Populus nigra	Black poplar	1
Potamogeton pectinatus	Curly leaf pondweed	1
Potamogeton perfoliatus	Perfoliate pondweed	2
Rubus cf. caesius	Dewberry	1
Salix cinerea	Grey willow	1
Salix fragilis	Crack willow	2
Scutellaria hastifolia	Spear leaved skullcap	1.5
Solanum dulchamara	Bittersweet	1
Typha angustifolia	Narrowleaf cattail	3
Ulmus laevis	European white elm	3
Utricularia vulgaris	Greater bladderwort	1
Veronica anagallis-aquatic	Water speedwell	1

Table 12.4.2-7: List of macrophytes on the Dead Danube of Fadd

Similarly of the sampling units was analysed by cluster analysis (Figure 12.4.2-3).

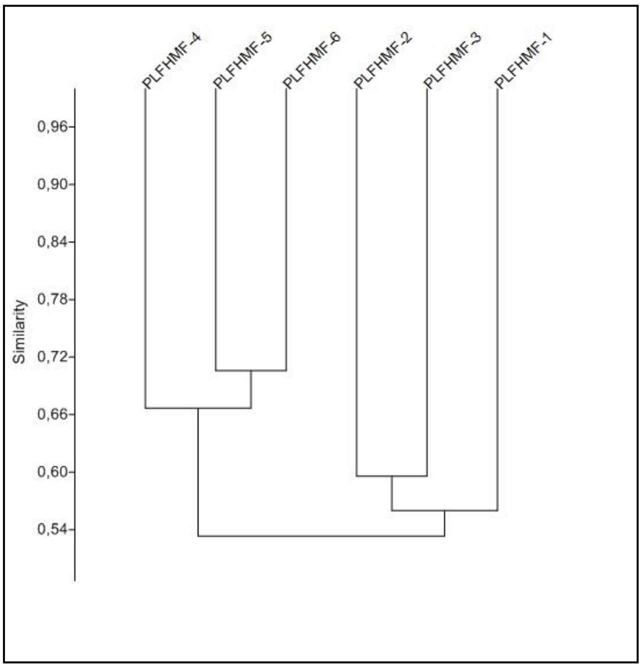


Figure 12.4.2-3: Cluster of the macrophyte populations at the Dead Danube of Fadd sampling sites dervied from the Bray-Curtis similarity function on the basis of the aggregate summer and autumn sampling data

As a result of the cluster analysis the sampling points of the northern (FAD-1-2-3) and southern (FAD-4-5-6) end of the channel bottom are separated. The differentiation between the two branches of the cluster is caused by the extensive reed *(Phragmites australis)* and whorled water milfoil *(Myriophyllum verticillatum)* stands and the higher number of reeds colouring elements in the southern end of the backwater channel. The differences revealed in the number and quantity of the species concur with the river morphology variations detected between the two ends of the bottom channel.

Findings of the Dead Danube of Fadd were compared to those of the Danube and of the Kondor-Lake, as well as the Angler Ponds.

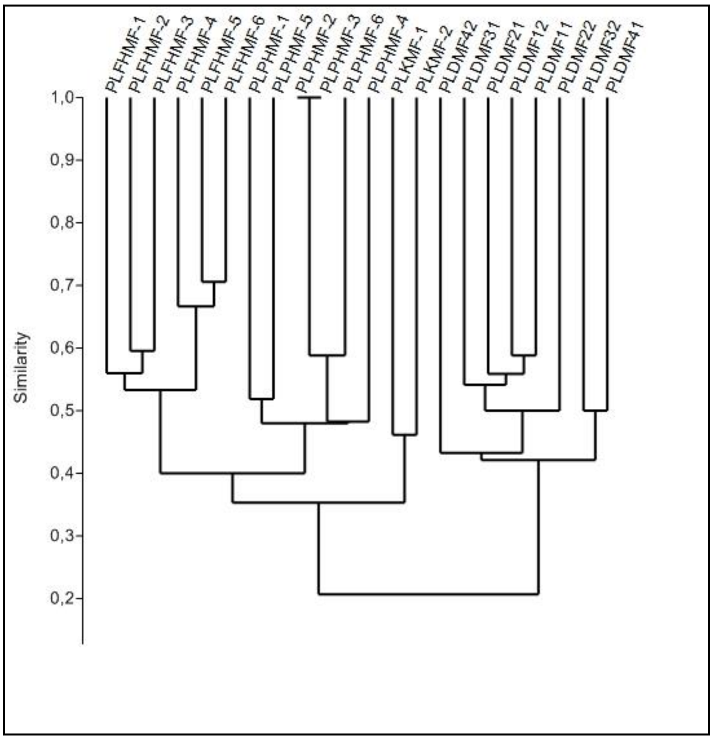


Figure 12.4.2-4.: Cluster of the macrophyte populations at the Danube, the Dead Danube of Fadd, Kondor Lake and Fishing Ponds sampling sites derived from the Bray-Curtis similarity function on the basis of the aggregate summer and autumn sampling data

Based on the analysis the lakes and Danube samples showed a distinct separation, reflecting the hydrological difference of the two types of water body. Vegetation of the Kondor Lake and Angler Pond sampling points seemed to be similar to each other, the vegetation of the Dead Danube of Fadd was different and the Fadd sampling sections were arranged in a north-south alignment, reflecting the river morphology variations. The dendrogram clearly shows that species swap between the macrophyte stocks on the Dead Danube of Fadd and of the Danube is negligible.

DEAD DANUBE OF FADD WFD SAMPLING POINTS

During the ecological status assessment the water space as a whole is classified according to the WFD criteria and based on the data sets obtained from the sampling sites. The status of the body of water is provided as the average of the findings in the different seasons and at the different sampling sites.

PLFHDMF	Aggregate DAFOR cubic value	Number of species
A (indicator species)	73,8	3
B (neutral species)	412,3	24
C (disturbance indicator species)	2	1
SUM	488,1	
Reference Index	14,7	
EQR Value	0.57	
Classification	good	

Table 12.4.2-8: Ecological status assessment of the Dead Danube of Fadd based on macrophyte derived water quality

*Based on the findings of the assessment it can be stated that the ecological status of the Dead Danube of Fadd according to the macrophyte analysis was **good**. Ecological analysis pointed out the fact that macrophyte vegetation of the backwater differs fundamentally from that of the Danube.*

Cooling water discharged from the Paks Nuclear Power Plant has no effect on the macrophyte community in the Dead Danube of Fadd and such impact can not be expected in the future by the erection or operation of Paks II, either.

12.4.2.5 Macrozoobenthos

Faunistic and ecological status assessment of the Dead Danube of Fadd findings

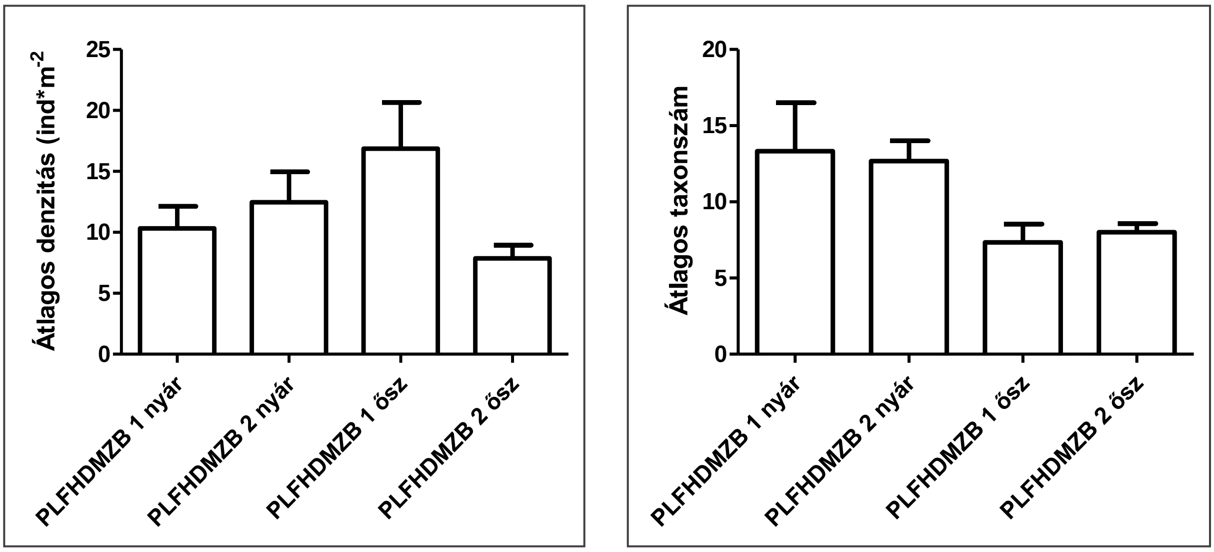
Macrozoobenthos sampling of the Dead Danube of Fadd was accomplished in 2012 in two sampling sessions (summer and autumn season). During summer and autumn sampling 46 different macroscopic invertebrate taxons were identified (Table 12.4.2-9).

Taxons	PLFHDMZB1	PLFHDMZBF2
Water worms (Oligochaeta)		4
Leeches (Hirudinea)		
Alboglossiphonia heteroclita (LINNAEUS, 1761)	2	
Snails (Gastropoda)		
Acroloxus lacustris (LINNAEUS, 1758)		6
Bithynia tentaculata (LINNAEUS, 1758)	16	2
Ferrissia clessiniana (JICKELI, 1882)	2	
Gyraulus albus (O. F. MÜLLER, 1774)	2	5
Gyraulus crista (LINNAEUS, 1758)	2	
Gyraulus laevis (ALDER, 1838)	2	
Physa fontinalis (LINNAEUS, 1758)	15	2
Physella acuta (DRAPARNAUD, 1805)	21	
Planorbis planorbis (LINNAEUS, 1758)		2
Radix auricularia (LINNAEUS, 1758)		2
Radix balthica (LINNAEUS, 1758)		3
Radix sp.	2	2
Valvata cristata O. F. MÜLLER, 1774		3
Valvata piscinalis (O.F. MÜLLER, 1774)	22	26
Mussels (Bivalvia)		
Dreissena polymorpha (PALLAS, 1771)		2
Mites (Acari)		
Hydrachnidia	7	3
Crustaceans (Crustacea)		
Asellus aquaticus (LINNAEUS, 1758)	2	
Corophium curvispinum		2
Limnomysis benedeni CZERNIAVSKY, 1901	13	6
Mayflies (Ephemeroptera)		
Caenis robusta EATON, 1884	4	39
Cloeon dipterum (LINNAEUS, 1761)	2	4
Dragonflies (Odonata)		
Aeshnidae Gen. sp.	2	2
Anax parthenope (SÉLYS, 1839)	2	
Coenagrion puella (LINNAEUS, 1758)	3	
Coenagrion sp.	3	
Crocothemis erythraea (BRULLE, 1832	18	2
Erythromma viridulum (CHARPENTIER, 1840)	7	
Ischnura elegans (VANDER LINDEN, 1820)	34	2
Orthetrum brunneum (FONSCOLOMBE, 1837)		3
True bugs (Heteroptera)		
Gerridae		2
Gerris argentatus SCHUMMEL, 1832	2	
Ilyocoris cimicoides (LINNAEUS, 1758)		3
Micronecta sp.		2
Plea minutissima LEACH, 1817	2	
Caddisflies (Trichoptera)		
Ecnomus tenellus RAMBUR, 1842	2	14
Leptocerus tineiformis CURTIS, 1834	12	
Flies (Diptera)		
Ablabesmyia sp.	6	2
Chironominae	28	2
Forcipomyia sp.		2
Glyptotendipes sp.	2	
Limoniidae		2
Procladius sp.	2	
Tanytarsini	2	27

Table 12.4.2-9: List of macrozoobenthos taxons on the Dead Danube of Fadd from summer and autumn sampling

Almost all the taxons detected are typical lenitic, stagnant organisms, the majority of which basically associated with aquatic plants (for instance *Cloeon dipterum, mayfly; Ecnomus tenellus, caddis fly*). At the same time other invasive lotic species found in rivers as well also occur here (for instance the amphipod *Corophium curvispinum*; the Ponto-Caspian mysid, *Limnomysis benedeni* and zebra mussel, *Dreissena polymorpha*, which were most probably introduced here from the Danube.)

No seasonal difference or differences across the sampling units were revealed by the analysis of the density and of the sampling units in the summer and autumn samples (Figure 12.4.2-5).



Átlagos denzitás – average density
Átlagos taxonszám – average number of taxons
nyár – summer
ősz – autumn

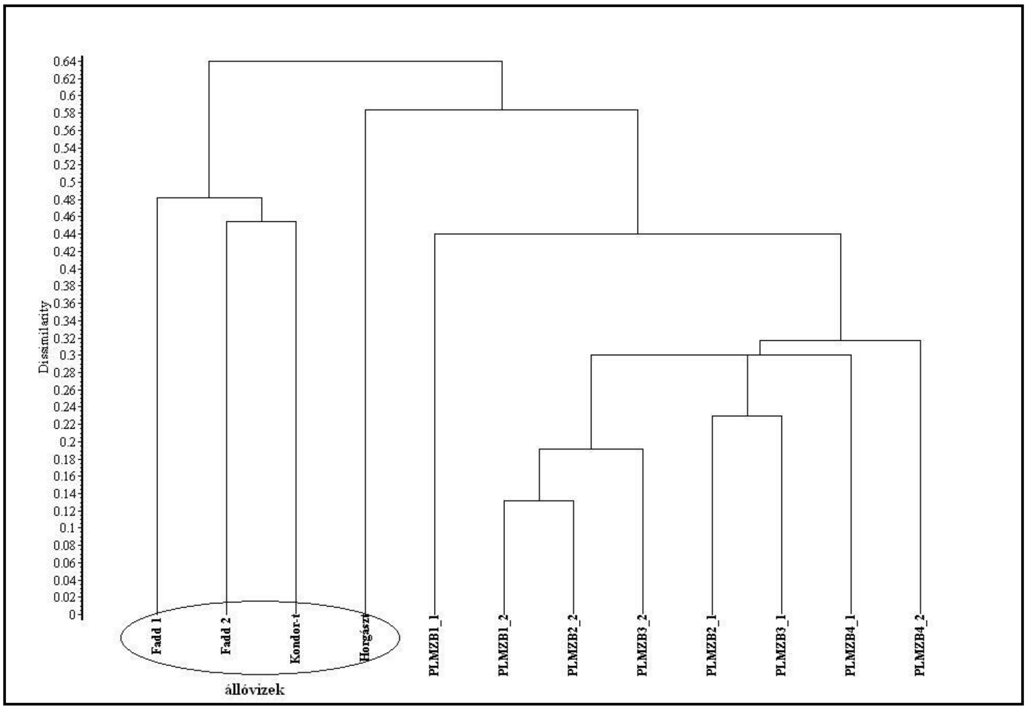
Figure 12.4.2-5.: Density and number of taxons of macroscopic invertebrates collected in the sampling units of the Dead Danube River section of Fadd

Although statistically no serious differences existed between the community structure indicators, some deviations can be seen on the diagrams nevertheless. Differences in density might be caused by the fact that a continuous mat of *Ceratophyllum demersum* hair weeds can be found on the PLFHDMZB1 sampling site, while there were hardly any in other places, which rendered the site homogeneous and had a shadowing effect, resulting in poor catches both in summer and autumn. As opposed to this, emerging and submerging vegetation with a large amount of detritus occurred at the PLFHDMZB2 sampling site which – mainly in the littoral zone – is able to provide food (for instance *Cloeon dipterum*, mayfly; *Asellus aquaticus*, crab) and substrate (snails, leeches) for a significant number of invertebrate organisms.

The number of taxons identified was higher during the summer which depends on the fenological (lifecycle) properties of the aquatic insects. In other words, a number species can not be collected in autumn because they fly out from the water space concerned (for instance caddis flies, mayflies and dragonflies).

The hair weed mats of PLFHDMZB1 basically have a relatively large surface which represents a very heterogeneous habitat (microhabitats) and such a feature is usually associated with a low number of individuals and an increase in the number of taxons.

The comparison of the Dead Danube of Fadd macrozoobenthos samples with those from the Danube, as well as from the Kondor Lake and the Fishing Ponds demonstrated that macrozoobenthos community in the Dead Danube of Fadd differs essentially from that of the Danube, indicating the subsistence of a typically lacustrine community (for instance *Ecnomus tenellus*, caddis fly, *Cloeon dipterum*, mayfly etc.), though a few invasive elements from the Danube (for instance Eastern crayfish, *Orconectes limosus*, Ponto-Caspian mysid, *Limnomysis benedeni*) also appeared in the samples. The dendrogram points out that of all stagnant water habitats the Fishing Ponds are the closest to the Danube while Kondor Lake resembles more to the habitats at Fadd. This represents the connectivity to the Danube well.



állóvízek – still waters

Figure 12.4.2-6: Cluster diagram of the sampling sites based on the presence or absence of macroscopic invertebrate organisms derived using the Rogers-Tanimoto similariy function for all summer samples on the Dead Danube of Fadd

A Dead Danube of Fadd WFD sampling points

Having regard to the fact that no multimetric method is available for the purposes of ecological status assessment of stagnant water using macroscopic invertebrates, classification was made on the basis of the Hungarian macrozoobenthos family scoring system (MMCP) [12-7] which is used internationally as well.

Ecological status of the two water spaces were defined as the average of the summer and autumn samples (Table 12.4.2-10).

HULWAIH066 water body	Summer			Autumn		
	MMCP	TÁP	Classification	MMCP	TÁP	Classification
PLFHDMZB1	58.5	3.90	good	47	3.92	moderate
PLFHDMZB2	64	3.56	moderate	49	3.77	moderate
Aggregate classification:	**moderate**					

Table 12.4.2-10: Ecological status assessment of the Dead Danube of Fadd based on macrozoobenthos

*The ecological status defined as the outcome of the classification procedure was **moderate**. The Dead Danube of Fadd can be characterised by a basically lacustrine macrozoobenthos community, but Danube based elements also appear in lesser numbers.*

The impact of the Paks Nuclear Power Plant on the macrozoobenthos community in the Dead Danube of Fadd can not be confirmed, and it can not be expected that during the construction or operation of Paks II there will be any change to be associated with anthropogenic effects.

12.4.2.6 Fishes

Faunistic and ecological status assessment of the Dead Danube of Fadd findings

Fish sampling in the Dead Danube of Fadd took place twice (summer, autumn) in 2012, in two profiles. During the summer and autumn survey a total of 1 472 individuals of 17 species could be identified in the two sampling units. Young individuals of 10 species were detected in the samples. One of the species found was protected *(Rhodeus amarus)*. The

European bitterling is at the same time a protected species of Community importance under Annex No II of the Habitat directive.

Species name	PLFHDH1	PLFHDH2
Rutilus rutilus	1	1
Scardinius erythrophthalmu	1	1
Alburnus alburnus	1	1
Abramis brama	1	1
Tinca tinca	1	1
Pseudorasbora parva	1	1
Rhodeus amarus	1	1
Carassius gibelio	1	1
Cyprinus carpio	1	1
Silurus glanis	1	1
Ameiurus melas	1	1
Esox Lucius	0	1
Lepomis gibbosus	1	1
Perca fluviatilis	0	1
Sander lucioperca	1	1
Proterorhinus semilunaris	1	1
Neogobius fluviatilis	1	1

Table 12.4.2-11: Fish species found in the Dead Danube of Fadd samples

Abundance levels in the samples from the two sampling units were homogeneous, though differences in the habitat conditions were distinguishable mainly in the autumn samples. A slight but constant difference in the number of species can also be seen between the two sampling units. The reason for this can be explained by the environmental conditions but also by the different depth of water of the two sampling units.

The ecological analysis and their functional characteristics for the fish community in the two sampling units of the Dead Danube of Fadd were provided based on (Halasi-Kovács and Tóthmérész [12-17]).

Functional features summer	PLFHDH1	PLFHDH2
Feeding grounds		
Open water	18,61	0.46
Metaphytic	68,40	94,47
Benthic	12,99	5,07
Flow rate		
Stagnofil	65,80	87,56
Eurytop	34,20	12,44
Rheofilic	0.00	0.00
Origin		
Introduced	45,45	71,89
Indigenous	54,55	28,11
Functional features Autumn	**PLHF1**	**PLHF2**
Feeding grounds		
Open water	17,76	6,19
Metaphytic	59,81	81,43
Benthic	22,43	12,38
Flow rate		
Stagnofil	58,88	81,43
Eurytop	41,12	18,57
Rheofilic	0.00	0.00
Origin		
Introduced	33,64	58,10
Indigenous	66,36	41,90

Table 12.4.2-12: Selected functional characteristics in the Dead Danube of Fadd fish community

The fish community of the Dead Danube of Fadd shows a structure typical for lakes. Rheofilic fauna components are missing entirely. This confirms the assumption that fish migration is essentially not ensured even between the backwater bottom channel and the natural watercourses with which it is in indirect connectivity. This also means that the backwater channel bottom has an independent and basically self sufficient stock of fish. Based on the findings of this study and on references from the professional literature (Halasi-Kovács [12-19]) it can be demonstrated that stocking of fish have an essential influence on the structure of the natural fish community.

Differences in the environmental conditions between the two respective areas in the backwater channel are reflected by the deviations in the functional characteristics of the respective fish communities. A higher level of relative abundance of open water as well as benthic species and an accompanying lower level of metaphytic and stagnofil species is typical for the sampling unit marked PLFHDH1. This means that the Fadd area of the backwater channel point towards a benthic eutrofication metabolic pathway, evidenced by the strengthening of the fauna components associated with macrophyte vegetation and also by the increase of abundance of stagnofil species. However, a higher level of relative abundance of the invasive species in this area indicates also that the process does not point toward a climax association of the fish community with lower number of species and consisting primarily of stagnofil species, but towards a continuously pioneer association which is the result of the management of the fish stock.

Similarity of the fish communities in the Dead Danube of Fadd, as well as the Danube, Kondor Lake, Fishing pond was analysed by a multiple variable method. Adult and young specimens of the 12 sampling units and data from the two sampling seasons were tested in an aggregate manner by the quantitative Bray-Curtis distance function. The dendrogram was drawn up by cluster analysed calculated according to the group average (Unweighted Pair Group Method with Arithmetic Mean or UPGMA) (Figure 12.4.2-7).

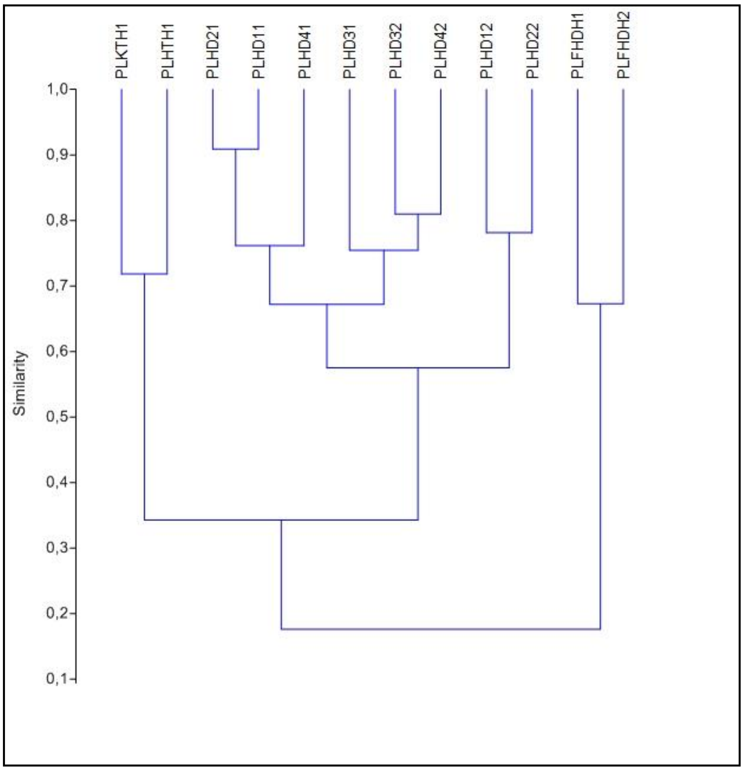


Figure 12.4.2-7: Dendrogram of the sampling units based on abundance of fishes

You can see from the results that the Fadd samples (PLFHDH1, PLFHDH2) are further away than the Danube samples. This supports the assumption that the fish community in the Dead Danube of Fadd was isolated, practically no exchange of species was possible between the Danube and the backwater. The fish community of the Dead Danube of Fadd shows a structure typical for lakes. At the same time homogeneity of the two sampling units within the backwater channel is indicated by their close relationship.

A DEAD DANUBE OF FADD WFD SAMPLING POINTS

No WFD based classification method exists in Hungary at the time being for lakes. Halasi-Kovács et al. [12-17] made a recommendation on the classification method for stagnant water bodies in the course of the river basin management planning process. In this work the assessment was made on this basis.

During the assessment process results from both the summer and autumn sampling were taken into consideration in a way by which the final classification values were determined as the arithmetic means of the base values according to the rules of rounding.

Classification criteria	PLHF1	
	Value	Value index
Expert judgement	2	2
Specialist species, relative abundance	33,49	3
Indigenous species, relative abundance	47,73	2
Classification result		2,33
WFD Classification Value indexa		**good (4)**

Table 12.4.2-13: Ecological status assessment of the Dead Danube of Fadd based on the fish community

*Taking into account the recommendation made for the classification method for stagnant water bodies in the course of the river basin management planning process (VGT) the outcome of the classification process according to the WFD criteria the ecological status the Dead Danube of Fadd was **good**.*

Findings of this study and references from the professional literature both confirm that the backwater channel has basically an independent and self-sustaining stock of fish. At the same time, artificial stocking has a substantial influence on the structure of the natural fish community. Correspondingly, the Dead Danube of Fadd can be listed in the category of modified lakes with a fish stock determined basically by the fish management practices applied. Based on the data analysis no change attributable to the discharge from the Paks Nuclear Power Plant could be found and no such impact can be expected during the construction and operation of Paks II, either. Ecological status of the Dead-Danube will be determined by the prevailing environmental conditions and its utilisation.

12.4.2.7 Comprehensive ecological status classification of the body of water marked HULWAIH066 named Dead Danube of Fadd according to the WFD

For the purposes of evaluation, basically the fundamental principles included in the ECOSTAT guidance document no. 13. (ECOSTAT 2005: Common Implementation Strategy for the Water Framework Directive (2000/60/EC) were taken into consideration, as well as the domestic national guidance specified in the course of the planning process of the national river basin management plan in 2008.

During the assessment of the water body in accordance with the Water Framework Directive the classification principle of "one bad means all bad" was followed.

Though no WFD based classification method exists for lakes with respect to macrozoobenthos and fish community, due to the reliability of the sampling and evaluation of these biological elements the classification results carried out on the basis of these two biological elements were taken into account with full weight.

HULWAIH066	Physico-chemical properties	Phytoplankton	Phytobenthos	Macrophyte	Macrozoobenthos	Fishes
Dead Danube of Fadd	Does not reach good status (moderate)	good	good	good	medium	good

Table 12.4.2-14: Classification of the Dead Danube of Fadd (HULWAIH066) based on the WFD

Based on the evaluation results of the water quality assessment pursuant to the requirements laid down in the WFD carried out in 2012 the ecological status of the water body marked HULWAIH066 was moderate. It can be stated furthermore that the discharge from the Paks Nuclear Power Plant has no detectable impact on any of the assessed groups and no such impact can be expected from the construction of Paks II or during the service period which cen be characterised by a number or different operating stats including failure events.

12.4.3 NORTHERN DEAD DANUBE OF TOLNA (HULWAIH136)

Tests concerning the determination of the physico-chemical parameters were carried out in the Northern Dead Danube of Tolna situated some 25 km to the south from the site two times in the second half of the year 2013. The layout of the profile is shown on Figure 12.4.3-1. Classification of the Northern Dead Danube of Tolna was made according to these tests.

12.4.3.1 Physical and chemical results of water testing

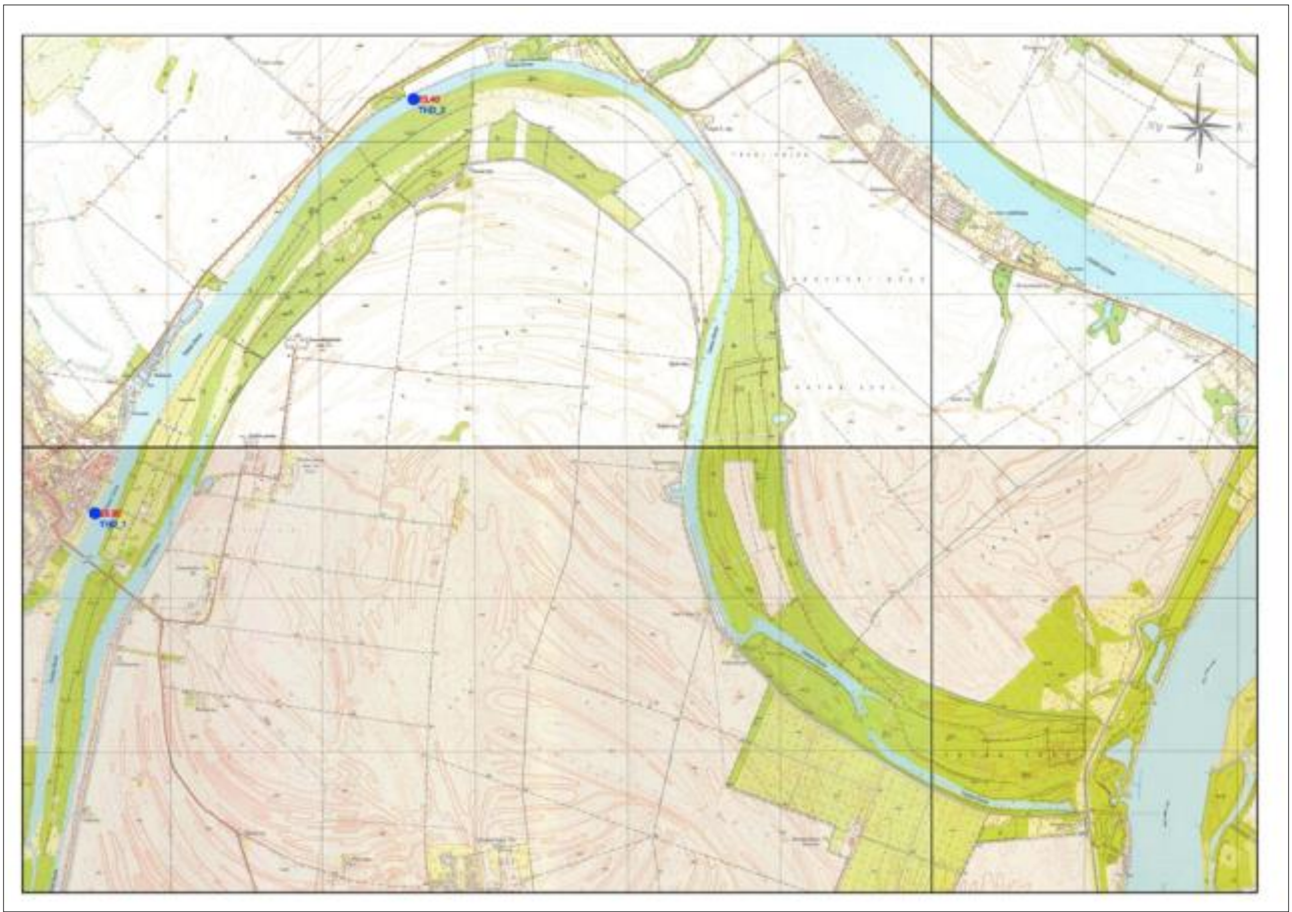


Figure 12.4.3-1: Test site on the Northern Dead Danube of Tolna

The findings of the water quality tests carried out on the Northern Dead Danube of Tolna in two profiles in the second half of the year 2013 are shown in Table 12.4.3-1 for each element and each group according to the criteria of the WFD.

NORTHERN DEAD DANUBE OF TOLNA PROFILE CLASSIFICATION ACCORDING TO THE WFD

The acidification status of the Northern Dead Danube of Tolna on the basis of the pH is in Class II, the evaluation grade is 4.0. Therefore the acidification status based on the test results from the second half of the year 2013 is classified as good status in accordance with the WFD assessment methodology.

The salinity status on the basis of the conductivity is in Class II, the evaluation grade is 4.0. Therefore the salinity status based on the test results from the second half of the year 2013 is classified as good status in accordance with the WFD assessment methodology.

The oxygenation conditions based on the basis of the elements dissolved oxygen is in Class I, oxygen saturation Class I, BOD_5 and COD in Class IV, the evaluation grade is 2.5. Therefore, the status of the oxygenation conditions based on the test results from the second half of the year 2013 DID NOT REACH THE GOOD STATUS in accordance with the WFD assessment methodology.

The nutrient conditions based on the basis of the elements ammonium-N and orto-phosphate-P is in Class II, while nitrate-N, total nitrogen, total phosphorus, a-chlorophyll did not reach good status. The evaluation grade of the group is therefore 1.0, and the status of the nutrient conditions based on the test results from the second half of the year 2013 DID NOT REACH THE GOOD STATUS in accordance with the WFD assessment methodology.

With respect to metal status, all elements are in Class I, the evaluation grade of the group is 5, therefore, the status of the status of metals based on the test results from the second half of the year 2013 is classified as excellent in accordance with the WFD assessment methodology.

*The Northern Dead Danube of Tolna (HULWAIH136 water body) d**id not reach good status** in terms of physico-chemical parameters based on the test results from the second half of the year 2013 in the ecological status assessment according to the WFD.*

Elements	Unit of measurement	Tolnai-Northern-Dead Danube THD I. and THD II.	Sió-channel downstream	Tolnai-Northern Dead Danube classification	Sió-channel downstream classification	Tolnai-Northern Dead Danube THD I. and THD II.	Sió-channel downstream
		average	average			Group classification status	Group classification status
pH		8.37	8.15	4	4		
Acidification status				**4.0**	**4.0**	good status	good status
Conductivity	µS/cm	652	1052	5	0		
Salinity				**4.0**	**0**	good status	Did not reach good status
Dissolved oxygen	mg/l	9.1	10.0	5	5		
Oxygen saturation	%	101	104	5	5		
BOD_5	mg/l	7.6	4.5	0	0		
CODk	mg/l	42.5	43.6	0	0		
Oxygenation conditions				**2.5**	**2.5**	Did not reach good status	Did not reach good status
Ammonium-N (NH_4^+-N)	mg/l	0.29	0.39	4	0		
Nitrate-N (NO_3^--N)	mg/l	0.56	1.35	0	0		
Total nitrogen	mg/l	4.18	4.67	0	0		
Orto-phosphate (PO_4-P)	µg/l	39	458	4	0		
Total phosphorus	µg/l	108	485	0	0		
a-chlorophyll	µg/l	80.2	43.0	**0**	**0**		
Nutrient conditions				**1.0**	**0**	Did not reach good status	Did not reach good status
As	µg/l	3.98	6.34	5	5		
Cd	µg/l	0.01	0.02	5	5		
Cr	µg/l	0.93	0.89	5	5		
Cu	µg/l	0.99	1.86	5	5		
Hg	µg/l	0.07	0.08	5	5		
Ni	µg/l	1.66	4.28	5	5		
Pb	µg/l	0.22	0.02	5	5		
Zn	µg/l	4.06	11.30	5	5		
Metals				**5**	**5**	high status	high status
Tolnai-Northern-Dead Danube (HULWAIH136 WATER BODY) physico-chemical parameters, ecological status assessment according to the WFD						Did not reach good status	
Sió canal downstream (HURWAEP959 WATER BODY) physico-chemical parameters, ecological status assessment according to the WFD							Did not reach good status

Table 12.4.3-1: Water quality test results from the Northern Dead Danube of Tolna and Sió canal downstream section, with classification according to the WFD

12.4.3.2 Phytoplankton

Findings of the Northern Dead Danube of Tolna and their evaluation

Phytoplankton sampling on the Tolnai-Dead-Danube was carried out in two sessions 7 August 2013 and 1 October 2013 in two sampling units for the quantitative and qualitative assessment of phytoplankton, at the same place and date when the water was sampled for chemical testing.

TAXONS	Sampling sites and dates			
	Tolnai-Dead-Danube I.		Tolnai-Dead-Danube II.	
	P50THDFP1	P50THDFP1	P50THDFP1	P50THDFP1
	27.08.2013	11.10.2013	27.08.2013	11.10.2013
SUM pico	165	25	111	25
SUM nano	89	7	142	16
SUM Flagellates	609	152	336	385
SUM Chroococcales	778	57	555	58
SUM Oscillatoriales	3279	0	3034	0
SUM Nostocales	6267	0	4521	0
SUM Euglenophyta	194	0	75	0
SUM Cryptophyta	1328	18518	1491	13581
SUM Dinophyta	186	0	1	0
SUM Chrysophyceae	325	0	400	33
SUM Xanthophyceae	503	0	104	0
SUM Centrales	13032	0	3688	16
SUM Pennales	377	3	180	1
SUM Volvocales	184	0	43	0
SUM Chlorococcales	4102	72	3450	113
SUM Ulothricales	9	0	0	0
SUM Desmidiales	247	139	84	101
SUM Zygnematales	39	0	11	0
SUM	**31715**	**18973**	**18225**	**14329**
a-chlorophyll concentration (µg/l)	**145,9**	**19,5**	**117,0**	**38,5**
a-chlorophyll contents of biomass (%)	**0.460**	**0.103**	**0.642**	**0.269**
degree of trophity	**7 (eu-p)**	**4 (m)**	**7 (eu-p)**	**5 (m-eu)**

Table 12.4.3-2: Phytoplankton biomass (µg/l) and a-chlorophyll concentration (µg/l) levels on the Northern Dead Danube of Tolna

At sampling point 1 in August phytoplankton biomass was 31.7 mg/l, a-chlorophyll concentration 145.9 µg/l, corresponding to the 7 (eu-polytrophic) grade on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (41.1%), blue algae from the orders Nostocales- and Oscillatoriales (19.8% and 10.3%), green algae in the order Chlorococcales (12.9%), as well as grooved cryptomonads (Cryptophyta: 4.2%).

In October, phytoplankton biomass was 19.0 mg/l, a-chlorophyll concentration 19.5 µg/l, corresponding to the 4 (mesotrophic) grade. Components of phytoplankton biomass in the highest ratio (97.6%) were almost exclusively grooved cryptomonads (Cryptophyta) represented by Cryptomonas-species.

A the sampling point 2 in August phytoplankton biomass was 18.2 mg/l, a-chlorophyll concentration 117.0 µg/l, corresponding to the 7 (eu-polytrophic) grade on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included blue algae from the orders Nostocales- and Oscillatoriales (24.8% and 16.6%), diatom species in the Centrales-order (20.2%), green algae in the order Chlorococcales (18.9%), as well as grooved cryptomonads (Cryptophyta: 8.2%).

In October phytoplankton biomass was 14.3 mg/l, a-chlorophyll concentration 38.5 µg/l corresponding to the 5 (meso-eutrophic) grade. Components of phytoplankton biomass in the highest ratio (94.8%) were almost exclusively grooved cryptomonads (Cryptophyta) represented by Cryptomonas-species.

Sampling results suggest that phytoplankton on the Northern Dead Danube of Tolna is basically of lacustrine nature and differs radically from the phytoplankton composition of the Danube.

NORTHERN DEAD DANUBE OF TOLNA WFD SAMPLING POINTS

The HLPI EQR index value calculated in accordance with the recommendations of the WFD on the basis of the phytoplankton composition at the sampling point 1 (P50THDFP1) of the Tolnai-Dead-Danube in August 2013 was 0.223, corresponding to a poor ecological status.

The HLPI EQR index value calculated on the basis of the phytoplankton composition in October was 0.878, corresponding to a high ecological status.

The HLPI EQR index value calculated in accordance with the recommendations of the WFD on the basis of the phytoplankton composition at the sampling point 2 (P50THDFP2) of the Tolnai-Dead-Danube in October 2013 was 0.455, corresponding to a moderate ecological status.

The HLPI EQR index value calculated on the basis of the phytoplankton composition and chlorophyll-a contents in October was 0.826, corresponding to a high ecological status.

Sampling unit	EQR	Ecological status (based on EQR)
P50THDFP1 August	0.223	poor
P50THDFP2 August	0.455	moderate
P50THDFP1 October	0.878	high
P50THDFP2 October	0.826	high
average value:	**0.596**	**moderate**

Table 12.4.3-3: Ecological status assessment of the body of water marked (HULWAIH136), named Northern Dead Danube of Tolna based on phytoplankton, according to the WFD

Based on the phytoplankton composition in the Tolnai-Dead-Danube, the HLPI EQR index value calculated in accordance with the recommendations of the WFD can be regarded as a ***moderate*** *ecological status. The Tolnai-Dead-Danube is connected to the Paks-Fadd-Main Canal (HURWAEP868) through the Dead Danube of Fadd. Based on the results it can be stated that the phytoplankton in the backwater channel was lacustrine in nature, which is essentially different from the phytoplankton composition in the Danube.*

Cooling water discharged from the Paks Nuclear Power Plant has no effect on the phytoplankton community in the Northern Dead Danube of Tolna and such impact can not be expected in the course of the erection and operation of the Paks II plant, including potential failure events.

12.4.3.3 Phytobenthos

Sampling of the phytobenthos on solid substrate (rock, wood) at the dedicated littoral sampling sites on the Tolnai-Dead-Danube was carried out in two sessions 7 August 2013 and 1 October 2013 in two sampling profiles for the quantitative and qualitative assessment of phytobenthos.

TAXONS	Tolnai-Dead-Danube 1 (P50THDFB1)		Tolnai-Dead-Danube 2 (P50THDFB2)	
	27.08.2013	11.10.2013	27.08.2013	11.10.2013
	pi (%)	pi (%)	pi (%)	pi (%)
CENTRALES				
SUM Centrales	8,2	0.0	30.1	5,8
PENNALES				
SUM Fragilariaceae	13,6	14,2	9,1	5,2
SUM Achnanthaceae	21,5	11,4	4,6	6,3
SUM Naviculaceae	44,1	48,9	38,5	27,0
SUM Bacillariaceae	8,8	24,7	15,2	55,6
SUM Epithemiaceae	3,9	0.5	0.5	0.0
SUM Surirellaceae	0.0	0.0	0.0	0.0
SUM Pennales spp. (other	0.0	0.5	2,0	0.0
SUM	**100.0**	**100.0**	**100.0**	**100.0**

Table 12.4.3-4: Composition of the benthic diatom populations on the Tolnai-Holt-Dunában

On the Tolnai-Dead-Danube 1 at the sampling point (P50THDFB1) on 7 August 2013 8.2% of the individuals counted in the benthic diatom population belonged to the order Centrales, 91.8% of them belonged to diatom species in the order Pennales. The components in the highest rate of the Pennales-diatom stock were the taxons in the Naviculaceae-, Achnanthaceae-, Fragilariaceae-, Bacillariaceae, and Epithemiaceae-family, of which the relative abundance projected to the individuals counted was 44.1%, 21.5%, 13.6%, 8.8% and 3.9%, respectively. The Naviculaceae-family was represented by Navicula-, Cymbella-, Gomphonema-, and Amphora-species, as well as by Rhoicosphaenia abbreviata. The Achnanthaceae-family was represented by Achnanthidium minutissimum (=Achnanthes minutissima) (20.5%), Cocconeis pediculus, and Cocconeis placentula. Taxons of the Fragilariaceae-family with the highest relative abundance included Fragilaria ulna var. ulna (6.0%), Fragilaria nanana and Fragilaria pinnata. The Bacillariaceae-family was represented by Nitzschia-species, the Epithemiaceae family by Epithemia sorex. The EQR value of the lake diatom index was NTDIL(1-20)=0.596 corresponding to the moderate ecological status.

On 11 October 2013 most of the benthic diatom populations consisted exclusively of taxons belonging to the order Pennales. The components in the highest rate of the Pennales-diatom stock were the taxons in the Naviculaceae-, Bacillariaceae, Fragilariaceae-, Achnanthaceae-, and Epithemiaceae-family, of which the relative abundance projected to the individuals counted was 48.9%, 24.7%, 14.2%, 11.4% and 0.5%, respectively. The Naviculaceae-family was represented by Navicula-, Cymbella-, Gomphonema-, and Amphora-species, as well as Rhoicosphaenia abbreviata, the Bacillariaceae family was represented by Nitzschia species. The taxon of the Fragilariaceae-family with the highest relative abundance was Fragilaria capucina var. vaucheriae (13.2%). The Achnanthaceae-family was represented by Achnanthidium minutissimum (=Achnanthes minutissima) (20.5%), and Cocconeis pediculus. The Epithemiaceae family was represented by Epithemia sorex. The EQR value of the lake diatom index was NTDIL(1-20)=0.586 corresponding to a moderate ecological status.

On the Tolnai-Dead-Danube 2 at the sampling point (P50THDFB2) on 27 August 2013 30.1% of the individuals counted in the benthic diatom population belonged to the order Centrales, 69.9% of them belonged to diatom species in the order Pennales. Components of Centrales-diatom species populations in the highest ratio included Aulacoseira granulata var granulata and Aulacoseira granulata var angustissima (25.3% and 3.0%). Components of Pennales-diatom populations in the highest ratio were represented by Naviculaceae-, Bacillariaceae, Fragilariaceae-, Achnanthaceae-, and Epithemiaceae-family, of which the relative abundance projected to the individuals counted was 38.5%, 15.2%, 9.1%, 4.6% and 0.5%, respectively. The Naviculaceae-family was represented by Amphora-, Navicula-, Cymbella- and Gomphonema- species. Relative abundance of the Amphora pediculus was 13.4%. The Bacillariaceae-family was represented by Nitzschia species. Taxons of the Fragilariaceae-family with the highest relative abundance included Fragilaria nanana, Fragilaria pinnata and Fragilaria ulna var. ulna. The Achnanthaceae-family was represented by Achnanthidium minutissimum (=Achnanthes minutissima), Cocconeis pediculus, and Cocconeis placentula, the Epithemiaceae family by Rhopalodia gibba. The EQR value of the lake diatom index was NTDIL(1-20)=0.576 corresponding to a moderate ecological status.

On 11 October 2013 5.8% of the individuals counted in the benthic diatom population belonged to the order Centrales, 94.2% of them belonged to diatom species in the order Pennales. The components in the highest rate of the Pennales-diatom stock were the taxons in the Bacillariaceae-, Naviculaceae-, Achnanthaceae-and Fragilariaceae-family, of which the relative abundance projected to the individuals counted was 55.6%, 27.0%, 6.3% and 5.2%, respectively. The Bacillariaceae-family was represented by Nitzschia species., of which Nitzschia fonticola relative abundance of the 17.1%. The Naviculaceae-family was represented by Navicula-, Cymbella-, and Gomphonema species. The relative abundance of Navicula cryptotenella was 10.5%. The Fragilariaceae-family was represented by Fragilaria-species, the Achnanthaceae family be Achnanthidium minutissimum (=Achnanthes minutissima) and Cocconeis placentula. The EQR value of the lake diatom index was NTDIL(1-20)=0.576 corresponding to a moderate ecological status.

Sampling unit	EQR	Ecological status (based on EQR)
P50THDFP1 August	0.596	moderate
P50THDFP2 August	0.576	moderate
P50THDFP1 October	0.586	moderate
P50THDFP2 October	0.576	moderate
average value:	**0.584**	**moderate**

Table 12.4.3-5: Ecological status assessment based on phytobenthos of the body of water marked (HULWAIH136) and named Northern Dead Danube of Tolna according to the criteria of the WFD

*Based on the values of the lacustrine diatom index NTDIL(1-20)) the Northern Dead Danube of Tolna can be regarded in a **moderate** ecological status. Based on the results it can be stated that the phytobenthos in the backwater channel was lacustrine in nature, which is essentially different from the phytobenthos composition in the Danube.*

Cooling water discharged from the Paks Nuclear Power Plant has no effect on the phytobenthos community in the Northern Dead Danube of Tolna and such impact can not be expected in the course of the erection and operation of the Paks II plant, including potential failure events.

12.4.3.4 Macrophyte

Floristic and ecological status assessment of the Northern Dead Danube of Tolna findings

Macrophyte sampling of the Northern Dead Danube of Tolna was accomplished on 21 July 2013 and 6 October 2013. The location of the sampling was identical in the two sampling sessions.

The sampling revealed 14 macrophyte species. No Natura 2000 indicator species occurred. Quantitative surveys mainly involved common species but a number of other species represent intensively and aggressively spreading introduced elements. They are able to adapt to the changing environmental conditions very quickly, possess rapid reproduction capabilities and a part of them may threaten elements of the native vegetation in a serious manner.

Scientific name	English name	P50THDMF
Alnus glutinosa	Common alder	5
Amorpha fruticosa	Desert false indigo	1
Fraxinus pennsylvanica	Red ash	5
Humulus lupulus	Common hop	2
Iris pseudacorus	Yellow flag	1
Lycopus europaeus	Gypsywort	1
Myriophyllum verticillatur	Whorled water milfo	2
Phragmites australis	Common reed	4
Populus tremula	Common aspen	3
Robinia pseudo-acacia	Honey locust	2
Rubus cf. caesius	Dewberry	2
Typha angustifolia	Narrowleaf cattail	4
Typha latifolia	Broadleaf cattail	1
Ulmus glabra	Wych elm	2

Table 12.4.3-6: Macrophyte species identified in the Northern Dead Danube of Tolna

In the analysis of the quantitative values of the macrophyte species in the samples taken during the sampling (ANOVA) no statistically significant differences could be detected ($F_{4,350}=0.3943$ $p=0.81$) for all samples (Figure 12.4.3-2). When testing for number of species and diversity levels, significant differences could be detected between individual samples (Figure 12.4.3-3; Figure 12.4.3-4). Quantitative analysis of the composition indicators for the community in the samples was carried out for all samples. On this basis it can be stated that the individual Tolnai-Dead-Danube sampling sites have a substantially but not significantly different species inventory (see ANOVA).

With respect to the Shannon diversity value and average number of plant species the Tolnai-Dead-Danube sampling points are very similar in terms of diversity and species number. Only sampling point 3 is different. No regularities can be detected in the quantitative analysis of the Tolnai-Dead-Danube samples, they rather indicate various levels of disturbance in the sampling points.

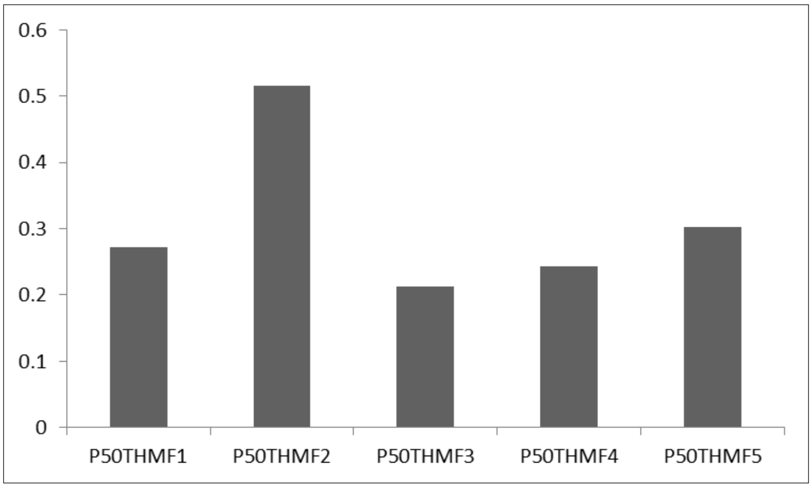


Figure 12.4.3-2: Average volumes of macrophyte species based on the aggregate summer and autumn sampling data at the Tolnai-Dead-Danube sampling points

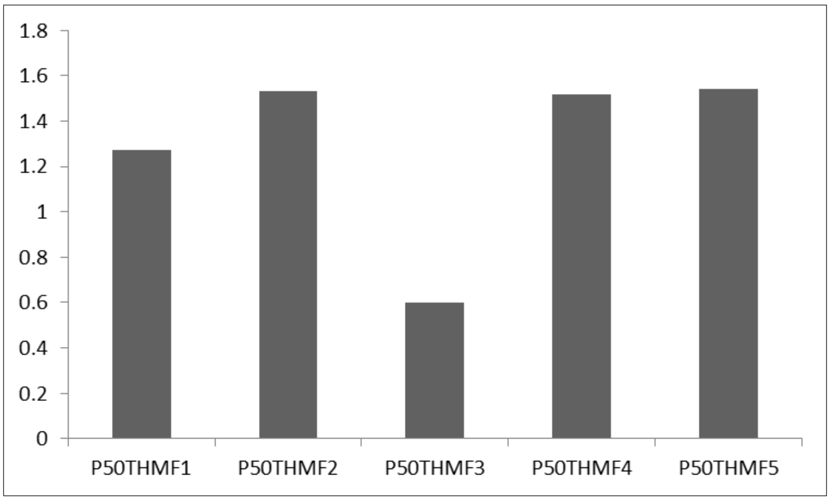


Figure 12.4.3-3: Shannon diversity levels of macrophyte species in the Tolnai-Dead-Danube sampling points based on aggreageted summer and autumn sampling data

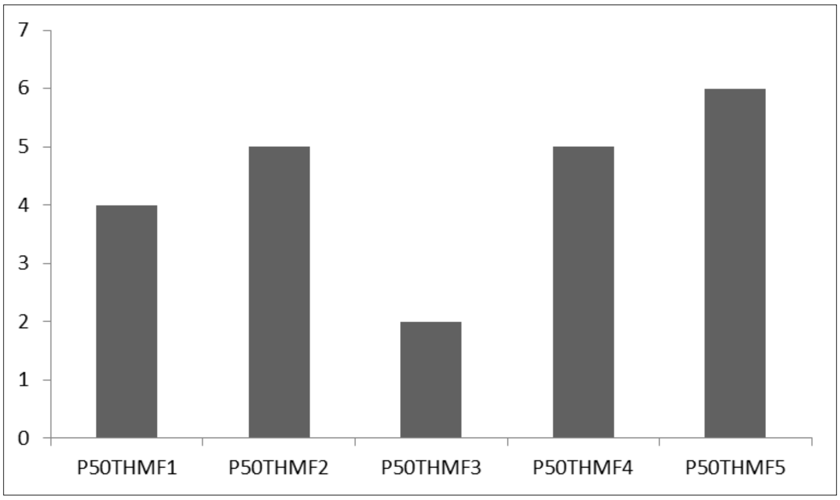


Figure 12.4.3-4: Numbes of macrophyte species in the Tolnai-Dead-Danube sampling points based on aggreageted summer and autumn sampling data

Samples from the Tolnai-Dead-Danube were compared with the values obtained from the Kondor Lake, Fishing pond, Dead Danube of Fadd using the principal coordinate analysis (PCoA). The principal coordinate analysis used for the evaluation was prepared on the basis of the Bray-Curtis similarity function (Figure 12.4.3-5).

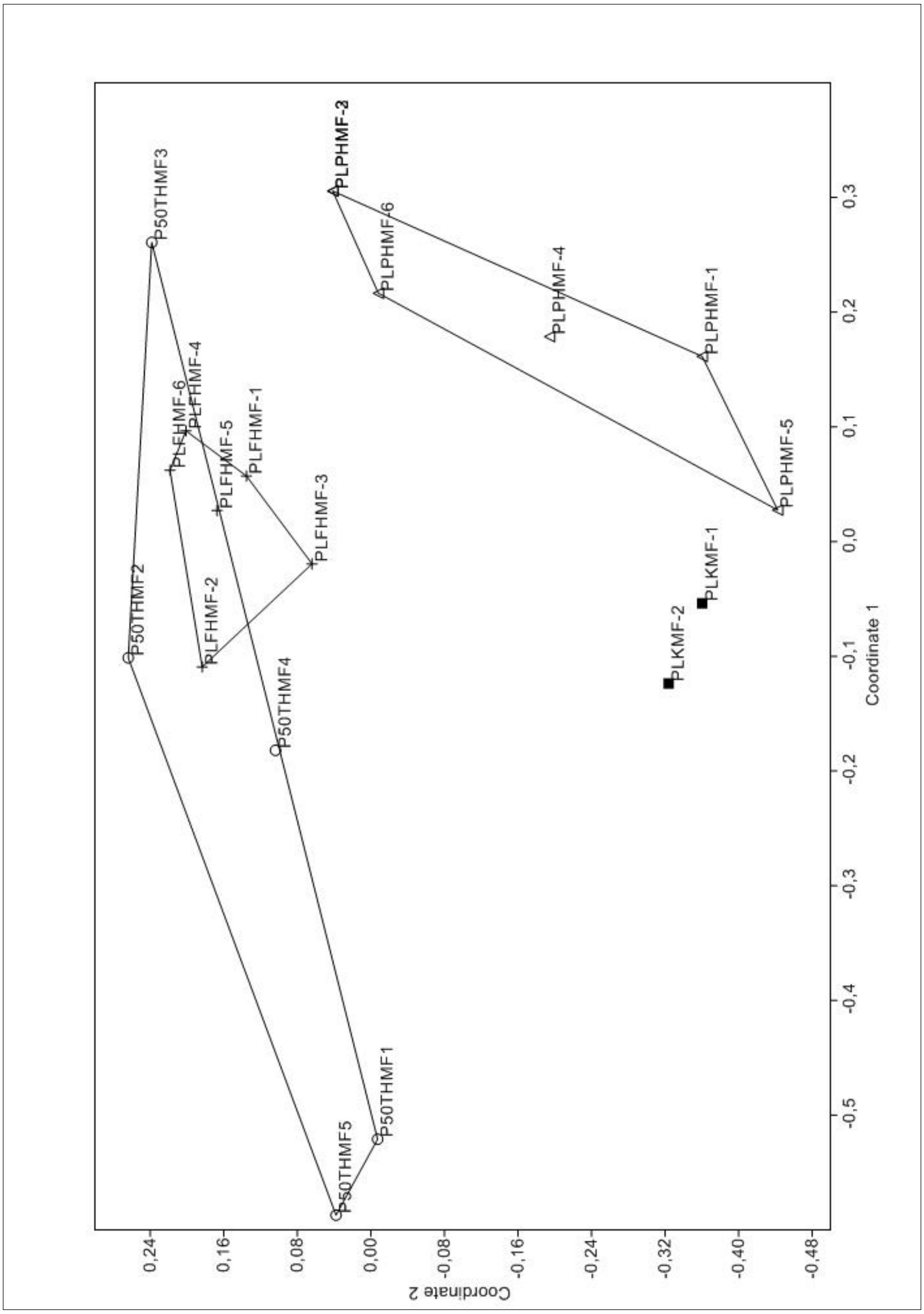


Figure 12.4.3-5: Principal coordinate analysis of the macrophyte stands in the Tolnai-Holt-Danube, Dead Danube of Fadd, Kondor Lake and Fishing Ponds based on the aggregated macrophyte data from the 2012 and 2013 summer as well as autumn sampling sessions

The analysis revealed similarity of the sampling points defined in the two backwater sections. Sampling points are differentiated along the y axis basically on the basis of the morphological nature of the respective channel bottoms, while along the x axis on the basis of fishing/angling intensity.

A NORTHERN DEAD DANUBE OF TOLNA WFD SAMPLING POINTS

During the ecological status assessment the water space as a whole is classified according to the WFD criteria and based on the data sets obtained from the sampling sites. The status of the body of water is provided as the average of the findings in the different seasons and at the different sampling sites.

P50THDMF	Aggregate DAFOR cubic value	Number of species
A (indicator species)	0	0
B (neutral species)	133	6
C (disturbance indicator species	0	0
SUM	133	6
Reference Index	0	
EQR Value	0.5	
Classification	**moderate**	

Table 12.4.3-7. táblázat: Ecological status assessment of the Northern Dead Danube of Tolna based on macrophyte derived water quality

Based on the findings of the assessment it can be stated that the ecological status of the Northern Dead Danube of Tolna according to the macrophyte analysis was ***moderate****. Ecological analysis pointed out the fact that macrophyte vegetation of the backwater differs fundamentally from that of the Danube and was more similar in terms of habitat conditions to that of the Dead Danube of Fadd.*

Cooling water discharged from the Paks Nuclear Power Plant has no effect on the vegetation in the Northern Dead Danube of Tolna and such impact can not be expected in the course of the erection and operation of the Paks II plant, including potential failure events.

12.4.3.5 Macrozoobenthos

Faunistic and ecological status assessment of the Northern Dead Danube of Tolna findings

Macrozoobenthos sampling of the Northern Dead Danube of Tolna was accomplished in summer on 21 July 2013 and in autumn on 6 October 2013 in two sampling units and six subunits representing the habitat conditions of the backwater channel adequately.

During summer and autumn sampling 24 and 32 different macroscopic invertebrate taxons of various levels were identified, respectively.

A substantial part of all the taxons detected are typical lenitic, stagnant organisms, including many mollusc and dragonfly taxons which are basically associated with aquatic plants (macrophytes) in stagnant water *(Physella acuta, Radix auricularia, R. balthica, Ischnura elegans, Coenagrion puella)* and were detected in high numbers.

Invasive lotic species found in rivers occurred here in lower numbers (for instance the Ponto-Caspian mysid, *Limnomysis benedeni* and zebra mussel, *Dreissena polymorpha*).

Taxons	P50THDMZB 1	P50THDMZB 2
Water worms (Oligochaeta)	1	3
Leeches (Hirudinea)		
Alboglossiphonia heteroclita (LINNAEUS, 1761)	2	
Snails (Gastropoda)		
Bithynia leachii (SHEPPARD, 1823)		4
Bithynia tentaculata (LINNAEUS, 1758)	13	19
Galba truncatula (O.F. MÜLLER, 1774)	1	4
Gyraulus crista f. spinulosa (LINNAEUS, 1758)		1
Physella acuta (DRAPARNAUD, 1805)	13	23
Stagnicola palustris (O.F. MULLER, 1774)		1
Radix auricularia (LINNAEUS, 1758)	4	5
Radix balthica (LINNAEUS, 1758)	10	12
Valvata piscinalis (O.F. MÜLLER, 1774)	1	4
Viviparus sp.	1	
Mussels (Bivalvia)		
Anodonta cygnea (LINNAEUS, 1758)	1	1
Dreissena polymorpha (PALLAS, 1771)		1
Crustaceans (Crustacea)		
Asellus aquaticus (LINNAEUS, 1758)		1
Limnomysis benedeni CZERNIAVSKY, 1901	6	35
Mayflies (Ephemeroptera)		
Caenis horaria (LINNAEUS, 1758)		1
Caenis robusta EATON, 1884		11
Cloeon dipterum (LINNAEUS, 1761)		7
Alderflies (Megaloptera)		
Sialis lutaria (LINNAEUS, 1758)		1
Dragonflies (Odonata)		
Anax imperator LEACH, 1815	1	
Coenagrion puella (LINNAEUS, 1758)	2	
Ischnura elegans (VANDER LINDEN, 1820)	11	22
Libellula fulva MÜLLER, 1764		1
Orthetrum albistylum (SELYS, 1848)		3
Orthetrum cancellatum (LINNAEUS, 1758)	8	5
Platycnemis pennipes (PALLAS, 1771)	6	6
True bugs (Heteroptera)		
Gerridae		7
Ilyocoris cimicoides (LINNAEUS, 1758)		1
Micronecta sp.		1
Caddisflies (Trichoptera)		
Ecnomus tenellus RAMBUR, 1842		9
Beetles (Coleoptera)		
Anacaena limbata (FABRICIUS, 1792)	6	2
Flies (Diptera)		
Bezzia sp.		3
Chironominae	23	36
Glyptotendipes sp.	6	14
Orthocladiinae	5	2
Limoniidae		1
Tabanidae		1
Tanypus punctipennis MEIGEN, 1818		1
Tanytarsini		1

Table 12.4.3-8: List of macroscopic invertebrate taxons on the Northern Dead Danube of Tolna

The analysis of the macrozoobenthos density in the samples collected during the summer sampling with the Mann-Whitney test (to compare two sites) did not indicate any statistically significant differences between individual units (U = 104.0; p = 0. 4004). There was no detectable difference when the average number of taxons was tested, either (U = 2.500; p = 0.5066), just like in the case of the average Shannon diversity values, which did not deviate significantly, either (U = 3.000; p = 0.7000) (Figure 12.4.3-6).

Basically it can be seen that structural indicators of the profile No 2 are higher attributable to the fact that this is a more heterogeneous place (including emerging, marshy plants and hair weeds, submerged vegetation) which is able to attract a number of lenitic macroscopic invertebrate taxons.

The analysis of the macrozoobenthos density in the samples collected during the autumn sampling with the Mann-Whitney test (to compare two sites) did not indicate any statistically significant differences between individual units (U = 147.0; p =

0. 1988). There was a strongly significant difference when the average number of taxons was tested (U =0.000 ; p = 0.0071), just like in the case of the average Shannon diversity values, which did deviate significantly (U = 0.003; p = 0.0261) (Figure 12.4.3-7)**.**

The average number of taxons in the autumn sampling of profile 2 was a lot higher, caused by dragonflies of the Orthetrum spp, mayfly species and more snails compared to summer.

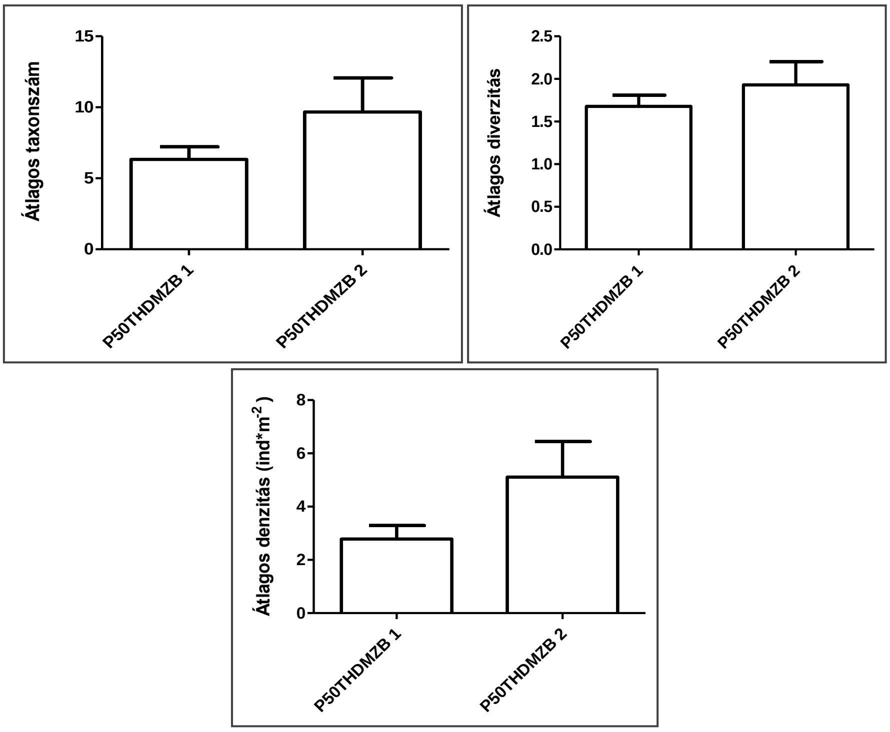


Figure 12.4.3-6 Average number of individuals, number of taxons and diversity in the macrozoobenthos in the two profiles in summer

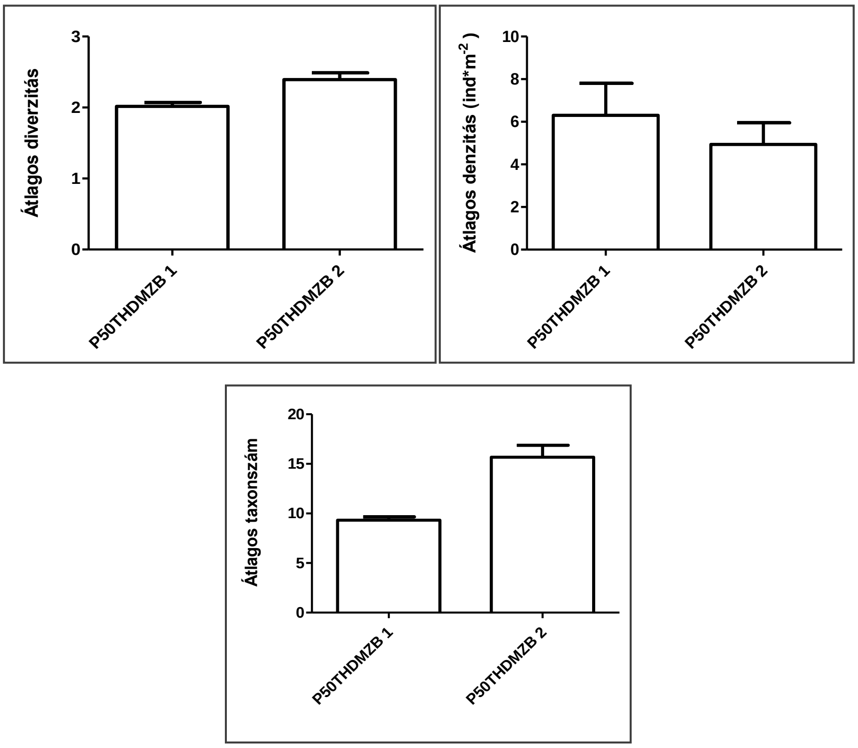


Figure 12.4.3-7: Average number of individuals, number of taxons and diversity in the macrozoobenthos in the two profiles in autumn

The qualitative data of the Tolnai-Dead-Danube from the analysis of the summer samples were compared to the data from the sampling of the Danube in 2013 with the help of the Rogers-Tanimoto binary function. The group average method was used for cluster analysis. (Figure 12.4.3-8).

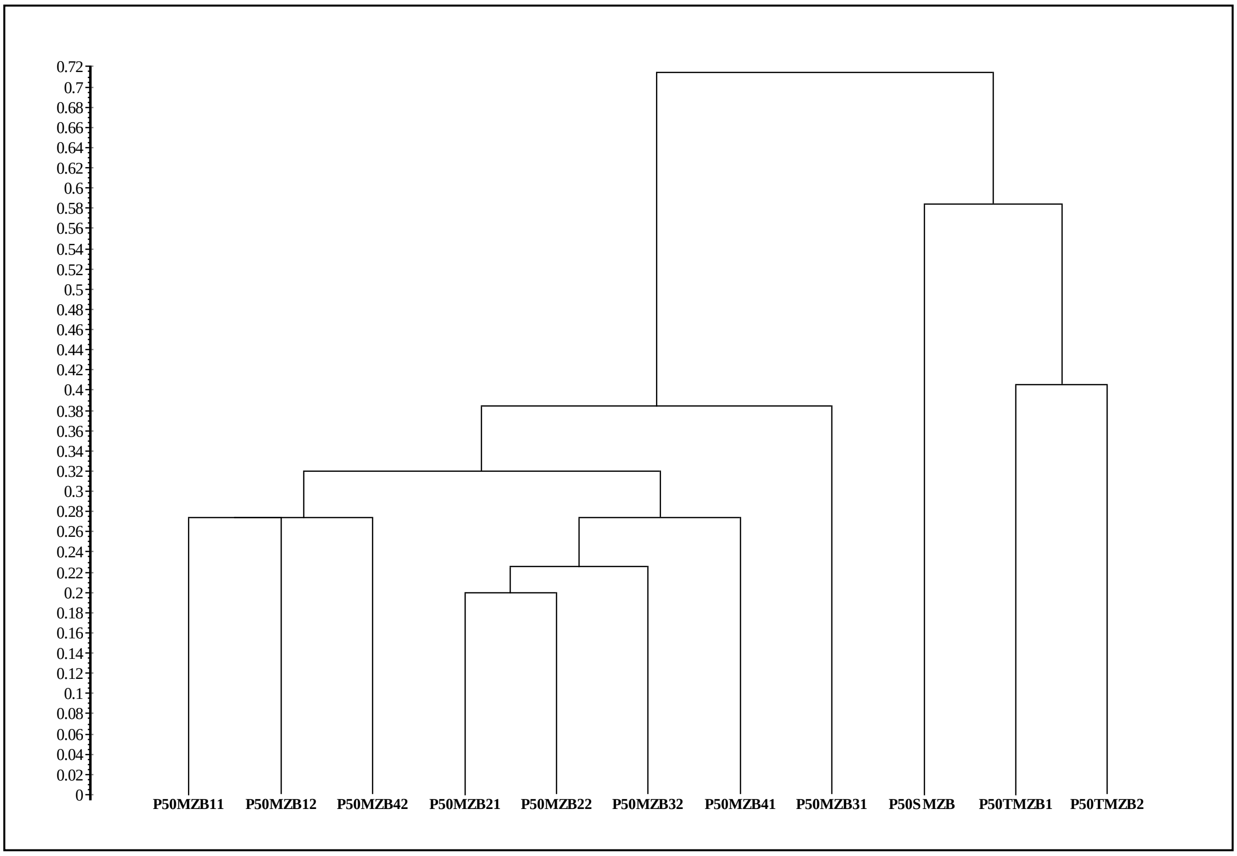


Figure 12.4.3-8: Cluster of qualitative data based on summer macrozoobenthos sampling

Result show that the set of taxons in the Tolnai-Dead-Danube – just like in the case of the Dead Danube of Fadd – differs significantly from the Danube data. It can be explained by the fact that the inventory in the Dead-Danube consists almost entirely of lenitic organisms living in stagnant water, as opposed to the lotic (rheofilic) taxons in the Danube. At the same time this also means, that – albeit Danube based elements also appear in lesser numbers – basically it is not subject to the impact of the Danube and the backwater channel has its own independent lenitic fauna.

NORTHERN DEAD DANUBE OF TOLNA WFD SAMPLING POINTS

The classification was made on the basis of the Hungarian macrozoobenthos family scoring system (MMCP) [12-7]. In this system the middle value (3) is called medium, as opposed to that used in the WFD. Ecological status of the backwater space was defined as the average of the summer and autumn samples.

HULWAIH136 water body	Summer			Autumn		
	MMCP	TÁP	Classification	MMCP	TÁP	Classification
P50THDMZB1	35	3.80	medium	33	3.30	medium
P50THDMZB1	56	3.50	medium	69	3.45	medium
Aggregate classification:	**medium**					

Table 12.4.3-9.: WFD classification of the Tolnai-Dead-Danube based on MZB

*The ecological status defined as the outcome of the classification procedure was **moderate**. The Northern Dead Danube of Tolna can be characterised by a basically lacustrine macrozoobenthos community. At the same time this also means, that – albeit Danube based elements also appear in lesser numbers – basically it is not subject to the impact of the Danube and the backwater channel has its own independent lenitic fauna.*

Cooling water discharged from the Paks Nuclear Power Plant has no effect on the macroscopic invertebrate community in the Northern Dead Danube of Tolna and such impact can not be expected in the course of the erection and operation of the Paks II plant, including potential failure events.

12.4.3.6 Fishes

Faunistic and ecological status assessment of the Northern Dead Danube of Tolna findings

Two sampling units 300 metres long each were sampled on the Northern Dead Danube of Tolna is two sampling sessions (summer, autumn).

During the summer and autumn survey a total of 1 612 individuals of 20 species could be identified in the two sampling units.

Species name	P50THDH1	P50THDH2
Rutilus rutilus	1	1
Ctenopharyngodon idella	1	1
Scardinius erythrophthalmu	1	1
Alburnus alburnus	1	1
Blicca bjoerkna	1	1
Abramis brama	1	1
Pseudorasbora parva	1	1
Rhodeus amarus	**1**	**0**
Carassius gibelio	1	1
Cyprinus carpio	1	1
Misgurnus fossilis	**1**	**0**
Silurus glanis	1	1
Ameiurus melas	1	1
Esox lucius	1	1
Lepomis gibbosus	1	1
Perca fluviatilis	1	1
Gymnocephalus cernua	1	1
Sander lucioperca	1	1
Proterorhinus semilunaris	1	1
Neogobius fluviatilis	1	0
Number of species:	**20**	**17**

Table 12.4.3-10: Fish species found in the Northern Dead Danube of Tolna during sampling

Two of the species found in the sampling profiles were protected *(Rhodeus amarus, Misgurnus fossilis).* The same species are at the same time included as protected species of Community importance under Annex No II of the Habitat directive.

The species inventory in the two sampling profiles is homogeneous to a large extent, only *Rhodeus amarus, Misgurnus fossilis* and *Neogobius fluviatilis* of the 20 species identified were encountered only from one of the sampling units.

Dominant species in the backwater channel based on the number of individuals included *Rutilus rutilus, Scardinius erythrophthalmus, Alburnus alburnus, Pseudorasbora parva, Carassius gibelio, Ameiurus melas.* Additionally beside them a great abundance of species important for fishing/angling purposes are also observed, primarily *Cyprinus carpio, Sander lucioperca, Ctenopharyngodon idella*.

Young individuals of 13 species of the total of 20 were detected in the samples. This means the presence of offspring for 65% for all species. This is a relatively low ratio. On top of all that, the highest numbers of individuals included in the disturbance tolerant species *Rutilus rutilus*, as well as the non native and invasive *Pseudorasbora parva*, *Carassius gibelio, Ameiurus melas, Lepomis gibbosus*.

The ecological analysis and their functional characteristics for the fish community in the two sampling units of the Tolnai-Dead-Danube were provided based on (Halasi-Kovács and Tóthmérész [12-18]) (Table 12.4.3-11; Table 12.4.3-12).

Functional features	P50TH1	P50TH2
Feeding grounds		
Open water	25.30	52.21
Metaphytic	45.42	15.63
Benthic	29.28	32.15
Flow rate		
Stagnofil	39.64	22.42
Eurytop	60.36	77.58
Rheofilic	0.00	0.00
Habitat specialisation		
Tolerant	77.69	79.65
Generalista	10.96	11.80
Specialist	11.35	8.55
Origin		
Introduced	41.83	25.07
Indigenous	58.17	74.93

Table 12.4.3-11: Selected functional characteristics of the Tolnai-Dead-Danube fish community in summer

Functional features	P50TH1	P50TH2
Feeding grounds		
Open water	0.00	5,77
Metaphytic	90.73	68.46
Benthic	9.27	25.77
Flow rate		
Stagnofil	65.37	16.92
Eurytop	34.63	83.08
Rheofilic	0.00	0.00
Habitat specialisation		
Tolerant	69.27	66.92
Generalista	10.24	17.69
Specialist	20.49	15.38
Origin		
Introduced	68.29	58.46
Indigenous	31.71	41.54

Table 12.4.3-12: Selected functional characteristics of the Tolnai-Dead-Danube fish community in autumn

The fish community of the Tolnai-Dead-Danube fish community shows a structure typical for paleopotamon backwater based on the "Flow rate" functional characteristics. Rheofilic fauna components are missing entirely. This confirms the assumption that fish migration is essentially not ensured even between the backwater bottom channel and the natural watercourses with which it is in indirect connectivity. This also means that the backwater channel bottom has an independent and basically self sufficient stock of fish. Grouping according to the functional characteristics of the feeding ground across each of the sampling sessions shows a greatly varied picture both in terms of location and time. Such rate of presence of benthic taxons with a view to the strong deposition of sediments from the perspective of oxygenation conditions can be accepted as whole. Disturbance tolerant fish species form a dominant stock in the backwater channel. This is homogeneous both in terms of space and time. The level of relative abundance of specialist species is extremely low. A similarly unfavourable picture is shown by clustering according to the origin. Relative abundance of non native fish taxons is very high.

Based on the analysis of functional characteristics the presence of the disturbance tolerant and non native fish species in high relative abundance in the Northern Dead Danube of Tolna suggest a significant level of disturbance. Both the findings of this study and the stocking and catching data (MVM ERBE [12-30]) confirm that stocking with fish has a strong influence on the natural fish community. However, a higher level of relative abundance of the invasive species in this area indicates also that the process does not point toward a climax association of the fish community with lower number of species and consisting primarily of stagnofil species, but towards a continuously pioneer association which is the result of the management of the fish stock. Based on the data the picture of a strongly disturbed stagnant water body with intensive fish management practices can be drawn up.

NORTHERN DEAD DANUBE OF TOLNA WFD SAMPLING POINTS

Just like in the case of the other bodies of lacustrine water the ecological classification method was provided pursuant to Halasi-Kovács et al. [12-17], a recommendation made on the classification method for stagnant water bodies in the course of the river basin management planning process. In this work the assessment was made on this basis.

Classification criteria	P50THD	
	Value	Value index
Expert judgement	1	1
Specialist species, relative abundance	13.94	1
Indigenous species, relative abundance	51.59	2
Classification result		**1.33**
WFD Classification value index		**poor (2)**

Table 12.4.3-13: Ecological status assessment of the Northern Dead Danube of Tolna based on autumn sampling

*All in all the fish community of the Northern Dead Danube of Tolna can be ranked as a water body with **poor** ecological status. This concurs with the outcome of the ecological survey. This also means that the backwater channel bottom has an independent and basically self sufficient stock of fish. Stocking the backwater channel artificially with fish has a strong influence on the natural fish community. Based on the data the picture of a strongly disturbed stagnant water body with intensive fish management practices can be drawn up.*

Based on the data analysis the cooling water discharged from the Paks Nuclear Power Plant has no effect on the structure of the fish community in the Northern Dead Danube of Tolna and such impact can not be expected in the course of the erection and operation of the Paks II plant, including potential failure events.

12.4.3.7 Comprehensive ecological status classification of the body of water marked HULWAIH136 named Dead Danube of Tolna according to the WFD

For the purposes of evaluation, basically the fundamental principles included in the ECOSTAT guidance document no. 13. (ECOSTAT 2005: Common Implementation Strategy for the Water Framework Directive (2000/60/EC) were taken into consideration, as well as the domestic national guidance specified in the course of the planning process of the national river basin management plan in 2008.

During the assessment of the water body in accordance with the Water Framework Directive the classification principle of "one bad means all bad" was followed.

Though no WFD based classification method exists for lakes with respect to macrozoobenthos and fish community, due to the reliability of the sampling and evaluation of these biological elements the classification results carried out on the basis of these two biological elements were taken into account with full weight.

HULWAIH136	Physico-chemical properties	Phytoplankton	Phytobenthos	Macrophyte	Macrozoobenthos	Fishes
Northern Dead Danube of Tolna	Does not reach good status	moderate	moderate	moderate	medium	poor

Table 12.4.3-14: Classificaiton of the Northern Dead Danube of Tolna (HULWAIH136) based on the WFD

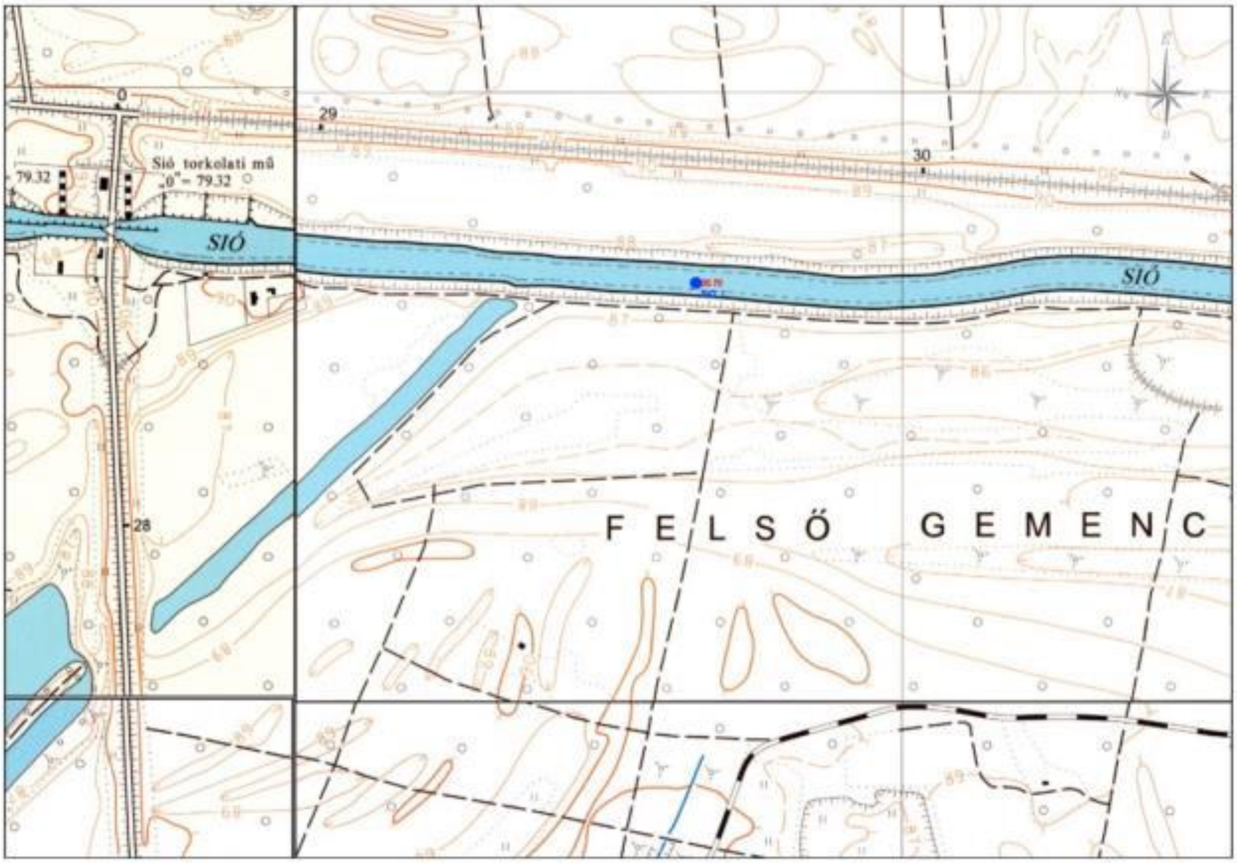
Based on the evaluation results of the water quality assessment pursuant to the requirements laid down in the WFD carried out in 2013 the ecological status of the water body marked HULWAIH136 was poor.

It can be stated furthermore that the discharge from the Paks Nuclear Power Plant has no detectable impact on any of the assessed groups and no such impact can be expected from the construction of Paks II or during the service period which cen be characterised by a number or different operating stats including failure events.

12.4.4 SIÓ-CHANNEL

12.4.4.1 Physical and chemical results of water testing

Tests concerning the determination of the physico-chemical parameters were carried out in the downstream branch of the Sió situated some 30 km to the south from the site two times in the second half of the year 2013. The layout of the profile is shown on Figure 12.4.4-1. Classification of the Sió channel was made according to these tests.



Sió torkolati mű – mouth of the Sió Canal
FELSŐ GEMENC – Upper Gemenc mountain

Figure 12.4.4-1: General layout map of the Sió canal downstream test profile

The general layout map of the Danube in the area is seen onFigure 12.3.3-2.

The findings of the water quality tests carried out on the Sió-channel downstream profile in the second half of the year 2013 are shown in Table 12.4.3-1 for each element and each group according to the criteria of the WFD.

SIÓ-CHANNEL DOWNSTREAM PROFILE CLASSIFICATION ACCORDING TO THE WFD

The acidification status of the Sió canal (downstream) profile on the basis of the pH is in Class II, the evaluation grade is 4.0. Therefore the acidification status based on the test results from the second half of the year 2013 is classified as good status in accordance with the WFD assessment methodology.

The salinity status on the basis of the conductivity did not reach a good status, the evaluation grade is therefore 0.0. As a consequence, the salinity status based on the test results from the second half of the year 2013 did not reach a good status in accordance with the WFD assessment methodology.

The oxygenation conditions based on the basis of the elements dissolved oxygen is in Class I, oxygen saturation Class I, BOD_5 and COD failed to reach good status, the evaluation grade is therefore 2.5. As a consequence, the status of the oxygenation conditions based on the test results from the second half of the year 2013 did not reach the good status in accordance with the WFD assessment methodology.

The nutrient conditions based on the basis of the elements ammonium-N and orto-phosphate-P, nitrate-N, total nitrogen, total phosphorus, a-chlorophyll did not reach good status. The evaluation grade of the group is therefore 0.0, and the status of the nutrient conditions based on the test results from the second half of the year 2013 did not reach the good status in accordance with the WFD assessment methodology.

With respect to metal status all element are in Class I, the evaluation grade of the group is 5, therefore, the status of the status of metals based on the test results from the second half of the year 2013 is classified as high in accordance with the WFD assessment methodology.

*The Sió canal downstream profile (HULWAEP959 water body) d**id not reach good status** in terms of physico-chemical parameters based on the test results from the second half of the year 2013 in the ecological status assessment according to the WFD.*

12.4.4.2 Phytoplankton

Findings of the phytoplankton samples taken on the Sió canal downstream section profile and their evaluation

Phytoplankton sampling on the Sió lower section was carried out in two sessions 28 August 2013 and 10 October 2013 in two sampling units for the quantitative and qualitative assessment of phytoplankton, at the same place and date when the water was sampled for chemical testing. At this section the Sió was exposed to impoundment due to the high water stage of the Danube.

TAXONS	Sampling sites and dates	
	Sió Lower-Section	
	P50SFP	P50SFP
	28.08.2013	10.10.2013
SUM pico	2	19
SUM nano	2	21
SUM Flagellates	20	37
SUM Chroococcales	5	7
SUM Oscillatoriales	2	55
SUM Nostocales		16
SUM Euglenophyta	94	
SUM Cryptophyta	87	138
SUM Dinophyta	157	
SUM Chrysophyceae	9	43
SUM Xanthophyceae	9	1
SUM Centrales	123	1589
SUM Pennales	3	59
SUM Volvocales	9	11
SUM Chlorococcales	123	227
SUM Ulothricales	2	
SUM Desmidiales	17	2
SUM Zygnematales		2
SUM	**6705**	**22331**
a-chlorophyll concentration (μg/l)	**9,6**	**76,4**
a-chlorophyll contents of biomass (%)	**0.143**	**0.342**
degree of trophity	**3 (o-m)**	**6 (eu)**

Table 12.4.4-1: Phytoplankton biomass (μg/l) and a-chlorophyll concentration (μg/l) levels on the Sió canal

In August phytoplankton biomass was 6.7 mg/l, a-chlorophyll concentration 9.6 μg/l, corresponding to the 3 (oligo-mesotrophic) grade on the ten grade Felföldy (1987)-type (0-9) trophity scale (J. Németh 1998: p. 251., T. 2.2.9.) [12-11], [12-31]. Components of phytoplankton biomass in the highest ratio included Dinoflagellates (Dinophyta: 23.4%), diatom species in the order Centrales and green algae in the order Chlorococcales (18.4% and 18.4%), flagellate algae (Euglenophyta: 14.1%) and grooved cryptomonads (Cryptophyta: 13.0%).

In October phytoplankton biomass was 22.3 mg/l, a-chlorophyll concentration 76.4 µg/l, corresponding to the 4 (mesotrophic) grade. Components of phytoplankton biomass in the highest ratio included diatom species from the Centrales-order (71.2%), Chlorococcales green algae (10.2%) and grooved cryptomonads (Cryptophyta: 6.2%).

SIÓ-CHANNEL LOWER SECTION WFD SAMPLING POINTS

The HLPI EQR index value calculated in accordance with the recommendations of the WFD on the basis of the phytoplankton composition of the Sió lower section in August 2013 was 0.660, corresponding to a good ecological status.

The HLPI EQR index value calculated on the basis of the phytoplankton composition in October was 0.255, corresponding to a poor ecological status.

Sampling unit	EQR	Ecological status (based on EQR)
P50SFP August	0.660	good
P50SFP October	0.255	poor
Average Value:	**0.458**	**moderate**

Table 12.4.4-2: Ecological status assessment of the body of water marked (HURWAEP959), named Sió canal downstream profile based on phytoplankton, according to the WFD

Significant difference was seen in the phytoplankton classification value on the lower, tested section of the Sió between the two periods. Under natural conditions worse conditions develop mostly during the summer as a result of the quicker production than in autumn. The Sió phytoplankton clearly indicates that the ecological status developing under natural conditions is periodically heavily modified by external exposures. All in all the ecological status of the Sió on the basis of the phytoplankton was moderate.

The results indicate that instead of a Danube impact much rather the nutrient loads of the Sió itself must be reckoned with in the Danube. Yet it can be stated that the discharge from the Paks Nuclear Power Plant has no impact on the Sió phytoplankton community. At the same time, nutrient exposure of the Sió must be reckoned with during the operation period of the Paks II plant when all units operates simultaneously – between 2030 and 2032 as planned -, which may reinforce the impact of the hot water discharge indirectly in the area below the mouth, resulting in higher phytoplankton biomass values.

12.4.4.3 Phytobenthos

Findings of the phytobenthos samples taken on the Sió canal downstream section profile and their evaluation

Sampling of the phytobenthos on solid substrate (rock, wood) at the dedicated littoral sampling sites on the Sió lower section was carried out in two sessions 7 August 2013 and 1 October 2013 in two sampling profiles for the quantitative and qualitative assessment of phytobenthos. Phytobenthos sampling for the Sió-channel lower section took place in the profile below the Sió-sluice, because this was the place where a paved surface appropriate for the test was found nearest to the dedicated sampling site.

TAXONS	Sió-channel P50SFB	
	28.08.2013	10.10.2013
	pi (%)	pi (%)
CENTRALES		
SUM Centrales	62.6	65.5
PENNALES		
SUM Fragilariaceae	0.9	2.8
SUM Achnanthaceae	2.4	1.6
SUM Naviculaceae	16.6	15.5
SUM Bacillariaceae	17.5	14.7
SUM Epithemiaceae	0.0	0.0
SUM Surirellaceae	0.0	0.0
SUM Pennales spp. (othe	0.0	0.0
SUM	**100.0**	**100.0**

Table 12.4.4-3: Composition of the benthic diatom population in the Sió-channel

A Sió-channel lower section on 28 August 2013 62.6% of the individuals counted in the diatom population of the benthos constituted in a major part from Centrales-diatom species settled from the plankton, of which the relative abundance of Cyclotella meneghiniana with Vi=2 indicator value was 47.4%. The share of the diatom species in the order Pennales was 37.4%. The highest ratio components of the Pennales-diatom populations included the Bacillariaceae family and Naviculaceae-family (17.5% and 16.6%), respectively.

On 10 October 2013 65.5% of the individuals counted in the diatom population of the benthos belonged to the order Centrales, 34.5% of them belonged to diatom species in the order Pennales. The relative abundance of Cyclotella meneghiniana with Vi=2 indicator value in the order Centrales was 39.7%. The highest ratio components of the Pennales-diatom populations (15.5%) included Naviculaceae-taxons represented by Caloneis- and Navicula-species. The share of the Bacillariaceae-family was 14.7%.

SIÓ-CHANNEL LOWER SECTIONS WFD SAMPLING POINTS

The EQR=0.244 value calculated on the basis of the IPS diatom index corresponded to the poor ecological status during the summer sampling. A similar situation could be observed in the autumn sampling session, The EQR=0.270 value calculated on the basis of the IPS diatom index corresponded to the poor ecological status.

Sampling unit	EQR	Ecological status (based on EQR)
P50SFB 08.	0.244	poor
P50SFB 10.	0.270	poor
average value:	**0.257**	**poor**

Table 12.4.4-4: Phytobenthos based ecological assessment of the water body marked (HURWAEP959), named Sió Low according to the WFD

The lower section of the Sió reflected poor ecological status on the basis of the phytobenthos both in summer and autumn. This confirms what was written for the phytoplankton.

Yet it can be stated that the discharge from the Paks Nuclear Power Plant has no impact on the Sió phytobenthos community. At the same time, nutrient exposure of the Sió must be reckoned with during the operation period of the Paks II plant when all units operates simultaneously – between 2030 and 2032 as planned -, which may reinforce the impact of the hot water discharge indirectly in the area below the mouth, resulting in higher phytobenthos biomass values.

12.4.4.4 Macrophyte

Findings of the macrophyte samples taken on the Sió canal downstream section profile and their evaluation

Macrophyte sampling on the Sió lower section was carried out in two sessions 28 August 2013 and 10 October 2013 in one sampling profile.

The floristic picture of the Sió-channel sampling section does not differ much from that of the Danube. Eight species were found in the profile. No Natura 2000 indicator species occurred. Quantitative surveys mainly involved common species but a number of other species represent intensively and aggressively spreading introduced elements (*Aster lanceolatus*). Woody species typical for the section included red ash (*Fraxinus pennsylvanica*), with blueberry below it (*Rubus caesius*). Major spots were formed by the greater pond sedge (*Carex riparia*) and dwarf nettle (*Urtica urens*).

- *Carex riparia*
- *Urtica urens*
- *Rorippa sylvestris*
- *Rubus cf. caesius*
- *Aster lanceolatus*
- *Fraxinus pennsylvanica*
- *Plantago media*
- *Salix fragilis*

SIÓ-CHANNEL LOWER SECTION WFD SAMPLING POINTS

The EQR value was provided on the basis of the average calculated from the two sampling sessions for the purposes of ecological status assessment of the water body.

P50SMF1	Aggregate DAFOR cubic value	Number of species
A (indicator species)	27	1
B (neutral species)	64	1
C (disturbance indicator species)	0	0
SUM	91	2
Reference Index	29,67	
EQR Value	0.65	
Classification	**good**	

Table 12.4.4-5: Outcome of the ecological status assessment of the Sió-channel sampling unit based on the aggregatemacrophyte 2013 data.

Ecological status of the water quality in the Sió-channel sampling point according to the mecrophytes was good, since in terms of their quantity positive indicators (Urtica dioica, Carex riparia) were in majority. With respect to classification it should be noted that the number of plant species and their abundance did not allow exact classification, since they did not reach the minimum level necessary. The data obtained this way are for information only.

12.4.4.5 Macrozoobenthos

Findings of the macrozoobenthos samples taken on the Sió canal downstream section profile and their evaluation

Macrozoobenthos sampling of the Sió canal downstream profile was accomplished in summer on 21 July 2013 and in autumn on 6 October 2013 in one sampling unit and three subunits.

The number of the macroscopic invertebrate taxons detected was considerably low, merely 10 and 6 different macroscopic invertebrate taxons were found in summer and autumn, respectively.

Taxons	P50SMZB
Water worms (Oligochaeta)	417
Snails (Gastropoda)	
Anisus spirorbis (LINNAEUS, 1758)	1
Viviparus acerosus (BOURGUIGNAT, 1862	13
Mussels (Bivalvia)	
Dreissena polymorpha (PALLAS, 1771)	3
Sinanodonta woodiana (LEA, 1834)	3
Sphaerium corneum (LINNAEUS, 1758)	1
Unio pictorum (LINNAEUS, 1758)	1
Unio tumidus RETZIUS, 1788	5
Beetles (Coleoptera)	
Graphoderus austriaca (STURM, 1834)	1
Flies (Diptera)	
Bezzia sp.	1
Chironominae	21
Chironomus sp.	51
Tanypus punctipennis MEIGEN, 1818	1

Table 12.4.4-6: List of macroscopic invertebrate taxons on the Sió-channel

The macroscopic invertebrate fauna on the Sió lower section was mainly set up by the molluscs typical for the loose bedding material and larvae of the non-biting midge family (Chironominae) as wall as water worms (Oligochaeta) which favour sediment rich in organic matter but endure poor oxygenation conditions as well. From the faunistic perspective the presence of the beetle species *Graphoderus austriaca* which was located in summer from among the twigs of a tree overhanging the water.

During the ecological assessment the taxon figures of the Sió sampling site was compared to Danube, and Tolnai-Dead-Danube data from 2013. The comparison was made with the help of the Rogers-Tanimoto binary function. The group average method was used for cluster analysis (Figure 12.4.3-8).

Result show that the set of taxons in the Sió lower section differs definitely from the Danube data and is closed to that of the Tolnai-Dead Danube. This supports the statement was said for phytoplankton, that the wildlife in the lower sections of the Sió differs from that of the Danube and that anthropogenic loads on the Sió will cause on the lower section of the river a state significantly different from that which occurs naturally.

SIÓ-CHANNEL LOWER SECTION WFD SAMPLING POINTS

Classification was provided separately for summer and autumn samples and individual EQR values were averaged for the purposes of status assessment.

	Summer		Autumn	
HURWAEP959	**HMMI EQR**	**Classification**	**HMMI EQR**	**Classification**
P50SMZB	0.23	poor	0.09	bad
	HMMI EQR		Classification	
AVERAGE:	**0.16**		**poor**	

Table 12.4.4-7: WFD classification of the Sió lower section based on MZB

All in all the ecological status of the Sió on the basis of the macrozoobenthos classification was ranked in the poor category, determined as the average of the samples from the two sampling periods. The lower section of the Sió differs considerably from the Danube based on the macroscopic invertebrate fauna. The macrozoobenthos community consists typically of taxons favouring muddy bedding material and indicating richness in terms of organic matter, that is organic pollution (Chironominae and Oligochaeta), to which anthropogenic loads have a substantial contributing effect.

The cooling water discharged from the Paks Nuclear Power Plant has no effect on the structure of the macro invertebrate community in the Sió and such impact can not be expected in the course of the erection and operation of the Paks II plant, including potential failure events.

12.4.4.6 Fishes

Findings of the fish samples taken on the Sió canal downstream section profile and their evaluation

The sampling site was assigned on the downstream section of the closing structure at the Sió lower section. This section is directly connected to the Danube, thus data obtained here might be informative in terms of the Danube as well. One sampling unit was identified on this watercourse and samples were taken in two sessions (summer, autumn).

Data analysis and classification was made in the course of the summer and autumn survey based on 885 individuals of 25 species caught on the Sió profile (Table 12.4.4-8).

Species name	P50SH1 Summer	P50SH1 Autumn
Rutilus rutilus	1	1
Rutilus virgo	0	1
Scardinius erythrophthalmu	0	1
Leuciscus idus	1	1
Aspius aspius	1	1
Leucaspius delineatus	0	1
Alburnus alburnus	1	1
Blicca bjoerkna	1	1
Abramis brama	1	1
Ballerus ballerus	1	0
Ballerus sapa	0	1
Romanogobio vladykovi	1	0
Pseudorasbora parva	1	0
Rhodeus amarus	1	1
Carassius gibelio	1	1
Cyprinus carpio	1	1
Ameiurus melas	0	1
Esox lucius	1	1
Lepomis gibbosus	1	1
Perca fluviatilis	1	1
Sander lucioperca	1	1
Sander volgensis	0	1
Ponticola kessleri	1	0
Neogobius melanostomus	1	0
Babka gymnotrachelus	1	1

Table 12.4.4-8: List of fish species found in the Sió in 2013

Four of species caught in the sampling unit tested was subject to nature conservation efforts (*Rutilus virgo, Leucaspius delineatus, Romanogobio vladykovi, Rhodeus amarus*). Species listed as protected species of Community importance under Annex No II of the Habitat directive included *Rutilus virgo, Aspius aspius, Romanogobio vladykovi, Rhodeus amarus*.

Naturally, the impact of the Danube on the assessed section of the Sió is felt on the species inventory. This is indicated by *Rutilus virgo*, and the occurrence of all goby species. However, the structure of the fish community found here differs essentially from the Danube species inventory, showing much more a picture characterising lowland medium sized watercourses. Dominant species include *Rutilus rutilus*, *Leuciscus idus*, *Alburnus alburnus*, *Carassius gibelio*, and beside them a larger number of *Blicca bjoerkna* and *Abramis brama* are also present. At the same time, Percidae species typical for this section of the Danube were missing (*Gymnocephalus. baloni, Gymnocephalus. schraetser, Zingel zingel*), and rheofilic fishes otherwise frequently encountered in the Danube such as for instance *Squalius cephalus* did not appear. As a result of the nutrient load on the Sió the number of individuals of the species *Carassius gibelio* is relatively high.

Compared to Danube sampling sites the total number of young individuals considering the relative low figures of adults was expressly high on the lower section of the Sió.

Though the species structure was similar in the Sió sampling unit in both sampling periods, the number of species found only in one session was relatively high (11). It should be noted here that one week before the sampling a significant pollution plume migrated down the Sió canal causing mass destruction of fishes on the river. The extent can be judged by the supplementary assessment made on the Gemenc section which revealed that hardly any adult individuals were present except the species *Carassius gibelio*. The stock of offspring was less affected. Due to the pollution the chaotic structure seen after major pollution incidents developed downstream of the closing sluice. This means that at some places very high number of individuals can be registered, while fishes disappear almost entirely from others. At this time you encounter species not typically characteristic for the habitat more frequently. In my mind this is the reason why *Rutilus virgo*, *Stizostedion volgensis*, *Leucaspius delineatus* could be identified, but also the extreme high numbers of *Cyprinus carpio*, *Esox lucius*. The pollution incident had an impact on the fish community structure accordingly, which could exert only a lesser impact on the classification status of the section assessed (it might even result in a slight improvement of the results). Thus classification can be done by both sampling.

It was important for classification purposes to analyse to which extent the fish community of the lower Sió section assessed was exposed to the impact of the receiver Danube. In order to detect this function, an analysis was carried out to compare similarities of the 2013 sampling units. Similarity of the sampling units was determined by the quantitative Bray-Curtis distance function and by cluster analysed calculated according to the group average (Unweighted Pair Group Method with Arithmetic Mean or UPGMA) from the summer and autumn sampling (Figure 12.4.4-2; Figure 12.4.4-3). The basic data added up, contain the number of adult and young individuals.

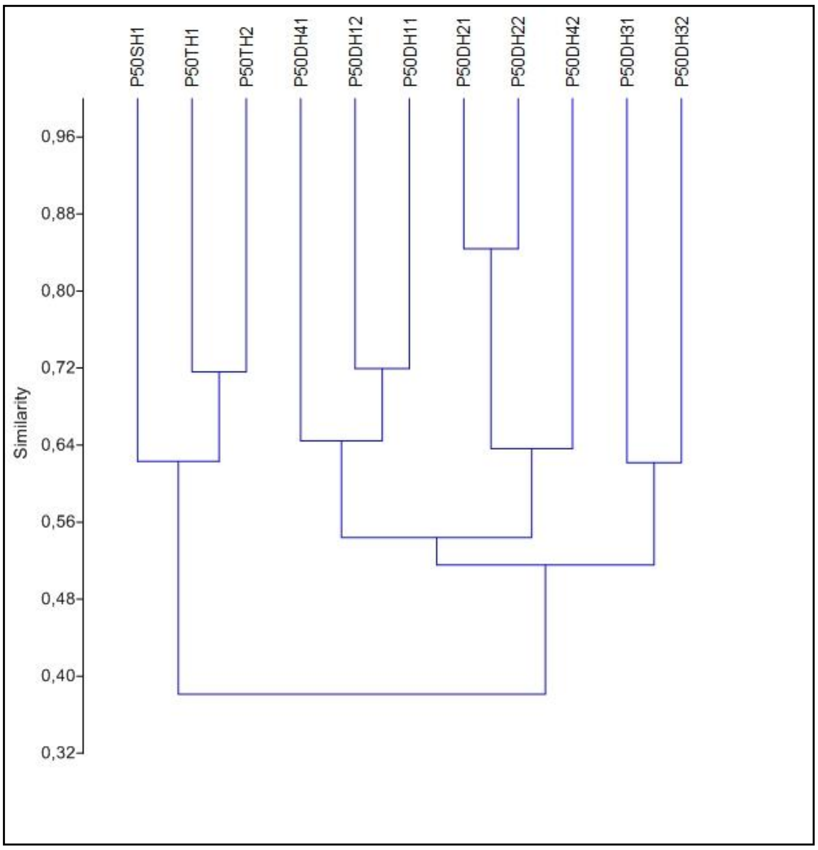


Figure 12.4.4-2: Dendrogram of the 2013 summer sampling on the Sió

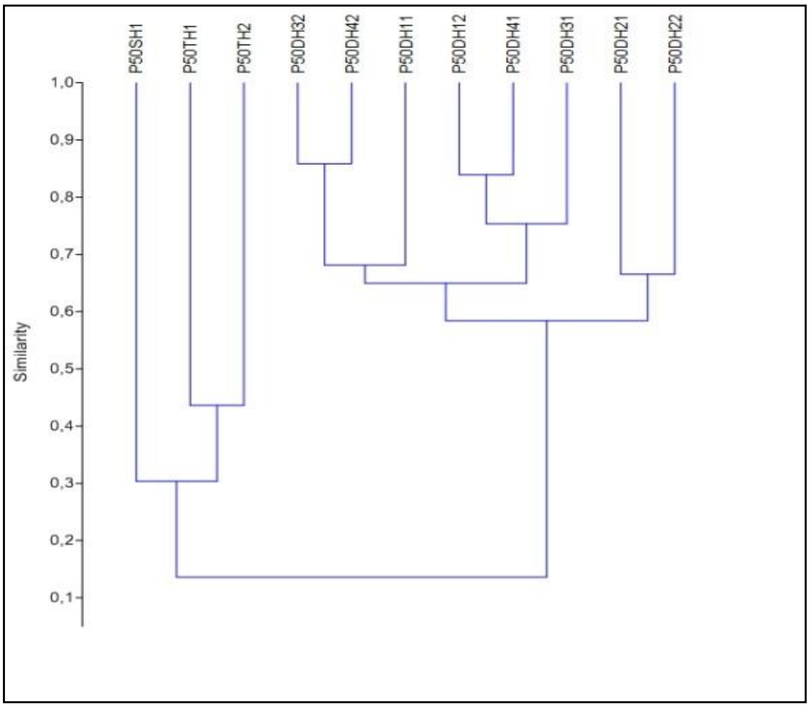


Figure 12.4.4-3: Dendrogram of the 2013 autumn sampling on the Sió

Based on the analysis is can be demonstrated that the assessed Sió section is isolated statistically from the Danube sampling units, implying that the Danube exerts only a slight influence on the Sió fish community, and therefore a separate classification was justified. Dendrograms prepared on the basis of both summer and autumn sampling results shows that the fish community of the Sió canal separates from the Danube fish community significantly, constitutes a separate isolated cluster and as a whole, it is closer to the fish community of the Northern Dead Danube of Tolna which is a lacustrine community. In ecological sense this is a kind of transition from the Danube to the lacustrine fish community.

SIÓ-CHANNEL LOWER SECTION WFD SAMPLING POINTS

Ecological water quality of the section called Sió Low was carried out on the basis of fish communities in accordance with the set of criteria of the WFD, based on the EQI_{HRF} method established in Hungary (Halasi-Kovács et al. [12-17]). The process was carried out for both the summer and autumn sampling results but for the purposes of classification the findings of the summer session is considered to be decisive (Table 12.4.4-9; Table 12.4.4-10).

Sió summer	Number of scores	Value
1. Relative abundance of the omnivorous species (%)	84.68	4
2. Relative abundance of the open water species	3.00	4
3. Relative abundance of the metaphyte species (%)	40.00	3
4. Number of benthic species (piece)	8.00	4
5. Number of litophile species (piece)	2.00	3
6. Relative abundance of the phytophile species (%)	20.85	3
7. Number of rheophilic species(piece)	4.00	4
8. Relative abundance of the stagnophile species (%)	5.11	3
9. Relative abundance of the specialist species (%)	13.62	3
10. Relative abundance of the indigenous species (%)	78.30	2
Total number of scores		**33**
Classification		**moderate**

Table 12.4.4-9: Results of the ecological status assessment on the Sió based on the data from the summer sampling session

Sió autumn	Number of scores	Value
1. Relative abundance of the omnivorous species (%)	65.59	5
2. Relative abundance of the open water species	2.00	3
3. Relative abundance of the metaphyte species (%)	41.94	3
4. Number of benthic species (piece)	9.00	4
5. Number of litophile species (piece)	2.00	3
6. Relative abundance of the phytophile species (%)	37.10	2
7. Number of rheophilic species(piece)	3.00	4
8. Relative abundance of the stagnophile species (%)	22.04	4
9. Relative abundance of the specialist species (%)	5.91	2
10. Relative abundance of the indigenous species (%	79.57	2
Total number of scores		**32**
Classification		**moderate**

Table 12.4.4-10: Results of the ecological status assessment on the Sió based on the data from the autumn sampling session

*Based on the findings of the assessment it can be stated that the ecological status of the assessed lower section of the Sió according to the fish community analysis was **moderate**. On the basis of the analysis it can also be stated that the lower section of the Sió is isolated from the Danube to a larger extent and hence, the Danube has a lower intensity impact on the Sió fish community. The community structural indicators of the Sió lower sections suggest the impact of the anthropogenic pollution of the water course on the fish community (independently of the operation of the power plant).*

Based on the data analysis the cooling water discharged from the Paks Nuclear Power Plant has no effect on the structure of the fish community in the Sió and such impact can not be expected in the course of the erection and operation of the Paks II plant, including potential failure events.

12.4.4.7 Comprehensive ecological status classification of the body of water marked HULWAIH136 named Sió Low according to the WFD

For the purposes of evaluation, basically the fundamental principles included in the ECOSTAT guidance document no. 13. (ECOSTAT 2005: Common Implementation Strategy for the Water Framework Directive (2000/60/EC) were taken into consideration, as well as the domestic national guidance specified in the course of the planning process of the national river basin management plan in 2008.

During the assessment of the water body in accordance with the Water Framework Directive the classification principle of "one bad means all bad" was followed.

Macrophyte classification findings were provided just for your information, their levels were not considered for classification purposes.

HURWAEP959	Physico-chemical properties	Phytoplankton	Phytobenthos	Macrophyte	Macrozoobenthos	Fishes
Northern Dead Danube of Tolna	Does not reach good status	moderate	poor	good	poor	moderate

Table 12.4.4-11: Classification of Sió Low (HURWAEP959) according to the WFD

Based on the evaluation results of the water quality assessment pursuant to the requirements laid down in the WFD carried out in 2013 the ecological status of the water body marked HULWAEH959 was poor.

It can be stated, furthermore, that the discharge from the Paks Nuclear Power Plant has no detectable impact on any of the assessed groups and no such impact can be expected from the construction of Paks II or during the service period which can be characterised by a number of different operating statuses including failure events. At the same time, nutrient exposure of the Sió canal must be reckoned with during the operation period of the Paks II plant when all units operate simultaneously (between 2030 and 2032, as planned), which may reinforce the impact of the hot water discharge indirectly in the area below the mouth, resulting in an ecological status other than the natural one downstream.

12.5 THE IMPACT OF THE ERECTION OF PAKS II ON THE DANUBE

In the course of the environmental impact assessment concerning the impacts of the investment project Paks II – including its erection, operation and abandonment - on the ecological status of the Danube the potential active impact factors, expected impacts, the nature of the impact and the bearers of the effects are identified and evaluated. Additionally, recommendations will be made to suggest measures for the preservation of the ecological status of surface waters.

Based on the assessments made in the Chapters "Base state of the Danube section assessed (1560.6 river km-1481.5 river km)", as well as "The other surface bodies of water in the neighbourhood" it can be stated that even potential impacts of the investment project Paks II will extend to the adjacent surface water bodies – that is fishing ponds of the Paks Nuclear Power Plant (Kondor Lake, Fishing Ponds) (HULWAIH005), Dead Danube of Fadd (HULWAIH066), Northern Dead Danube of Tolna (HULWAIH136), as well as Sió-low (HURWAEP959) – and correspondingly in the impact assessment stage only statements concerning the bodies of water on the Danube potentially effected by Paks discharges (HURWAEP444; HURWAEP445) will be made.

All potential active factors are taken into account which might reasonably emerge with regard to the investment project Paks II. At the same time the evaluation will point out whether or not the active factor will have any actual impact on any of the Danube entities exposed, in other words is it an actual impact factor for the purposes of the Danube ecological status.

In terms of impacts and impact areas, the laws under the relevant applicable Government Decree No (314/2005 (XII. 25.), make a distinction between direct, indirect and transboundary impacts and their respective areas. When direct and indirect impact areas are differentiated, the direct impact area in this document will be understood as the area where the impact in question can be detected or estimated. Indirect impact and impact area are impacts migrating to further areas as a result of a transmission medium. The transmitting medium may be an abiotic environmental element (for instance underground water, soil, air), but a group of living organisms as well (for instance impacts propagating in the food web). The indirect impact area was defined as the area where ecologically evaluable complex aquatic metabolic processes – usually below detection level – might realistically occur at the population level. However, it can be seen quite clearly that the areas of the respective impacts transmitted in living systems by biological processes in fact overlap each other, since for instance the biomass of producer organisms would grow in a given area as the consequence of increased nutrient supply, but the growth of the biomass in the organisms consuming such producers would apparently affect the same area as an indirect impact. Certainly, there might be impact classified as indirect in the course of the biological processes where the area of impact exceeds the size of the direct impact area considerably. A part of these are however processes observed at the level of the individual in a theoretical manner, and, accordingly, not covered by the ecological studies and mainly due to their accidental nature their area can not be estimated on a professional basis. Additionally, such an impact can not be really interpreted under the framework provided by the law. The issue of the invasive species is such an indirect impact. When the impacts are evaluated, the technical data included in the various chapters of the documentation of this environmental impact study are relied upon. The base state assessment of the Danube substantiated with calculations in chapter *12.2.1.2* is given weight. Whenever it was possible, the statements on the determination of impacts were supported by calculations, but additional references from the professional literature and expert judgements/opinions were also used mainly with respect to the biological elements and impact which could not be detected in the base state, since the ecosystem of the Danube under investigation is so complicated, operating as an open and primarily self-regulating mechanism, which does not allow mathematical modelling as part of the impact assessment study due to the lack or uncertainty of the necessary data and algorithms.

The nature of the impact in the impact assessment was determined with the living organisms in the focus (that is, investigating them from the perspective of aquatic organisms) based on the DURABILITY, STRENGTH and SIGNIFICANCE thereof. Based on durability the impact may be **short term** (maximum a couple of months), **mid-term** (maximum three years), **and long term** (longer than three years).

In term of strength – referring to the habitat complex of the impact area in the ecological sense – it might be **poor**, **medium and strong**. And based on the significance which also concerns the habitat complex of the impact area in the ecological and nature conservation perspective, it might have **low**, **medium** and **high importance.** The significant impact referred to in Government Decree No 314/2005. (XII. 25.) on the environmental impact study and the integrated licensing procedure for the utilisation of the environment is equal with the impact of high significance in this sense.

Taking into account the aspects laid down in the WFD wildlife is considered to be the entity exposed to the impacts.

During the impact assessment biological elements relevant with respect to the WFD based status classification are identified as bearers of the impact, irrespective whether or not any impact can be observed on other groups of organisms not denominated in the WFD. This restriction is used because status assessment was made for these taxons in the first place, and therefore actual information is available for these entities, and also because these taxons allow the formulation of a wildlife based evaluation with appropriate depth and complexity as a whole.

It should be noted that although the physical and chemical properties of the water or the Danube water as such is not considered to be a bearer of the impact, they provide essential information for the evaluation of the ecological status.

12.5.1 IMPACT FACTORS DURING THE CONSTRUCTIION PERIOD

- groundwater extracted during groundwater depression
- treated municipal wastewater discharge
- the erection of a recuperation hydropower plant

12.5.1.1 Direct impacts

12.5.1.1.1 Impact of groundwater extracted during groundwater depression

During the construction works of the Paks II units there are several buildings which will be built on deep foundations between 14 and 20 metres, consequently the works have to be carried out below groundwater level. As a result, dewatering is necessary in the work pit during the foundation works. Extracted groundwater is discharged into the cold water canal, passes the cooling circuit and gets into the hot water canal to be discharged finally into the Danube.

The volume of the groundwater to be extracted will be – according to the calculations made by Isotoptech Zrt. in the chapter of the Environmental impact study entitled "*Geological medium and underground water at the site and the immediate neighbourhood*" – 13 000 – 18 000 m^3/day, max: 0.2 m^3/s. Water extracted as part of the dewatering process may contain tritium. Government Decree No 201/2001. (X. 25.) restricts radioactivity in the drinking water on the basis of two criteria. Activity concentration of tritium shall not exceed 100 Bq/dm^3, and the total indicative dose (tritium, potassium-40. radon and radon decomposition products) shall not be any higher than 0.1mSv/year. “Drinking water should not be tested for tritium or radioactivity for the purposes to determine the total indicative dose in the case when the level of tritium according to the calculated indicative dose computed on the basis of another test is far below the limit value.” For this a condition precedent is that total alpha activity and total beta activity must remain below the activity concentration levels of 0.1 Bq/dm^3 and 1 Bq/dm^3, respectively. Isotoptech Zrt. demonstrated by detailed calculations and model studies that taking into account the aggregate impacts of the two power plants the activity concentration levels of both tritium and consolidated other (alpha, beta decay isotopes) substances on the Danube as the receiver medium are below the aforementioned limit values be several orders of magnitude, and hence, have no considerable impact on the Danube.

Nutrient contents of the groundwater originating from the dewatering efforts made in the course of the foundation works and in particular that of nitrogen form is expected to be higher than those of the Danube water, and as a consequence, the wildlife in the cold water canal will be exposed to it. However, as a result of the more than five hundredfold dilution and mixing it can be expected that any impact in addition to the base state would be present on the ecological status of the wildlife in the Danube.

12.5.1.1.2 Impact of treated and purified municipal waste water

Maximum drinking water needs necessary in the construction period of Paks II will be present for a five years period than the first unit is already commissioned and operating and the second unit is being erected at the same time.

Based on the respective estimates concerning the number of workforce for the erection and operation period of Paks II a maximum of strong construction staff consisting of 5 250 persons and for the operation of one unit the presence of 520 persons at the site a day were calculated with. On this basis the maximum amount of drinking water needed will be 646 m^3/day, while the maximum volume of municipal waste water generated will be 95 % of this amount, i.e. 614 m^3/day.

The total capacity of the municipal wastewater treatment structures in the Paks Nuclear Power Plant site is 1 870 m^3/day, of which the plant marked No II refurbished in 2012 is currently operated with a capacity of 1 200 m^3/day, the other one is in reserve.

The average volume of municipal wastewater in the Paks Nuclear Power Plant area is currently ~300 m^3/day, therefore an ~1 570 m^3/day free treatment capacity is safely available.

Thus the design volume of municipal wastewater to be treated is 300 + 614 m^3/day, rounded upwards for the sake of safety: 1000 m^3/day, which can be met by the purification capacity of the structure No II of the waste water treatment plant refurbished in 2012 (1200 m^3/day) in itself.

The own waste water treatment plant of the Paks Nuclear Power Plant is equipped with total oxidation and sewage treatment by sludge activation, and has a nominal capacity of 1870 m^3/day (657 thousand m^3/year).

Purified wastewater is led in a pipeline to the hot water-canal in the section upstream of the energy dissipation/dissipating device and from here it is discharged into the Danube together with the treated industrial wastewater and rainwater, after dilution up to several thousand-fold.

Disposal and monitoring works of the treated municipal wastewater is regulated by the currently effective water rights operating permit held by Paks Nuclear Power Plant Zrt. Water chemistry testing is made on a quarterly basis at the following sites as part of the monitoring efforts.

MF-shaft	Water upstream of the scale
Raw water	Raw wastewater treatment plant
V1	cold water canal
V3	Treated wastewater (I-II T.), at the outlet to the hot water canal
V4	hot water canal energy dissipation device (Danube discharge site)

Monitoring results were summarised in Table 12.5.1-1 on the basis of the data supplied by Paks Nuclear Power Plant Zrt.

It can be seen from the test results that water samples taken from both the treated wastewater and from the sampling site No V4 established at the outlet to the Danube met the limits provided for by Annex No 2 to the Ministerial Decree No 28/2004: (XII. 25.) KvVM.

Komponens/ Mintavételi hely	Dátum	pH	SZOE	BOI5	KOIcr	Össz. lebegő anyag	Ammónium (NH_4^+)	Ammónium -N (NH_4^+-N)	Nitrát (NO_3^-)	Nitrát-N (NO_3^--N)	Nitrit (NO_2^-)	Nitrit-N (NO_2^--N)	Összes szervetlen N
	Határértékek		(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
	(28/2004)	**6.0-9.5**	**10**	**50**	**150**	**200**	**--**	**20**	**-**	**-**	**-**	**20**	**50**
MF-akna	2012.03.21	9.10	0.3	0.0	5	3	43.0	34.0	3.9	0.88	2.06	0.63	36.0
MF-akna	2012.05.14	7.60	0.3	0.0	2	3	5.9	4.6	4.7	1.06	1.80	0.55	6.2
MF-akna	2012.08.15	9.40	0.3	0.0	6	4	7.2	5.6	1.9	0.43	0.05	0.02	6.1
MF-akna	2012.11.06	7.30	0.3	0.0	2	3	1.7	1.4	3.9	0.89	0.27	0.89	2.3
MF-akna	2013.03.20	8.48	5.0	0.0	10	51	6.8	5.3	2.9	1.00	0.38	0.12	5.4
MF-akna	2013.05.15	5.73	5.0	0.0	32	15	5.6	4.3	1.6	1.00	6.53	1.99	6.3
MF-akna	2013.08.14	9.69	5.0	0.0	46	15	12.2	9.5	1.0	1.00	0.10	0.10	9.5
MF-akna	2013.11.06	6.94	5.0	7.0	28	15	0.5	0.5	4.4	1.00	0.05	1.00	9.5
Nyersvíz	2012.03.21	7.80	1.3	136.0	761	359	44.0	34.0	0.0	-	-	-	0.0
Nyersvíz	2012.05.14	7.80	3.1	259.0	734	304	64.3	50.0	0.0	-	-	-	0.0
Nyersvíz	2012.08.15	8.10	1.1	143.0	343	202	36.0	28.0	0.0	-	-	-	0.0
Nyersvíz	2012.11.06	8.00	0.7	92.0	127	126	36.0	28.0	0.0	-	-	-	0.0
Nyersvíz	2013.03.20	7.08	6.8	92.0	90	10	34.1	26.5	0.0	-	-	-	0.0
Nyersvíz	2013.05.15	7.46	5.0	95.0	250	64	51.3	39.9	1.0	1.00	-	-	40.0
Nyersvíz	2013.08.14	7.29	41.0	160.0	530	70	53.8	41.9	1.0	1.00	-	-	42.5
Nyersvíz	2013.11.06	7.09	13.3	73.6	285	55	73.0	56.8	1.0	1.00	-	1.00	56.8
V1	2012.03.01	8.10	0.3	2.4	7	8	0.0	0.0	9.7	2.20	1.50	0.82	3.0
V1	2012.05.14	8.60	0.3	1.1	12	12	0.0	0.0	4.3	1.00	0.04	0.03	1.0
V1	2012.08.14	8.10	0.3	0.7	7	13	0.1	0.0	5.7	1.30	0.03	0.02	1.3
V1	2012.11.06	8.30	0.3	1.2	8	6	0.0	0.0	7.0	1.58	0.03	0.05	1.7
V1	2013.03.20	7.94	5.0	3.0	10	20	0.1	0.1	12.9	2.91	0.05	0.05	2.9
V1	2013.05.15	7.87	5.0	3.0	10	20	0.1	0.1	7.4	1.66	0.05	0.05	1.7
V1	2013.08.14	8.34	5.0	7.3	23	78	0.1	0.1	4.3	0.98	0.05	0.05	1.0
V1	2013.11.06	8.17	5.0	37.0	100	10	0.1	0.1	7.6	1.72	0.05	0.05	1.7
V3	2012.03.21	7.80	2.0	17.0	79	26	14.0	35.0	62.0	14.00	3.33	1.01	43.0
V3	2012.05.14	7.50	2.0	17.0	238	184	20.7	16.1	72.0	16.30	13.40	4.07	36.0
V3	2012.08.15	7.70	3.2	66.0	130	73	16.4	12.7	45.0	10.10	6.46	1.96	25.0
V3	2012.11.06	7.70	0.3	21.0	28	8	11.3	8.8	39.0	8.86	3.54	1.08	18.8
V3	2013.03.20	7.28	5.0	3.0	13	10	0.1	0.1	211.0	47.60	0.56	0.17	47.8
V3	2013.05.15	7.56	5.0	4.2	14	15	0.1	0.1	153.0	34.50	2.93	0.89	35.4
V3	2013.08.14	7.31	5.0	6.0	14	15	0.5	0.5	180.0	40.60	0.78	0.24	40.8
V3	2013.11.06	6.97	5.0	17.4	64	15	11.9	9.3	74.6	16.80	1.00	1.00	26.1
V4	2012.03.01	8.30	0.3	3.0	9	11	0.0	0.0	0.0	-	0.03	0.03	0.0
V4	2012.05.14	8.60	0.3	2.9	19	59	0.0	0.0	0.0	-	0.04	0.03	0.0
V4	2012.08.14	8.20	0.3	0.8	9	27	0.0	0.0	0.0	-	0.04	0.03	0.0
V4	2012.11.06	8.40	0.3	1.4	9	14	0.0	0.0	0.0	-	0.04	0.09	0.0
V4	2013.03.20	7.92	5.0	12.0	34	80	0.0	0.0	0.0	-	0.13	0.10	3.1
V4	2013.05.15	7.86	5.0	4.0	10	82	0.0	0.0	0.0	-	0.05	0.05	1.7
V4	2013.08.14	8.29	5.0	6.4	19	126	0.1	0.1	4.5	-	0.05	0.05	1.0
V4	2013.11.06	8.13	5.0	22.0	70	15	0.1	0.1	7.6	1.72	0.05	0.05	1.7
Nyersvíz	Időszak átla	**7.58**	**9.0**	**131.3**	**390**	**149**	**49.1**	**38.1**	**0.4**	**0.38**	**0.12**	**0.16**	**17.4**
V1	Időszak átla	**8.18**	**2.7**	**7.0**	**22**	**21**	**0.0**	**0.0**	**7.4**	**1.67**	**0.23**	**0.14**	**1.8**
V3	Időszak átla	**7.48**	**3.4**	**19.0**	**72**	**43**	**9.4**	**10.3**	**104.6**	**23.60**	**4.00**	**1.30**	**34.1**
V4	Időszak átla	**8.21**	**2.7**	**6.6**	**22**	**52**	**0.0**	**0.0**	**1.5**	**0.34**	**0.05**	**0.05**	**0.9**

Komponens/ Mintavételi hely	Dátum	Összes N	Összes P	Összes Fe	Összes Mn	Összes Cu	Összes Zn	Összes Pb	Összes Ni	Összes Cr	Összes Ag	Összes Cd	Összes Hg	Fluorid	Összes As	Összes Ba	Összes Co	Összes Mo	Összes Sb	Összes Sn
	Határértékek	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(mg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)
	(28/2004)	**55**	**10**	**20**	**5**	**2000**	**5000**	**200**	**1000**	**1000**	**100**	**50**	**10**	**20**	**500**	**500**	**1000**	**300**	**-**	**500**
MF-akna	2012.03.21	40.0	0.08	0.04	0.01	7.0	5.3	7.0	5.0	6.0	1.5	2.0	8							
MF-akna	2012.05.14	7.6	0.08	0.07	0.01	7.0	3.0	7.0	5.0	6.0	1.5	2.0	8							
MF-akna	2012.08.15	11.0	0.08	0.03	0.01	7.0	3.0	7.0	5.0	6.0	1.5	2.0	8							
MF-akna	2012.11.06	3.0	0.08	0.02	0.01	7.0	8.4	7.0	5.0	6.0	1.5	2.0	8							
MF-akna	2013.03.20	6.8	0.16	0.10	0.01	41.4	36.8	5.0	3.3	5.0	2.0	2.0	0.5							
MF-akna	2013.05.15	6.3	0.20	0.10	0.01	39.9	51.2	5.0	9.3	5.0	18.2	2.2	10							
MF-akna	2013.08.14	11.2	0.20	0.25	0.02	114.0	69.4	5.0	25.1	59.9	10.0	2.0	10							
MF-akna	2013.11.06	2.0	0.20	0.06	0.03	19.6	32.7	5.0	22.5	9.0	10.0	2.0	0.5							
Nyersvíz	2012.03.21	70.0	13.69	0.59	0.03	23.2	835.0	0.0	0.0	0.0	1.5	2.0	8							
Nyersvíz	2012.05.14	82.0	17.04	0.71	0.07	24.1	383.0	0.0	0.0	0.0	1.8	2.0	8							
Nyersvíz	2012.08.15	43.0	10.78	0.42	0.02	16.3	137.0	0.0	0.0	0.0	1.5	2.0	8							
Nyersvíz	2012.11.06	50.0	5.56	0.34	0.07	9.0	77.4	7.0	0.0	0.0	1.5	2.0	8							
Nyersvíz	2013.03.20	39.8	4.61	0.33	0.03	35.3	148.0	7.0	0.0	0.0	2.0	2.0	0.5							
Nyersvíz	2013.05.15	40.0	6.90	2.11	0.04	63.9	236.0	0.0	0.0	0.0	12.4	2.8	10							
Nyersvíz	2013.08.14	56.1	9.88	1.53	0.10	167.0	342.0	0.0	0.0	0.0	10.0	2.1	10							
Nyersvíz	2013.11.06	61.8	6.36	0.61	0.04	52.6	145.0	0.0	0.0	0.0	10.0	2.0	0.5							
V1	2012.03.01	4.2	0.08	0.10	0.05	7.0	3.4	7.0	5.0	6.0	1.5	2.0	8	0.10	10	28.8	5.0	4.0	15.0	56.8
V1	2012.05.14	1.1	0.08	0.11	0.03	7.0	3.0	7.0	5.0	6.0	1.5	2.0	8	0.10	10	21.2	5.0	4.0	15.0	10.0
V1	2012.08.14	1.6	0.08	0.16	0.02	7.0	3.0	7.0	5.0	6.0	1.5	2.0	8	0.18	10	23.4	5.0	4.0	15.0	10.0
V1	2012.11.06	2.5	0.08	0.10	0.03	7.0	3.0	7.0	5.0	6.0	1.5	2.0	8	0.13	10	29.5	5.0	4.0	15.0	10.0
V1	2013.03.20	3.5	0.07	0.57	0.02	21.0	48.6	8.3	6.4	5.0	2.0	2.0	0.05	0.07	5	32.7	5.0	5.0	6.1	186.0
V1	2013.05.15	1.7	0.09	2.38	0.06	80.4	49.9	5.0	6.7	15.4	2.0	2.0	0.05	0.08	5	38.9	5.0	5.0	5.0	5.7
V1	2013.08.14	1.3	0.05	0.79	0.06	72.3	74.4	5.0	13.1	18.7	2.0	2.0	0.5	0.09	5	41.1	5.0	5.0	5.0	207.0
V1	2013.11.06	1.9	0.10	0.29	0.02	26.8	28.8	5.0	5.0	9.1	2.0	2.0	0.5	0.11	5	31.2	5.0	5.0	5.0	311.0
V3	2012.03.21	48.0	7.14	0.15	0.02	7.0	40.4	7.0	5.0	6.0	1.5	2.0	8							
V3	2012.05.14	39.0	8.02	0.34	0.04	7.0	3.0	7.0	5.0	6.0	1.5	2.0	8							
V3	2012.08.15	33.0	6.87	0.28	0.02	10.9	81.4	7.0	6.1	6.0	1.5	2.0	8							
V3	2012.11.06	21.0	2.64	0.18	0.04	7.0	11.7	7.0	5.0	6.0	1.5	2.0	8							
V3	2013.03.20	47.6	2.22	0.15	0.01	50.9	72.3	5.0	11.3	5.0	2.0	2.0	0.5							
V3	2013.05.15	35.7	6.01	0.39	0.03	28.9	48.5	5.0	10.7	5.1	10.0	2.0	10							
V3	2013.08.14	41.4	3.10	0.45	0.03	92.0	89.4	5.0	17.0	151.0	10.0	2.0	10							
V3	2013.11.06	26.6	24.80	0.31	0.03	35.0	61.2	5.0	5.0	9.2	10.0	2.0	0.5							
V4	2012.03.01	2.9	0.08	0.13	0.02	7.0	7.7	7.0	5.0	6.0	1.5	2.0	8	0.11	10	29.4	5.0	4.0	15.0	10.6
V4	2012.05.14	2.1	0.08	0.48	0.11	7.0	3.0	7.0	5.0	6.0	1.5	2.0	8	0.10	10	25.7	5.0	4.0	15.0	10.0
V4	2012.08.14	1.1	0.08	0.31	0.03	7.0	3.0	7.0	5.0	6.0	1.5	2.0	8	0.15	10	24.2	5.0	4.0	15.0	10.0
V4	2012.11.06	3.3	0.08	0.21	0.02	7.0	3.0	7.0	5.0	6.0	1.5	2.0	8	0.12	10	30.8	5.0	4.0	15.0	10.0
V4	2013.03.20	4.4	0.11	0.42	0.02	48.4	37.8	5.0	6.7	6.0	2.0	2.0	0.5	0.07	5	32.5	5.0	5.2	5.0	207.0
V4	2013.05.15	1.9	0.10	4.60	0.12	63.5	37.8	5.0	9.2	8.4	3.0	2.0	0.5	0.08	8	50.5	5.0	5.0	5.0	20.7
V4	2013.08.14	1.5	0.10	0.73	0.04	19.8	32.3	5.0	5.0	14.9	8.7	2.0	0.5	0.09	5	33.0	5.0	5.0	5.0	212.0
V4	2013.11.06	1.8	0.10	0.29	0.02	29.1	36.0	5.0	5.0	9.6	2.0	2.0	0.5	0.09	5	31.0	5.0	5.0	5.0	295.0
Nyersvíz	Időszak átla	**55.3**	**9.35**	**0.83**	**0.05**	**48.9**	**287.9**	**1.8**			**5.1**	**2.1**	**6.63**							
V1	Időszak átla	**2.2**	**0.08**	**0.56**	**0.04**	**28.6**	**26.8**	**6.4**	**6.4**	**9.0**	**1.8**	**2.0**	**4.14**	**0.11**	**8**	**30.9**	**5.0**	**4.5**	**10.1**	**99.6**
V3	Időszak átla	**36.5**	**7.60**	**0.28**	**0.03**	**29.8**	**51.0**	**6.0**	**8.1**	**24.3**	**4.8**	**2.0**	**6.63**							
V4	Időszak átla	**2.4**	**0.09**	**0.90**	**0.05**	**23.6**	**20.1**	**6.0**	**5.7**	**7.9**	**2.7**	**2.0**	**4.25**	**0.10**	**8**	**32.1**	**5.0**	**4.5**	**10.0**	**96.9**

Komponens/mintavételi hely – component/sampling point
akna – pit
nyersvíz – raw water
időszak átlag – average during the period
dátum – date
össz. lebegő anyag – total floating materials
összes szervetlen – total inorganic
összes – total

Figures underlined in the table correspond to the sign less than (<) (values below the detection limit).

Table 12.5.1-1: Water chemistry test results of 2012 and 2013 from the monitoring system of the treated municipal wastewater disposal at Paks Nuclear Power Plant

Modelling of the discharged municipal wastewater mixing with Danube water was dealt with by VITUKI Hungary Kft. in the Chapter entitled "*Modelling the Danube river morphology and Danube heat loads*".

During the calculations made with the help of the 2D analytical mixing model the concentration of the elements characterising water quality was determined on the basis of the highest wastewater discharge levels measured in the past two years at the sampling site V4 set up in the energy dissipation device of the hot water canal mouth defined in the Water rights operating permit No 917-20/2009-9992 as the official sampling point. The distance between the outlet point and the measurement profile was taken as 50 m. The results of the calculation are shown in Table 12.5.1-2:

Pollutant	Unit of measurement	Limit value	Calculated concentration in V4 profile
Dichromate oxygen consumption COD_k	mg/l	150	7.15
Biochemical oxygen demand BOD_5	mg/l	50	1.98
Organic solvent extract	mg/l	10	0.30
Total nitrogen N_{total}	mg/l	55	1.44
Total phosphorus P_{total}	mg/l	10	0.75
Ammonia-ammonium nitrogen	mg/l	20	1.05
Total iron	mg/l	20	0.010
Total copper	mg/l	2	0.000
Total manganese	mg/l	5	0.000
Total silver	mg/l	0.1	0.000
Total mercury	mg/l	0.01	0.000
Total zinc	mg/l	5	0.000
Total cadmium	mg/l	0.05	0.000

Table 12.5.1-2: Calculated concentration increments in case of standard operation at the V4 profile

You can clearly see from the outcome of the modelling session that the concentration for each element is substantially lower that that defined in the operating license held by Paks Nuclear Power Plant. For the purposes of water quality the decisive quality parameters in water include dichromatic oxygen consumption (COD_k) and ammonia-ammonium.

The calculation made for the **extreme low water level** on the Danube recurrent in every 20 000 years, 579 m^3/s provided the results listed in Table 12.5.1-3. Calculated concentration increment(s) is (are) applicable not on the entire cross profile, only within the body of Danube water measured as an approximately 25 m wide section from the Danube right bank (toward the inner side).

Distance from the inlet site downstream (m)	Danube rate of flow 579 m^3/s (extreme low water level on the Danube recurrent in every 20 000 years) Calculated maximum pollutant concentration increase (Danube right bank)					
	COD_K (mg/l)	BOD_5 (mg/l)	SZOE (mg/l)	Total nitrogen (mg/l)	Total phosphorus (mg/l)	Ammonia-ammonium (mg/l)
1	0.61	0.17	0.03	0.12	0.06	0.09
10	0.19	0.05	0.01	0.04	0.02	0.03
20	0.14	0.04	0.01	0.03	0.01	0.02
50	0.09	0.02	0.00	0.02	0.01	0.01
100	0.06	0.02	0.00	0.01	0.01	0.01
200	0.04	0.01	0.00	0.01	0.00	0.01
500	*0.03*	*0.01*	*0.00*	*0.01*	*0.00*	*0.00*
1000	0.02	0.01	0.00	0.00	0.00	0.00
1500	0.02	0.00	0.00	0.00	0.00	0.00
2000	0.01	0.00	0.00	0.00	0.00	0.00
2500	0.01	0.00	0.00	0.00	0.00	0.00
3000	0.01	0.00	0.00	0.00	0.00	0.00
3450	0.01	0.00	0.00	0.00	0.00	0.00
5000	0.01	0.00	0.00	0.00	0.00	0.00

Table 12.5.1-3: Calculated longitudinal concentration increment in case of standard operating mode, Danube rate of flow 579 m^3/s (extreme low water level on the Danube recurrent in every 20 000 years)

A 0.03 mg/l COD_k concentration increment can be expected at the reference profile situated in a distance of approximately 500 m from the mouth of the hot water canal to the Danube, which is negligible.

Taking the concentration increments of the pollutant parameters included in the table into account it can be stated that they remain below the detection limit values laid down in the Hungarian standards used for their identification.

Ministerial Decree No.10/2010. (VIII. 18.) VM on the limit values applicable to the contamination of surface waters and laying the rules for the application thereof provides for the physico-chemical water quality classification of the body of water on the Danube concerned based on the average levels of the physico-chemical components measured at the monitoring points of the water quality Core Network. Therefore the assessment of the mixing of the purified wastewater should be made under **average rates of flow on the Danube** (annual mean rate of flow). Having regard to the fact that even in the case of extremely low rate of flow on the Danube (except a very small body of Danube water) no material change can be detected in the physico-chemical elements exceeding the background contamination levels of the Danube (implying for instance a quantum leap in water quality classes), the potential changes in the case of average rate of flow on the Danube can be seen as still lower.

Based on the mixing tests it can be stated that no changes in the quality grade of the water can be anticipated compared to the average concentration measured by the FEVI database: Danube, Dunaföldvár Core Network profile in 2006-2011, the mixed treated wastewater discharge does not cause any impairment in water quality grades.

The concentration and composition of the residual nutrients in the treated wastewater is expected to exceed that of the Danube in a slight extent, and deviated from that typical for the Danube naturally, respectively. The large scale, approximately nine thousand fold dilution taking place in the hot water canal and the natural purification process experienced in the course of the blending phase decreases this impact even further. Due to this fact the purified wastewater discharge will have no detectable impact on the ecological structure of the aquatic organisms in the Danube. Taking the discharge volume into account the hydrological impact of the discharge will not be detected, either (Paks Nuclear Power Plant hot water discharge=100 m^3/s, treated wastewater discharge=0.012 m^3/s). On this basis the impact of the treated wastewater represents a long term impact throughout the approximately 10 years long construction phase, but it will have a low and low significance intervention, highlighting the fact that it will not have any detectable impact on the wildlife of the receiver Danube.

Continuous monitoring of the discharge from the wastewater treatment plant is recommended to be continued in the future in accordance with the terms and conditions included in the water rights operating license held by Paks Nuclear Power Plant.

12.5.1.1.3 The construction of the recuperation hydropower plant

The erection of Paks II is accompanied by the establishment of a recuperation hydropower plant, therefore it was included as an active impact in the impact matrix, but it is an activity subject to an environmental impact study and water rights establishment permit itself, therefore no further assessment will be made with respect to it in this document.

12.5.1.2 Indirect impacts

The Danube will not be exposed to indirect impacts through abiotic environmental elements except at the site, because the groundwater will not leave the site underground due to the prevailing flow conditions there. Thus no indirect impact will influence the ecological, physical and chemical status of the live watercourse of the Danube.

The amount of radioactive materials transported to the Danube by the groundwater flow is negligible compared to the liquid discharges and the same can be said of the impact of dewatering. Conventional pollutants may leak onto the ground or in the unsaturated zone only in case of a failure event. They may leach out or infiltrate directly into the groundwater and from there into the Danube. However, since the migration time between the site and the river falls within the 10 to 20 years range even in the case of tritium which flows with the groundwater directly, there is sufficient time available for the management and clean up of eventual pollution incidents before the pollutants escaped would have reached the Danube.

Consumer organisms appearing to feed on the plankton communities of living organisms with growing biomass as a result of the increased nutrient levels may be mentioned as an indirect impact transmitted by the ecological communities. Yet the territorial scope of this impact which can be interpreted at the supra-individual organisation level does not differ from the territorial scope of the direct impact area.

12.5.1.3 Transbounday environmental impacts

No transboundary environmental impacts can be expected in the period of construction of Paks II which would affect the Danube or modify the ecological structure of the Danube wildlife.

12.5.2 IMPACT FACTORS OF OPERATING TRUBLES AND FAILURES DURING THE CONSTRUCTIION PERIOD

- damage to the Diesel oil tank during construction
- failure type operating trouble of the municipal waste water treatment plant

12.5.2.1 Direct impact of operating troubles and failures on the Danube

12.5.2.1.1 Damage to the Diesel oil tank during construction

Any pollutants may leak onto the ground or in the unsaturated zone only in case of a failure event. They may leach out or infiltrate directly into the groundwater and from there into the Danube.

Migration of pollutant emissions occurring eventually at the site and the consequences of such incidents were investigated by Isotoptech Zrt. in the chapter of this Environmental impact study entitled "*Geological medium and underground water at the site and the immediate neighbourhood*". As a summary of this study it can be established that the migration time between the site and the river falls within the 10 to 20 years range.

Through instant local containment of the spilled oil in the event of eventual damage to the Diesel oil tank used during the power plant erection it can be ensured that the pollutants escaped never reached the Danube.

Potential failure events occurring at the time of construction in the construction site represent no risk to the surface waters.

12.5.2.1.1 Failure type operating trouble of the municipal waste water treatment plant

The potential failure event during the construction period from the perspective of the Danube is when the municipal wastewater generated is released into the Danube as a result of the breakdown of the municipal wastewater treatment plant.

The modelling of the failure event was made for the **extreme low water level** on the Danube recurrent in every 20 000 years, 579 m³/s and 1000 m³/day municipal wastewater volumes, taking the highest concentration of the discharged raw wastewater measured in the last two years as the applicable concentration.

Maximum concentration increments developing along the longitudinal profile are shown on Table 12.6.2-1.

Distance from the inlet site downstream (m)	Danube rate of flow 579 m³/s (extreme low water level on the Danube recurrent in every 20 000 years) Calculated maximum pollutant concentration increase (Danube right bank)					
	COD_K (mg/l)	BOD_5 (mg/l)	SZOE (mg/l)	Ammonia-ammonium (mg/l)	Total nitrogen (mg/l)	Total phosphorus (mg/l)
1	27.70	9.43	1.49	2.07	2.98	0.62
10	8.76	2.98	0.47	0.65	0.94	0.20
20	6.19	2.11	0.33	0.46	0.67	0.14
50	3.92	1.33	0.21	0.29	0.42	0.09
100	2.77	0.94	0.15	0.21	0.30	0.06
200	1.96	0.67	0.11	0.15	0.21	0.04
500	*1.24*	*0.42*	*0.07*	*0.09*	*0.13*	*0.03*
1000	0.88	0.30	0.05	0.07	0.09	0.02
1500	0.72	0.24	0.04	0.05	0.08	0.02
2000	0.62	0.21	0.03	0.05	0.07	0.01
2500	0.55	0.19	0.03	0.04	0.06	0.01
3000	0.51	0.17	0.03	0.04	0.05	0.01
3450	0.47	0.16	0.03	0.04	0.05	0.01
5000	0.39	0.13	0.02	0.03	0.04	0.01

Table 12.5.2-1: Increments of longitudinal concentration in case of failure events, Danube rate of flow 579 m³/s

It should be noted that nitrate concentration in the untreated wastewater is practically zero, therefore it has no impact on the water quality status of the body of water in the Danube in the event when untreated loads are discharged due to of failure events.

Water quality parameters are impaired in the environment along the right bank strip of the Danube water body by failure event discharge situations of untreated wastewater only for a limited period of time in terms of time, the negative impact will be eliminated as soon as the operating troubles of the waste water treatment plant are corrected.

Breakdown of the wastewater treatment plant during the construction period may represent a realistic threat to the wildlife in the Danube. Provided the approximately 1000 m^3/day municipal wastewater generated during the construction phase is discharged into the hot water canal and later the Danube untreated, this will represent a higher nutrient concentration as well as increased levels of suspended loads and turbidity in comparison to those during normal operation. Having regard to the approximately nine thousand dilution in the hot water canal and an addition dilution factor of an additional approximately ten thousand fold dilution in the Danube even in case of the critical low water stages, any untreated wastewater exposure might not have more serious than a slight, sub lethal impact on the Danube wildlife. Phytoplankton biomass will have an augmented level in the plume of the contamination water. In principle the biomass of fishes may be increased in the plume. As a result of the contamination species less sensitive to organic nutrient loads may appear in greater numbers on a temporary basis among the organisms of the phytobenthos in the proximity of the discharge site as a result of the contamination. Species in the macrozoobenthos will react to increasing nutrient loads partly by avoidance and partly by an increase in the number of individuals, pending on their tolerance against declining oxygen levels. However, due to the dilution effect the lethal threshold is not reached by the untreated wastewater discharge for macrozoobenthos organisms, either. Untreated wastewater causes rather avoidance by more sensitive fish species in the discharge area while other species tolerant against nutrients may even appear in higher numbers of individuals. For reasons of the great difference in the volumes of the wastewater generated and the cooling water discharged only local impacts can be reckoned with even in this case. Correspondingly, the impact is short term, medium strength and low significance. Yet, the setup of a buffer capacity in the wastewater treatment plant may be recommended which allows the prevention of direct discharge.

12.5.3 IMPACT AREAS OF CONSTRUCTION

12.5.3.1 Direct impact area

Groundwater from the dewatering efforts containing tritium and the discharge of treated municipal wastewater will have no detectable impact on the Danube wildlife under normal operating conditions.

Failure type operating trouble of the municipal waste water treatment plant might have an estimated direct impact area up to a distance of 500 m.

12.5.3.2 Indirect impact area

No contamination sources leached out from the groundwater and originating from the construction and erection operations should be reckoned with, no indirect impact in this context will occur.

12.5.3.3 Transboundary environmental impacts

In the construction period of Paks II no transboundary environmental impacts affecting the Danube or damaging the ecological structure of the Danube wildlife can be expected and hence, no such impact area can be defined.

12.5.4 Comprehensive impact matrix for the construction of Paks II

Potential impact factor estimates were summarised in an impact matrix. Expected actual Danube impact factors were highlighted in colours.

Impact factor	Impact	Impact area	Impact nature	Impact bearer	Suggested measures, notes
Standard operation					
Groundwater discharge originating from the dewatering of the work pit (13 000 – 18 000 m^3/day - max: 0.2 m^3/s):	▪slight increase of suspended sediment contents ▪ slight increase of turbidity ▪ slight increase of nutrient contents (primarily nitrogen forms)	direct: <500m indirect: <500m transboundary: none	short term, poor, low significance	phytoplankton living in the cold water canal, phytobenthos, MZB, fishes	no impact on Danube wildlife in case of the proposed discharge into the cold water canal
Treated municipal wastewater (max. 1000 m^3/day - 0.012 m^3/s):	▪ slight increase of nutrient contents	direct: <50m indirect: <50m transboundary: none	long term, poor, low significance	phytoplankton living in the hot water canal, phytobenthos, MZB, fishes	no detectable impact on Danube in case of the proposed discharge into the hot water canal monitoring of the treated wastewater discharged is recommended
Construction of the recuperation power plant:	disturbance of the riparian wildlife	direct: construction site indirect: <250m transboundary: none	short term, poor, low significance	macrophyte, MZB, fishes	Proposed duration and time of the interventions in the Danube channel bottom: between June 15. – March 15
Operating troubles and failure events encountered during the erection phase					
Damage to the diesel tank during construction	no impact on surface waters should be reckoned with	direct: surrounding of the tank indirect: within the industrial site transboundary: none			
Failure event type fault of the municipal wastewater treatment plant	increase of nutrient contents increase of suspended sediment contents increase of turbidity	direct: <500m* indirect: none transboundary: none	short term, medium strength, low significance	phytoplankton, phytobenthos, MZB, fishes	local impact may be expected on Danube wildlife in case of discharge into the hot water canal; Buffer capacity is suggested to prevent direct discharge

Note:
Expected actually effective impact factors on the Danube highlighted in orange colour.
* the impact distance calculated from the discharge point into the Danube was recorded

Table 12.5.4-1: The impact of the construction works at Paks II on Danube wildlife, summary table

12.6 THE IMPACT OF THE OPERATION OF PAKS II ON THE DANUBE

12.6.1 STANDARD OPERATION

12.6.1.1 Impact factors in the period of standard operation

- Water extraction from the Danube
- Discharge of warmed up cooling water into the Danube
- Discharge of purified process waste water
- Discharge of purified municipal wastewater
- Discharge of purified rainwater into the Danube

12.6.1.1.1 Water extraction from the Danube

Water is extracted from the Danube through the cold water canal in order to provide cooling water for the power plant. The water volumes extracted are identical with the volume of hot water returned through the hot water canal.

In the current operating state of Paks Nuclear Power Plant this level is 25 m^3/s for each unit, representing at the time being a total of 100 m^3/s, while for the newly constructed units this value is expected to be 66 m^3/s for each unit. Water extraction will have any impact on the rate of flow in the Danube only between the cold water canal and the hot water canal. The maximum amount of 132 m^3/s water extracted even in case of low flow rates on the river does not represent any material intervention in this section.

In the chapter entitled “Modelling Danube river morphology and Danube heat loads” river morphology impacts were presented in details, which have a negligible impact on the physico-chemical and ecological ranking of the water.

12.6.1.1.2 Discharge of warmed up cooling water into the Danube

Beside electric power generation of the new nuclear power plant units thermal power which can not be utilised will also be generated both in the primary and secondary circuits. The cooling systems of the proposed new nuclear power plant units can be divided up into three main parts:

- condenser cooling water
- process cooling water
- backup cooling water

Condenser and process technology cooling water serves the supply of equipment in the secondary cooling circuit, while backup cooling water provides cool water to certain consumers in the primary circuit. Condensers need a total of 132 m^3/s cooling water volume in the units of Paks II. The water requirement of both technology and backup water system is 2.4 m^3/s. Maximum water needs for the backup cooling water system is not expected to exceed the level of 2.75 m^3/s. For the purposes of heat loads the condenser cooling water volumes represent the dominant factor.

In Table 12.6.1-1 and Table 12.6.1-2 quantitative values of hot water associated with the existing and expected future operating states were summarised.

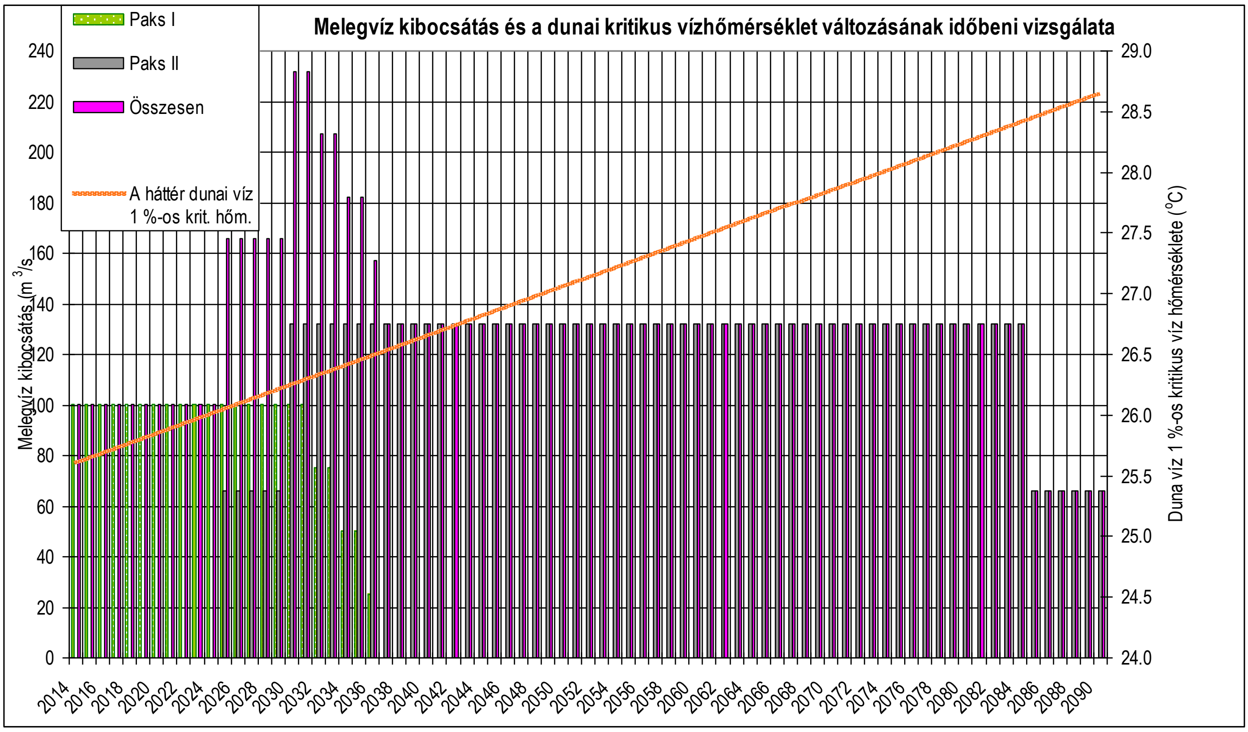
Current and proposed operation of Paks Nuclear Power Plant			
Δt=8-12 °C in a distance of 500 m from the discharge point - 30 °C Cooling water volume per unit is 25m^3/s			
Start	End	Number of unit	Discharged hot water
year	year	piece	m^3/s
2014	2032	4	100
2032	2034	3	75
2034	2036	2	50
2036	2037	1	25

Table 12.6.1-1: Paks Nuclear Power Plant hot water discharge

Paks II proposed operation			
Δt=8 °C in a distance of 0 m from the discharge point 33 oC Amount of cooling water per unit is 66 m^3/s			
Start	End	Number of unit	Discharged hot water
year	year	piece	m^3/s
2025	2030	1	66
2030	2085	2	132
2085	2090	1	66

Table 12.6.1-2: Discharges of hot water from Paks Nuclear Power Plant and Paks II

The quantitative figures of hot water discharge and natural temperature changes on the Danube are seen on the graph of Figure 12.6.1-1. (This data set does not include the Δt increase of Danube water caused by the hot water inlet.) When the Δt water temperature levels are assigned to various operation scenarios the desired Core Network water sampling sites were used for graphic data supply.



Legend:
Melegvíz kibocsátás - Hot water discharge,
Dunavíz 1%-os kritikus víz hőmérséklete - Danube water 1% critical temperature,
Összesen - total
háttér dunai víz 1 %-os kritikus hőmérséklete – 1% critical temperature of the background Danube River water

Figure 12.6.1-1: Hot water discharge and assessment of critical water temperature changes over time in the Danube

ASSESSMENT OF THE HEAT LOAD STATUSES IN THE CASE THE PROPOSED DEVELOPMENT PROJECT IS IMPLEMENTED

Modelling of the hot water mixing discharged into the Danube with the water in the Danube is set forth in details in the chapter entitled *"Modelling Danube river morphology and Danube heat loads"* of this Environmental Impact Study.

The schedule of the operation in Paks Nuclear Power Plant and in the proposed development project is summarised in Table 12.6.1-3.

Period [years]	Maximum hot water volume [m³/s]	Number of units in operation [piece]	Design dates [year]	Estimated highest annual water temperature on the Danube [°C]
2014. (present)	100	Paks Nuclear Power Plant 4 existing unit	2014	25.61 [°C]
2014 – 2025	100	Paks Nuclear Power Plant 4 existing unit		
2025 – 2030	166	Paks Nuclear Power Plant 4 existing unit + Paks II 1 new unit		
2030 – 2032	232	Paks Nuclear Power Plant 4 existing unit + Paks II 2 new unit	2032	26.38 [°C]
2032 – 2034	207	Paks Nuclear Power Plant 3 existing unit + Paks II 2 unit		
2034 – 2036	182	Paks Nuclear Power Plant 2 existing unit + Paks II 2 unit		
2036 – 2037	157	Paks Nuclear Power Plant 1 existing unit + Paks II 2 unit		
2037 – 2085	132	Paks II 2 unit	2085	28.64 [°C]
2085 – 2090	66	Paks II 1 unit		
2090	0	-		

Table 12.6.1-3: *Trends in hot water discharge (Q m³/s) in case Paks II is implemented, when the expected highest water temperature (T_{Danube}, °C) on the Danube is considered in design operating states*

The starting point of the line projected for maximum water temperature in the Danube profile at the power plant is in 2014 with a starting value of 25.61 °C, and the slope of its linear trend is the represented by the 0.04 °C/year obtained from the climate change models, extended up to 2120.

Mixing states critical for heat loads (which take into account the highest possible temperature which may occur as a consequence of the climate change) may be characterised by the following parameters:

Design state in 2014

- background temperature of the Danube (T_{Danube}) T_{Danube} = 25.61 °C,
- Cooling water discharge of Paks Nuclear Power Plant (q) 100 m³/s,
- warmed up cooling water is discharged into the Danube at the current outlet,
- temperature of the warmed up cooling water at the outlet site
  - (i) ($T_{hot\ water}$)=33 °C
  - (ii) 8 °C heat gradient inlet ($T_{hot\ water}$=T_{Danube}+8 °C = 33.61 °C)

Design state in 2032

- T_{Danube} = 26.38 °C,
- Due to the simultaneous operation of both Paks Nuclear Power Plant and Paks II hot water is discharged into the Danube at the current discharge outlet site with $q_{current}$=100 m³/s and with q_{future} =132 m³/s at the future discharge outlet site proposed to be located on the upstream side of the current outlet site through recuperation structure
- temperature of the warmed up cooling water at the outlet site
  - (i) $T_{hot\ water}$ = 33 °C,
  - (ii) $T_{hot\ water}$ = 34.38 °C,

Design state in 2085

- T_{Danube} = 28.64 °C,
- q_{future} = 132 m³/s at the future discharge outlet site proposed to be located on the upstream side of the current outlet site through recuperation structure
- temperature of the warmed up cooling water at the outlet site
  (i) $T_{hot\ water}$ = 33 °C,
  (ii) $T_{hot\ water}$ = 36.64 °C.

12.6.1.1.3 Discharge of purified process waste water

Radioactive waste water generated during normal operation is collected, processed, stored and disposed of by the waste water system of the primary circuit. This system receives potentially radioactive wastewater from the systems in the turbine house. Liquid state radioactive water is mostly returned to the appropriate technology process of the primary circuit after the necessary cleaning and decontamination operations are completed. Radioactive wastewater which can not be returned to the technology process is passed through a purification line where the waste water is deprived of the active contaminants and then the chemicals applied are separated and neutralised. The treated wastewater with controlled radionuclide concentration levels obtained from the treatment and decontamination of the radioactive wastewater is discharged from the wastewater system of the primary circuit into the hot water canal after passing a control tank through a controlled discharge line. The expected maximum amount of radioactive wastewater for the two units is 10 m³/h.

Wastewater from the turbine engineering room and of the auxiliary facilities is collected and processed by the waste water treatment plant of the turbine engineering room. This system handles only non radioactive wastewater. Wastewater flows from the turbine engine compartment are processed by various purification processes in different subsystems, but are finally discharged into the hot water canal. In standard operating conditions their volume for the two units is 40 m³/h.

12.6.1.1.4 Discharge of purified municipal waste water

After the commissioning of the second unit, following the year of 2030 the construction staff will not be present at the site any more.

For the operation of one unit the presence of 520 persons at the site a day were calculated with. Upon the commissioning of the second unit a total of 680 persons will be needed on a daily basis for the simultaneous operation of the two units. Maintenance crew is not included in the operating number of staff having regard to the current practice when a significant ratio of this task is outsourced.

Additional requirement of workforce for overhaul of each of the units expected to happen in every 10 years ranges up to 680 persons in addition to the operating staff.

For operation of the two new units an approximate number of 4000 persons will be needed, representing ~320 m³/s increase in discharges, in other words the volume of municipal wastewater discharge up to 2032 will be 1620 m³/s. After 2032 the four existing units will gradually shut down and therefore the loads will be decreased. This might only be modified by the staff requirements of dismantling works, which is not any grater than the requirement for construction, thus the capacity of the waste water treatment plant will meet the needs.

Direct receiver of the treated municipal wastewater is the hot water canal, where from it is led into the Danube, together with cooling water, purified industrial waste water, and rainwater.

Modelling of the discharged municipal wastewater mixing with Danube water was dealt with by VITUKI Hungary Kft. in the Chapter entitled "*Modelling the Danube river morphology and Danube heat loads*". Based on this modelling efforts the changes of pollutant concentration mixing calculated for extreme low water levels on the Danube in the case of normal operating mode of the waste water treatment plant were presented in the subchapter No 12.5.1.1.2 in accordance with the detailed discharge data of wastewater.

It can be seen from the modelling results that the concentration of all elements was substantially lower than the limits provided for in the operating license of Paks Nuclear Power Plant by Annex No 2 to the Ministerial Decree No 28/2004: (XII. 25.) KvVM.

12.6.1.1.5 Drainage of purified rainwater

Flow conditions in the regions mandate that for a great part of the year the Danube drains on groundwater bodies and hence, the natural receiver of precipitation fallen in the area is the Danube. Rainwater fallen onto the plant site is collected by the northern and southern intercepting ditches where from it is transferred into the cold water canal on the north and the hot water canal in the south.

12.6.1.2 Evaluation of the impacts on surface waters according to the Water Framework Directive (WFD)

Based on the identification scheme of the Hungarian river basin management plan (VGT) the following surface bodies of water can be found within the 30 km district of the Paks Nuclear Power Plant: Danube (HURWAEP444), Danubekömlődi-canal and tributaries (HURWAEP447), Csámpa-streamlet (HURWAEP869), Paks-Fadd main canal (HURWAEP868), Györköny-Bikácsi-watercourse (HURWAEP549), Éri-streamlet (HURWAEP463), Dead Danube of Fadd (HULWAIH066), Northern Dead Danube of Tolna (HULWAIH136), and the fishing ponds of the Paks Angler Association (Kondor Lake, Fishing Ponds) (HULWAIH005), Sió-Low (HURWAEP959), Fűzvölgyi- and Szelidi-Lake canals (HURWAEP497), Szelidi-Lake (HU_LW_AIH128), Csorna-Foktő-canal (HURWAEP398), Sárközi-I main canal (HURWAEP943). Of all the surface water listed, the Danube, the Kondor Lake, the Fishing Ponds, Dead Danube of Fadd, Northern Dead Danube of Tolna, and the Sió-channel was subjected to detailed water quality and ecological studies as part of the programme in 2012 and 2013, and the results obtained with regard to their respective base states were summarised in Chapters 12.3 and 12.4

Potential impacts of the operation of the new units on the ecological system of the Danube:

(1) heat load of the cooling water discharged,

(2) hydrological impact of the waters discharged,

(3) toxic impact of the residual chemicals and oil exposure from the treated industrial wastewater and rainwater, as well as

(4) impact of nutrient loads from municipal wastewater.

The Danube has not directly connected to the surface waters found in the surrounding areas -- Dead Danube of Fadd, Tolnai-Holt-Danube, Kondor Lake and Fishing Ponds – and this is the reason why any impact from the cooling water and wastewater discharge from the Paks Nuclear Power Plant can not be demonstrated.

The downstream section of the Sió-channel gets in direct connection with the living water flow of the Danube in case of high water stages at the Danube, but the findings of the studies suggested that a much more intensive impact should be reckoned with on the Danube wildlife from the nutrient loads the Sió is exposed to.

Based on the facts outlined above, only the potential effects on the Danube are analysed below.

12.6.1.2.1 Direct impacts on the physical and chemical status of the Danube

The findings of the water temperature modelling conducted by VITUKI Hungary Kft. and set forth in details in the chapter entitled "*Discharge of warmed up cooling water into the Danube*" of this Environmental Impact Study were handled as input parameters for the purposes of assessing the impacts in the surface waters.

The impact of the warmed up cooling water

Environmental impacts of the cooling water returned into the Danube, issues related to the heat loads caused and heat contamination potentially representing an adverse change in the water quality are continuously dealt with ever since the commissioning of Paks Nuclear Power Plant. The statements can be summarised as follows:

- The maximum water temperature of the Danube water indicative with respect to the heat loads, it is exposed to, is usually 21-24 °C in summer, or exceptionally it reaches a level above 25 °C. The time series of water temperature are typical, the well-established season of maximum levels lasts from the beginning of July up to the end of August, as presented on Figure 12.2.1-3

- The annual course of the Danube rate of flow (volume flow) is less regular, yet it is clear that the low water stages representing the heat load maximum periods of the river occur in the autumn and winter seasons with the greatest degree of probability;
- A typical feature of the Danube reducing the risk rate of heat loads is that high water temperature levels occur exclusively in July and August, while low water levels approaching the 1000 m³/s volume are encountered mostly only from September on.

This statistically substantiated probability scenario was modified by the dry and warm summer weather conditions in the years between 1992 and 2003, because the water temperature varied between 20 – 26 ⁰C in July and August.

All in all the former assessment reported that no such water quality changes are expected until 2015, which would be caused directly by the discharge of the treated and used waters of the Paks Nuclear Power Plant into the Danube causing the modification of the classification grade of the Danube water quality. However, in the period following this even an improvement in water quality may occur [12-4], [12-9], [12-10].

Investigation of the relationships between the Danube water temperature and Danube water chemistry parameters and forecast for the design dates in the Dunaföldvár, Fadd and Hercegszántó area

Based on the Danube water temperature forecast calculated from the chapter entitled “Modelling the Danube river morphology and Danube heat loads” the critical Danube water temperature levels expected for the river section upstream from the Paks mouth of the hot water canal in 2014, 2032 and 2084 are 25.61 ⁰C, 26.38 ⁰C, and 28.64 ⁰C, respectively. These data not yet include the extra Δt values calculated from the course of operation. The Δt value in the chapter referred to above was calculated for the river section as a whole, irrespective of the operating conditions. The critical temperature value provided was incremented with this Δt figure, and the calculations for the forecast, value estimates and determination of the associated standard deviations were accomplished this way.

Danube water temperature data measured at the same time when water sampling was carried out in the three core network profiles varied as described below: The value of the median measured in the 2006-2011 period at the three Dunaföldvár profiles was 12.2 ⁰C (min. -0.7, max. 25.5 ⁰C). In the Fadd area it was 12.8 ⁰C (min. -0.3, max. 24.3 ⁰C), while in the Hercegszántó area it was 13.0 ⁰C (min. -0.3, max. 27.4 ⁰C).

Predicted values and the with the interval of their degree of probability of the changes occurring in the water chemical parameters of the Danube associated with the critical water temperature levels specified in the Chapter referred to above were determined by statistical methods. Under the core network measurement sessions tests were carried out for the various elements on a monthly basis, usually twelve times a year. The monthly tests allowed monitoring of the annual seasonal changes. Under the study carried out on a large number of elements it was determined on the basis of the linear trend deviation analysis, whether or not the linear trend in question is correlated with temperature changes or is independent from them. Provided such correlation exists, the predicted value associated with each of the difference temperature levels can be determined by statistical methods. In this case, when no correlation exists between the element in question and the Danube water temperature, it can be assumed that the average and distribution pattern of the element measured in the past seven years equals with the average and distribution pattern expected for the future period.

For this purpose the correlation factor and the parameters of the equalling linear trend were determined. The correlation factor parametered the closeness of the correlation and the function of the equalling linear line provided the opportunity to determine the expected predicted value for various temperature scenarios. Under the statistical analysis the deviation of the element in question was determined which was influenced by the seasonal temperature fluctuations, water levels on the Danube, including the associated volume rate of flow values, furthermore the minimum and maximum levels for the element in the period under investigation. Taking into account the correlation factor representing the correlation the expected value of the occurrence of the element in question and its value interval were predicted on the basis of the coefficient of standard variation figures as well as the minimum-maximum values encountered so far.

The classification process according to the WFD requirements, the limit values of which are contained in Table 12.1.3-1, was carried out for both the predicted value and the calculated predicted range.

Of the downstream profiles calculations on the maximum permitted heat load of 30 ⁰C at the Nagysarkantyú were carried out on the basis of the water quality data at the Fadd profile for the purposes of comparison.

The annual time series of the elements measured at the Core Network points referred to above (Dunaföldvár, Fadd, Hercegszántó) were processed in 2013 in details as part of the supplementary specialist field assessment studies laying the foundations for the MVM Paks II Zrt –Environmental and site licensing procedure. It can be clearly seen from the course of these curves that water quality parameters measured at the stations show a strong correlation with each other over time. In addition to the processing made per profile, the correlation analysis between the , water temperature and elements using the summarised figure of the three stations belonging to the mean stream line of the assessed Danube section, the graphic representation of which was provided in the report in Figure 12.6.1-2 to Figure 12.6.1-20. The classification grades according to the WFD requirements were featured on the figures in each case (*excellent status* - ***blue***, *good status* - ***green***, *moderate status* - ***yellow***). On figures where no line of the respective limit value is presented, the Regulation on the WFD classification scheme does not contain any actual limit figures.

Parameters of the equalizing linear line and of the correlation coefficient differed to a slight extent from the correlation analysis carried out for the profile in question (the findings of which were presented only in a table), nevertheless the graphic correlation analysis carried out with the increased number of elements provides an illustration of the closeness of correlation and the expected extremes of the predicted values along the entire Danube section in a consistent manner.

Correlation analysis sessions were illustrated on analytical graphs, in other words with the WFD limit values associated with the element in question, regardless of the fact that such limit values are assigned to the annual average levels.

The findings of the impact assessment studies were presented one by one for each classification group according to the set of criteria laid down in the WFD.

Outcome of the detailed classification process for each profile was presented in Table 12.6.1-4, Table 12.6.1-5 and Table 12.6.1-6.

Acidification status

pH

Fluctuations in the pH levels are influenced by the amount of plankton algae in the water, photosynthetic and decomposition processes of organic matter, furthermore the impact of the municipal wastewater the surface waters are exposed to. Changes in water temperature boost or inhibit these processes.

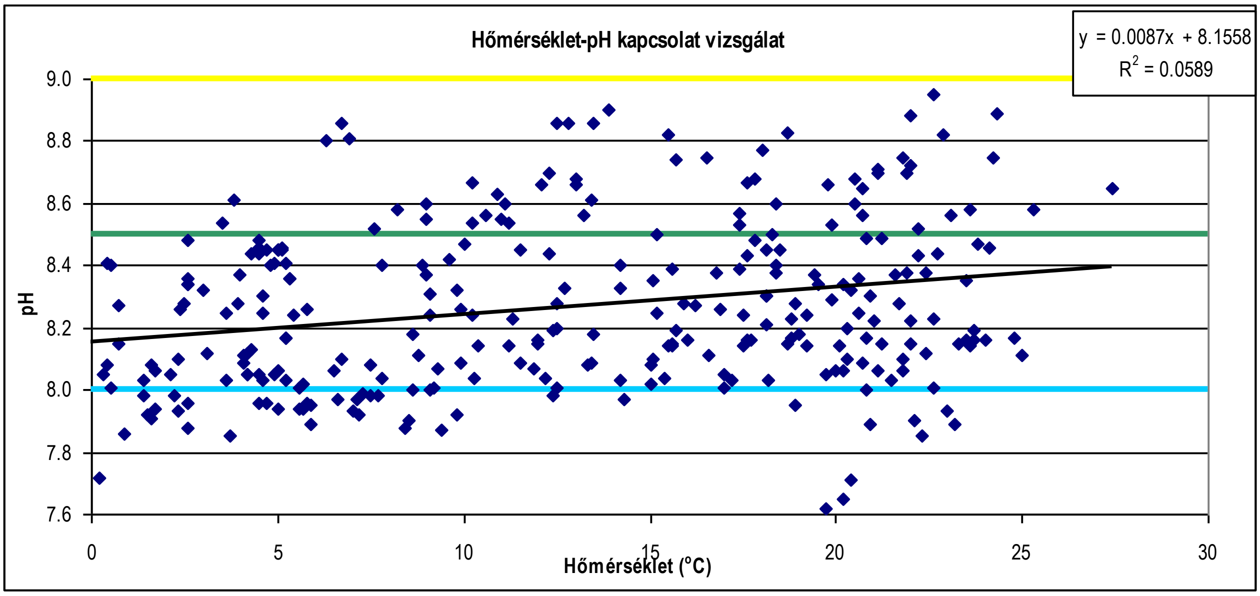
The correlation between the pH level and the Danube water temperature at Dunaföldvár is less than medium (0.3), poor at Fadd (0.25), and no correlation can be established any more at Hercegszántó (0.14).

The measured average in the three Core Network profiles in the period between 2006 and 2011 was 8.25 in the Dunaföldvár area, 8.27 in the Fadd area, and 8.25 in the Hercegszántó area. The coefficient of standard variation was low, varying in the 0.25-0.26 range with slight seasonal fluctuations of the element.

According to the statistical processing of the values the predicted level along the longitudinal profile in the current operational state at the critical water temperature varies between 8.18 and 8.25, in the operating state expected for 2032 between 8.3-8.4, and in the operating state expected for 2085 between 8.3 and 8.5. In the state of the maximum Danube heat load it will vary in the range of 8.34-8.48. The coefficient of standard variation was low, varying in the 0.25-0.27 range, reflecting a low level of seasonal fluctuations. No substantial changes will occur in the levels of this element.

The range of the coefficient of standard variation for the expected values of the upcoming decades will be as follows: current state 7.9-8.5, in 2032: 8.1-8.7 in 2085: 8.3-8.7.

It can be seen on Figure 12.6.1-2, that pH values and water temperature do not indicate a strong correlation. Expected levels and their seasonal coefficient of standard variation will be increased to a slight extent in linear correlation with the higher temperature. The feature can most probably be explained by the photosynthetic activity of the algae.



Hőmérséklet-ph kapcsolat vizsgálat – assessment of the correlation between water temperature and the pH in the River Danube
hőmérséklet - temperature

Figure 12.6.1-2: Assessment of the correlation between water temperature in the Danube and the pH

Salinity status

Electrical conductivity

Electrical conductivity indicates the minerals content of waters which might be of natural origin from leaching out of the soil or may change as a result of the impaired municipal wastewater quality migrating into the soil and decaying there. The latter is influenced by the temperature fluctuations through the alteration of the speed of decomposition processes. It can be stated from the assessment of the 30 years test results that the conductivity of the river water hardly changed, but the figures reflect the fluctuations caused by more wet and drier periods well.

The levels of conductivity and temperature of the water of the Danube River are in a good and high correlation with each other; At Dunaföldvár (0.7), Fadd (0.8), at Hercegszántó (0.8).

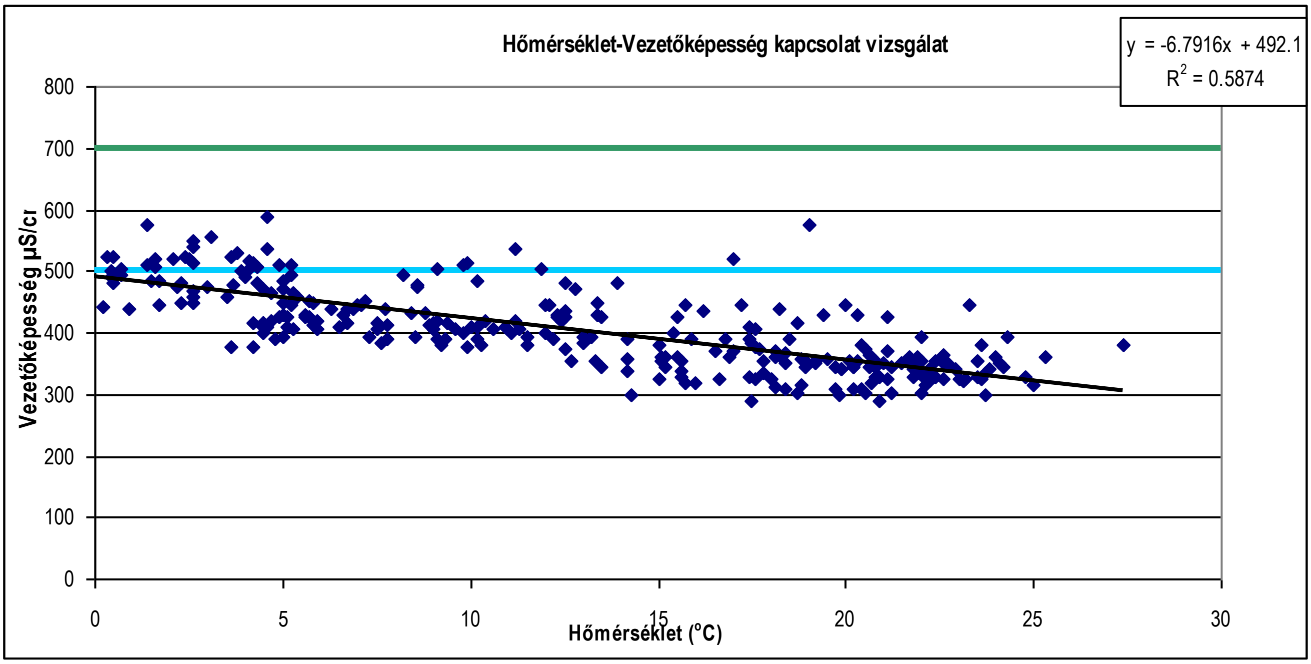
The measured average in the three Core Network profiles in the period between 2006 and 2011 was 415.8 µS/cm at Dunaföldvár, 400.8 µS/cm in the Fadd area, and 405.0 µS/cm in the Hercegszántó area. The coefficient of standard variation was high, varying in the 60-72 range, indicating a high level of seasonal fluctuations.

According to the statistical processing of the values the predicted level along the longitudinal profile in the current operational state at the critical water temperature varies between 318-321 µS/cm in the operating state expected for 2032 between 300-316 µS/cm, and in the operating state expected for 2085 between 295-301 µS/cm. In the state of the maximum Danube heat load it will vary in the range of 288-292 µS/cm.

According to the statistical calculations a significant level of reduction of the original levels is expected as the result of the diminishing of the various contamination types on the long term. No substantial changes will occur in the levels of this element.

The range of the coefficient of standard variation for the expected values of the upcoming decades will vary as follows: current state 335-482 µS/cm, in 2032: 290-480 µS/cm, in 2085: 285-480 µS/cm.

It can be seen on Figure 12.6.1-3 that the correlation between electrical conductivity and water temperature was good. Levels gradually decline as a result of the water temperature increase.



Vezetőképesség – conductivity
hőmérséklet - temperature

Figure 12.6.1-3: Assessment of the correlation between water temperature in the Danube and conductivity

Chloride

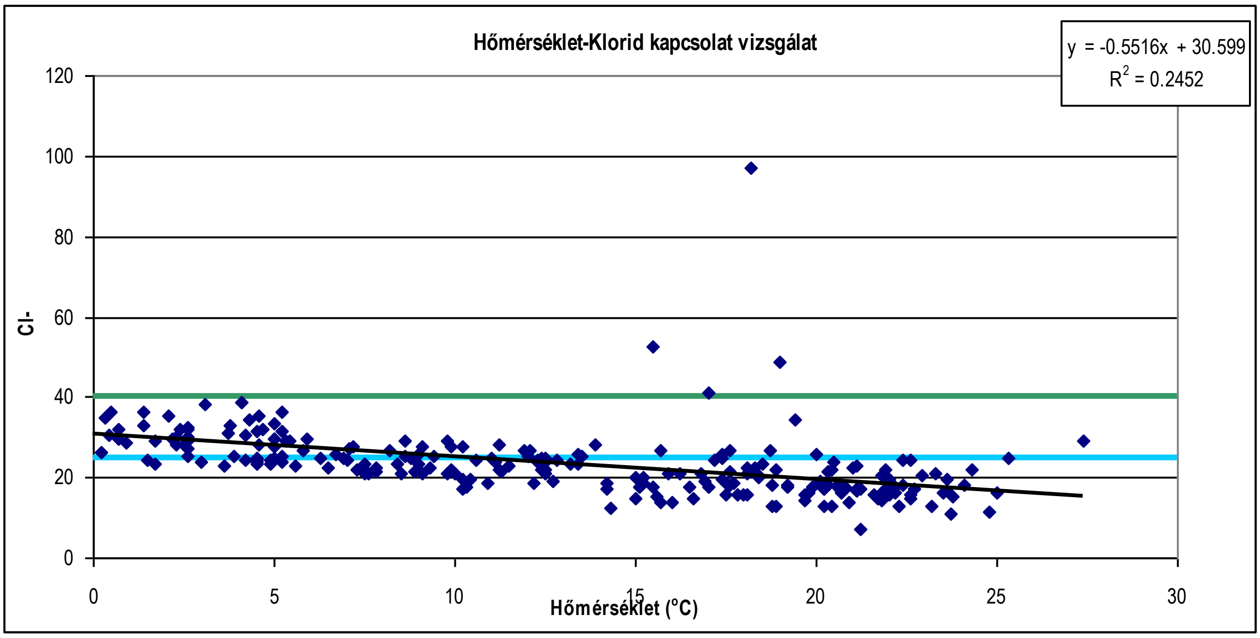
Chloride gets into natural waters with sewage. The concentrations in the assessed Danube section was continuously low over the decades which were practically not influenced by the water temperature changes. It also has no perceivable impact on the life functions of living organisms, mainly of algae.

The correlation between the chloride level and the Danube water temperature at Dunaföldvár is good and medium; At Dunaföldvár (0.59) Fadd (0.61) and Hercegszántó (0.42).)

The measured average in the three Core Network profiles in the period between 2006-2011 was 24.0 mg/l in the Dunaföldvár area, 22.7 mg/l in the Fadd area, and also 22.7 mg/l in the Hercegszántó area. The coefficient of standard variation was medium, varying in the 6.8-9.2 along the longitudinal profile, with perceivable seasonal fluctuations.

According to the statistical processing of the values the predicted level along the longitudinal profile in the current operational state at the critical water temperature varies between 15.1-16.9 mg/l, in the operating state expected for 2032 between 16.0-16.5 mg/l and between 13.2-15.1 mg/l in 2085. In the state of the maximum Danube heat load it will vary in the range of 12.4 mg/l, with a standard deviation in the range of 5.1-19.7 mg/l. According to the forecast a slight increase in the levels might be expected with the growing temperature of the Danube water.

It can be seen on Figure 12.6.1-4 that the correlation between the values and water temperature was good to medium with a seasonal fluctuation range of 10-40 mg/l.



Hőmérséklet-Klorid kapcsolat vizsgálat – Assessment of the correlation between water temperature and clorides
Hőmérséklet - temperature

Figure 12.6.1-4: Assessment of the correlation between water temperature in the Danube and chlorides

Oxygenation conditions status (indicators of oxygen turnover)

Indicators of the oxygen turnover react sensitively to life phenomena taking place in the water, the decomposition processes of organic matter and photosynthesis of plants. Changes in water temperature have a strong influence on such processes.

Dissolved oxygen

Dissolved oxygen contents and saturation levels are shaped by diffusion from the atmosphere and photosynthesis. The findings of the past 30 years indicate that the levels in the river section under investigation were increased in most of the cases or did not change. No adverse impacts were detected on the sections upstream and downstream of Paks Nuclear Power Plant.

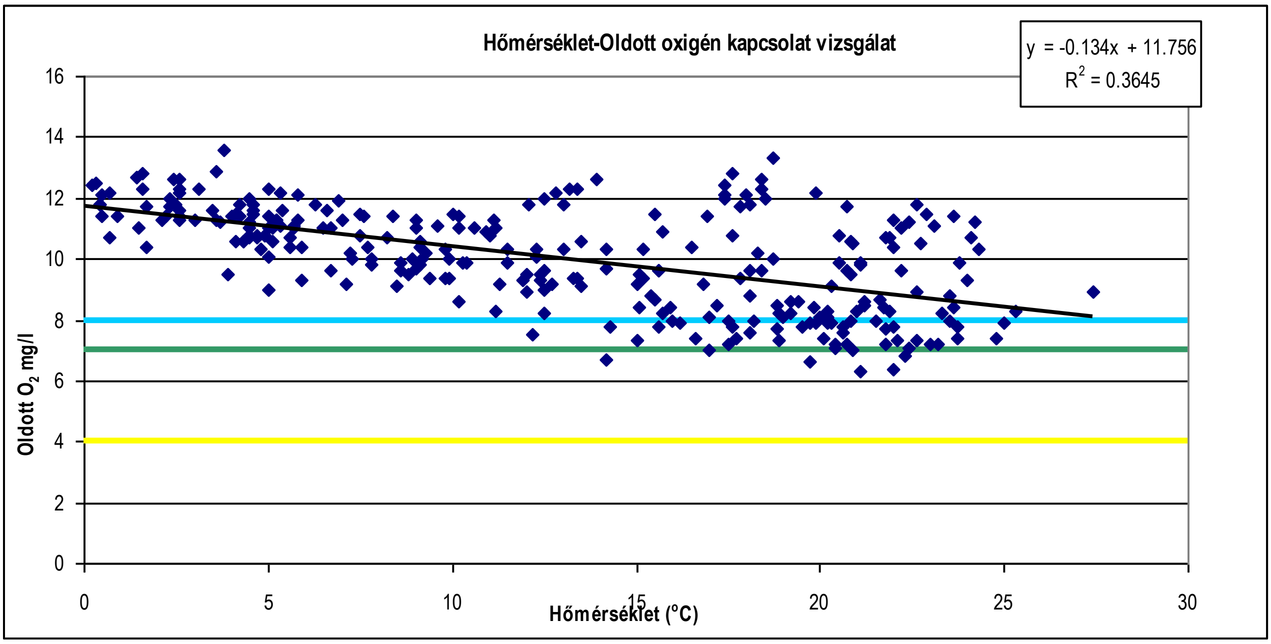
The correlation between oxygen contents and saturation levels and the Danube water temperature at Dunaföldvár is good; At Dunaföldvár (0.6), Fadd (0.55), at Hercegszántó (0.7).

The measured average in the three Core Network profiles in the period between 2006-2011 was 9.94 mg/l (91,4%) in the Dunaföldvár area,, 10.14 mg/l (94,9%) in the Fadd area, and 10.0 mg/l (93,8%) in the Hercegszántó area. The coefficient of standard variation for dissolved oxygen was low, varying in the (1.6-1.7) range, but higher for saturation levels, varying between 14.2 and 16.3 %, due to seasonal fluctuations.

According to the statistical processing of the values the predicted level along the longitudinal profile in the current operational state at the critical water temperature varies between 8.0-8.6 mg/l and 103-109 %, in the operating state expected for 2032 between 7.7-8.3 mg/l and 104-113%, in the operating state expected for 2085 between 7.6-8.2 mg/l and 106-113%. In the state of the maximum Danube heat load it will vary in the range of 8.1 mg/l and 114%.

The range of the coefficient of standard variation for the expected values of the upcoming decades can be estimated as follows: current state 8-8.6 mg/l (88-118 %), 6.1-9.9 mg/l (89-129 %) in 2032, and 5.9-9.8 mg/l (91-130 %) in 2085.

It can be seen on Figure 12.6.1-5 that the correlation between the values of dissolved oxygen content and a water temperature was good, the values show a slight decrease along with water temperature growth in the 15-25 ^{0}C range. Due to the increased standard deviation growing with the temperature no substantial change is expected to occur.

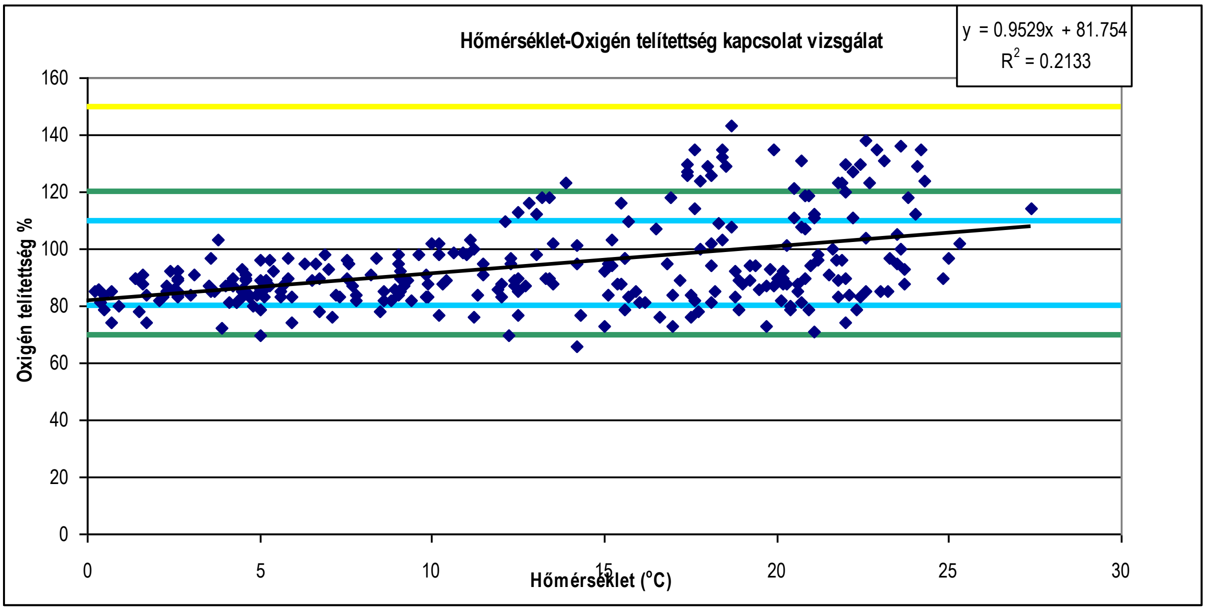


Hőmérséklet-Oldott oxigén kapcsolat vizsgálat – Assessment of the correlation between water temperature and dissolved oxygen in the River Danube
Oldott O2 – Dissolved O2

Figure 12.6.1-5: Assessment of the correlation between water temperature in the Danube and dissolved oxygen

Oxygen saturation

The correlation between oxygen saturation and a water temperature on Figure 12.6.1-6 shows an increasing tendency on the other hand in the 10-25 ^{0}C range, also by increasing levels of standard deviation, which might just as well be the consequence of the photosynthetic activity of the algae.



Oxigén telítettség – oxygen saturation
hőmérséklet – temperature

Figure 12.6.1-6: Assessment of the correlation between water temperature in the Danube and oxygen saturation

Biochemical oxygen demand

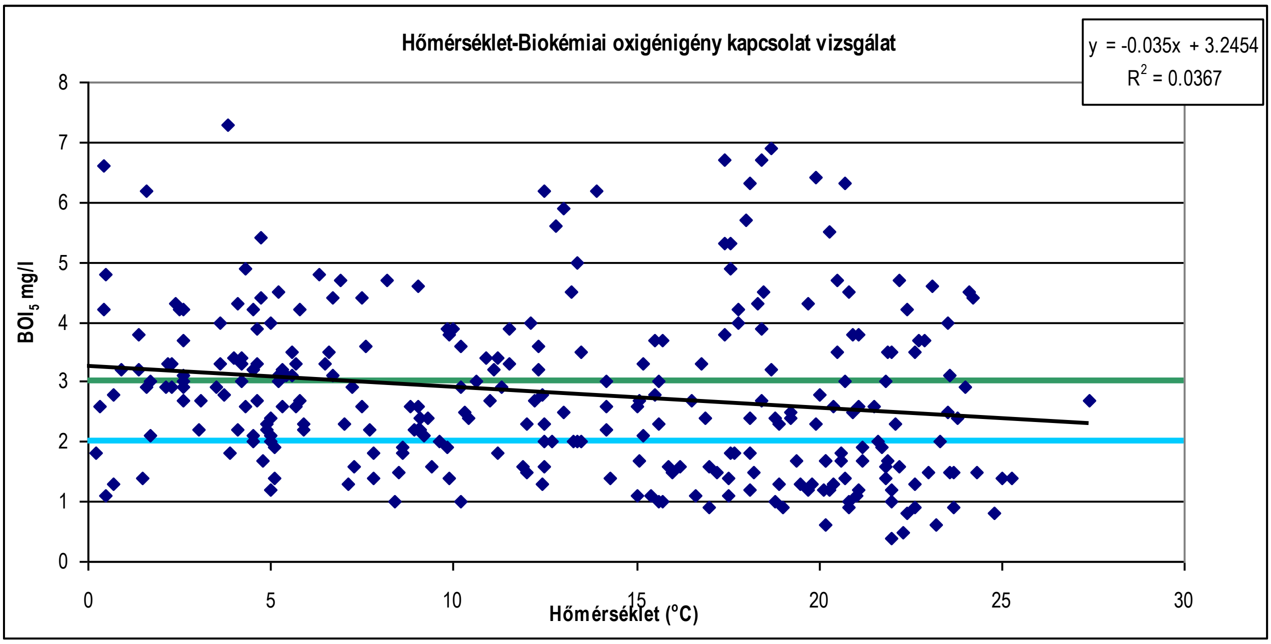
The indicators of the organic matter content – a part of the figures indicating oxygen turnover – the levels of biochemical oxygen demand (BOD_5) and chemical oxygen consumption (COD_{Cr}, COD_{ps}) were diminished in the last three decades systematically. Namely, because the degradable organic matter content in the river water declined as a consequence of the wastewater treatment programmes launched in the meantime.

The measured average **biochemical oxygen demand** (BOD_5) in the three Core Network profiles in the period between 2006-2011 was 2.71 mg/l in the Dunaföldvár area, 2.70 mg/l in the Fadd area, and 2.74 mg/l in the Hercegszántó area, respectively. The coefficient of standard variation significant, varying between 1.3-1.4, fluctuations of the element were intensive.

The correlation between the BOD_5 value and the Danube water temperature was poor; At Dunaföldvár (0.26), Fadd (0.11), at Hercegszántó (0.2). Taking this finding into account the statistically calculated predicted values must be considered as indicative levels only. Based on them it can be stated that the Danube temperature rise will influence the BOD_5 value and its fluctuations only to a very low extent. Future levels are expected to reflect the current status or diminish slightly.

According to the statistical processing of the values the predicted level along the longitudinal profile in the current operational state at the critical water temperature varies between 1.93-2.44 mg/l, in the operating state expected for 2032 between 1.89-2.43 mg/l, and in the operating state expected for 2085 between 1.77-2.38 mg/l. In the state of the maximum Danube heat load it will vary in the range of 1.70-2.35 mg/l. No substantial changes will occur as a result of the temperature increase.

It can be seen on Figure 12.6.1-7 that the correlation between the values and a water temperature was low. The highest level of standard deviation was observed in the value range of 4-7 mg/l. The coefficient of standard variation in the values was high due to the seasonal fluctuations.



Hőmérséklet - temperature

Figure 12.6.1-7: Assessment of the correlation between water temperature in the Danube and BOD5

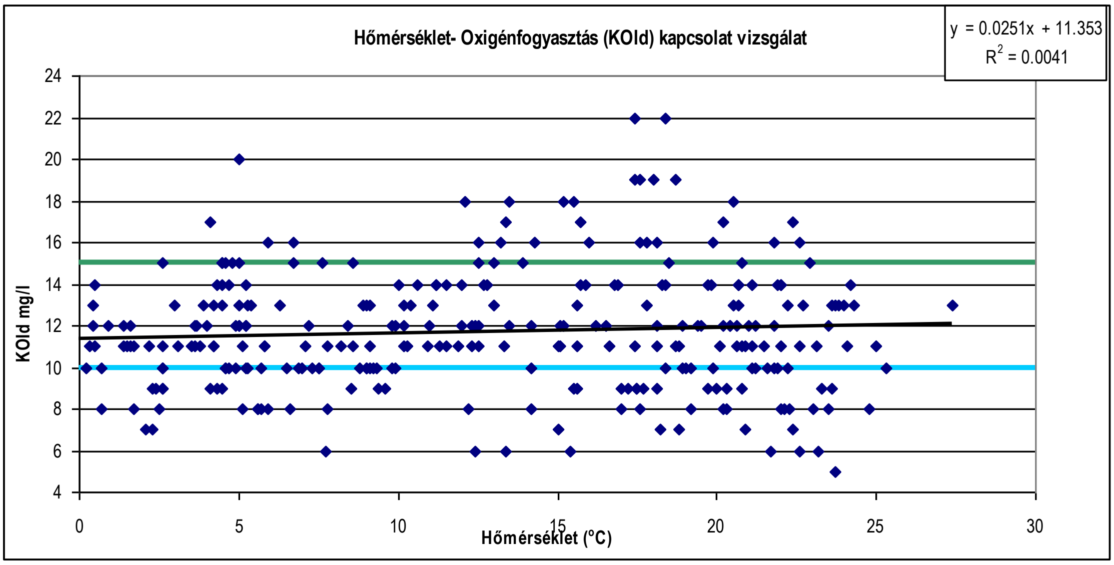
Oxygen consumption

The measured average of oxygen consumption measured with **potassium chromate** (COD_{Cr}) in the three Core Network profiles in the period between 2006-2011 was 11.95 mg/l in the Dunaföldvár area, 11.25 mg/l in the Fadd area, and 11.39 mg/l in the Hercegszántó area. The coefficient of standard variation varied in a medium extent between 2.8-3.1, with low levels of seasonal fluctuations of the element.

No or only low correlation exists between the COD_{Cr} and COD_{ps} value and the Danube water temperature. At Dunaföldvár it was (0.09, 0.09), Fadd (0.22, 0.17), at Hercegszántó (0.04, 0.08). Taking this finding into account the statistically calculated predicted values must be considered as indicative levels only. Based on them it can be stated that the Danube temperature rise will influence the COD_{Cr} COD_{ps} value and its fluctuations only to a very low extent. Future levels are expected to reflect the current status.

According to the statistical processing of the values the predicted level along the longitudinal profile in the current operational state at the critical water temperature varies between 11.2-12.5 mg/l, in the operating state expected for 2032 between 11.20-12.6 mg/l, and in the operating state expected for 2085 between 11,2-12,6 mg/l. In the state of the maximum Danube heat load it will vary in the range of 12.70 mg/l, with an estimated range of standard deviation at the levels between 9.9-15.5 mg/l.

It can be seen on Figure 12.6.1-8 and Figure 12.6.1-9 that no correlation exists between the values and a water temperature. The coefficient of standard variation varies to an ever increasing extent with the increasing water temperature both in the increasing and the decreasing directions. However, the tendency of the values hardly changes. No substantial changes will occur.



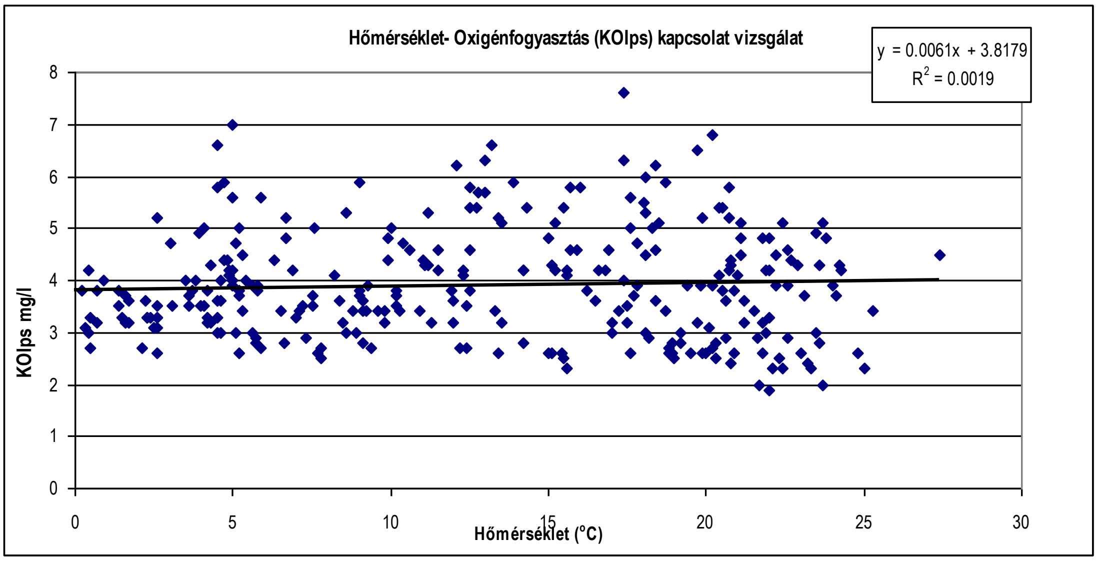
KOld - COD_d
hőmérséklet – temperature

Figure 12.6.1-8: Assessment of the correlation between water temperature in the Danube and COD_d

The measured average of oxygen consumption measured with **potassium permanganate** (COD_{ps}) in the three Core Network profiles in the period between 2006-2011 was 4.0 mg/l in the Dunaföldvár area, 3.8 mg/l in the Fadd area, and 3,8 mg/l in the Hercegszántó area. The coefficient of standard variation varied in a medium extent between 1.0-1.1, with low levels of seasonal fluctuations of the element.

According to the statistical processing of the values the predicted level along the longitudinal profile in the current operational state at the critical water temperature varies between 3.6-4.1 mg/l, in the operating state expected for 2032 between 3,6-4,2 mg/l, in the operating state expected for 2085 between 3,6-4,2 mg/l. In the state of the maximum Danube heat load it will vary in the range of 4,2 mg/l with an estimated range of the coefficient of standard variation between 3.1-5.3 mg/l.

It can be seen on Figure 12.6.1-9 that the correlation between the values and a water temperature was low, standard deviation and the direction of change are similar to that measured with potassium dichromate. No substantial changes will occur as a consequence of the temperature increase in the Danube.



hőmérséklet – temperature
KOl_{ps} - COD_{ps}

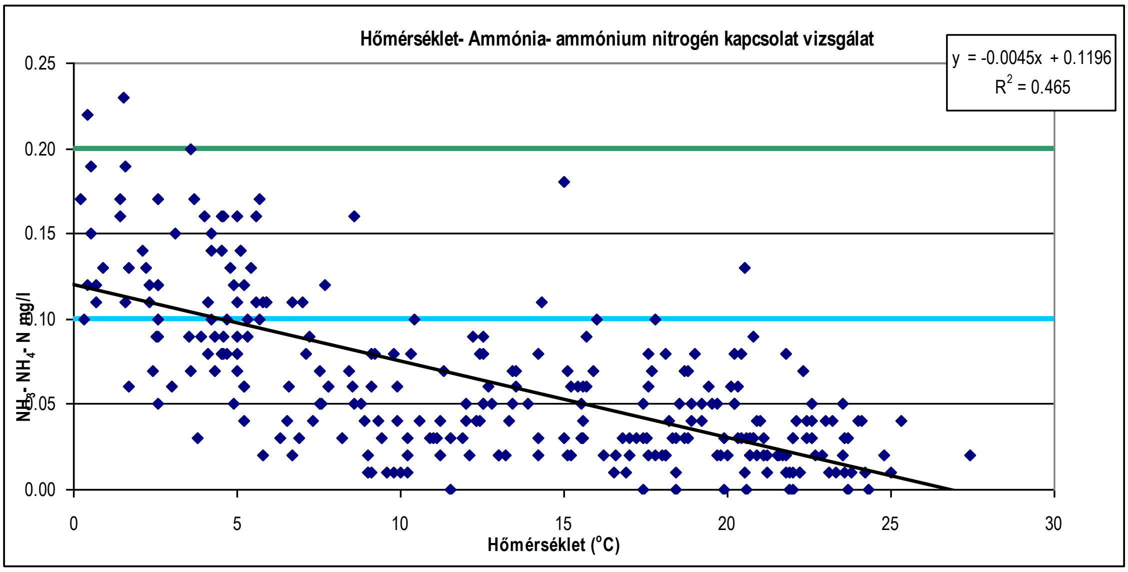
Figure 12.6.1-9: Assessment of the correlation between water temperature in the Danube and COD_{ps}

Ammonia, ammonium-N

The measured average of **ammonia and ammonium N** in the three Core Network profiles in the period between 2006-2011 was 0.06 mg/l in the Dunaföldvár area, 0.07 mg/l in the Fadd area, and 0.06 mg/l in the Hercegszántó area. The coefficient of standard variation varied in a low extent between 0.04-0.06, with low levels of seasonal fluctuations of the element. Correlation between the NH_4-N value and the Danube water temperature is strong. At Dunaföldvár (0.68), Fadd (0.72), at Hercegszántó (0.66).

According to the statistical processing of the values the predicted level along the longitudinal profile at the critical water temperature varies between 0.0-0.001 mg/l. According to the calculations there values will practically not change. According to the forecast these values are expected to decline over time.

It can be seen on Figure 12.6.1-10 that the correlation between the values and a water temperature was good, with a low level of seasonal fluctuations. The value and the coefficient of standard variation of the latter will increase in times of low water temperature.



hőmérséklet – temperature

Figure 12.6.1-10: Assessment of the correlation between water temperature in the Danube and ammonia-nitrogen

Nutrient conditions status

Ammonium, ammonium nitrogen, (NH_3, NH_4-N), (listed by WFD as one of the oxygenation conditions, it was described there) nitrite- (NO_2), nitrate (NO_3) nitrogen and total organic nitrogen can be listed as **plant nutrients**. Ammonia has two forms pending on the pH in the solution. For the ammonium ions a living cell membrane is impenetrable, while free ammonia penetrates the sell membrane and is considered a toxin for cells, therefore it has a significance in environmental sciences. It gets into the surface waters by the elemental nitrogen fixing ability of bacteria and cyanobacteria (blue algae) and by the degradation of wastewaters with contamination by organic substances. Levels of the aforementioned parameters diminished in the past decades systematically and the extent of it was greater than those indicating organic matter content.

Nitrite-N

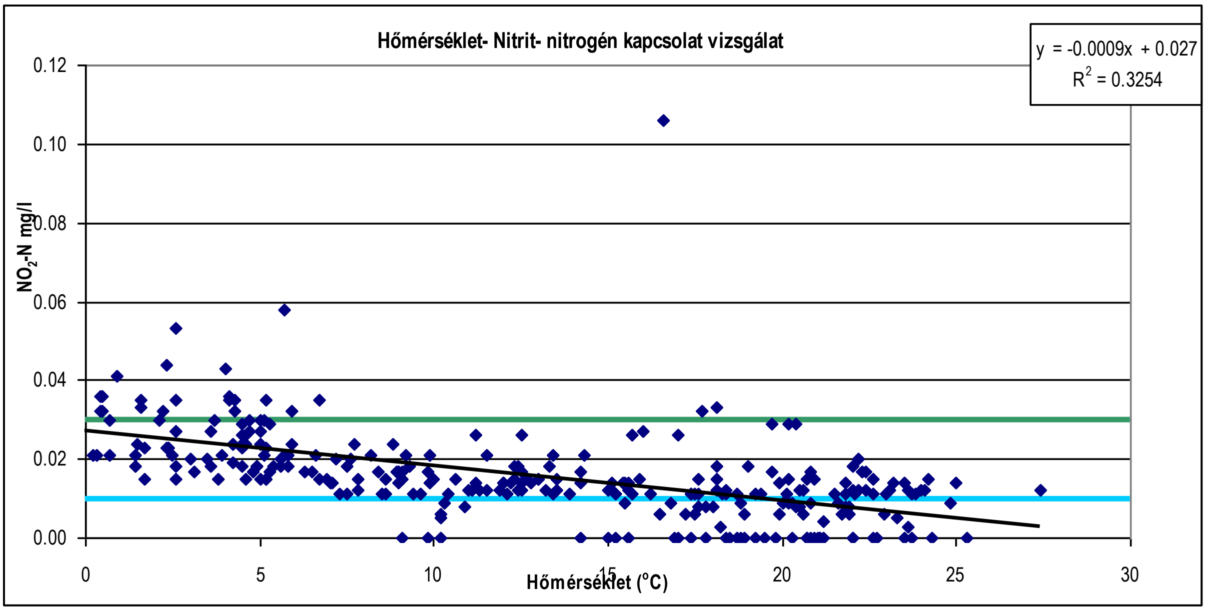
Nitrite-N is the product of nitrite generating bacteria, produced in the course of the nitrification process by the oxidation of ammonia. Nitrate-N is the final product of this *chemoautotrophic* process.

The measured average of nitrite-N in the three Core Network profiles in the period between 2006-2011 was 0.019 mg/l in the Dunaföldvár area, 0.015 mg/l in the Fadd area, and 0.014 mg/l in the Hercegszántó area. The coefficient of standard variation varied in a low extent between 0.01-0.06, with low levels of seasonal fluctuations of the element.

The correlation between the NO_2-N value and the Danube water temperature was poor at Dunaföldvár (0.1), but good at Fadd (0.6) and Hercegszántó (0.6) profiles.

According to the statistical processing of the values the predicted level along the longitudinal profile at the critical water temperature varies between and in the operating state expected for 2032 between 0.004-0.025 mg/l. These values will diminish in a slight extent in 2085 and in the state of the maximum Danube heat load. According to the forecast these values are expected to decline over time.

It can be seen on Figure 12.6.1-11 that the correlation between the values and a water temperature was good, and levels of seasonal fluctuations of the data was very low.



Hőmérséklet – temperature

Figure 12.6.1-11: Assessment of the correlation between water temperature in the Danube and nitritee nitrogen

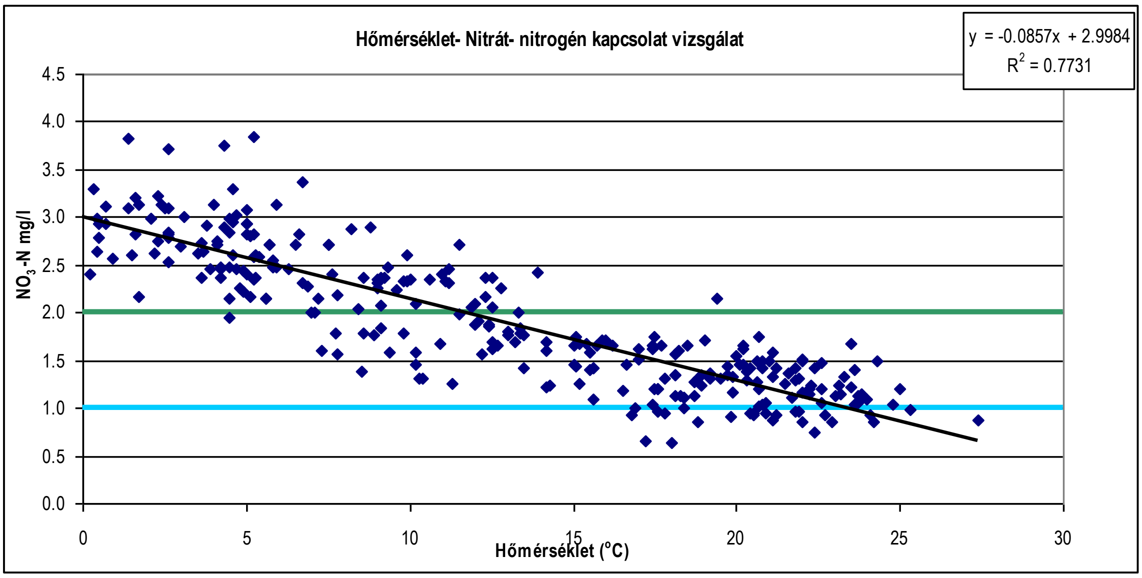
Nitrate-N

Nitrate-N in natural waters is the product of nitrifying bacteria beside pollution, produced by further processes of nitrification.

The measured average of nitrate-N in the three Core Network profiles in the period between 2006-2011 in the Dunaföldvár area was 2.0 mg/l, in the Fadd area 1.80 mg/l, and in the Hercegszántó area 1,85 mg/l volt. The coefficient of standard variation varied in a medium extent between 0.70-0.75, with seasonal fluctuations of the element in the 1-3 mg/l range. The correlation between the NO_3-N value and the Danube water temperature was (0.87) at Dunaföldvár, Fadd (0.89) and Hercegszántó (0.87).

According to the statistical processing of the values the predicted level along the longitudinal profile at the critical water temperature varies between 0.7-0.8 mg/l, in the operating state expected for 2032 between 0.5-0.7 mg/l. These values will diminish in a slight extent (0.5-0.6) in 2085 and in the state of the maximum Danube heat load. According to the forecast these values are expected to decline over time.

It can be seen on Figure 12.6.1-12 that the correlation between the values and a water temperature was high, the concentration of the element will diminish with the increase of the temperature, the seasonal fluctuations are between 1 and 3 mg/l. The levels show a definitely diminishing tendency in line with the water temperature increase in the range above 10 ^{0}C. Future increase of the Danube water temperature will result in slight decrease of the concentration.



Hőmérséklet – temperature

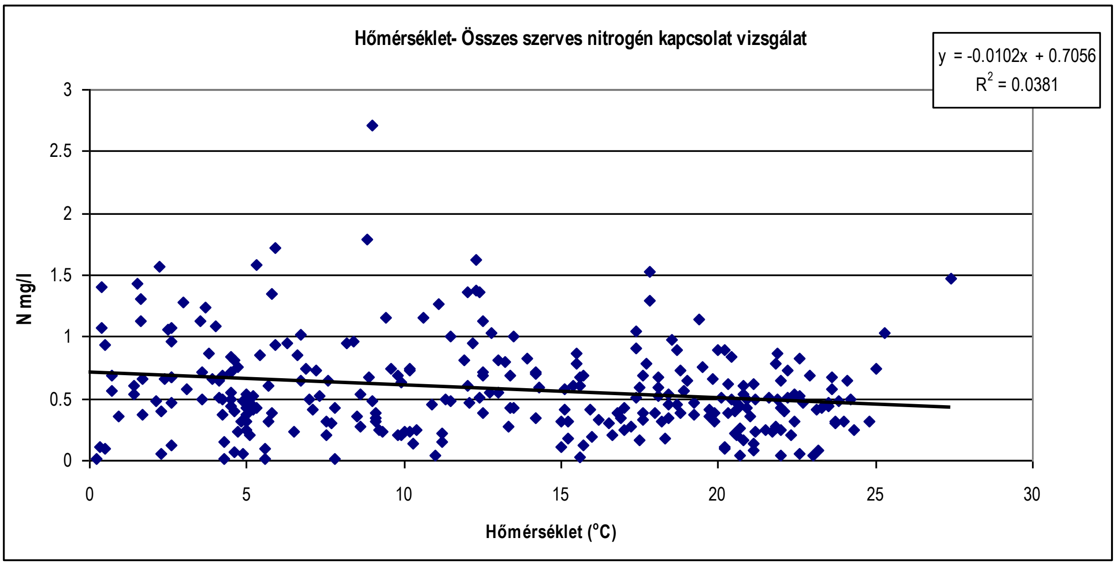
Figure 12.6.1-12: Assessment of the correlation between water temperature in the Danube and nitrate nitrogen

Total organic nitrogen, and total nitrogen

The measured average value of **total organic nitrogen and total nitrogen** in the three Core Network profiles in the period between 2006-2011 was 0.60 and 2.68 mg/l, respectively, in the Dunaföldvár area, 0.52 and 2.44 mg/l in the Fadd area, and 0.57 and 2,50 mg/l in the Hercegszántó area. The coefficient of standard variation medium varying between 0.3-0.9, and 0.8-0.9, respectively, the seasonal fluctuations of the element varied at 0.2-1.5 mg/l and 1-4 mg/l, respectively.

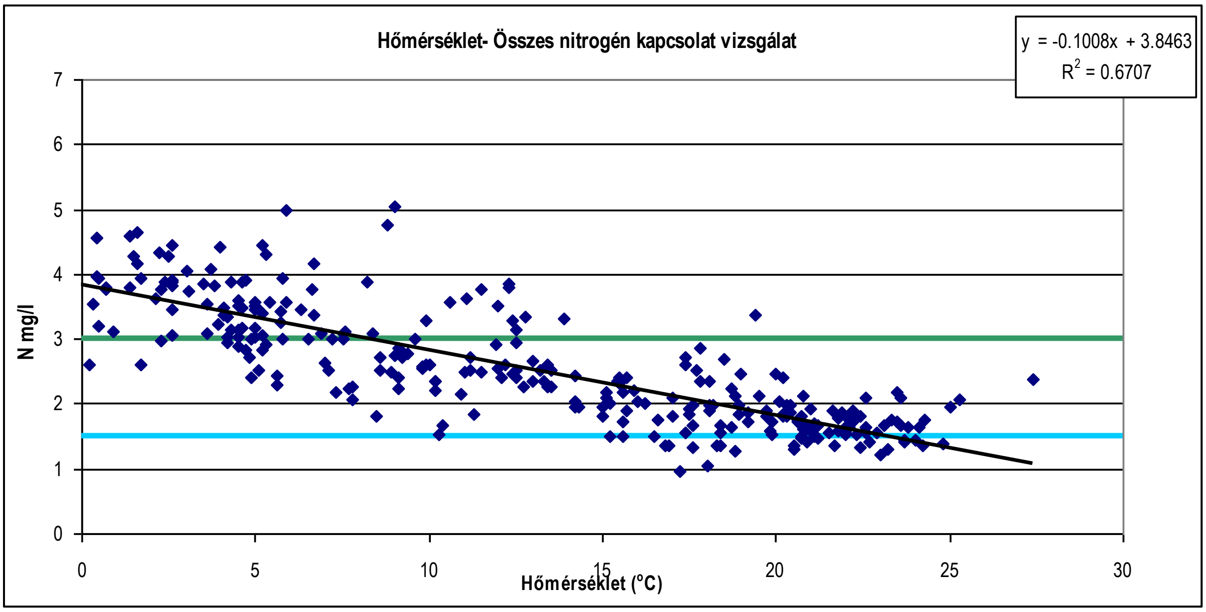
The correlation between total nitrogen contents and the Danube water temperature at Dunaföldvár (0.16) Fadd (0.16) and Hercegszántó (0.21) was poor, while it was high for total nitrogen: Dunaföldvár (0.82) Fadd (0.85) and Hercegszántó (0.79).

According to the statistical processing of the values the predicted level along the longitudinal profile in the current operational state at the critical water temperature varies between 0.42-0.49 and 1,21-1,27 mg/l, in the operating state expected for 2032 between 0.43-0.52 and 1,14-1,22 mg/l, and in 2085 0.38-0.46 mg/l and 0.9-1.0 mg/l, respectively. In the state of the maximum Danube heat load these values will diminish slightly but not substantially (0.11 mg/l the range of the coefficient of standard variation: 0.08-0.14 mg/l and 0.79 mg/l the range of the coefficient of standard variation: 0.4-1.6 mg/l).



Hőmérséklet – temperature

Figure 12.6.1-13: Assessment of the correlation between water temperature in the Danube and total organic nitrogen



Hőmérséklet – temperature

Figure 12.6.1-14: Assessment of the correlation between water temperature in the Danube and total nitrogen

It can be seen on Figure 12.6.1-13 that the correlation between the values of total organic nitrogen and water temperature was poor, with a seasonal fluctuation of 0-1.8 mg/l. It can be seen on Figure 12.6.1-14 that the correlation between the values of total nitrogen and water temperature was good, with a seasonal fluctuation of expected in the 1-5 mg/l value range.

The levels show a definitely diminishing tendency in line with the water temperature increase in the range above 10 ^{0}C for both elements just like in the case of nitrate concentrations. Future increase of the Danube water temperature will result in slight decrease of the concentration.

Provided wastewater containing untreated organic matter is discharged into a watercourse, the amount of nitrogen derivatives and that of organic and total nitrogen will increase dramatically.

In an aquatic environment polyphosphates of various degrees of condensation play a role beside orto-phosphate-ions and organic phosphorus compounds. They may be present in the form of colloid particles dissolved in the water, or absorbed to such particles or as suspended load. The most common forms include orto-phosphate phosphorus and total phosphorus. Plankton algae incorporate water dissolved reactive phosphorus into their bodies therefore this compound is one of the limiting factors of their growth.

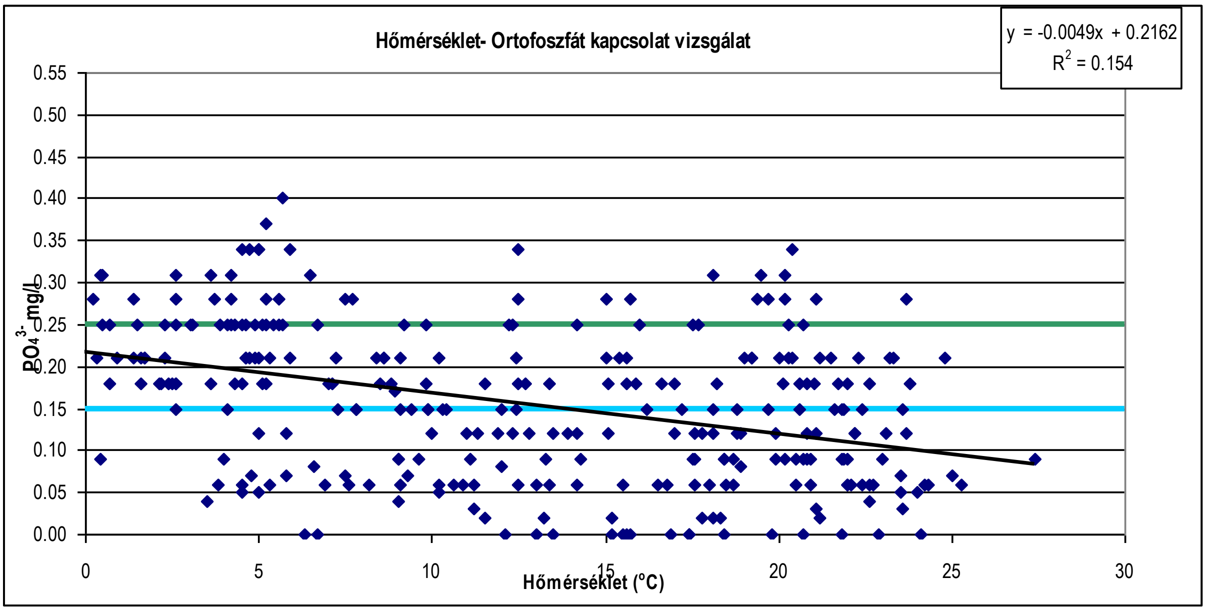
Orto-phosphate

The measured average **orto-phosphate values** in the three Core Network profiles in the period between 2006 and 2011 were 0.168 mg/l in the Dunaföldvár area, 0.181 mg/l in the Fadd area, and 0.139 mg/l in the Hercegszántó area, respectively. The coefficient of standard variation was (0.08), seasonal fluctuations along the longitudinal profile were high (0.05-0.35).

The correlation between orto-phosphate levels and the Danube water temperature is medium; At Dunaföldvár (0.41) Fadd (0.42) and Hercegszántó (0.33).

According to the statistical processing of the values the predicted level along the longitudinal profile at the critical water temperature varies between 0.088-0.118 mg/l, in the operating state expected for 2032 between 0.085-0.114 mg/l in 2085 0.075-0.103 mg/l. In the state of the maximum Danube heat load it will vary in the range of 0.1 mg/l, with an estimated range of the coefficient of standard variation between, 0.01-0.19 mg/l to be decreased to a slight extent. According to the forecasts the concentration over the upcoming decades will the identical with the current status or it will be decreased to a slight extent.

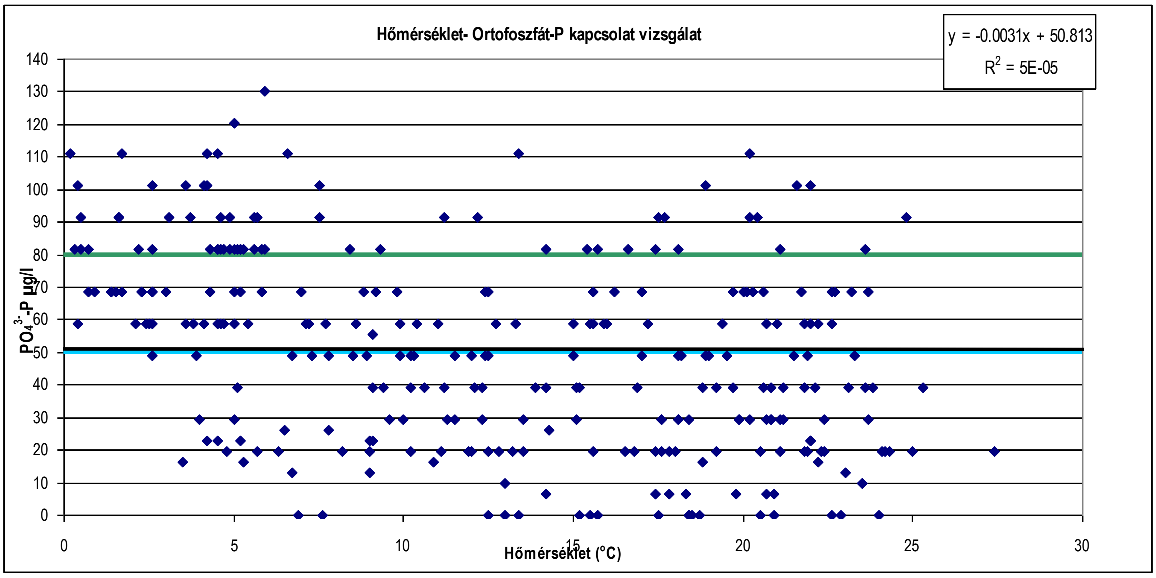
It can be seen on Figure 12.6.1-15 that the correlation between the values and a water temperature can be determined as medium strong. The coefficient of standard variation in the values was high irrespective of the seasons. The seasonal fluctuation of the values is 0.05-0.35 mg/l.



Hőmérséklet – temperature

Figure 12.6.1-15: Assessment of the correlation between water temperature in the Danube and orto-phosphate

The correlation diagram of **orto-phosphate-phosphorus** (PO_3-P) was also prepared, shown in Figure 12.6.1-16.



Hőmérséklet – temperature

Figure 12.6.1-16: Assessment of the correlation between water temperature in the Danube and ortophosphate-P

Total phosphorus

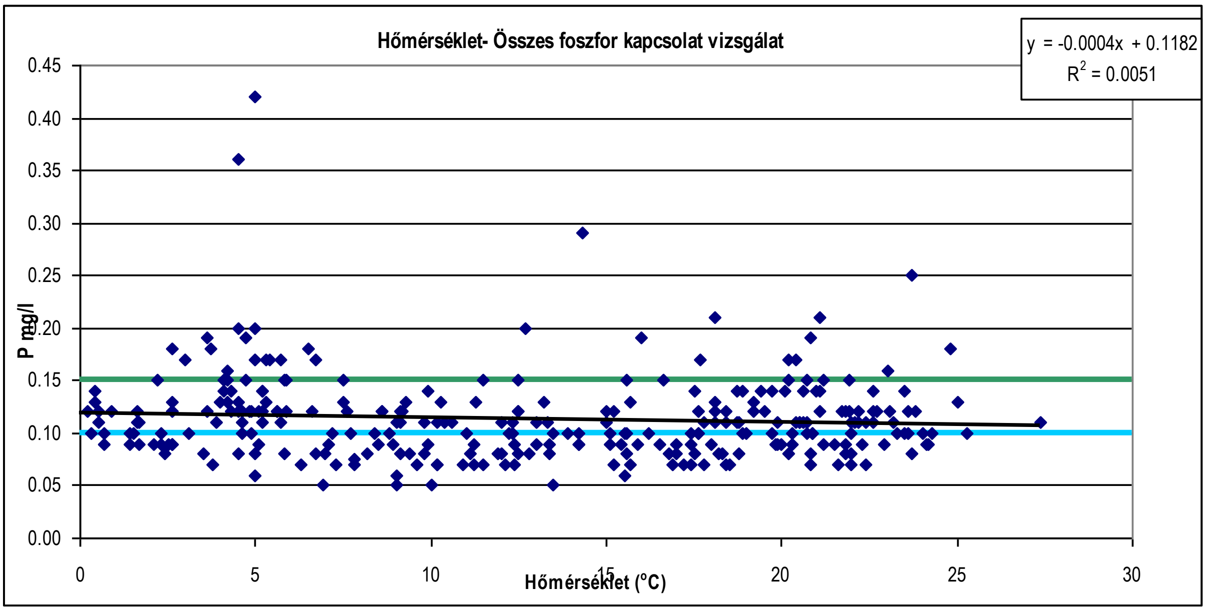
The measured average **total phosphorus values** in the three Core Network profiles in the period between 2006 and 2011 were 0.114 mg/l in the Dunaföldvár area, 0.108 mg/l in the Fadd area, and 0.115 mg/l in the Hercegszántó area. The coefficient of standard variation was low (0.04) and homogeneous across seasons, did not change along the longitudinal profile, with a low level of seasonal fluctuation.

The correlation between total phosphorus levels and the Danube water temperature is very poor; Dunaföldvár (0.09) Fadd (0.02) and Hercegszántó (0.08). Taking this finding into account the statistically calculated predicted values must be considered as indicative levels only. Based on them it can be stated that the Danube temperature rise will influence the total phosphorus value and its fluctuations only to a very low extent. Future levels are expected to reflect the current status.

According to the statistical processing of the values the predicted level along the longitudinal profile at the critical water temperature in the current status varies between 0.10-0.11 mg/l, in the operating state expected for 2032 between 0.10-0.11 mg/l and 0.10-0.11 mg/l in 2085. In the state of the maximum Danube heat load it will vary in the range of 0.10 mg/l, with an estimated range of the coefficient of standard variation between 0.08-0.14 mg/l.

According to the forecasts the concentration over the upcoming decades will the identical with the current status or it will be decreased to a slight extent.

It can be seen on Figure 12.6.1-17 that the correlation between the values and a water temperature was poor, the seasonal fluctuation of the values varies usually in the 0.05-0.2 mg/l value range.



Hőmérséklet – temperature

Figure 12.6.1-17: Assessment of the correlation between water temperature in the Danube and total phosphorus

Other elements not included in the WFD

The chlorophyll pigments in the cells of the green plants take advantage of the complementary radiation of light (red and blue). Beside the photosynthetic pigments there are so called accompanying (carotene, xanthophyll), which transmit light energy to a-chlorophyll. You can conclude to the amount and photosynthetic activity of the algae (phytoplankton) from it. The photosynthetic activity of the plankton algae depends very much from the water temperature beside the nutrient supply, which is the reason why their volume undergoes a large scale fluctuation in our natural surface waters. However, this element is not included in the physico-chemical assessment according to the WFD, as an element to be evaluated. However, since it has an important role in the ecological classification process, therefore its evaluation was carried out nevertheless.

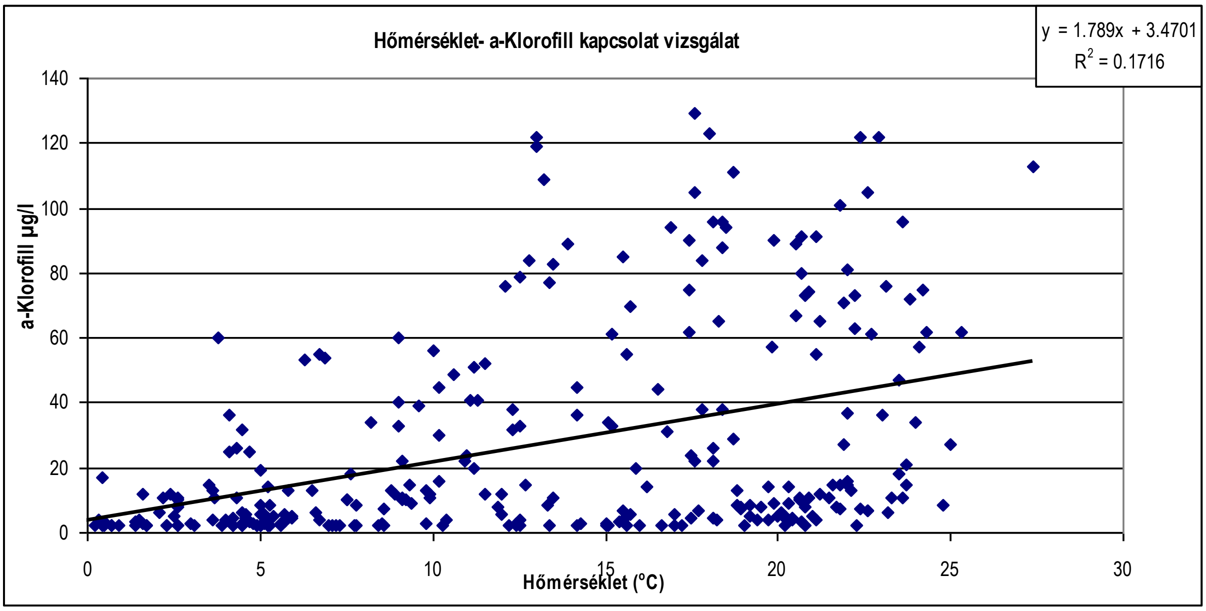
a-chlorophyll

The measured average **a-chlorophyll values** in the three Core Network profiles in the period between 2006-2011 were 25,1 µg/l in the Dunaföldvár area, 26,2 µg/l in the Fadd area, and 24,6 µg/l in the Hercegszántó area. The aforementioned considerations are substantiated by the substantial difference between the minimum and maximum levels which varied between 1.0-129.0 µg/l. The coefficient of standard variation is increased in linear correlation with the temperature, its extent is (31-33 µg/l), and the seasonal fluctuations in the values of the element are high.

The correlation between a-chlorophyll levels and Danube water temperature was good-medium; Dunaföldvár (0.40) Fadd (0.42) and Hercegszántó (0.38).

According to the statistical processing of the values the predicted level along the longitudinal profile at the critical water temperature in the current operating state varies between 45,0-51,2 µg/l, in the operating state expected for 2032 between 46,3-52,7 µg/l, 49,9-56,9 µg/l in 2085. In the state of the maximum Danube heat load it will vary in the range of 52.1-59.4 and increase slightly in the 49.9-56.9 µg/l range.

It can be seen on Figure 12.6.1-18 that the correlation between the values and a water temperature was good-medium, with a high level of seasonal fluctuations (20-120 µg/l). Levels are low in seasons with low water temperature, then increase gradually with the increased water temperature, but simultaneously the values of the coefficient of standard variation will also be greater. With the increase in water temperature both the expected values and their coefficient of standard variation increase.



Hőmérséklet – temperature

Figure 12.6.1-18: Assessment of the correlation between water temperature in the Danube and a-chlorophyll

Sodium-ion

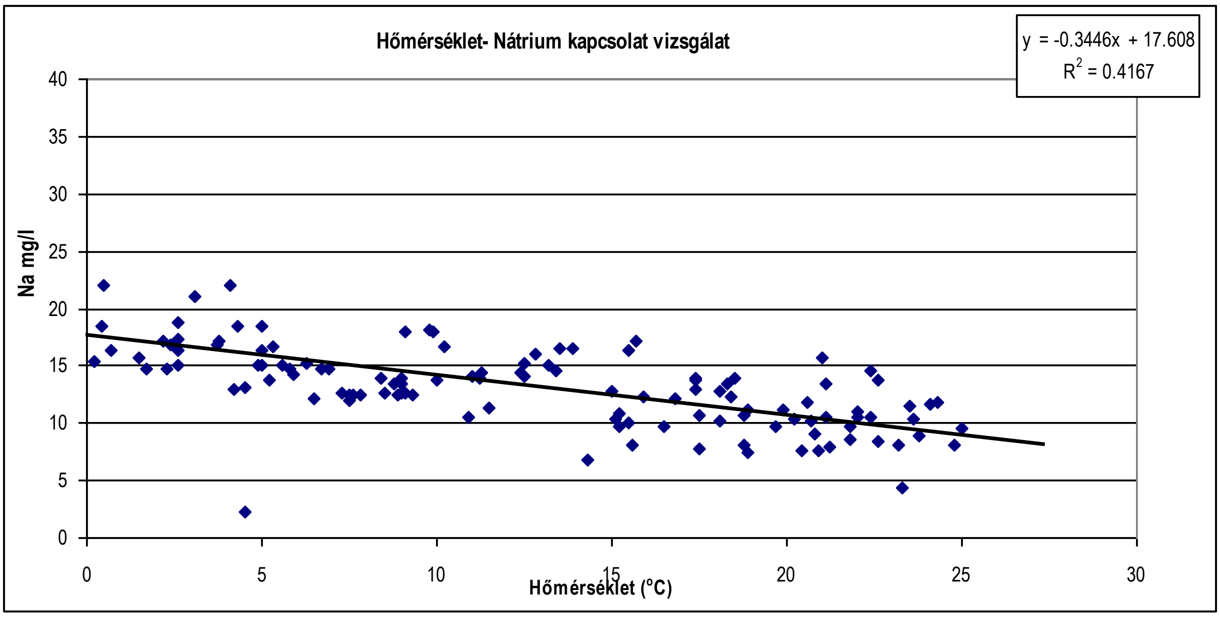
High **sodium ion** content is a typical feature of salt lakes which is usually accompanied by high pH. It arrives into the surface waters by way of contamination (wastewater) and through leaching out from soil. Its concentration was also low in the assessed Danube section. Its volume was not influenced by changes in the water temperature. Cyanobacteria (blue algae) are algae with high sodium requirements, therefore they may grow in waters exposed to organic wastewater load in larger volumes.

The correlation between sodium ion levels and the Danube water temperature is good. Dunaföldvár (0.57) Fadd (0.73) and Hercegszántó (0.69).

The measured average values in the three Core Network profiles in the period between 2006-2011 were 13.7 mg/l in the Dunaföldvár area, 13.4 mg/l in the Fadd area, and 12.8 mg/l in the Hercegszántó area. The coefficient of standard variation along the longitudinal profile varied in the 3.0-3.8 range, seasonal fluctuations of the element are small.

According to the statistical processing of the values the predicted level along the longitudinal profile at the critical water temperature varies between 18.6-10.8 mg/l, in the operating state expected for 2032 between 8.4-10.6 mg/l, and between 7.6-10.3 mg/l in 2085. In the state of the maximum Danube heat load it is expected to vary in the range of 8.3 mg/l, with an estimated range of the coefficient of standard variation between 5.4-11.3 mg/l. With the increase in Danube water temperature a decline of the values is expected over the upcoming decades.

It can be seen on Figure 12.6.1-19 that the correlation between the values and a water temperature was good, referring to a low level of seasonal fluctuations.



Hőmérséklet – temperature

Figure 12.6.1-19: Assessment of the correlation between water temperature in the Danube and sodium ions

Potassium-ion

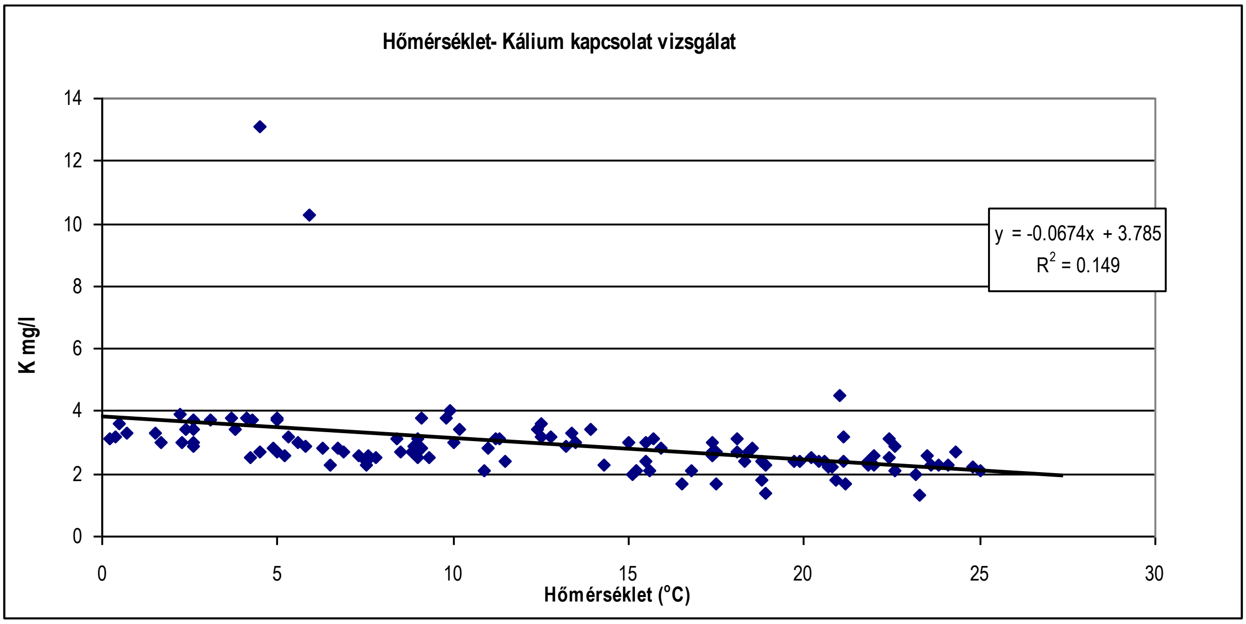
Potassium also gets in the natural waters by sewage. The concentration in the assessed Danube section has always been low throughout the decades under investigation, which is partly influenced by the changes in the water temperature. It also has no impact on the life functions of the living beings and in particular on that of algae.

The correlation between potassium ion levels and the Danube water temperature is good and medium; Dunaföldvár (0.52) Fadd (0.61) and Hercegszántó (0.38).

The measured average values in the three Core Network profiles in the period between 2006 and 2011 were 2.85 mg/l in the Dunaföldvár area, 2.75 mg/l in the Fadd area, and 2.96 mg/l in the Hercegszántó area. The coefficient of standard variation along the longitudinal profile varied in the 1.3-2.3 range, and the seasonal fluctuations of the element exists.

According to the statistical processing of the values the predicted level will vary between 2.0-2.2 mg/l, in the operating state expected for 2032 between 1.8-2.2 mg/l, in 2085 1.7-2.1 mg/l. In the state of the maximum Danube heat load it is expected to be 2.1, with an estimated range of the coefficient of standard variation between 1.6-2.5 mg/l. According to the forecast these values are expected to decline over time. With the increase in Danube water temperature a decline of the values is expected over the upcoming decades.

It can be seen on Figure 12.6.1-20 that the correlation between the values and a water temperature was good-medium, with seasonal fluctuations in the 0.1-0.4 mg/l range.



Hőmérséklet – temperature

Figure 12.6.1-20: Assessment of the correlation between water temperature in the Danube and potassium ions

Evaluation of the expected physico-chemical parameters of the Danube water in the period between 2014 and 2085 according to the WFD for each of the profiles

The status of the Danube waters upstream was characterised by the test profile at Dunaföldvár, at 1560.6 river km,(Table 12.6.1-4), in the downstream section by the Fadd profile at 1506.8 river km, (Table 12.6.1-5) and in the Hercegszántó profile at 1433.5 river km for the national border (Table 12.6.1-6) by the findings of the statistical analysis based on the water quality test data measured in the 2006-2011 (2012) period.

The evaluation according to the WFD was carried out for elements and groups of elements and illustrated in the table for the current period of 2014, and the forecasts for 2032 and 2085 with respect to the expected critical Danube water temperature values.

The summarised evaluation of the physico-chemical parameters in the Danube water body sections according to the WFD was presented in the Table 12.6.1-7.

Water quality parameter /Operating state	Unit	R corr.	Dunaföldvár existing operating state 25.61 °C+ Δt (0.0 °C) = 25.61 °C			Dunaföldvár operating state of 2032 26.38 °C+ Δt (0.0 °C) = 26.38 °C			Dunaföldvár operating state of 2085 28.64 °C+Δt (0.0 °C) = 28.64 °C			2014	2032	2085
			Expected Value	Expected fluctuations		Expected Value	Expected fluctuations		Expected Value	Expected fluctuations		Status/grade		
The critical value of the Danube water temperature and outcome of th profile status assessment	°C		25.6			26.38			28.64			good	good	good
Acidification status												4.0	4.0	4.0
pH (laboratory measurement)		0.302	8.40	8.13	8.68	8.41	8.14	8.68	8.44	8.16	8.71	*4*	*4*	*4*
Salinity												5.0	5.0	5.0
Chloride (Cl^-)	mg/l	**0.591**	16.7	9.8	23.5	16.3	9.4	23.1	15.0	8.2	21.9	*5*	*5*	*5*
Conductivity	µS/cm	**0.707**	322	250	394	316	300	480	301	300	480	*5*	*5*	*5*
Oxygenation conditions												4.6	4.6	4.6
Oxygen (dissolved) (O_2)	mg/l	**0.618**	8.0	6.4	9.7	7.9	6.2	9.6	7.6	5.9	9.3	*5*	*4*	*4*
Dissolved oxygen (percent of oxygen saturation)	%	0.425	103	88	118	104	89	119	106	91	120	*5*	*5*	*5*
Biochemical oxygen demand (BOD_5)	mg/l	0.266	2.02	0.62	3.41	1.98	0.59	3.37	1.86	0.47	3.25	*4*	*5*	*5*
Oxygen consumption(CODd) original	mg/l	0.091	12.5	9.4	15.5	12.5	9.4	15.5	12.6	9.5	15.6	*4*	*4*	*4*
Ammonia-ammonium-nitrogen (NH_3-,NH_4--N	mg/l	**0.680**	0.00	0.01	0.05	0.01	0.00	0.06	0.01	0.00	0.06	*5*	*5*	*5*
Nutrient conditions												4.4	4.6	4.6
Nitrite-nitrogen (NO_2-N)	mg/l	0.104	0.01	0.01	0.05	0.01	0.00	0.05	0.01	0.00	0.05	*5*	*5*	*5*
Nitrate-nitrogen (NO_3-N)	mg/l	**0.865**	0.78	0.01	1.54	0.71	0.30	1.47	0.50	0.25	1.26	*5*	*5*	*5*
Total nitrogen	µg/l	**0.825**	1.28	0.36	2.20	1.20	0.28	2.12	0.97	0.05	1.89	*4*	*4*	*4*
Orto-phosphate (PO_4-P)	mg/l	0.410	0.09	0.01	0.18	0.09	0.01	0.18	0.081	0.00	0.16	*4*	*4*	*4*
Total phosphorus (P)	mg/l	0.095	0.11	0.06	0.15	0.10	0.06	0.15	0.10	0.06	0.15	*4*	*5*	*5*
Other elements not included in WFD														
Total organic nitrogen (in N)	mg/l	0.160	0.49	0.10	0.87	0.48	0.10	0.86	0.46	0.08	0.85			
Chlorophyll-a	µg/l	0.397	47.9	16.8	78.9	49.2	18.1	80.3	53.0	22.0	84.1			
Sodium (Na)	mg/l	**0.570**	9.9	6.3	13.4	9.7	6.1	13.2	9.0	5.5	12.6			
Potassium (K)	mg/l	**0.522**	2.2	1.6	2.9	2.2	1.6	2.8	2.1	1.5	2.7			
Oxygen consumption (CODps) original	mg/l	0.085	4.1	3.0	5.3	4.2	3.0	5.3	4.2	3.0	5.3			

Table 12.6.1-4: Evaluation of the expected water quality parameters in the Danubei background water (Dunaföldvár 1560.6 river km) profile according to the WFD

Water quality parameter /Operating state	Unit of measurement	R corr.	Fadd existing operating state 25.61 °C+ Δt (0.0 °C) = 25.61 °C			Fadd operating state in 2032 26.38 °C+ Δt (2.03 °C) = 28.41 °C			Fadd operating state in 2085 28.64 °C+Δt (0.56 °C) = 29.20 °C			2014	2032	2085	Critical 30 °C
			Expected Value	Expected fluctuations		Expected Value	Expected fluctuations		Expected Value	Expected fluctuation		Classification grade / Status			
The critical value of the Danube water temperature and outcome of the profile status assessment	°C		25.6			28.41			29.20			good	good	good	good
Acidification status												4.0	4.0	4.0	4.0
pH (laboratory measurement)		0.252	8.39	8.13	8.66	8.42	8.15	8.68	8.43	8.16	8.69	*4*	*4*	*4*	*4*
Salinity												5.0	5.0	5.0	5.0
Chloride (Cl^-)	mg/l	**0.612**	15.1	7.8	22.4	13.4	6.1	20.7	12.9	5.6	20.2	*5*	*5*	*5*	*5*
Conductivity	µS/cm	**0.812**	318	258	378	300	290	480	295	285	470	*5*	*5*	*5*	*5*
Oxygenation conditions												4.6	4.6	4.6	4.6
Oxygen (dissolved) (O_2)	mg/l	**0.554**	8.6	7.0	10.2	8.3	6.7	9.9	8.2	6.6	9.8	*5*	*5*	*5*	*5*
Dissolved oxygen (percent of oxygen saturation)	%	**0.516**	109	93	126	113	96	129	113	97	130	*5*	*4*	*4*	*4*
Biochemical oxygen demand (BOD_5)	mg/l	0.114	2.44	1.09	3.79	2.38	1.03	3.74	2.37	1.02	3.72	*4*	*5*	*5*	*5*
Oxygen consumption(CODd) original	mg/l	0.221	12.3	9.5	15.2	12.6	9.7	15.4	12.6	9.8	15.5	*4*	*4*	*4*	*4*
Ammonia-ammonium-nitrogen (NH_3-,NH_4--N	mg/l	**0.724**	0.00	0.01	0.05	0.00	0.00	0.06	0.02	0.01	0.08	*5*	*5*	*5*	*5*
Nutrient conditions												4.2	4.8	4.8	4.8
Nitrite-nitrogen (NO_2-N)	mg/l	**0.628**	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.01	*5*	*5*	*5*	*5*
Nitrate-nitrogen (NO_3-N)	mg/l	**0.887**	0.77	0.06	1.47	0.53	0.40	1.24	0.47	0.30	1.17	*4*	*5*	*5*	*5*
Total nitrogen	µg/l	**0.851**	1.21	0.36	2.05	0.94	0.80	1.79	0.87	0.60	1.71	*4*	*5*	*5*	*5*
Orto-phosphate (PO_4-P)	mg/l	0.426	0.12	0.03	0.21	0.10	0.01	0.19	0.100	0.01	0.19	*4*	*5*	*5*	*5*
Total phosphorus (P)	mg/l	0.017	0.11	0.07	0.14	0.11	0.08	0.14	0.11	0.08	0.14	*4*	*4*	*4*	*4*
Other elements not included in WFD															
Total organic nitrogen (in N)	mg/l	0.165	0.44	0.12	0.75	0.42	0.10	0.74	0.41	0.10	0.73				
Chlorophyll-a	µg/l	0.420	49.7	17.0	82.4	54.9	22.2	87.6	56.4	23.7	89.1				
Sodium (Na)	mg/l	**0.730**	9.6	6.7	12.6	8.8	5.8	11.7	8.6	5.6	11.5				
Potassium (K)	mg/l	**0.609**	2.2	1.8	2.7	2.1	1.7	2.6	2.1	1.6	2.6				
Oxygen consumption(CODps) original	mg/l	0.166	4.1	3.0	5.2	4.2	3.1	5.2	4.2	3.1	5.3				

Table 12.6.1-5: Evaluation of the expected water quality parameters in the Danube downstream (Fadd 1506.8 river km) profile according to the WFD

Water quality parameter /Operating state	Unit of measurement	R corr.	Hercegszántó existing operating state 25.61 °C+ Δt (0.0 °C) =25.61 °C			Hercegszántó operating state in 2032 26.38 °C+ Δt (0.0 °C) =26.38 °C			Hercegszántó operating state in 2085 28.64 °C+Δt (0.0 °C) =28.64 °C			2014	2032	2085
			Expected Value	Expected fluctuations		Expected Value	Expected fluctuations		Expected Value	Expected fluctuations		Status / Class		
The critical value of the Danube water temperature and outcome of the profile status assessment	°C		25.6			26.38			28.64			good	good	good
Acidification status												4.0	4.0	4.0
pH (laboratory measurement)		0.143	8.32	8.06	8.58	8.33	8.08	8.59	8.34	8.08	8.59	4	4	4
Salinity												5.0	5.0	5.0
Chloride (Cl^-)	mg/l	0.418	16.4	7.2	25.6	14.9	5.7	24.2	14.5	5.3	23.7	5	5	5
Conductivity	µS/cm	**0.800**	321	258	384	302	290	480	297	285	470	5	5	5
Oxygenation conditions												4.6	4.4	4.4
Oxygen (dissolved) (O_2)	mg/l	**0.669**	8.1	6.5	9.8	7.7	6.1	9.4	7.6	5.9	9.3	5	4	4
Dissolved oxygen (percent of oxygen saturation)	%	0.413	104	89	118	106	92	120	106	92	120	5	5	5
Biochemical oxygen demand (BOD_5)	mg/l	0.198	2.29	0.92	3.67	2.19	0.82	3.56	2.16	0.79	3.54	4	4	4
Oxygen consumption(COD_d) original	mg/l	0.036	11.2	8.3	14.2	11.2	8.2	14.1	11.2	8.2	14.1	4	4	4
Ammonia-ammonium-nitrogen (NH_3-,NH_4--N	mg/l	**0.663**	0.01	0.01	0.06	0.00	0.00	0.05	0.00	0.00	0.04	5	5	5
Nutrient conditions												4.6	4.8	4.8
Nitrite-nitrogen (NO_2-N)	mg/l	**0.620**	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	5	5	5
Nitrate-nitrogen (NO_3-N)	mg/l	**0.874**	0.83	0.12	1.53	0.60	0.40	1.30	0.53	0.30	1.24	5	5	5
Total nitrogen	µg/l	**0.792**	1.27	0.34	2.20	0.99	0.50	1.93	0.92	0.40	1.85	4	5	5
Orto-phosphate (PO_4-P)	mg/l	0.333	0.09	0.00	0.18	0.08	0.03	0.17	0.074	0.02	0.16	5	5	5
Total phosphorus (P)	mg/l	0.085	0.11	0.07	0.15	0.11	0.07	0.15	0.11	0.07	0.15	4	4	4
Other elements not included in WFD														
Total organic nitrogen (in N)	mg/l	0.214	0.42	0.01	0.83	0.39	0.25	0.80	0.38	0.20	0.79			
Chlorophyll-a	µg/l	0.383	45.0	13.2	76.8	49.5	17.7	81.4	50.8	19.0	82.6			
Sodium (Na)	mg/l	**0.667**	8.6	4.8	12.4	7.7	3.9	11.4	7.4	3.6	11.2			
Potassium (K)	mg/l	0.379	2.0	0.5	3.5	1.8	0.3	3.3	1.7	0.3	3.2			
Oxygen consumption(CODps) original	mg/l	0.080	3.6	2.6	4.6	3.6	2.6	4.6	3.6	2.6	4.6			

Table 12.6.1-6: Evaluation of the expected water quality parameters in the Danube downstream national border (Hercegszántó 1433 river km) profile according to the WFD

Danube water body sections	Existing operating state (2014)	Operating state in 2032	Operating state in 2085	2014	2032	2085	Critical 30 °C
DANUBE (HURWAEP444) water body Paks upstream section	**Dunaföldvár** 25.61 °C+ Δt (0.0 °C) =25.61 °C	**Dunaföldvár** 26.38 °C+ Δt (0.0 °C) =26.38 °C	**Dunaföldvár** 28.64 °C+Δt (0.0 °C) =28.64 °C	good	good	good	
DANUBE (HURWAEP444) water body Paks downstream section	**Fadd** 25.61 °C + Δt (0.0 °C) =25.61 °C	**Fadd** 26.38 °C+ Δt (2.03 °C) =28.41 °C	**Fadd** 28.64 °C+Δt (0.56 °C) =29.20 °C	good	good	good	good
DANUBE (HURWAEP445) water body national border	**Hercegszántó** 25.61 °C + Δt (0.0 °C) =25.61 °C	**Hercegszántó** 26.38 °C+ Δt (0.0 °C) =26.38 °C	**Hercegszántó** 28.64 °C+Δt (0.0 °C) =28.64 °C	good	good	good	

Table 12.6.1-7: Summary sheet of the evaluation of the Danube water body sections by physico-chemical parameters according to the WFD

Summary of the consequences of warmed up cooling water discharge into the Danube

Based on the summary of former studies on the water quality, water discharge rate and water temperature conditions of the Danube the increase of heat generation can be implemented in a manner which does not violate any restrictions intended to protect the water quality of the receiver and does not contradict the interests of nature conservation. Provided the limits contained in the applicable provisions are met during operation, the water quality and physical quality of the Danube will not be changed compared to the current status with respect to heat generation as a result of the discharges from the Paks II Nuclear Power Plant even under adverse conditions.

In summary, it can be concluded from the water quality testing of the Danube carried out at the Core Network points in the 2006-2011 (2012) period and under the assignment from MVM ERBE Zrt. in 2012-2013 that the heat load will be slightly increased according to the calculations after the implementation of the increase of the proposed power output.

However, no substantial changes are expected to occur as a result of the increase of the output in the future in terms of the level of the indicators showing acidification status, salinity status, oxygenation conditions status and nutrients status characterising the water quality of the Danube, that is in terms of the indicators depending on the increase of temperature to a major or lesser extent.

Although decomposition processes of organic matter in the river are accelerated by the impact of the warmed up cooling water discharged into the river from the Nuclear Power Plant which are accompanied by oxygen consumption and oxygen abstraction, they are offset by the hydraulic and mixing conditions in the river as well as by the typically high dissolved oxygen content. The aforementioned impacts are not expected to be considerable in their extent yet they can not be disregarded for water quality reasons and their future monitoring is recommended.

Summary of the consequences of treated wastewater discharge into the Danube

The current volume of treated wastewater will grow up to about three times, meaning primarily yet another source of organic matter. The volume of biologically degradable organic matter along a short 100 metres section downstream of the hot water canal will be increased in the river. Water quality changes are expected in oxygen turnover (dissolved oxygen contents, BOD_5, COD_{ps}, COD_{Cr}) and in the indicators of plant nutrients. For the latter the amount of ammonia/ammonium, a nitrite and nitrate ions is expected to grow, leading to the reduction of dissolved oxygen contents during decomposition processes and furthermore in the seasons characterised by high water temperature levels to a stronger algal growth, thus encouraging eutrophication processes. The various forms of phosphorus originating from the municipal wastewater (primarily orto-phosphate phosphorus) reinforce the latter. Eventual strengthening of the processes referred to above is indicated by the increase of the a-chlorophyll contents along the longitudinal profile. Other indicators tested include electrical conductivity, chloride, sodium, potassium and sulphate ions reflecting by their increase the impact of pollutants the surface waters are exposed to.

Continuous tracking of the treated wastewater discharge from the waste water treatment plant of the existing power plant and ongoing monitoring of compliance with the respective emission limits for the water quality elements required by the water rights operating license will be important.

Earlier monitoring studies confirmed the conclusions drawn from testing of water at the Core Network sampling sites: the impact of spent water from the Paks Nuclear Power Plant on the longitudinal profile of the Danube could be mainly demonstrated in terms of water temperature, and the indicators of oxygen turnover, as well as with respect to certain micro-pollutants, crude oil derivatives and elements of household wastewater. However, the concentration of these pollutants exceeded the typical Danube water level only in a slight extent.

An amount of 240–280 thousand m^3 municipal wastewater is generated in the Paks Nuclear Power Plant annually. The own waste water treatment plant of the Paks Nuclear Power Plant is equipped with total oxidation and sewage treatment by sludge activation, and has a nominal capacity of 1870 m^3/day (657 thousand m^3/year). Purified wastewater is led in a pipeline to the hot water-canal in the section upstream of the energy dissipation/dissipating device and from here it is discharged into the Danube together with the spent cooling water, after dilution up to several thousand-fold.

Water extracted from the Danube is used as industrial process water for make up, in addition to its role as cooling water. Approximately 1 million m^3 desalinated water is produced by the ion exchange procedure. In the procedure some 140–160 thousand m^3 acidic and alkaline contaminated industrial wastewater is generated which is neutralised and settled in 10 000 m^3 sludge ponds in the area between the cold and hot water canal. Water quality of and discharges from the ponds are controlled by regular inspections both in plant and by the authorities. Industrial wastewater is discharged directly into the hot water canal, in the 0+900 km and 1+020 km profile.

In summary of the findings from the water quality tests carried out on the types of water and waters of the structured listed above it was concluded that they reflect a beneficial tendency in terms of trophity (nitrite, nitrate, ammonium concentration, orto-phosphate anion and a-chlorophyll contents) in the past years and past decades. They were ranked in good water quality classes, occasionally (summer and early autumn periods) with radically increased numbers of algae. A similarly favourable picture could be described for the parameter of oxygenation conditions (COD, dissolved oxygen contents and percentage value of saturation). Based on organic matter contents and mineral loads of the Danube (parameters reflected by the specific electrical conductivity) all of the samples could be listed in the high quality class.

Based on the evaluation of test results from earlier decades it can be demonstrated that municipal wastewater discharged into the Danube from the hot water canal of the Paks Nuclear Power Plant have practically no detectable impact on the quality of water. Danube water quality improved gradually in the past years on the basis of the findings from tests carried out at the Core Network sampling sites.

Practically no detectable impact on the quality of water can be confirmed from the treated municipal wastewaters discharged into the river in double or triple amounts during the erection, operation and abandonment of Paks II. In failure event situations untreated wastewater may raise the levels of the elements listed before to a slight extent along a shorter section, but this extent will not change the ranking of the current water quality grade.

12.6.1.2.2 Direct impacts on the ecological status of the Danube

Hydrological impacts of the waters discharged from the hot water canal

Cooling water and other wastewater discharged into the main riverbed of the Danube across the approximately 1500 metres long profile of the hot water canal represent a discharge volume of ~135 m^3/s in total during the period when both units of Paks II operate independently (2037-2085). This will change the flow conditions in the Danube at the outlet. As a consequence, the findings of the research laying the foundations for the impact study suggest that in the surrounding of the discharge point the species composition of the phytobenthos conditionally and that of the macrozoobenthos as well, as of the fish community decidedly will be modified and their abundance levels increased at least partially. This impact is long term, medium strength, but low significance.

During operation a ban on fishing and angling may be suggested in a 250 radius circle around the discharge point for the purposes of protecting the fish community.

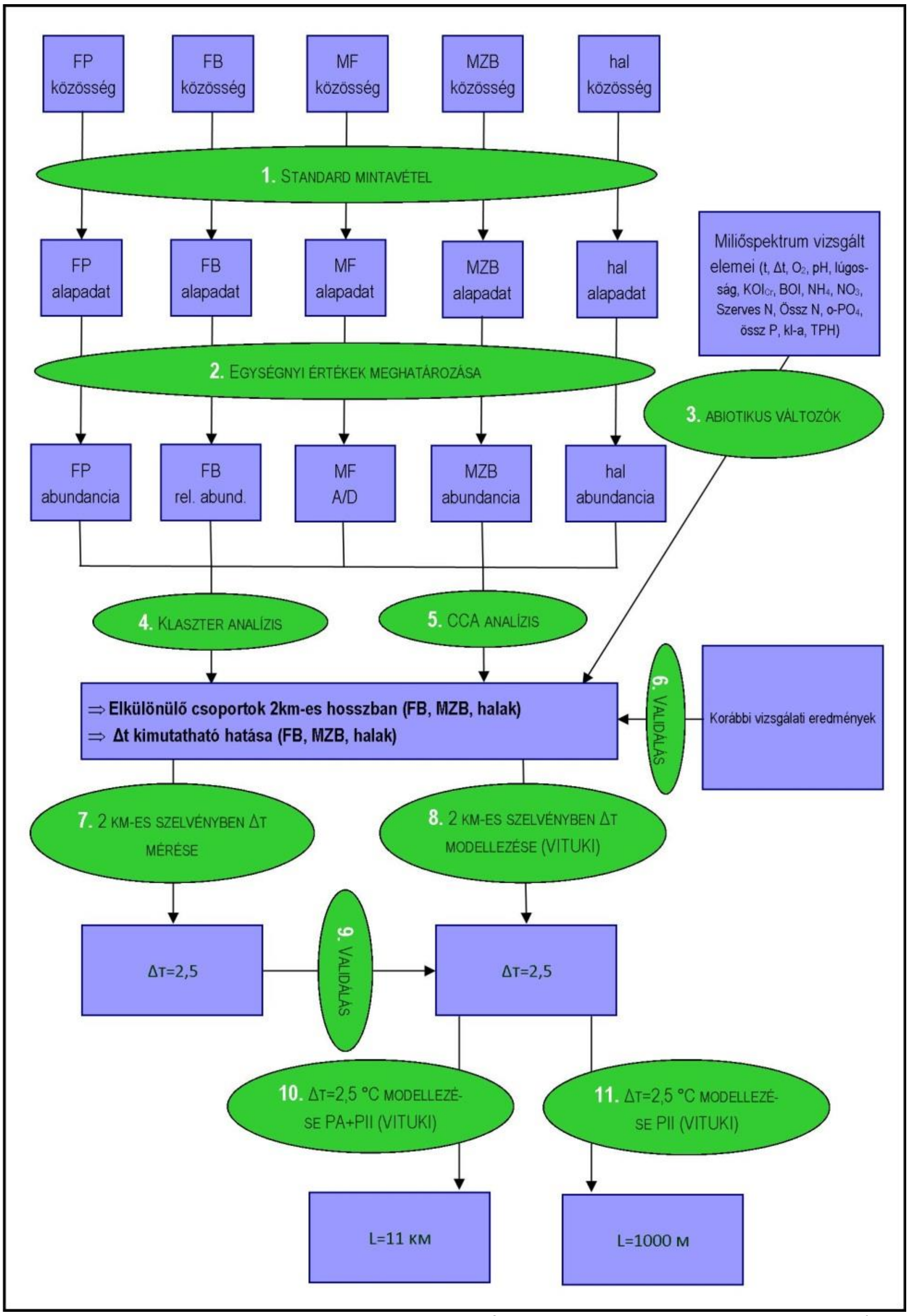
Impacts of temperature increase in the waters discharged from the hot water canal

During the independent operation of Paks II the largest single environmental impact on the ecological status of the Danube is represented by the warmed up cooling water.

When the base state was assessed, the impact of hot water in a length of approximately 2 kilometres on the right bank profile could be demonstrated conditionally in the case of the phytobenthos and beyond doubt for the macrozoobenthos and the fish. It means the detection of a Δt=2.5 °C temperature increase for these taxons. At the same time the growing temperature did not cause any detectable change on the structure of the plankton algal community (for details see Chapter 12.3).

The findings of the ecological analysis indicate that the impact demonstrated can not be seen as a lethal or sub lethal acute effect, much rather a long term, chronic impact where environmental factors of shorter duration play only a negligible role no role at all. Albeit the strength of the impact may be different pending on the season or the water level, thus for instance a hypothetical effect in the case of the phytobenthos could be identified only in the late summer season characterised by high level of biomass, and the same was the case for fishes, while in the event of the macrozoobenthos the impact was felt more explicitly in the low water stage autumn season, yet all in all these differences were not originating from the actual seasonal impact but the deviations of the sampling sessions conducted under different conditions. It is demonstrated by the analyses that the impact of hot water varies at the detection level even under optimum sampling conditions, because the impact of the Paks Nuclear Power Plant discharge is superseded by the natural diversity of the environmental conditions on the Danube. A good example for this is that any changes in the fish community structure could be detected definitely only when evaluating sampling sites with homogeneous environmental conditions with pebbled bottom. The impact itself bears significance more for the duration and permanent manner of the exposition rather than due to its extent. During the period of independent operation of Paks II (2037-2085) lower heat loads should be calculated with then the benchmark levels, at least according to the model calculation prepared by VITUKI Hungary Kft. Thus it can also be assumed that no further impact bearer groups of living organisms need to be reckoned with beside the three taxons mentioned. Considering all these factors the impact caused by the heat load is deemed to be long term, medium strength and of large significance. Operation of the recuperation hydropower plant might be assumed as favourable for the purposes of the discharge temperature but the calculations also suggest that the construction of an auxiliary cooling capacity may also be needed in a conditional manner.

The determination of the impact and the impact area of heat generation on biological elements was carried out in accordance with the process on the following flowchart.



Legend:
közösség - community
hal közösség - Fish community,
alapadat – baseline data
abundancia – abundance
relative abundancia – relative abundance
hal abundancia – fish abundance
klaszter analízis – cluster analysis
elkülönülő csoportok 2 km-es hosszban – separating groups in a 2 km length
halak – fishes
ΔT kimutatható hatása (FB, MZB, halak) – detectable impact of temperature differential (FB, MZB, fishes)
2 km-es szelvényben ΔT mérése – measurement of temperature differential in a 2 km long section
2 km-es szelvényben ΔT modellezése (VITUKI) – modellilng of temperature differential in a 2 km long section (VITUKI)
abiotikus változók – abiotic variables
miliőspektrum vizsgált elemei – inspected elements of the environmental spectrum
validálás – validation
analízis – analysis
korábbi vizsgálati eredmények – findings from former investigations
ΔT 2,5 °C modellezése – modelling of temperature differential of 2.5 °C

Figure 12.6.1-21: Flow chart for the determination of the impact and impact area of heat loads ofr biological elements

Potential impacts of heat loads on the algal community

Having regard to the fact that biochemical processes in the cells are temperature dependent in their nature and their intensity is at the maximum mostly in the 25 °C and 40 °C range (Reynolds 1984) you may conclude that heat loads must cause a clear growth of biomass along the assessed section. This is however an over simplification of the problem doubtlessly leading to faulty conclusions.

In fact, three basic factors determine the formation of the phytoplankton biomass and composition: the amount of plant nutrients, the light climate and temperature conditions. In terms of importance light and the amount of nutrients prove to be the decisive factors in most of the cases. The secondary role of temperature is demonstrated by the observation that high biomass phytoplankton may be formed in winter seasons as well (Kiss & Genkal 1997). A large part of the fluvial taxons is able to reproduce at low temperature (5 °C-on), but naturally it can not be questioned that phytoplankton taxons are able to grow more intensively in higher temperature ranges. The overwhelming majority of the species grows well at 25°C (for instance *Asterionella formosa* and *Ceratium furcoides* reproduce with a frequency of 1.7 division/day and 0.3 division/day, respectively), but at 30 °C such taxons typical for watercourses like the flagellate and diatom species and certain cyanobacteria (*Cryptomonas marssonii*, Asterionella *formosa*, a *Dinobryon divergens* and *Eudorina spp.*) do not express growth any more. And at 35°C only a few species of cyanobacterium are able to reproduce, for instance *Aphanizomenon flos aquae* (Butterwick et al., 2005). In other words, the species are able to move along a wide range of temperature scale but they arguably have a kind of temperature optimum. For instance, the growth optimum for *Aulacoseira subarctica* and *Stephanodiscus hantzschii* is in the range of 20 °C. For *S astraea* this value is at 16 °C. Above that level a diminishing growth rate should be reckoned with. The rate of reproduction for *Stephanodiscus hantzschii* is 0.7 division/day at 5 ºC, but at 20 ºC the frequency of division is 1.4 division/day. At the temperature of 15 °C the reproduction rate of *Planktothrix agardhii* and *Limnothrix redekei* cyanobacterium species fall short of the level of 1 division/day. And the majority of the Microcystis species is simply not able to grow below the level of 15 °C (Robarts R.D. & T. Zohary, 1987). This means that the growth rate of the diatom species keeps up with that of cyanobacteria up to 14-15 °C, but above that temperature level blue algae gain advantage (Foy & Gibson, 1993).

The findings referred to above were determined under laboratory conditions and with such experimental circumstances where all parameters are controlled. In spite of this it can not be claimed that the figures obtained would be universal. It turned out by laboratory tests as well that the response of algae to temperature changes is subject to the conditioning method of the cultures. In fact, cultures kept at different temperature levels may react to the increase in the temperature in a number of ways. The reason for this is that genetic lines with varied temperature needs may exist within the same species which in turn will become dominant in the culture when temperature favours them.

Based on the considerations referred to above it can be understood why the impact of heat loads can not be simplified to such extent. Changes in the natural aquatic systems have an influence on the light and nutrient conditions and take place on a time scale decisive for phytoplankton. The impact of the temperature could not be justified beyond doubt even in cases when the heat load affected a stagnant water body. A Finnish example demonstrates (Ilus & Keskitalo 2008) that although the species composition of the phytoplankton varied with the rise of water temperature in the bay of the Baltic sea, but the process was accompanied by the eutrofication of the sea, and thus it can not be decided what is the role of temperature and what is the role of growing nutrient contents in the changes reflected by the composition and biomass of the phytoplankton. The same applies even more to fluvial systems. Differences in sediment loads caused by fluctuations of the rate of flow result in such dramatic changes in the light conditions that substantially exceed the potential impacts, and thus possibly contributing to the rise of temperature. Natural fluctuations in the water temperature of the river may range of to 2-5 °C when the same months of subsequent years are taken for the basis of comparison (Hirling 2011), meaning that in any given year the average monthly water temperature may be lower including the heat loads just as well than it would be in the next year without any heat loads. Another important factor affecting mainly rivers is that the cyanobacterium species enjoying an adaptive benefit from rising temperatures usually can not be detected in the momentary species inventory of a river. Certainly you must reckon with the possibility that the rise of the cooling water temperature taken place in a sudden manner, meaning rather a heat shock for living organisms as opposed to a gradual change pointing towards their respective temperature optimum. Thus it may well be the case that an increase in temperature would result in a decline of the growth rate. It is also an important momentum that from the perspective of thermodynamics rivers are open systems and the raised temperature values level out along the length of the river. In order to have a perceivable impact of increased temperature on phytoplankton it is needed that multiple generations of algae be exposed to the higher temperature. Taking the flow rate of major lowland watercourses approximately 1 m/sec (Lászlóffy, 1980) and calculated with the reproduction rate of the largest members of plankton in watercourses, that of the diatom species (1.5-2 day/division) this situation would occur when the raised temperature lasted up to a several hundred kilometres long section of the river, certainly without any material changes in the light and nutrient conditions.

For these reasons is might be understood why the current heat loads the Danube is exposed to have no substantial impact on the phytoplankton. Higher cooling water needs associated with the extension of the power plant cause higher heat exposure, yet in spite of all this it can not be expected to have any significant impact on the phytoplankton. The theoretical possibility of a potential impact may emerge in case of low water levels and higher nutrient loads.

Toxic impacts of the industrial wastewater discharged into the hot water canal

During the use of process water a number of different radioactive and conventional industrial waste water flows are generated in a total amount of 50 m^3/h. Under standard operating conditions these contaminations are removed by specific purification processes. Waste water thus generated with contaminant concentrations below the respective limit values are discharged into the Danube through the hot water canal. A part of the contaminants introduced in the wastewater might be present in detectable concentrations after treatment as well. At the same time a further part of the contaminants undergoes further biological degradation when passing along the 1500 metres of the hot water canal and is discharged into the Danube as the receiver diluted to a great extent (1:0.0001). When the benchmark data were assessed, this impact of the Paks Nuclear Power Plant on the ecological status of aquatic organisations could not be demonstrated. Therefore, in summary, the wastewater flows discharged will not have any detectable impact on the aquatic organisations of the Danube under standard operating conditions. However, this impact is still defined as a long term, poor, but medium significance impact due to the hazardousness of the substances emitted. Throughout the entire standard operating period efforts should be made to achieve ever higher efficiency rate of purification and to monitor discharges on an ongoing basis.

The impact of treated municipal wastewater

Based on the design data the amount of municipal wastewater generated during the independent operation of the two units is 320 m^3/day, which is lower than during the construction phase and is higher only to a slight extent than the daily volume generated by Paks Nuclear Power Plant (300 m^3/day). The waste water treatment plant will be able to handle the wastewater volumes generated. Purified wastewater is discharged into the Danube through the hot water canal. Residual nutrient concentration and composition in the treated wastewater flow is expected to exceed those in the Danube to a small extent and differs from that typical for the Danube under natural conditions. High ratio of dilution in the hot water canal and mixing reduce this impact due to the natural purification capacity. Due to this reason treated wastewater discharges will not have any detectable impact on the ecological structure of the aquatic organisations in the Danube. Taking the discharge volume into account the hydrological impact of the discharge will also not be detectable (hot water release = 132 m^3/s, treated wastewater release = 0.004 m^3/s). Based on this consideration the treated wastewater, albeit representing a long term impact, this impact will be poor and low significance, thanks to the purification process and the dilution effect, thus it can be highlighted that it will not have any detectable impact on the wildlife in the Danube. However, continuous monitoring of the emissions from the waste water treatment plant is an important measure to prevent a potential failure event.

12.6.1.2.3 Indirect impacts

During the independent operation of Paks II the indirect impact of hot water on the Danube might be transmitted by the riparian groundwater bodies at least partially. The extent and delineation of this impact is set forth in details by the studies described in the Chapter of this Environmental Impact Study prepared by *Kék Csermely Kft-Smaragd Kft*. and entitled "*Geological medium and underground water in the Danube valley*". No such kind of indirect impact can be justified from the other – partly potential only – environmental impacts revealed for the independent operation of Paks -II.

Indirect impacts transmitted through the living communities are partly represented by the structural modifications encountered in the communities concerned resulting from the competition and rivalry seen as a consequence of changes in the community of consumer organisations due to changes in the nutrient turnover and partly as a consequence of growing relative or absolute abundance of invasive species.

12.6.1.2.4 Transboundary environmental impacts

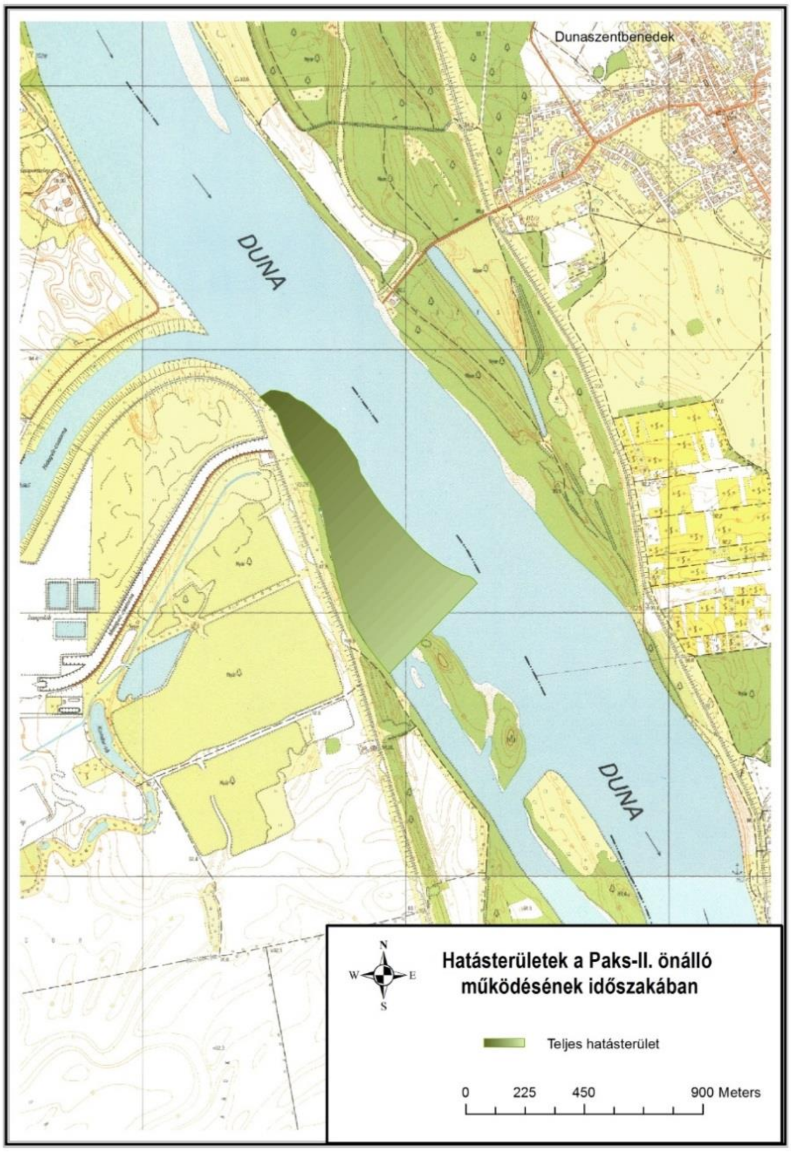
No transboundary physico-chemical or ecological impacts can be expected in the period of operation of Paks II on the living watercourse of the Danube, provided the respective parameters of the current water rights operating permit are adhered to.

12.6.1.3 Impact areas of the operation of Paks II

12.6.1.3.1 Direct impact area

When the restrictions currently applicable to the operation schedule of Paks Nuclear Power Plant are adhered to during the period of joint operation no independent impact area on the Danube can be considered with respect to physico-chemical parameters, since no such separate impact area can be identified due to the common hot water outlet point. The demarcation of the impact area was provided in Chapter 12.6.1.7.

The following impact area can be defined for the purposes of biological elements on the basis of statistical calculations. The impact of hot water in a length of approximately 2 kilometres on the right bank profile could be demonstrated conditionally in the case of the phytobenthos and beyond doubt for the macrozoobenthos and the fish during the assessment of the benchmark status. It means the detection of a Δt=2.5 °C temperature increase for these taxons. For the stand alone operation period of Paks II (2037-2085) VITUKI Hungary Kft. prepared a model calculation for low water levels in this Environmental Impact Study, taking into account the 33 °C limit to discharge temperatures, and the calculated rise in ambient temperature. The latter will be the highest in 2085, with a level of 28.64 °C according to the model calculations. On this basis it can be stated that the Δt=2.5 °C detection value in this period on the downstream section of the Danube – when calculated with the highest annual mean temperature in 2085 – is found in a distance of approximately 1000 metres, where its width reaches the main current line of the Danube. (Figure 12.6.1-22).



Hatásterületek a Paks-II önálló működésének időszakában – Impact areas in the period of stand alone operation of Paks II
Teljes hatásterület – entire impact area

Figure 12.6.1-22: The entire impact area of Paks II in the period of stand alone operation

12.6.1.3.2 Indirect impact area

During the independent operation of Paks II the indirect impact of hot water on the Danube might be transmitted by the riparian groundwater bodies at least partially. The extent and delineation of this impact is set forth in the Chapter of this Environmental Impact Study entitled "*Geological medium and underground water in the Danube valley*".

For biological elements the indirect impact area determined for heat loads in the period of stand alone operation of Paks II does not differ from the direct impact area in terms of nutrient turnover. However, the expanse of the impact area can not be interpreted at the supra-individual level for the release of the invasive species, therefore the impact is recorded but no associated impact area was determined. Accordingly, the entire impact area is identical with the direct impact area.

12.6.1.3.3 Transboundary environmental impacts

During the service period of Paks II Nuclear Power Plant the area of direct and indirect impacts does not reach the national border, consequently no transboundary impact can be identified.

12.6.1.4 Direct joint impacts of simultaneous operation of Paks II and Paks Nuclear Power Plant

The impact of joint operation of both Paks II and Paks Nuclear Power Plant on the physico-chemical status of the Danube was set forth in details in Chapter 12.6.1.2 and it was qualified on the basis of the WFD set of criteria. Classification outcome was presented on Table 12.6.1-4, Table 12.6.1-5, Table 12.6.1-6 and Table 12.6.1-7.

The period of full scale joint operation of both facilities will be in 2030 to 2032, while the terminal date for the gradual shut down of Paks Nuclear Power Plant units is 2036. The 2030-2032 period can be seen as the most robust in terms of discharges, and following this date the load will be gradually reduced to the level of stand alone operation. Impacts do not differ in qualitative terms, but their amount is greater. On this basis the following statements can be made for the impacts.

Hydrological impacts of the waters discharged at the hot water canal

Cooling water and other wastewater discharges amount to ~232 m^3/s. As a result of the research laying the foundations for the impact study suggest that in the surrounding of the discharge point the species composition of the macrozoobenthos and the fish community and the increase in their abundance – at least partially. Additionally, the change of the relative abundance in the phytobenthos and the impairment of its ecological status can be demonstrated. This impact is long term, medium strength, but low significance. During operation a ban on fishing and angling may be suggested in a 250 radius circle around the discharge point for the purposes of protecting the fish community.

Impacts of the temperature increase in waters discharged at the hot water canal

During the joint operation of Paks Nuclear Power Plant and Paks II the Δt value will not change as a result of the heat limit, but the growing volume of the cooling water let into the river may result in a substantial protraction of the heat load longitudinally.

Of all impacts assessed, this period and this impact are seen as the strongest and also the most significant, when all is taken together. Based on what was said in the former chapters, the group of organism exposed to direct impacts still include phytobenthos, macrozoobenthos and fishes. The impact caused by heat exposure is long term, strong and high significance. At the same time it can be concluded on the basis of the findings obtained from the ecological status assessment that the impact of heat loads (in aggregate, when all the six units operate jointly) will not cause any grade level impairment of the ecological status in any of the groups along the affected Danube-section when classified according to the WFD.

Operation of the recuperation hydropower plant might be assumed as favourable for the purposes of the discharge temperature. In low water stage seasons in summer operational shut down of units may be necessary and the construction of an auxiliary cooling capacity may also be needed.

Toxic impacts of the industrial wastewater discharged into the hot water canal

The amount of industrial wastewater discharged is increased to double in this period (~90 m^3/h), but the concentration does not change as a result of the purification process. Based on this the same statements can be made for joint operation which was made to the stand alone operating period of Paks II. A part of the contaminants introduced in the wastewater might be present in detectable concentrations after treatment as well. At the same time a further part of the contaminants undergoes further biological degradation when passing along the 1500 metres of the hot water canal and is discharged into the Danube as the receiver diluted to a great extent (1:0.0003). When the benchmark data were assessed, this impact of the Paks Nuclear Power Plant on the ecological status of aquatic organisations could not be demonstrated. Therefore, in summary, the wastewater flows discharged will not have any detectable impact on the aquatic organisations of the Danube under standard operating conditions. However, this impact is still defined as a long term, poor, but medium significance impact due to the hazardousness of the substances emitted. Throughout the entire standard operating period efforts should be made to achieve ever higher efficiency rate of purification and to monitor discharges on an ongoing basis.

The impact of treated municipal wastewater

Based on the calculations made the joint volume of the municipal wastewater generated by the simultaneously operating six units in the two facilities will be 620 m³/day. This value is lower than the wastewater level during the construction phase. The existing waste water treatment plant will be able to handle the wastewater volumes generated. Purified wastewater is discharged into the Danube through the hot water canal. Residual nutrient concentration and composition in the treated wastewater flow is expected to exceed those in the Danube to a small extent and differs from that typical for the Danube under natural conditions. High ratio of dilution in the hot water canal and mixing reduce this impact due to the natural purification capacity. Due to this reason treated wastewater discharges will not have any detectable impact on the ecological structure of the aquatic organisations in the Danube. Taking the discharge volume into account the hydrological impact of the discharge will also not be detectable (hot water release = 232 m³/s, treated wastewater discharge = 0.007m³/s). Based on this consideration the treated wastewater, albeit representing a long term impact, this impact will be poor and low significance, thanks to the purification process and the dilution effect, thus it can be highlighted that it will not have any detectable impact on the wildlife in the Danube. However, continuous monitoring of the emissions from the waste water treatment plant is an important measure to prevent a potential failure event.

12.6.1.5 Indirect joint impacts of simultaneous operation of Paks II and Paks Nuclear Power Plant

During the simultaneous operation of the six units in the two facilities indirect impacts are represented by the structural modifications encountered in the communities concerned resulting from the competition and rivalry seen as a consequence of changes in the community of consumer organisations due to changes in the nutrient turnover and partly as a consequence of growing relative or absolute abundance of invasive species. From the findings of earlier studies (Halasi-Kovács [12-14], SCIAP [12-37]) and of the base state assessment the fact can be established that water spaces with the appropriate conditions in the affected section may function as the focal points for reproduction of the invasive species, contributing to the further advancement of these species as an indirect impact of the hot water discharge.

12.6.1.6 Evaluation of the joint impacts of simultaneous operation of Paks II and Paks Nuclear Power Plant in the light of the River Basin Management Plan

Based on the river sub-basin management plan of the Danube (VKKI [12-45]) the entire domestic section of the Danube has a moderate ecological status, and does not reach the good status. This might partly be derived from qualitative, but also from hydromorphological causes of the same or similar weight, since in terms of chemical status the Danube is classified good. Based on the phytoplankton and phytobenthos the classification grades of the Danube Szob-Baja and south of Baja sections are good. Based on the assessment of the macrozoobenthos and fish communities, none of the Danube water bodies reached good status. This is predominantly due to the hydromorphological impacts originating from flood control works, embankment, channel bottom alterations, since in terms of other elements indicating organic matter contamination all sections received good grade. Macroscopic invertebrates in the macrozoobenthos show a medium-critical contamination level in the Danube and most of its tributaries on the basis of the assessment method approved by the ICPDR.

A hydromorphological factor to be highlighted is the diminishing volumes of sediment and consequential river bed erosion caused basically by the dams on the German, Austrian and Slovak section of the Danube. As a consequence, the natural bed load carriage of the river is impeded and transport of boulders bed load has practically vanished. The energy potential or the river destined for bed load movement is now dedicated to bed erosion and by the increased the low stage channel bottom is gradually incised. The reduced capacity of bed load movement and the deepening of the channel bottom has a material impact on the composition of the stream bed material, the water replenishment problems encountered on the tributary system but it also has significant consequences for the aquatic wildlife of the river. A hydromorphological intervention having the most significant impact on the ecological status of the entire domestic Danube-section is the upstream transversal closures – with the largest single impact caused by the Gabcikovo barrage system – on penetrability. As a consequence of the river training works between Budapest and Baja the length of the river was reduced by approximately 40 %, with a gradient increasing almost twice, increasing the speed of flow, which is accompanied by higher energy levels of stream bed destruction. Also important is the impact of hydromorphological interventions providing flood control and bank protection. Securing of the navigation route has an important role to play in this.

The Danube is a decisive part of the European inland water course, and the Danube - Main- Rhine water course constitutes a part of the Tran European Traffic Corridor No VII. Marking out of the navigation route must be accomplished on the Danube with a view to the local features of and traffic on the course, as well as to the dimensions of the convoys typically travelling on it, which are regulated by international conventions, laws and regulations. Important alterations were made to ensure the navigation route which however affected the ecological status negatively (for instance a great part of the river branches between the shore and the islands were closed off at the upstream end, elimination of the pebbled habitats and transient channel bottom sections which served as the most significant habitats of the endemic Danube fauna).

Based on the physico-chemical parameters, the quality of the water in the Danube River can be considered good up to Budapest, and impairment in the quality must be reckoned with due to the capital. The maximum level of contamination with organic matter (BOD_5 and COD) is reached downstream of Dunaföldvár (1560 river km), the quality starts to improve afterwards. The organic matter contents in the Hungarian downstream section are not high relative to the rate of flow in the river, but based on microbiological features the water is polluted. Key pollution sources of the river with paramount importance include the wastewater drainage systems in riparian cities like Budapest, Győr or Baja. Beside point sources diffuse pollution also represent a major exposure.

Based on the facts stated in the VGT it can be stated that the achievement of the good ecological status on the Hungarian Danube section is feasible only by a joint effort of all riparian countries. The moderate ecological status experienced as a result of the hydromorphological interventions and pollutant emissions can be improved by a grade level only through large scale and expensive interventions, while the measures necessary for such an improvement are very difficult to harmonise with a number of other measures of high political (the problem of Gabcikovo), as well as economic (navigation route) priority or can not be harmonised at all. According to the plans the good ecological status of the Danube water body in the Szob-Baja section marked HURWAEP 444 can be achieved by 2027 as an environmental target (VKKI [12-45]).

The findings of the benchmark assessment carried out as part of the environmental impact study in 2012 and in 2013 based on the WFD criteria demonstrated that the classification grades of the study elements (physical and chemical parameters of the water: good; FP: good; FB: moderate; MF: moderate; MZB: moderate; fish: good) were appropriate compared to the levels included in the VGT, none of them reflected any worse conditions. All in all the status of the assessed Danube-section defined in the VGT was moderate. Finer resolution analysis pointed out that the operation of the Paks Nuclear Power Plant causes detectable impact on the ecological structure of the macrozoobenthos, as well as the fish community by the head load from the hot water discharge, while the same impact in the event of phytobenthos could not be excluded. The impact manifested in the structural parameters of the community can be demonstrated up to a temperature differential of Δt=2.5°C. Temperature change is observed during the operation of the Paks Nuclear Power Plant in a 2 km length along the affected right bank profile of the Danube. As a result of the studies it could also be confirmed that the extent of the impact will not cause any grade level impairment of the ecological status in any of the groups along the Danube-sections concerned. This is proven by the findings of the upstream and unaffected sections, as well as the results of the status assessment included in the VGT.

Based on the ecological analyses the temperature variation (Δt) of the environmental factor could be detected due to the heat load. The findings of the ecological analysis indicate that the impact demonstrated can not be seen as a lethal or sub lethal acute effect, much rather a long term, chronic impact where environmental factors of shorter duration play only a negligible role no role at all. Therefore, the duration of the exposure is the significant factor in the heat loads. It is demonstrated by the analyses that the impact of hot water varies at the detection level even under optimum sampling conditions, which can be superseded by the variability of the natural environmental conditions of the Danube.

The key environmental impact in the course of the Paks II investment project is represented by the heat loads. The highest detectable heat exposure is expected to be present in the 2030-2032 period. At this time all the four units in Paks Nuclear Power Plant and the two new units of Paks II will be operational. The total impact area of the heat load can be specified as a maximum 11 km distance on the Danube downstream section. This profile is found at Danube 1515,8. river km. Therefore it can be stated that no transboundary contamination can be reckoned with for heat loads.

Based on what was discussed in former chapters the group of organisms bearing the direct impacts will be the phytobenthos, macrozoobenthos, as well as fishes. Indirect bearers of the impact include mainly consumer organisations - macrozoobenthos, fishes. The most intensive indirect impact of hot water is thought to be the role played in the penetration of invasive species. The impact caused by the heat load on the impact area is long term, strong and high importance. It can be concluded on the basis of the findings obtained from the ecological status assessment that the impact of heat loads (in aggregate, when all the six units operate jointly) will not cause any grade level impairment of the ecological status in any of the groups along the affected Danube-section when classified according to the WFD. The same applied to the aggregate ecological status.

During the stand alone operation of Paks II (2037-2085) the extent of heat loads will not reach the extent of the current discharge from Paks Nuclear Power Plant as the model calculations suggest. The size of the impact area downstream of the outflow on the Danube will be ~1 km. This also means that from 2037 on more favourable environmental state can be expected downstream of the discharge outflow than the one today.

Based on the studies it can be stated that the investment project Paks II has no influence on the objectives set for the water body of the Danube concerned, the date of the target objective should not be amended for this reason.

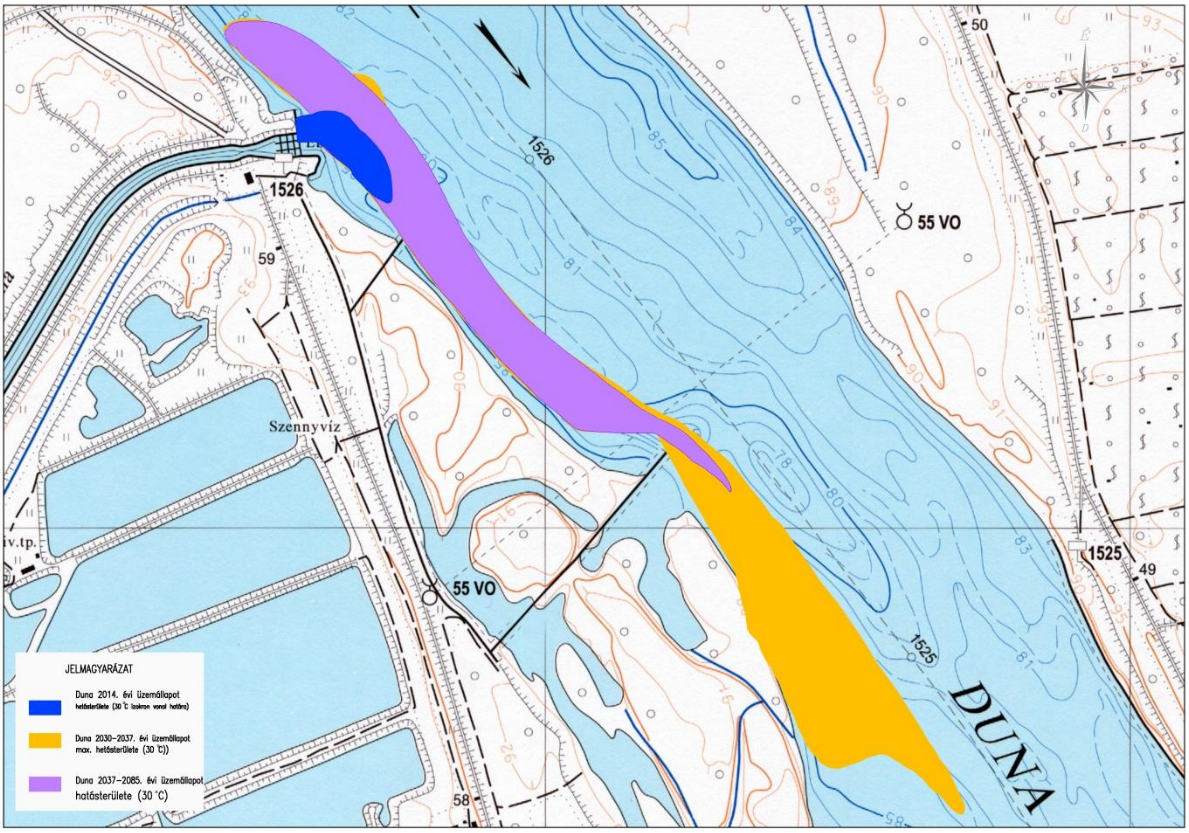
However, the contents of the VGT and the findings of the benchmark studies make it clearly visible that good ecological status of the domestic Danube section and with it, of the entire HURWAEP444 water body can only be achieved by the complex rehabilitation of the entire upstream Danube-section, which involves the very serious coordination efforts of the current forms of usage, in some cases even their restriction. In this context the implementation of Paks II and the operation of the power plant does not prevent the achievement of the good ecological status of the Danube water body concerned on the long term.

12.6.1.7 Impact areas of simultaneous operation of Paks II and Paks Nuclear Power Plant

12.6.1.7.1 Direct impact area on the physical and chemical status of the Danube

The direct impact area of the Paks II Nuclear Power Plant for physical and chemical parameters on the Danube was marked on the basis of the heat plume 30 °C isochronal line, provided the respective parameters of the current water rights operating permit of Paks Nuclear Power Plant are adhered to.

VITUKI Hungary Kft. defined water temperature distribution in the Danube for the critical periods (low water levels and high water temperature) in the case of various operating states. As a result, the boundaries of the areas associated with the minimum 30ºC isochronal lines were provided on Figure 12.6.1-23 in the case of the respective operating states.



Blue area: the area of Danube water with minimum temperature of 30 °C associated with the current operating state of the Paks Nuclear Power Plant
Orange area: the area of Danube water with minimum temperature of 30 °C associated with the joint operating state of the Paks II and Paks Nuclear Power Plant in the years 2030-2037

Mauve area: the area of Danube water with minimum temperature of 30 °C associated with the joint operating state of Paks II 2037-2085

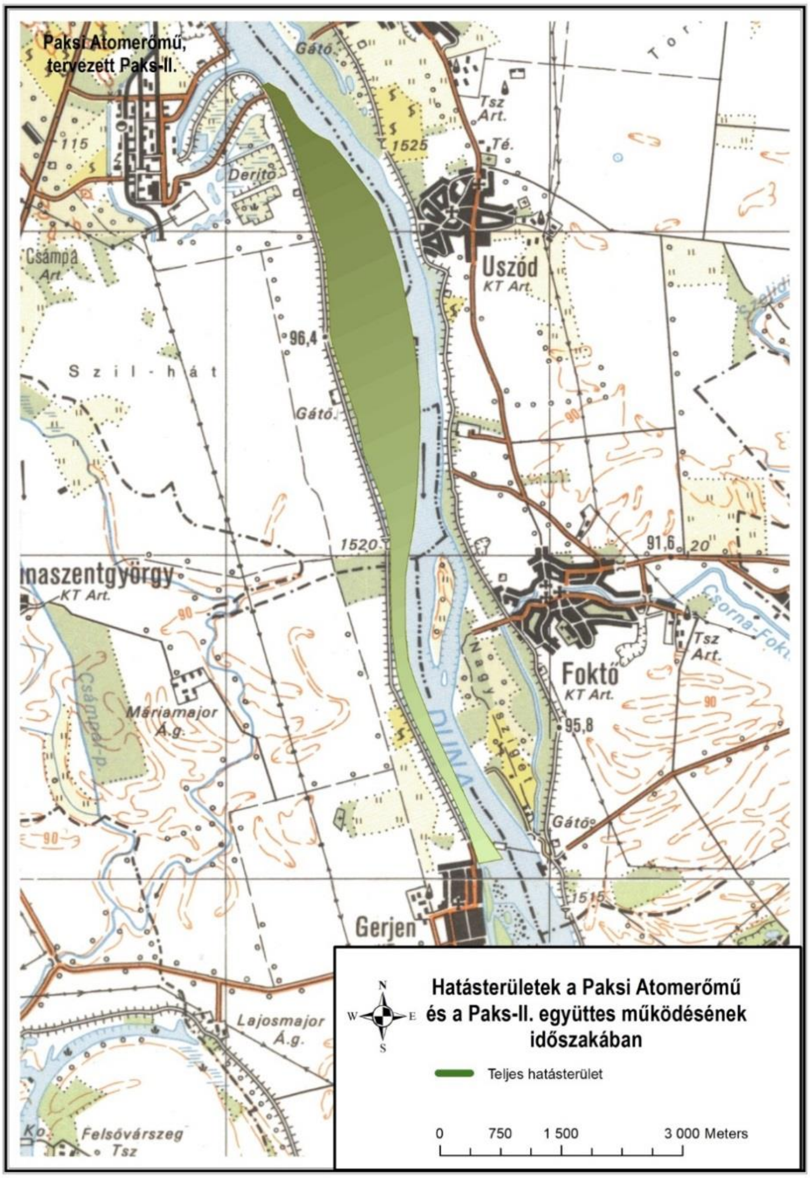
Figure 12.6.1-23: Demarcation of the critical impact area of the warmed up cooling water discharge into the Danube up to 2085

The boundary of the impact area for physico-chemical parameters on the Danube associated with the longest duration operating states between 2038 and 2085 extends to the south-southwest from the main stream line, up to the Danube right bank line, and up to the profile of the 1525.3 river km section in south-southeast direction, reaching over the tip of the "*Nagysarkantyú*" to a small extent.

12.6.1.7.2 Direct impact area on the ecological status of the Danube

During the period of joint operation the discharge of the warmed up cooling water represents the most significant impact on the ecological status of the Danube, at the same time it is the most significant single detectable impact during the construction and operation of Paks II with respect to the living communities.

The impact of hot water in a length of approximately 2 kilometres on the right bank profile could be demonstrated conditionally in the case of the phytobenthos and beyond doubt for the macrozoobenthos and the fish during the assessment of the benchmark status. It means the detection of a Δt=2.5 °C temperature increase for these taxons. For the joint operation period (2030-2032) VITUKI Hungary Kft. prepared a model calculation for low water levels in this Environmental Impact Study. The model applies to low water stages, taking into account the 33 °C limit to discharge temperatures, and the calculated rise in ambient temperature. The latter will be the highest in 2085, with a level of 28.64 °C according to the model calculations. On this basis it can be stated that the Δt=2.5 °C detection value in this period on the downstream section of the Danube is found in a distance of approximately 11 kilometres, at Danube 1515.8 river km (Figure 12.6.1-24). Based on the model calculations the heat plume characterised by the Δt=2.5 °C isotherm reaches the main current line of the Danube but does not cross it significantly.



Paksi Atomerőmű, tervezett Paks II – Paks Nuclear Power Plant – planned Paks II
Hatásterületek a Paksi Atomerőmű és a Paks-II együttes működésének időszakában – impact areas during the joint operation of Paks Nuclear Power Plant and Paks II
Teljes hatásterület – entire impact area

Figure 12.6.1-24: Full impact area of joint heat loads from Paks Nuclear Power Plant and Paks II

12.6.1.7.3 Indirect impact area

The mediator of the indirect impact from Paks II Nuclear Power Plant and Paks Nuclear Power Plant on the Danube might be transmitted by abiotic environmental elements such as the riparian groundwater reserves. The extent perpendicular to the river of this impact was determined in the Chapter entitled "*Geological medium and underground water in the Danube valley downstream of Paks*".

For biological elements the indirect impact area determined for heat loads in the period of joint operation does not differ from the direct impact area in terms of nutrient turnover. However, the expanse of the impact area can not be interpreted at the supra-individual level for the release of the invasive species, therefore the impact is recorded but no associated impact area was determined. Accordingly, the entire impact area is identical with the direct impact area.

12.6.1.7.4 Transboundary environmental impacts

During the joint service period of Paks II Nuclear Power Plant and Paks Nuclear Power Plant the area of direct and indirect impacts does not reach the national border, consequently no transboundary impact can be identified.

12.6.2 OPERATING TROUBLES, FAILURES ENCOUNTERED DURING THE SERVICE PERIOD

12.6.2.1 Impact factors of the operating troubles, failures encountered during the service period

- damage of the chemicals storage tanks, unloading gear
- damage to the fuel tank of the Diesel generator set
- spill of spent oil or other liquid waste
- discharge of untreated industrial wastewater due to inappropriate operation of the waste water treatment plant
- failure type operating trouble of the municipal waste water treatment plant

12.6.2.2 Impact on the Danube of the operating troubles, failures encountered during the service period

Conventional pollutants may leak onto the ground or into the unsaturated zone only in case of a failure event. They may leach out or infiltrate directly into the groundwater and from there into the Danube. However, since the migration time between the site and the river falls within the 10 to 20 years range even in the case of tritium which flows with the groundwater directly, there is sufficient time available for the management and clean up of eventual pollution incidents before the pollutants escaped would have reached the Danube. Migration of pollutant emissions occurring eventually at the site and the consequences of such incidents were investigated by Isotoptech Zrt. in the chapter of this Environmental impact study entitled "*Geological medium and underground water at the site and the immediate neighbourhood*".

Potential failure events not resulting radioactive contamination threatening the wildlife of the Danube include the case when untreated wastewater makes its way to the Danube as a result of the breakdown of the industrial as well as the municipal waste water treatment plants.

The breakdown of the waste water treatment plant of the industrial wastewater in itself does not cause the escape of untreated industrial wastewater directly into the Danube or other surface waters, since it is transferred first into the hot water canal first through sludge storage ponds and from there into the Danube. Final treatment takes place in the sludge pond area. Their injury may realistically no contamination in surface waters, rather soil contamination may occur instead. Approaching the issue of discharge of untreated industrial wastewaters into the Danube from the theoretical side the following can be stated. Contamination by discharge into the Danube through the hot water canal is assumed not to result in the destruction of any living being because of the substantial level of dilution (1:0.0003) even in the case of untreated discharges, the impact is thought to be sub lethal, and temporary avoidance of organisms capable of active locomotion can be observed. However, the effects of the toxic substances emitted might have a long term impact on aquatic organisms due to their slow decomposition. This impact, taking into account the extent of dilution in the Danube can not exceed 50 kilometres according to the estimates of the experts.

12.6.2.2.1 Failure type operating trouble of the municipal waste water treatment plant

VITUKI Hungary Kft. carried out mixing calculations of purified wastewater for failure events, the outcome of which is summarised here (for details see Chapter 11.8.2).

The assessment assumed that untreated municipal wastewater reaching the waste water treatment plant will pass it without treatment (1000 m^3/day) into the Danube. For the purposes of failure event calculations that concentration of the raw (untreated) wastewater discharged was taken as the highest concentration of the discharged raw wastewater measured in the last two years (2012-2013) as the applicable concentration. In case of a failure in the worst case scenario untreated wastewater is discharged into the right bank strip of the Danube through the ND 300 by-pass pipeline at the 1525.81 river km profile of the Danube.

Maximum concentration increments are shown on Table 12.6.2-1 for the extreme low water level on the Danube recurrent in every 20 000 years, 579 m^3/s along the right bank strip of the Danube.

Distance from the inlet site downstream (m)	Danube rate of flow 579 m³/s (extreme low water level on the Danube recurrent in every 20 000 years) Calculated maximum pollutant concentration increase (Danube right bank)					
	COD_K (mg/l)	BOD_5 (mg/l)	SZOE (mg/l)	Ammonia-ammonium (mg/l)	Total nitrogen (mg/l)	Total phosphorus (mg/l)
1	27.70	9.43	1.49	2.07	2.98	0.62
10	8.76	2.98	0.47	0.65	0.94	0.20
20	6.19	2.11	0.33	0.46	0.67	0.14
50	3.92	1.33	0.21	0.29	0.42	0.09
100	2.77	0.94	0.15	0.21	0.30	0.06
200	1.96	0.67	0.11	0.15	0.21	0.04
500	1.24	0.42	0.07	0.09	0.13	0.03
1000	0.88	0.30	0.05	0.07	0.09	0.02
1500	0.72	0.24	0.04	0.05	0.08	0.02
2000	0.62	0.21	0.03	0.05	0.07	0.01
2500	0.55	0.19	0.03	0.04	0.06	0.01
3000	0.51	0.17	0.03	0.04	0.05	0.01
3450	0.47	0.16	0.03	0.04	0.05	0.01
5000	0.39	0.13	0.02	0.03	0.04	0.01

Table 12.6.2-1: Longitudinal concentration increments in case of a failure event, Danube water flow 579 m³/s

It should be noted that nitrate concentration in the untreated wastewater is practically zero, therefore it has no impact on the water quality status of the body of water in the Danube in the event when untreated loads are discharged due to of failure events.

Taking the concentration increments of the pollutant parameters included in the table into account it can be stated that they remain below the detection limit values laid down in the Hungarian standards used for their identification already within a 10 metres distance calculated from the Danube discharge point. Based on the mixing tests the level of the various water chemistry parameters may be dropped to one fifth within a 20 m section. Water quality parameters are impaired in the environment along the right bank strip of the Danube water body by failure event discharge situations of untreated wastewater only for a limited period of time in terms of time, the negative impact will be eliminated as soon as the operating troubles of the waste water treatment plant are corrected.

The water quality limit values provided for the vulnerable underground waters – and for the 50 years migration time safety zones of the prospective long term bank filtrated drinking water bases – along the Danube section downstream of the wastewater outlet are not at risk even in the case of a failure event load (1000 m³/day discharge of untreated wastewater) at extreme low Danube water levels (579 m³/s) from the Danube water body.

Breakdown of the wastewater treatment plant during the construction period may represent a realistic threat to the wildlife in the Danube, since discharge volumes in this period are the highest 1000 m³/day. According to our expert estimates the untreated wastewater discharge will have an impact on the Danube wildlife both during the construction phase and operation. Having regard to the approximately nine thousand dilution in the hot water canal and an addition dilution factor of an additional approximately tenfold dilution in the Danube even in case of the critical low water stages, any untreated wastewater exposure might not have more serious than a slight, sub lethal impact on the Danube wildlife. The level of phytoplankton biomass will show a slight increase in the plume of the contaminated water. Fish biomass may also be higher in the plume theoretically. As a result of the contamination species less sensitive to organic nutrient loads may appear in greater numbers on a temporary basis among the organisms of the phytobenthos in the proximity of the discharge site as a result of the contamination. Species in the macrozoobenthos will react to increasing nutrient loads partly by avoidance and partly by an increase in the number of individuals, pending on their tolerance against declining oxygen levels. However, due to the dilution effect the lethal threshold is not reached by the untreated wastewater discharge for macrozoobenthos organisms, either. Untreated wastewater causes rather avoidance by more sensitive fish species in the discharge area while other species tolerant against nutrients may even appear in higher numbers of individuals. Correspondingly, the impact is short term, medium strength and low significance.

Systematic monitoring is important to avoid failure events. The setup of a buffer capacity in the wastewater treatment plant for both the industrial and the municipal wastewater may be recommended which allows the prevention or at least the reduction of direct discharge into the Danube in case of a failure event. Effective implementation of the cleanup procedures is supported well by a well drilled disaster management plan in case of a failure event.

12.6.2.3 Impact areas of the operating troubles, failures encountered during the service period

In the event of an eventual failure event the discharge of untreated wastewater can exert only a locally detectable impact on the ecological system of the Danube, the main reason of which is the high ratio of dilution and quick mixing. Correspondingly, an impact area shorter than 500 metres can only be assumed in the Danube.

The untreated wastewater flow let into the river in the case of a failure event is expected to be degraded completely within a 500 m section as a result of the mixing and biological processes. However, any detectable structural modifications in the aquatic living community can be expected only on a shorter section than this.

12.6.3 SUMMARISED IMPACT MATRIX FOR THE OPERATION OF PAKS II

Impacting factor	Impact	Impact area	Nature of impact	Impact bearer	Suggested measures, Comments
Normal operation					
cooling water (condenser, process) discharge (hydrological impact) in the Danube (132 m^3/s)	▪Modification of the flow conditions at the Danube discharge point	direct: <250m* indirect: <250m* transboundary: none	▪long term, medium strength, low significance	▪phytobenthos, MZB, fish	▪ ban on fishing and angling may be suggested in a 250 radius circle around the discharge point
cooling water (condenser, process) discharge (132 m^3/s) hea load:	▪temperature increase ▪encroachment of invasive species, complex impact	direct: cca. 1km* (Δt=2,5°C) indirect: cca. 1km* transboundary: none	▪long term, medium strength, high significance	▪phytobenthos, MZB, fish	▪installation of auxiliary cooling if necessary
cooling water (132 m^3/s) and process wastewater discharge (74 m^3/hour – 0.02 m^3/s) toxic substance loads	▪slight increase of toxic substances content	direct: <1500m indirect: <1500m transboundary: none	▪long term, poor, medium significance	▪hot water canal phytoplankton, phytobenthos, macrophyte, MZB, fish community	▪no detectable impact on the Danube can be reckoned with in case of standard operation ▪high efficiency cleaning ▪continuous monitoring
treated municipal wastewater discharge (320 m^3/day – 0.004 m^3/s):	▪increase in nutrient contents	direct: <50m indirect: <50m transboundary: none	▪long term, poor, low significance	▪hot water canal phytoplankton, phytobenthos, MZB, fish community	▪ no detectable impact on the Danube can be reckoned with in case of standard operation ▪monitoring of the treated wastewater discharged is recommended
rainwater discharge:	▪ increase of toxic substances (oil) content ▪increase in nutrient contents	direct: <50m indirect: <50m transboundary: none	▪long term, poor, low significance	▪hot water canal phytoplankton, phytobenthos, MZB, fish community	▪ no detectable impact on the Danube can be reckoned with in case of standard operation ▪cleaning by sand and oil trap ▪continuous monitoring of limits ▪transfer into the waste water treatment plant when limits are exceeded

Note:
Expected actually effective impact factors on the Danube highlighted in orange colour.
*In these cases the impact distance calculated from the Danube discharge point was recorded, partly due to the reasonable approach, partly due to the calculations

Table 12.6.3-1: Impacts of the stand alone operation of the two units of Paks II on the Danube aquatic wildlife, summary table (2037-2085)

12.6.4 PAKS NUCLEAR POWER PLANT AND THE SUMMARISED IMPACT MATRIX FOR THE OPERATION OF PAKS II

Impacting factor	Impact	Impact area	Nature of impact	Impact bearer	Suggested measures, Comments
cooling water (condenser, process) discharge (hydrological impact) in the Danube (232 m^3/s)	▪ Modification of the flow conditions at the Danube discharge point	direct: <500m* indirect: <500m* transboundary: none	▪long term, medium strength, low significance	▪phytobenthos, MZB, fish	▪ ban on fishing and angling may be suggested in a 250 radius circle around the discharge point
cooling water (condenser, process) discharge (232 m^3/s) heat load:	▪temperature increase ▪encroachment of invasive species, complex impact	direct: cca. 11km* (Δt=2,5°C) indirect: cca. 11km* transboundary: none	▪long term (2030-2036), strong, high significance	▪ phytobenthos, MZB, fish	▪ auxiliary cooling as necessary ▪in low water stage summer periods standard operating maintenance, shut down
cooling water (232 m^3/s) and process wastewater discharge (148 m^3/hour – 0.041 m^3/s) toxic substance loads (chemicals, oil)	▪slight increase of toxic substances content	direct: <1500m indirect: <1500m transboundary: none	▪ long term, poor, medium significance	▪hot water canal phytoplankton, phytobenthos, macrophyte, MZB, fish community	▪ no detectable impact on the Danube can be reckoned with in case of standard operation ▪high efficiency cleaning ▪continuous monitoring
rainwater discharge:	▪ increase of toxic substances (oil) content ▪increase in nutrient contents	direct: <50m indirect: <50m transboundary: none	▪ long term, poor, low significance	▪hot water canal phytoplankton, phytobenthos, MZB, fish community	▪ no detectable impact on the Danube can be reckoned with in case of standard operation ▪ cleaning by sand and oil trap ▪continuous monitoring of limits ▪transfer into the waste water treatment plant when limits are exceeded
treated municipal wastewater discharge (cca. 300+320 = 620 m^3/day - 0.007 m^3/s):	▪increase in nutrient contents	direct: <50m indirect: <50m transboundary: none	▪ long term, poor, low significance	▪hot water canal phytoplankton, phytobenthos, MZB, fish community	▪ no detectable impact on the Danube can be reckoned with in case of standard operation ▪ monitoring of the treated wastewater discharged is recommended

Note:
Expected actually effective impact factors on the Danube highlighted in orange colour.
*In these cases the impact distance calculated from the Danube discharge point was recorded, partly due to the reasonable approach, partly due to the calculations

Table 12.6.4-1: Impacts of the joint operation of Paks Nuclear Power Plant and Paks II on the Danube wildlife, summary table

12.6.4.1 Impact matrix for the operating troubles and failures encountered during the operating period

Estimates on the impact of potential impact factors are summarised in the impact matrix. Expected actual Danube impact factors were highlighted in colour.

Impacting factor	Impact	Impact area	Nature of impact	Impact bearer	Suggested measures, Comments
damage of the chemicals storage tanks, unloading gear	▪no impact on the surface waters is expected	direct: within the building indirect: plant site transboundary: none			
damage to the fuel tank of the Diesel generator set	▪no impact on the surface waters is expected	direct: within the building indirect: plant site transboundary: none			
spill of spent oil or other liquid waste	▪no impact on the surface waters is expected	direct: within the building indirect: plant site transboundary: none			
escape of untreated industrial wastewater	▪sub lethal poisoning of aquatic organisms as an impact of toxic substances ▪Realistically the escape of untreated wastewater into the Danube is not expected	In principle, if untreated industrial wastewater is discharged into the Danube, its impact can be protracting longitudinally in downstream direction, but taking into account the dilution effect of the hot water canal and the Danube this does not exceed 50 km	▪In principle this impact is short term, strong, high significance	▪phytoplankton, phytobenthos, macrophyte, macrozoobenthos, fishes	▪prevention of discharge of water loaded with toxic substances into the Danube by storage ponds and dilution
escape of untreated municipal wastewater:	▪increased nutrient contents ▪ increased suspended bed load contents ▪increased turbidity	direct: <500m indirect: <500m transboundary: none	▪short term, medium strength, low significance	▪phytoplankton, phytobenthos, MZB, fishes	▪when discharge is into the hot water canal a local impact can be expected on the Danube wildlife ▪Setting up a buffer capacity ▪making a quick and effective plan for failure events in order to mitigate damages

Note:
Expected actually effective impact factors on the Danube highlighted in orange colour.

Table 12.6.4-2.: Potential impacts of a failure event encountered during operation on the Danube wildlife, summary table

12.7 EXPECTED IMPACT OF THE ABANDONMENT OF PAKS II TO THE DANUBE

12.7.1 IMPACT FACTORS UPON THE ABANDONMENT OF PAKS II

12.7.1.1 Direct impacts

The impact of the wastewater discharged during the dismantling procedure on the living watercourse of the Danube is dealt with by VITUKI Hungary Kft., in the Chapter entitled "*Modelling the Danube river morphology and Danube heat loads*" of this Environmental Impact Study.

It is stated that the existing waste water treatment plant will be able to handle the increased wastewater volumes generated during construction and abandonment, and that the discharge of the treated wastewater into the Danube through the hot water canal will have no impact on the water chemistry or ecological status of the living watercourse of the Danube.

During the period of abandonment of Paks II the discharge of warmed up cooling water is gradually diminishing and is finally eliminated, therefore this process does not exert any impact on the water chemistry or ecological status of the living watercourse of the Danube.

Provided any major amount of dewatering in the work pit will be necessary at the proposed site during the dismantling works, the extracted water may contain tritium which is disposed of in the cold water canal and subsequently into the Danube. The impact of this is discussed in details by the parts related to the site. Only the statement is reiterated hereby that the tritium containing groundwater extracted during the dewatering process will exert no impact on the water chemistry or ecological status of the living watercourse of the Danube.

Government Decree No 201/2001. (X. 25.) restricts radioactivity in the drinking water on the basis of two criteria. Activity concentration of tritium shall not exceed 100 Bq/dm^3, and the total indicative dose (tritium, potassium-40. radon and radon decomposition products) shall not be any higher than 0.1mSv/year. "Drinking water should not be tested for tritium or radioactivity for the purposes to determine the total indicative dose in the case when the level of tritium according to the calculated indicative dose computed on the basis of another test is far below the limit value." For this a condition precedent is that total alpha activity and total beta activity must remain below the activity concentration levels of 0.1 Bq/dm^3 and 1 Bq/dm^3, respectively. Isotoptech Zrt. demonstrated by detailed calculations and model studies in the sub chapter of this Environmental Impact Study entitled "*Geological medium and underground water at the site and the immediate neighbourhood*", that during abandonment the activity concentration levels of both tritium and consolidated other (alpha, beta decay isotopes) substances on the Danube as the receiver medium are below the aforementioned limit values be several orders of magnitude, and hence, have no considerable impact on the Danube.

12.7.1.2 Indirect impacts

The impacts originating from the dismantling activities will not change the water quality and the temperature of the Danube, therefore no impact area can be interpreted.

12.7.1.3 Transboundary environmental impacts

The impacts originating from the dismantling activities will not change the water quality and the temperature of the Danube, no impact on the ecological status of the wildlife is expected, therefore no impact area can be interpreted. Accordingly, no transboundary physico-chemical and ecological impacts can be expected on the Danube in the period of abandonment of Paks II.

12.8 ENVIRONMENTAL MONITORING SYSTEM

12.8.1 PHYSICO-CHEMICAL PROPERTIES OF WATER

It is necessary to operate an environmental monitoring system south of the discharge site, in the Danube valley off the site.

The environmental impact of the proposed Paks II and the operating Paks Nuclear Power Plant on the Danube and on the underground water bodies below the Danube can not be differentiated either in their impact mechanism or impact areas. MVM Paks Nuclear Power Plant Zrt. currently operates a monitoring system entitled “Environmental monitoring system of the underground waters along the Danube", in line with the water rights operation license. The findings of this system were relied upon in a great extent when the present chapter of the Environmental Impact Study was drawn up. The facilities of the monitoring system were described in details in the sub-chapter entitled Monitoring systems in the area of the chapter entitled Geological medium and underground waters in the Danube valley downstream of Paks.

This monitoring system with its current rules of operation meets the requirements set by the Client MVM Paks Nuclear Power Plant Zrt. and the South Transdanubian Environmental Protection and Nature Conservation Inspectorate. It is suitable to continue monitoring during the joint operating period provided the detection density of the current facilities is increased and additional instruments are installed.

It is recommended to continue the operation of the Environmental monitoring system of the underground waters along the Danube with the following additions:

- Installation of continuous operation pressure, temperature and conductivity measuring metering instruments in the channel bottom probes of the 4 Gerjen, 5É Sió North, 5D Sió South, and 6 Baja profiles and in the background monitoring well at 4 Gerjen profile
- Sampling might be extended to the same profiles and taking Danube water samples from each profile for the same scope of analysis as from the channel bottom probes

For the purposes of monitoring the impact on the surface waters of the spent cooling water returned into the Danube continued operation of the currently functional check point situated in a distance of 500 m from the outflow is recommended.

Measurements of supplementary temperature and water quality parameters are best accomplished by accommodating to the profile arrangement of the currently operational underground monitoring system referred to above. In the typical and critical periods, adapting to the water quality sampling, temperature measurements along the profile must be conducted from the water surface in the line of the profile. Point temperatures must be taken in each functional profile from six typical and naturally to the extent possible under the framework provided by the technical opportunities steady cross sectional locations in three different depths, on the surface, in a depth of 1 m and 2 m, respectively. These measurements are completed by the temperature values measured in the profile along the river bank.

The rules of operation for the monitoring system outlines above should be introduced at least three years before the commissioning of the 5th unit in order to record the impact free base state (baseline).

For the purposes of monitoring the chemical properties of surface waters sampling of the Core Network sampling profiles and of the monitoring system profiles is recommended. The date of sampling should be identical with the date of measurement of the water surface temperature.

Three points in the recommended sampling profiles - right bank, midstream and left bank – need to be sampled.

	Denomination of the Danube profile	River km	Annual frequency of testing	Situation of the profile
1	Paks (ferry)	1534.0	4	Near Danube upstream profile.
2	Paks hot water canal	1526.0	4	Direct impacts downstream profile.
3	Nagysarkantyú	1525.3	4	Direct impacts downstream profile.
4	Uszód	1524.7	4	Direct impacts downstream profile.
5	Zsidó-zátony	1520	4	Direct impacts downstream profile.
6	Gerjen-Foktő	1516.0	4	Distant downstream profile
7	upstream Fadd-Dombori	1510	4	Distant downstream profile

Table 12.8.1-1: The proposed sampling profiles for Danube water quality

The proposed time for sampling includes critical and typical periods in terms of water quality and water temperature. Danube sampling would be made first in the spring, second after the green flood, third in the high temperature summer and fourth in the low water stage autumn seasons. Correspondingly the proposed dates for sampling are as follows: March, end of June - beginning of July, mid-end-August, October.

The range of parameters tested is the mandatory parameters pursuant to the Water Framework Directive and other parameters supplementing this range. It is expedient to also detect nutrient specific features, potential organic water pollutants and to measure bacteria and tritium.

The tests recommended for the purposes of the Danube monitoring system were summarised in Table 12.8.1-2.

Tested elements
temperature measurement (6 points _1.0 m)
dissolved oxygen
saturation level
chemical oxygen demand CODps
chemical oxygen demand CODk
Biochemical oxygen demand
Specific electrical conductivity
pH
Total suspended matter
alkalinity
orto-phosphate ion
Total phosphorus
ammonium ion
nitrate ion
nitrite ion
organic nitrogen
Total nitrogen (nitrite measurement and calculations)
a-chlorophyll
Chloride
Sodium
Potassium
Iron
Manganese
TPH-GC
Tritium
Bacteriological testing

Table 12.8.1-2: Study elements of the Danube monitoring system

12.8.2 BIOLOGICAL ELEMENTS

In the period of establishment and operation of Paks II systematic testing of biological elements of surface waters provides information of fundamental importance on the exploration of discharges and verification of their impacts. Methods for monitoring of biological elements in the surface waters based on the WFD is provided for by Ministerial Decree No.31/2004. (XII. 30.) KvVM laying down certain rules for the monitoring and state assessment of surface waters. At the same time information obtained from the assessment of the base state demonstrate that the identification of the impacts and determination of their strength can only be implemented by the establishment and operation of a unique monitoring system.

Guidelines for the wildlife monitoring system of surface waters can be summarised on the basis of the law and the data from earlier investigations as follows.

- The monitoring system must be unique in order to detect specific impacts (the sampling frequency, method, evaluation methodology adhering to the aspects of the WFD only does not allow exact exploration of the impacts in all cases).
- The monitoring system must be operated continuously, on an annually recurrent basis.
- The annual sampling frequency of individual groups of organisms varies, yet the sampling sessions must be coordinated with each other as well as with the testing of the physical and chemical parameters of the water.
- Background variables must cover the testing of a few basic hydrological parameter as well (for instance the speed of flow)
- The commissioning of the monitoring system should be started at least three years before the construction works in order to collect the necessary data set of the base state (baseline).
- Sampling should be extended to include the Danube HURWAEP444 water body. Testing of the other water bodies does not seem to be necessary on the basis of the previous research findings.
- It will be advisable to designate an upstream, a near downstream, and a mid-distant downstream section (up to the mouth of the Sió) for Danube monitoring, taking into account the section boundaries contained in the Environmental Impact Study.
- Beside the main channel, monitoring is best extended to the network of branches as well.
- In addition to the assessment efforts based on the WFD criteria a finer structure ecological analysis can not be omitted, either.
- Biological elements recommended for monitoring include the following: phytoplankton, phytobenthos, zooplankton, macrophyte, macrozoobenthos, fishes.

Specific recommendations for each group of organisms are summarised in the table below.

Group of organisms	Sampling frequency (/year)	Sampling period	Minimum total number of sampling units	Note
phytoplankton	6 /year	spring, summer, Autumn	36	WFD methodology is appropriate, evaluation is to be supplemented by ecological evaluation The number of sampling units upstream on the right and left bank as well as mid stream is 3 pieces each; in near downstream on right and left bank, as well as mid-stream 5 pieces each, in the side branch 3, in the mid-distant downstream section right and left bank, as well as mid stream 3 pieces each
phytobenthos	4 /year	spring, summer, Autumn	25	The assessment used by the WFD methodology and based only on the composition of the benthic diatom flora is not sufficient. The studies should target the characterisation of phytobenthos volumes and the exploration of the entire taxonomy. Quantitative tests can be accomplished by bento-fluorometric methods. Qualitative composition means microscopic examination, which must cover all alga groups. Species level identification of the benthic diatom flora can not be omitted, either. The number of sampling units upstream on the right and left bank is 3 pieces each; in near downstream on right and left bank 5 pieces each, in the side branch 3, in the mid-distant downstream section right and left bank 3 pieces each
zooplankton	6 /year	spring, summer, Autumn, winter	36	Dipped sampling, species level identification, ecological evaluation The number of sampling units upstream on the right and left bank as well as mid stream is 3 pieces each; in near downstream on right and left bank, as well as mid-stream 5 pieces each, in the side branch 3, in the mid-distant downstream section right and left bank, as well as mid stream 3 pieces each

Group of organisms	Sampling frequency (/year)	Sampling period	Minimum total number of sampling units	Note
macrophyte	1 /3 year	early summer	-	The macrophyte assessment means the mapping of the habitats in the foreshore areas in addition to WFD sampling points at least in a 1 km sample section in the upstream section, and up to the Sió mouth on both banks downstream
macrozoobenthos	2/year	spring, late summer	25	The WFD based assessment must be supplemented with deep sampling carried out in the main current line The number of sampling units upstream on the right and left bank is 3 pieces each; in near downstream on right and left bank 5 pieces each, in the side branch 3, in the mid-distant downstream section right and left bank 3 pieces each
fishes	1/year	summer	22	The WFD based assessment must be supplemented with deep sampling carried out in the main current line Sampling must be made by breaking down the sampling units into several sub-units, in accordance with the habitat conditions. The number of sampling units (500 m) upstream on the right and left bank is 2 pieces each; in near downstream on right and left bank 4 pieces each, in the side branch 2, in the mid-distant downstream section right and left bank 4 pieces each

Table 12.8.2-1. Organism specific indicators of the monitoring system recommended

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