



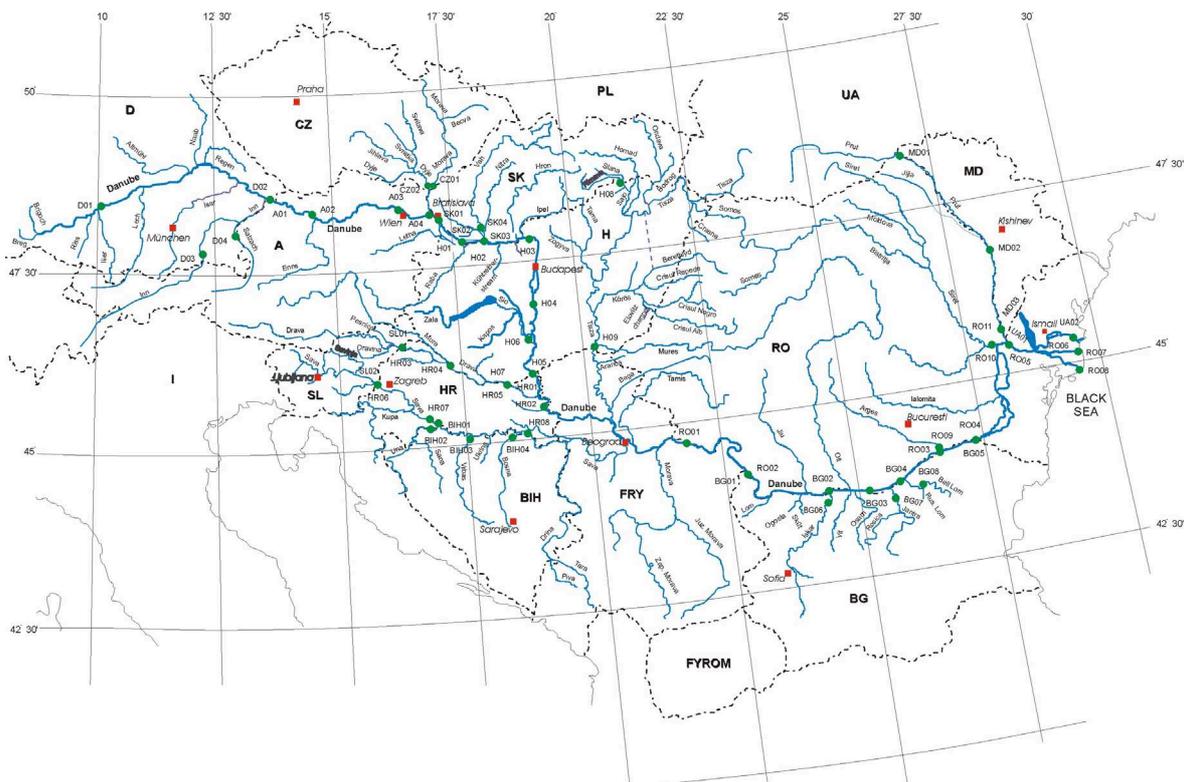
ENVIRONMENTAL PROGRAMME FOR THE DANUBE RIVER BASIN

in support of

DANUBE RIVER PROTECTION CONVENTION



WATER QUALITY IN THE DANUBE RIVER BASIN 1997 (TNMN – Yearbook)



2000

Austria – Bosnia and Herzegovina – Bulgaria – Croatia – Czech Republic – Germany –
Hungary – Moldova – Romania – Slovakia – Slovenia - Ukraine

Table of Contents

1. INTRODUCTION	3
2. HISTORY OF TNMN	4
3. OBJECTIVES OF TNMN	5
4. DESCRIPTION OF THE TNMN.....	6
4.1 PRINCIPLES OF THE NETWORK DESIGN	6
4.2 DETERMINANDS	7
4.3 ANALYTICAL QUALITY CONTROL (AQC)	9
4.3.1. Performance testing in the Danubian laboratories	11
4.4 INFORMATION MANAGEMENT	15
5. TABLES OF STATISTICAL DATA FROM THE TNMN STATIONS.....	17
6. MAPS OF SELECTED DETERMINANDS	22
7. PROFILES OF SELECTED DETERMINANDS	29
8. ABBREVIATIONS.....	33

1. Introduction

In June 1994 the Convention on cooperation for the protection and sustainable use of the Danube River (Danube River Protection Convention) was signed in Sofia, coming into force in October 1998 with the main objectives of achieving sustainable and equitable water management, including the conservation, improvement and the rational use of surface and ground waters in the Danube catchment area. The Convention refers also to the Convention on the protection and use of transboundary watercourses and international lakes of March 1992.

Regarding the monitoring programmes, it is stated in the Danube Convention that the Contracting Parties shall cooperate in the field of monitoring and assessment. For this aim they shall, e.g.:

- harmonise or make comparable their monitoring and assessment methods, in particular in the field of river quality
- develop concerted or joint monitoring systems applying stationary or mobile measurement devices, communication and data processing facilities
- elaborate and implement joint programmes for monitoring the riverine conditions in the Danube catchment area concerning both water quantity and quality, sediments and riverine ecosystems, as a basis for the assessment of transboundary impacts

The Parties shall agree upon monitoring points, river quality characteristics and pollution parameters regularly to be evaluated for the Danube River with sufficient frequency taking into account the ecological and hydrological character of the watercourse concerned as well as typical emissions of pollutants discharged within the respective catchment area. In addition, the Parties shall periodically assess the quality conditions of Danube River and the progress made by their measures taken aiming at the prevention, control and reduction of transboundary impacts.

The operation of the TransNational Monitoring Network (TNMN) is aimed to contribute to implementation of the Danube River Protection Convention, particularly of the above mentioned provisions of it. This report is the second Yearbook based on TNMN and was prepared with the main objective to present the monitoring programme and the data obtained during the year 1997, which was the second year of the TNMN Phase 1.

The first yearbook in a planned continuous series of the yearbooks compiled by the ICPDR - TNMN Yearbook for 1996 - was published in 1999.

As the detailed description of the development of the institutional framework supporting the TNMN has been given in the first TNMN Yearbook 1996, chapter 2 of this Yearbook consists of only the basic elements regarding the TNMN. In the chapter 3 the objectives of TNMN are mentioned, chapter 4 consists of description of TNMN. The tables with basic statistical characteristics of the data from TNMN stations, maps of selected determinands and profiles of selected determinands along the Danube River are given in chapters 5, 6 and 7 of the Yearbook.

2. History of TNMN

In spite of the fact that TNMN has been in the operation since 1996, the first steps towards it were taken many years ago. In December 1985 the Bucharest Declaration was signed by the Governments of the Danube riparian countries. The Declaration had as one of its objectives to observe the development of the water quality of the Danube, and in order to comply with this objective a monitoring programme based on agreed methods in order to obtain comparable data was established. The monitoring network used according to the Bucharest Declaration consisted of eleven cross sections of the Danube with 1 to 3 sampling locations. All cross sections were placed on the Danube itself where the river forms or crosses the border between the countries.

In 1991 the preparation of the Danube River Protection Convention (DRPC) started and was signed in Sofia in June 1994.

The Environmental Programme for the Danube River Basin (EPDRB) lead by a Task Force was also started in 1991; it was implemented to support and reinforce national actions for the restoration and protection of the Danube River, but also to supplement the future work of International Commission for the Protection of the Danube River.

The Task Force agreed in 1992 a three-year (1992-95) Work Plan. Emphasis was laid on creating consensus, sharing information and promoting joint decision-making between the Danubian countries. Monitoring, Laboratories and Information Management has been a main Programme action since December 1992 when the Monitoring, Laboratory and Information Management Sub-Group (MLIM-SG) dedicated to this topic met for the first time in Bucharest.

A main outcome of the three-year programme of work was the Strategic Action Plan (SAP). It was approved by the Task Force and supported by a Ministerial Declaration of the Danubian countries in December 1994. The Strategic Action Plan, once approved, marked the end of the first phase (1992-95) of the EPDRB, and in the next Phase II (1996-2000), implementation had to start. One of the major undertakings during 1996 was the initiation and approval by the Task Force of the Strategic Action Plan Implementation Programme (SIP), dedicated also to support the implementation of the Convention.

The 1996 and 1997 budgets of Phare Multi-Country Environmental Programme (MCEP) allocated substantial funding throughout the EPDRB projects to support the further development of the monitoring and assessment programme and the start of operation of TNMN. Further funding for the integration of Bosnia and Herzegovina is planned.

Moldova and Ukraine are joining now in MLIM projects. The Tacis 1996 Cross-Border Environmental Cooperation allocated funds to support the MLIM activities in Moldova and Ukraine. The implementation of these projects will significantly strengthen these activities of the ICPDR.

The responsibility for the TNMN was given to MLIM-SG. The three Working Groups set up under the MLIM-SG

- addressed the development of a Danubian water quality monitoring network (Monitoring Working Group, MWG)
- introduced harmonised sampling procedures and enhanced laboratory analysis capabilities (Laboratory Management Working Group, LMWG)
- formed the core of a Danubian information management system on the status of in-stream (immissions) water quality (Information Management Working Group, IMWG).

The Working Groups worked with the implementation plan of the TNMN according to an implementation plan approved by the Task Force and the MLIM-SG.

At the same time as the Danube River Protection Convention was signed, the International Commission for the Protection of the Danube River (ICPDR) on an interim basis was established, allowing for implementation pending the Convention's entry into force. The Task Force of the EPDRB was invited to co-operate with the Interim ICPDR and its Secretariat to contribute to the effective implementation of the DRPC.

The MLIM-SG as a Technical Sub-Group of the EPDRB was incorporated in the ICPDR Organisational structure as an Expert Group. Since October 29, 1998, the MLIM Expert Group - including its three Expert Sub-Groups - is working on the basis of TORs agreed upon by the first ICPDR Plenary Meeting.

3. Objectives of TNMN

The TNMN is a result of the work done according to the objectives defined in the "Environmental Programme for the Danube River Basin - Programme Work Plan", where it is stated that the monitoring network for the Danube shall:

- strengthen the existing network set up by the Bucharest Declaration
- be capable of supporting reliable and consistent trend analysis for concentrations and loads for priority pollutants
- support the assessment of water quality for water use
- assist in the identification of major pollution sources
- include sediment monitoring and bioindicators
- include quality control

Furthermore, it is defined that:

- The monitoring network shall provide outputs compatible with those in other major international river basins in Europe.
- In the future the monitoring network will comply with standards used in the western part of Europe.
- The design shall split into immediate and longer term needs - starting with practical and routine functions already performed.

The design, implementation and operation of the network were split into two phases. The first phase is seen as a period with:

- the operation of a limited number of stations with defined objectives already included in national monitoring networks according to defined objectives
- a determinand lists reflecting the Bucharest Declaration and EU-Directives
- an information management based on a simple data exchange file format between the riparian countries.

The second phase will be built upon experience gained through operation of the first phase and the organisational structures formed for discussion, planning, management procedures (QA, AQC, etc.), training and applied research. Also the second phase shall revise the number of stations, the sampling frequencies, the determinands and the procedures for information exchange.

4. Description of the TNMN

The TNMN was originally designed in 1993 during the project "Monitoring, Laboratory Analysis and Information Management for the Danube River Basin" conducted by the WTV Consortium. The implementation was agreed by the MLIM-SG, but the design has been further simplified resulting in the monitoring, laboratory and information management aspects and designs described in sub-chapters 4.1 to 4.4. These designs comprise the first phase starting with 1996. The evaluation and upgrading of the first phase are now under preparation.

4.1 Principles of the network design

As the new transboundary network should build on national surface water monitoring networks in the Danube basin and as the number of stations in these countries can be counted in thousands, it was decided to establish a simple procedure for selection of existing monitoring stations which could be the "candidates" for the new TransNational Monitoring Network - a procedure which also would respect the objectives as listed in chapter 3.

The criteria for selection of stations required these to be:

- Located just upstream/downstream of an international border
- Located upstream of confluences between Danube and main tributaries or main tributaries and larger sub-tributaries (mass balances)
- Located downstream of the biggest point sources
- Located according to control of water use for drinking water supply

The information obtained from Romania, Ukraine, Bulgaria, Croatia, Slovenia, Hungary, Slovakia and the Czech Republic, which were the countries included in the first design round, included detailed description of nearly 200 monitoring stations on the Danube and its tributaries located according to the above criteria. Originally 44 of these were selected to be included in the TNMN. Further discussion led to an increased number of 61 stations in Phase 1. The station list is shown in Chapter 5.

The determinand list was based on the list from the Bucharest Declaration extended/reduced with determinands recommended according to EC-directives and the riparian countries own demands. The list was divided into 10 groups, each group given a sampling frequency according to the different locations mentioned above. Furthermore, it was specified how many sampling points (Left, Middle, Right) each station should include, and this together with allocation of determinand groups and sampling frequencies according to the location of each station gave a full definition of each of the stations.

However, the discussions in the Working Groups during the implementation phase showed the need for a more simple approach and somewhat reduced determinand lists. The result of this was that all stations were given the same minimum sampling frequency of 12 per year for determinands in water and 2 per year for biomonitoring and for determinands in sediment.

Sampling and analyses are undertaken on a national level and carried out as far as possible according to the resulting determinand lists (on the total sample), which are presented in more detail in sub-chapters 4.2 and 4.3. The sediment sampling and analysis were not included in monitoring programme in 1997. All results are reported and distributed quarterly via e-mail (originally on diskettes) in a common data exchange file format (DEFF) also including station information and methods of analysis used, as these still can differ from country to country. The structure and use of DEFF, which was also included in the first design and further developed during implementation, is described in more details in section 4.4.

4.2 Determinands

The resulting lists of determinands for water and sediments as agreed for TNMN Phase 1 are presented in tables 4.2.1 and 4.2.2 together with the levels of interest and analytical accuracy targets, which are defined as follows:

- The minimum likely level of interest is the lowest concentration considered likely to be encountered or important in the TNMN.
- The principal level of interest is the concentration at which it is anticipated that most monitoring will be carried out.
- The required limit of detection is the target limit of detection (LOD) which laboratories are asked to achieve. This has been set, wherever practicable, at one third of the minimum level of interest. This is intended to ensure that the best possible precision is achieved at the principal level of interest and that relatively few "less than results" will be reported for samples at or near the lowest level of interest. Where the performance of current analyses is not likely to meet the criterion of a LOD of one third of the lowest level of interest, the LOD has been revised to reflect best practice. In these cases, the targets have been entered in *italics*.
- The tolerance indicates the largest allowable analytical error which is consistent with the correct interpretation of the data and with current analytical practice. The target is expressed as "x concentration units or P%". The larger of the two values applies for any given concentration. For example, if the target is 5 mg/l or 20% - at a concentration of 20 mg/l the maximum tolerable error is 5 mg/l (20% is 4 mg/l); at a concentration of 100 mg/l, the tolerable error is 20 mg/l (i.e. 20%) because this value exceeds the fixed target of 5 mg/l.
- Analytical accuracy targets for sediments are defined for <63 µm size fraction.

Sediments comprise suspended solids and bottom sediments.

Table 4.2.1: Determinand list for water for Phase 1 of the TNMN

Determinands in Water	Unit	Minimum likely level of interest	Principal level of interest	Target Detection	Limit of	Tolerance
Flow	m ³ /s	-	-	-	-	-
Temperature	°C	-	0-25	-	-	0.1
Suspended Solids	mg/l	1	10	1	-	1 or 20%
Dissolved Oxygen	mg/l	0.5	5	0.2	-	0.2 or 10%
pH	-	-	7.5	-	-	0.1
Conductivity @ 20 °C	µS/cm	30	300	5	-	5 or 10%
Alkalinity	mmol/l	1	10	0.1	-	0.1
Ammonium (NH ₄ ⁺ -N)	mg/l	0.05	0.5	0.02	-	0.02 or 20%
Nitrite (NO ₂ ⁻ -N)	mg/l	0.005	0.02	0.005	-	0.005 or 20%
Nitrate (NO ₃ ⁻ -N)	mg/l	0.2	1	0.1	-	0.1 or 20%
Organic Nitrogen	mg/l	0.2	2	0.1	-	0.1 or 20%
Ortho- Phosphate (PO ₄ ³⁻ -P)	mg/l	0.02	0.2	0.005	-	0.005 or 20%
Total Phosphorus	mg/l	0.05	0.5	0.01	-	0.01 or 20%
Sodium (Na ⁺)	mg/l	1	10	0.1	-	0.1 or 10%
Potassium (K ⁺)	mg/l	0.5	5	0.1	-	0.1 or 10%
Calcium (Ca ²⁺)	mg/l	2	20	0.2	-	0.1 or 10%
Magnesium (Mg ²⁺)	mg/l	0.5	5	0.1	-	0.2 or 10%
Chloride (Cl ⁻)	mg/l	5	50	1	-	1 or 10%
Sulphate (SO ₄ ²⁻)	mg/l	5	50	5	-	5 or 20%
Iron (Fe)	mg/l	0.05	0.5	0.02	-	0.02 or 20%
Manganese (Mn)	mg/l	0.05	0.5	0.01	-	0.01 or 20%
Zinc (Zn)	µg/l	10	100	3	-	3 or 20%
Copper (Cu)	µg/l	10	100	3	-	3 or 20%
Chromium (Cr) - total	µg/l	10	100	3	-	3 or 20%
Lead (Pb)	µg/l	10	100	3	-	3 or 20%
Cadmium (Cd)	µg/l	1	10	0.5	-	0.5 or 20%
Mercury (Hg)	µg/l	1	10	0.3	-	0.3 or 20%
Nickel (Ni)	µg/l	10	100	3	-	3 or 20%
Arsenic (As)	µg/l	10	100	3	-	3 or 20%
Aluminium (Al)	µg/l	10	100	10	-	10 or 20%
BOD ₅	mg/l	0.5	5	0.5	-	0.5 or 20%
COD _{Cr}	mg/l	10	50	10	-	10 or 20%
COD _{Mn}	mg/l	1	10	0.3	-	0.3 or 20%
DOC	mg/l	0.3	1	0.3	-	0.3 or 20%
Phenol index	mg/l	0.005	0.05	0.005	-	0.005 or 20%
Anionic active surfactants	mg/l	0.1	1	0.03	-	0.03 or 20%
Petroleum hydrocarbons	mg/l	0.02	0.2	0.05	-	0.05 or 20%
AOX	µg/l	10	100	10	-	10 or 20%
Lindane	µg/l	0.05	0.5	0.01	-	0.01 or 30%
pp' DDT	µg/l	0.05	0.5	0.01	-	0.01 or 30%
Atrazine	µg/l	0.1	1	0.02	-	0.02 or 30%
Chloroform	µg/l	0.1	1	0.02	-	0.02 or 30%
Carbon tetrachloride	µg/l	0.1	1	0.02	-	0.02 or 30%
Trichloroethylene	µg/l	0.1	1	0.02	-	0.02 or 30%
Tetrachloroethylene	µg/l	0.1	1	0.02	-	0.02 or 30%
Total Coliforms (37 C)	10 ³ CFU/100 ml	-	-	-	-	-
Faecal Coliforms (44 C)	10 ³ CFU/100 ml	-	-	-	-	-
Faecal Streptococci	10 ³ CFU/100 ml	-	-	-	-	-
Salmonella sp.	in 1 litre	-	-	-	-	-
Macrozoobenthos	no. of taxa	-	-	-	-	-
Macrozoobenthos	Sapr. index	-	-	-	-	-
Chlorophyll - a	µg/l	-	-	-	-	-

Table 4.2.2: Determinand list for sediments for Phase 1 of the TNMN

Determinands in sediments (dry matter)	Unit	Minimum likely level of interest	Principal level of interest	Target Detection	Limit of	Tolerance
Organic Nitrogen	mg/kg	50	500	10		10 or 20%
Total Phosphorus	mg/kg	50	500	10		10 or 20%
Calcium (Ca ²⁺)	mg/kg	1000	10000	300		300 or 20%
Magnesium (Mg ²⁺)	mg/kg	1000	10000	300		300 or 20%
Iron (Fe)	mg/kg	50	500	20		20 or 20%
Manganese (Mn)	mg/kg	50	500	20		20 or 20%
Zinc (Zn)	mg/kg	250	500	50		50 or 20%
Copper (Cu)	mg/kg	2	20	1		1 or 20%
Chromium (Cr) – total	mg/kg	2	20	1		1 or 20 %
Lead (Pb)	mg/kg	2	20	1		1 or 20 %
Cadmium (Cd)	mg/kg	0.05	0.5	0.05		0.05 or 20%
Mercury (Hg)	mg/kg	0.05	0.5	0.01		0.01 or 20%
Nickel (Ni)	mg/kg	2	20	1		1 or 20 %
Arsenic (As)	mg/kg	2	20	1		1 or 20 %
Aluminium (Al)	mg/kg	50	500	50		50 or 20%
TOC	mg/kg	500	5000	100		100 or 20%
Petroleum hydrocarbons	mg/kg	10	100	1		1 or 20 %
Total Extractable matter	mg/kg	100	1000	10		10 or 20 %
PAH – 6 (each)	mg/kg	0.01	0.1	0.003		0.003 or 30%
Lindane	mg/kg	0.01	0.1	0.003		0.003 or 30%
pp' DDT	mg/kg	0.01	0.1	0.003		0.003 or 30%
PCB – 7 (each)	mg/kg	0.01	0.1	0.003		0.003 or 30%

4.3 Analytical Quality Control (AQC)

The analytical methodologies for the determinands applied in TNMN are based on a list containing reference and optional analytical methods. The National Reference Laboratories (NRLs) have been provided with a set of ISO standards (reference methods) reflecting the determinand lists, but taking into account the current practice in environmental analytical methodology in the EU. It has been decided not to require each laboratory to use the same method, providing the laboratory would be able to demonstrate that the method in use (optional method) meets the required performance criteria. Therefore, the minimum concentrations expected and the tolerance required of actual measurements have been defined for each determinand (as reported in tables 4.2.1 and 4.2.2), in order to enable laboratories to determine whether the analytical methods currently in use are acceptable.

It is good practice that targets for analytical accuracy define the standard of the accuracy which is necessary for the task in hand. Therefore, two key concentration levels have been defined for each determinand:

- the lowest level likely to be encountered in the waters / sediments of interest (the minimum level of interest)
- the concentration which represents the likely level at which most monitoring (for example, for the assessment of trends or compliance with water quality standards) will be carried out (the principal level of interest)

These levels define the aims of the monitoring programme and can now be used to establish the performance needed from analytical systems used in the laboratories involved in the TNMN, assuming that the aims of the programme will be satisfied provided

- that relatively few results are reported as “less than“ the minimum level (This will assist in load calculations and will ensure that real data are reported for the majority of sampling sites.)

- that the accuracy achieved at the principal level is not worse than $\pm 20\%$ of the principal level. This assumption has been tested in a wide range of environmental monitoring laboratories. Experience suggests that it is usually appropriate to set a required limit of detection which is at least one tenth of the principal level of interest. A subsidiary aim is that the limit of detection should be at least one third of the minimum level of interest. It is obvious that the whole philosophy depends on the initial estimates of minimum and principal concentrations of interest. However, this approach to defining accuracy targets (or something closely similar) is the only logical strategy by which to establish the real analytical needs of a monitoring programme.

The above reflects that any practical approach to monitoring must take into account the current capabilities of analytical science. This means that if some targets are recognised as very difficult to achieve, it may be necessary to set more relaxed, interim targets and to review performance and data use in the course of the monitoring programme.

The described approach supports the work of harmonising the analytical activities within the Danube Basin related to the TNMN as well as the implementation and operation of an Analytical Quality Control (AQC) programme. Therefore, it has been used in development of the training needs required to improve the laboratory performance of the National Reference Laboratories as well as the other laboratories involved in the implementation of the TNMN. The result is that managers and personnel of the involved laboratories have been provided with practical training for analytical instrumentation and on-site sampling as well as with theoretical aspects of AQC.

4.3.1. Performance testing in the Danubian laboratories

The organisation of interlaboratory comparison in the Bucharest Declaration Danube monitoring was agreed in 1992. The Institute for Water Pollution Control of VITUKI, Budapest, Hungary, offered and took the responsibility for organising the first study under the name of QualcoDanube. The first distribution in 1993 included samples for the analysis of three determinands: pH, conductivity and total hardness. By the end of 1995, four more distributions had been made for the analysis of the following determinands: chlorides, COD, nutrients (ammonium, nitrate, Kjeldahl-nitrogen, orthophosphate and total-P) as well as different metals, including Fe, Mn, Ca, Mg, Cd, Cu, Hg, Pb, Ni, Zn. In 1996 the QualcoDanube proficiency testing scheme was extended to the National Reference Laboratories (NRL) in the TransNational Monitoring Network (TNMN) and the 1996/2 distribution already included all Danubian laboratories - 11 NRLs and 18 national laboratories - implementing the TNMN. This distribution was further extended to 6 Black Sea laboratories responsible for pollution monitoring in their area.

QualcoDanube distributions in 1997

In 1997 the distributions of samples were similar to the previous year. Most of determinands were the same as in 1996, but for the first time petroleum hydrocarbon extracts – among organic pollutants – were also distributed.

The samples included real surface waters, spikes, in addition to the artificial concentrates, extracts and also sediments.

The results and their evaluation during the four distributions have been published in the relevant report (QualcoDanube, AQC for Water Labs in the Danube River Basin, Summary Report 1997, VITUKI Plc., Budapest).

In the QualcoDanube performance testing scheme the Youden-pair evaluation technique is followed.

The results of the interlaboratory comparative study are discussed separately for the different determinands.

It was a success that all laboratories (35) reported results. Most of the laboratories reported results for general parameters and heavy metals in water, but 15 laboratories reported results for Kjeldahl-N and 15 laboratories analysed arsenic (in water). Heavy metals in sediment were reported from 22 laboratories.

General parameters

On the base of data of pH-determination the results are very good while in the case of conductivity the results are satisfactory, but slight systematic error characterises this determination.

Both TDS and total hardness demonstrate systematic error.

Chloride and sulphate: the results are excellent in the case of chloride but sulphate results are not so good, slight systematic error occurred.

Organic pollutants

Chemical oxygen demand with dichromate method at waste water level shows quite good results.

The same determinand at surface water level shows characteristic variation and systematic error too. This is definitely due to the relatively low concentration in the sample. The results also support the fact that this method is not reliable around 30 mg/l.

Chemical oxygen demand with permanganate method in real surface water shows significant discrepancies in both positive and negative direction. Systematic error can be observed.

Biological oxygen demand: in the case of this parameter the results demonstrate very high systematic error.

Anionactive surfactants (MBAS): in the case of real surface water the results are not acceptable. The most likely reason for this discrepancies is changing in stability during transport and waiting for analysis.

Petroleum hydrocarbons: relatively small number of laboratories reported acceptable results showing that some laboratories have no methods with sufficient sensitivity. Results of analyses of received extract show high systematic error.

Nutrients

Ammonium-N: the results demonstrate relatively high variation and significant systematic error in real surface water, while the results of waste water samples are characterised by systematic error, mainly.

Nitrate-N: the results of both types of samples show similar trends but in the case of waste water sample results are better due to higher concentration level.

Kjeldahl-N: in the case of this parameter about half of the laboratories reported results. Unfortunately some laboratories reported extremely high values while others reported low results.

Ortho-phosphate-P and total-P: the first determinand was analysed in real surface water and in synthetic sample at waste water level. In both cases the results were influenced by systematic error. Both systematic error and random error characterise the results of total phosphor.

Heavy metals in water

Cadmium, chromium, copper and iron as well as nickel, lead, zinc and arsenic had to be analysed at surface water level.

In the case of cadmium the results are influenced by systematic error and random error, respectively, while the results of chromium determination show systematic error mainly. In the determination of copper results show slight systematic error. In the case of nickel some results show discrepancies and the number of outliers – due to random error – are high relatively. This was most likely due to the low concentrations. High variation can be observed in the case of lead. As at nickel, concentrations of lead were low relatively. The most of results of zinc determination show surprisingly good. In spite of this fact, slight systematic error can be observed. In the determination of arsenic relatively high variation is observed.

Heavy metals in sediment

Mercury, cadmium, lead and chromium were analyzed in sediment.

In the case of mercury, the results are influenced by both systematic error and random error. The results of cadmium show very high variation, more extreme high results are than low results and systematic error can be observed too. In the case of chromium (Fig. 4.3.1.2), there are a few extreme positive and one very low result. Similar trend can be observed in the case of lead (Fig. 4.3.1.1)

Conclusions

Most of the data provided by the laboratories during the 1997 QUALCODanube intercalibration study were satisfactory, when comparing to error thresholds.

While the results in 1996 showed the quality improvement in most of the determinands, in 1997 could not be observed continuous improvement. The performance for the general parameters was satisfactory. Some problems arose due to stability of the samples (e.g. MBAS, PO₄-P) and a relatively long analysis time which can influence the variation between results.

In the case of organic pollutants the results are different.

The chemical oxygen demand (dichromate method) gave quite good results at waste water level but the analytical data are not appropriate at surface water level. On the based on results it is clear, this method is not reliable around 30 mg/l.

Chemical oxygen demand (with permanganate method) and biological oxygen demand results are influenced by systematic error mainly, especially BOD.

Results of nutrients, in general, show systematic error, except Kjeldahl-N, where discrepancies are extreme (both high and low).

In the case of metals different digestion methods were used and there were some problems for less commonly measured metals (e.g. Hg, As) and at low concentration level (e.g. Cd, Ni, Pb).

Need for continuation of interlaboratory comparison Studies

Interlaboratory studies organised regularly help to improve analytical performances because the participants can review their own performance concerning the accuracy of the analytical results and where necessary, investigate the sources of error and take corrective actions.

So, it is expected that performance of the Danube basin laboratories will further improve and the comparability of the water quality monitoring results in the river basin and related regions will be ensured.

4.4 Information Management

In the frame of Information Management is dealt with data storage, exchange, retrieval and analysis as well as other types of data processing needed for information management activities. On the basis of a relational data base instream water quality data of TNMN is organised in a well-defined structure using rules of reference integrity. This results in a system of joined tables, covering information about TNMN. For data processing values can be exported to various statistical software packages e.g. AARDVARK. Data exchange is organised quarterly according to a standard operational procedure. A special data exchange file format (DEFF) serves for this purpose. Data collection was initiated 1996 using diskettes as a medium for the exchange. At the beginning of 1997 the use of e-mail was tested and accepted for a new standard operational procedure.

The above summary briefly describes the current activities, which have been established by using the following approach:

- to concentrate on the quality of data obtained
- to introduce a process of exchanging data from the national information systems to a Central Information Point (CIP)
- to build on the existing experience in the individual countries and not to try to force all participating countries to adapt their national information system and procedures
- to promote and increase the use and processing of data into information by introducing dedicated software for time series analysis (AARDVARK)

It resulted in the important decision to leave the responsibility of the national information systems to the countries themselves and to concentrate on an agreed protocol and data exchange format (DEFF), which all countries after a training course in 1996 can use to send their national data to the Central Information Point (CIP) or to load data into their national information systems for further processing.

The format of DEFF should anticipate future changes and therefore the data of interest had to be normalised. This resulted in nine tables of which seven are filled with static data and two with dynamic data. The tables with static data are agreed by the MLIM-SG and contain the stations, determinands, analytical methods, remarks, participating countries and sampling methods. These tables are maintained by the CIP on the basis of the agreements in the MLIM-SG. The tables with dynamic data contain the samples and analytical results. These tables are also maintained at CIP level by merging data received from all countries quarterly.

The standard operational procedure (SOP) for the exchange of DEFF data starts at the data generation (sampling and analysis) and input of data to the system followed by a description of all the activities carried out by the three key players: the National Reference Laboratory (NRL), the National Information Centre (NIC) and the CIP before the merged and validated final data report can be used for further information processing (e.g. the Yearbook). In 1996 the CIP was in Sofia at the National Center of Environment and Sustainable Development (home Institution for NRL and NIC for Bulgaria and of a former chairman of IMWG). In 1997 this CCIP was transferred to Zagreb at the Center for Marine and Environmental Research of the Rudjer Boskovic Institute (home Institution for NRL and NIC of Croatia and of a current chairman of IMWG). TNO Institute of Applied Geoscience in Delft, The Netherlands, served as person for backup of data collected.

TNMN data were collected from Germany, Austria, Czech Republic, Slovakia, Hungary, Slovenia, Croatia, Bulgaria and Romania. During 1997 Bosnia and Herzegovina, Moldova and Ukraine did not provide their data.

At the end of 1996 the first Web Pages for TNMN in Danube region were created using Croatian data. National Web Pages of Austria served as an example for creation of Web Pages of Croatia. During 1997 a new technology was tested based on the integration of relational database and digital maps for creation of dynamic Web Pages. An experiment in using cellular telephone connection to the Internet for access to TNMN Web Pages was realised by the Croatian team, from the place (Thany in Hungary) without any wired connection.

Countries were requested to send data about flow for dates when the water samples are collected for analysis. At the beginning ANAMETH file within DEFF database was filled with 000.000 code (meaning unspecified). During 1997 an action was initiated to complete the list of analytical methods in ANAMETH file.

5. Tables of statistical data from the TNMN stations

The determinands measured in 1997, which was the second year of operating the TNMN - Phase 1, covered the main physical, chemical, biological and microbiological water quality characteristics including the major anions and cations, nutrients, oxygen regime determinands, organic pollutants, heavy metals and characteristic biological and microbiological determinands.

The 61 stations included in the TNMN - Phase 1 are characterised on the following station list and station map. In the station list official national data are specified, which are not harmonized in all cases. Inconsistencies concerning catchment area and altitude may be due to different national calculation procedures. It is recommended to solve these problems within the transboundary commissions.

Each station can have up to 3 sampling points named L, M and R (Left, Middle, Right). Counted by sampling points the TNMN - Phase 1 consists of 95 sampling points.

In 1997 data are available from 48 stations including in total 72 sampling points, which is less than in year 1996. At some stations no measurements were performed at all due to the lack of proper equipment or restricted access for political reasons. Lack of availability of data for some stations was for example in Croatia and Bosnia and Herzegovina due to the fact that sampling was not possible because of the war.

Data available from 72 sampling points mentioned above are presented in 72 tables in Annex 1 according to the following legend. Tables for those stations where no data were available are excluded from the yearbook.

Term used	Explanation
Determinand	The name of the determinand measured according to the agreed method
Unit	The unit of the determinand measured
N	The number of measurements
Min	The minimum value of the measurements done in the year 1997
Mean	The arithmetical mean of the measurements done in the year 1997
Max	The maximum value of the measurements done in the year 1997
C50	The 50 percentile of the measurements done in the year 1997
C90	The 90 percentile of the measurements done in the year 1997
Q1	The arithmetical mean of the measurements done in the first quarter of the year 1997
Q2	The arithmetical mean of the measurements done in the second quarter of the year 1997
Q3	The arithmetical mean of the measurements done in the third quarter of the year 1997
Q4	The arithmetical mean of the measurements done in the fourth quarter of the year 1997

If values less than the detection limit are present in the dataset for a given determinand, the calculations use half of the value of the detection limit. In case of all measurements in the year being below the detection limit, only minimum, mean and maximum were put in the table without any other statistical data. Similarly, in case of only four or less measurements of particular determinand in a year, only minimum, mean and maximum were calculated.

Station List

Country Code	River Name	Town/Location Name	Latitude d. m. s.	Longitude d. m. s.	Distance Km	Altitude m	Catchment Sqr.km	DEFF Code	Loc. profile
D01	Danube	Neu-Ulm	48 25 31	10 1 39	2581	460	8107	L2140	L
D02	Danube	Jochenstein	48 31 16	13 42 14	2204	290	77086	L2130	M
D03	/Inn	Kirchdorf	47 46 58	12 7 39	195	452	9905	L2150	M
D04	/Inn/Salzach	Laufen	47 56 26	12 56 4	47	390	6113	L2160	L
A01	Danube	Jochenstein	48 31 16	13 42 14	2204	290	77086	L2220	M
A02	Danube	Abwinden-Asten	48 15 21	14 25 19	2120	251	83992	L2200	R
A03	Danube	Wien-Nussdorf	48 15 45	16 22 15	1935	159	101700	L2180	R
A04	Danube	Wolfsthal	48 8 30	17 3 13	1874	140	131411	L2170	R
CZ01	/Morava	Lanzhot	48 41 15	16 59 27	79	150	9883	L2100	M
CZ02	/Morava/Dyje	Breclav	48 43 26	16 53 12	17	155	12352	L2120	L
SK01	Danube	Bratislava	48 8 10	17 7 40	1869	128	131329	L1840	M
SK02	Danube	Medvedov/Medve	47 47 31	17 39 6	1806	108	132168	L1860	M
SK03	Danube	Komarno/Komarom	47 45 17	18 7 40	1768	103	151961	L1870	M
SK04	/Váh	Komarno	47 46 41	18 8 20	1	106	19661	L1960	M
H01	Danube	Medve/Medvedov	47 47 31	17 39 6	1806	108	131605	L1470	M
H02	Danube	Komarom/Komarno	47 45 17	18 7 40	1768	101	150820	L1475	M
H03	Danube	Szob	47 48 44	18 51 42	1708	100	183350	L1490	LMR
H04	Danube	Dunafoldvar	46 48 34	18 56 2	1560	89	188700	L1520	LMR
H05	Danube	Hercegszanto	45 55 14	18 47 45	1435	79	211503	L1540	LMR
H06	/Sio	Szekszard-Palank	46 22 42	18 43 19	13	85	14693	L1604	M
H07	/Drava	Dravasabolcs	45 47 00	18 12 22	78	92	35764	L1610	M
H08	/Tisza	Tiszasziget	46 9 51	20 5 4	163	74	138498	L1700	LMR
H09	/Tisza/Sajo	Sajopuspoki	48 16 55	20 20 27	124	148	3224	L1770	M
SI01	/Drava	Ormoz	46 24 12	16 9 36	300	192	15356	L1390	L
SI02	/Sava	Jesenice	45 51 41	15 41 47	729	135	10878	L1330	R
HR01	Danube	Batina	45 52 27	18 50 03	1429	86	210250	L1315	M
HR02	Danube	Borovo	45 22 51	18 58 22	1337	89	243147	L1320	R
HR03	/Drava	Varazdin	46 19 21	16 21 46	288	169	15616	L1290	M
HR04	/Drava	Botovo	46 14 27	16 56 37	227	123	31038	L1240	M
HR05	/Drava	D.Miholjac	45 46 58	18 12 20	78	92	37142	L1250	R
HR06	/Sava	Jesenice	45 51 40	15 41 48	729	135	10834	L1220	R
HR07	/Sava	us. Una Jasenovac	45 16 02	16 54 52	508	92	30953	L1150	L
HR08	/Sava	ds. Zupanja	45 02 17	18 42 29	254	85	62890	L1060	M
BIH01	/Sava	Jasenovac	45 16 0	16 54 36	500	87	38953	L2280	M
BIH02	/Sava/Una	Kozarska Dubica	45 11 6	16 48 42	16	94	9130	L2290	M
BIH03	/Sava/Vrbas	Razboj	45 3 36	17 27 30	12	100	6023	L2300	M
BIH04	/Sava/Bosna	Modrica	44 58 17	18 17 40	24	99	10308	L2310	M
RO01	Danube	Bazias	44 47	21 23	1071	70	570896	L0020	LMR
RO02	Danube	Pristol/Novo Selo Harbour	55,57,58 44 11	24,40,54 22 45	834	31	580100	L0090	LMR
RO03	Danube	us. Arges	18,23,29 44 4 25	27,64,69 26 36 35	432	16	676150	L0240	LMR
RO04	Danube	Chiciu/Silistra	44 7 18	27 14 38	375	13	698600	L0280	LMR
RO05	Danube	Reni-Chilia/Kilia arm	45 28 50	28 13 34	132	4	805700	L0430	LMR
RO06	Danube	Vilkova-Chilia arm/Kilia arm	45 24 42	29 36 31	18	1	817000	L0450	LMR
RO07	Danube	Sulina - Sulina arm	45 9 41	29 40 25	0	1	817000	L0480	LMR
RO08	Danube	Sf.Gheorghe-Ghorghe arm	44 53 10	29 37 5	0	1	817000	L0490	LMR
RO09	/Arges	Conf. Danube	44 4 35	26 37 4	0	14	12550	L0250	M
RO10	/Siret	Conf. Danube Sendreni	45 24 10	28 1 32	0	4	42890	L0380	M
RO11	/Pрут	Conf.Danube Giurgiulesti	45 28 10	28 12 36	0	5	27480	L0420	M
BG01	Danube	Novo Selo Harbour/Pristol	44 09	22 47	834	35	580100	L0730	LMR
BG02	Danube	us. Iskar - Bajkal	50,58,66 43 42 58	36,47,58 24 24 45	641	20	608820	L0780	M
BG03	Danube	Downstream Svishtov	43 37 50	25 21 11	554	16	650340	L0810	MR
BG04	Danube	us. Russe	43 48 06	25 54 45	503	12	669900	L0820	MR
BG05	Danube	Silistra/Chiciu	44 7 02	27 15 45	375	7	698600	L0850	LMR
BG06	/Iskar	Orechovitza	43 35 57	24 21 56	28	31	8370	L0930	M
BG07	/Jantra	Karantzi	43 22 42	25 40 08	12	32	6860	L0990	M
BG08	/Russ.Lom	Basarbovo	43 46 13	25 57 34	13	22	2800	L1010	M
MD01	/Pрут	Lipcani	48 16 0	26 50 0	658	100	8750	L2230	L
MD02	/Pрут	Leuseni	46 48 0	28 9 0	292	19	21890	L2250	M
MD03	/Pрут	Conf. Danube-Giurgiulesti	45 28 10	28 12 36	0	5	27480	L2270	LMR
UA01	Danube	Reni - Kilia arm/Chilia arm	45 28 50	28 13 34	132	4	805700	L0630	M
UA02	Danube	Vilkova-Kilia arm/Chilia arm	45 24 42	29 36 31	18	1	817000	L0690	M

Distance:	The distance in km from the mouth of the mentioned river	Sampling location in profile:
Altitude:	The mean surface water level in meters above sea level	L: Left bank
Catchment:	The area in square km, from which water is drains through the station	M: Middle of river
ds.	Downstream of	R: Right bank
us.	Upstream of	
Conf.	Confluence tributary/main river	
/	Indicates tributary to river in front of the slash. No name in front of the slash means Danube	

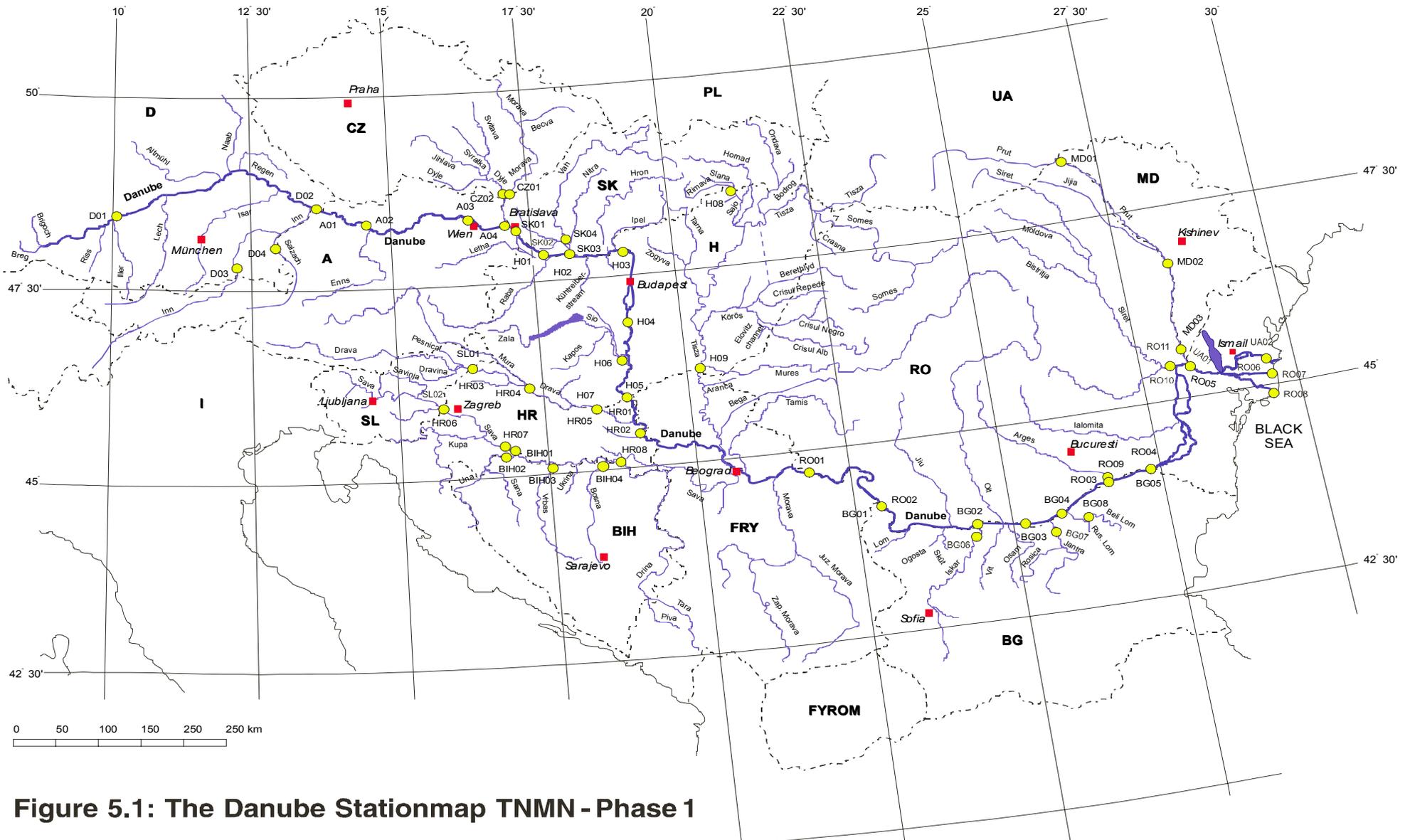


Figure 5.1: The Danube Stationmap TNMN - Phase 1

Water sampling and analysis should have been performed according to the specification in chapter 4. As was already mentioned, at some stations no measurements were performed at all. And even in sampling points from which water samples were taken, the range of measured determinands have not been uniform. Relatively few data are available for organic micropollutants and biological determinands, especially from the lower part of the Danube River Basin.

The agreed sampling frequency for physico-chemical determinands of at least 12 times per year was not kept at all monitoring sites. This is very essential especially for those determinands which vary seasonally or are highly correlated to the discharge.

When looking at the data, results from QualcoDanube intercalibration studies should be taken into account as the validity and full comparability of data is also a prerequisite for further use of the data in assessment process. On the basis of QualcoDanube studies it was stated that most of the data provided by the laboratories during 1997 had been satisfactory, but in case of some determinands the problems had been observed and further improvement is necessary.

It has also to be mentioned that method for measurements of microbiological and biological determinands are not yet fully harmonised.

Concerning the oxygen regime determinands dissolved oxygen, BOD₅ and COD_{Cr} are the major indicators.

Dissolved oxygen content had been measured in all 72 sampling points, from which data in 1997 are available. The concentration range varied from 3,9 – 18,3 mg/l (annual means 6,5 – 11,8 mg/l) in Danube itself, and from 2,3 – 15,2 mg/l (annual means 5,7 – 11,7 mg/l) in the tributaries.

BOD₅ characterising content of biodegradable organic substances in water was measured in 68 sampling points, but QualcoDanube intercalibration studies discovered very high systematic error for this determinand. BOD₅ values were in the range from 0,5 – 12,1 mg/l (annual means 1,4 – 5,1 mg/l) in the Danube River and from 0,5 – 28,7 mg/l (annual means 1,9 – 11,1 mg/l) in sampling points located in tributaries.

COD_{Cr} was measured in 68 sampling points, with concentrations varying from 2,5 – 37 mg/l (annual means 6,8 – 21,9 mg/l) in the Danube River and from 2,3 – 120 mg/l (annual means 4,4 – 50,2 mg/l) in tributaries.

Nutrient status of the Danube River and its tributaries is very important as nitrogen is blamed to be essential causing eutrophication effects in the Danube delta and the Black Sea. While inorganic fractions of nitrogen like ammonium-N and nitrate-N were measured in all 72 sampling points in 1997, information on organic nitrogen is available only from countries in the middle part of the Danube River Basin - from Czech Republic down to Croatia.

Content of ortho-phosphate phosphorus was measured in all sampling points, total phosphorus in 63 sampling points only.

Ammonium-N was observed in the range from 0,01 – 1,44 mg/l (annual means 0,06 – 0,45 mg/l) in the Danube itself and from 0,01 – 5,50 mg/l (annual means 0,03 – 1,60 mg/l) on tributaries.

Nitrate-N concentration range was from 0,62 – 6,20 mg/l (annual means 1,04 – 3,19 mg/l) in the Danube River and from 0,19 – 8,52 mg/l (annual means 0,60 – 7,40 mg/l) on tributaries.

Concentrations of ortho-phosphate-phosphorus were in the range from 0,0025 – 0,360 mg/l (annual means 0,024 – 0,247 mg/l) in the Danube River and from 0,0025 – 0,760 mg/l (annual means 0,007 – 0,360 mg/l) on tributaries.

The statistical results presented in the tables in Annex 1 indicate that in general the ranges of measured determinands were larger in the tributaries than in the Danube itself. The highest pollutant levels were typical for some tributaries.

Seasonal variation of some determinands were also typical. For example, in sampling sites, water samples from which were taken and analysed equably during the year, maximum concentrations of ammonium-N, nitrate-N and ortho-phosphate phosphorus were observed in the first or fourth quarter of the year, when water temperature was low.

6. Maps of selected determinands

For the selected determinands characterising organic pollution and nutrient fractions in surface waters in the Danube River Basin the assessment based on the available data of TNMN –Phase 1 from 1997 are presented on the Map 6.1, 6.2 and 6.3. The maps show interim water quality classes based on the average concentrations of BOD₅, ortho-phosphate-phosphorus (PO₄³⁻-P) and (NH₄⁺ + NO₃⁻)-N, respectively.

If there were data from three sampling sites (left, middle, right) of a monitoring station only the data of the “middle” is presented in the following maps.

As to this time there was not agreed common classification system for the Danube River Basin, the colour coding used for selected determinands presentation on the maps and tables of this chapter corresponds to the classification (5 class-system) which was proposed in the Final Report of the Applied Research Project “Water Quality Targets and Objectives for Surface Waters in the Danube Basin” WQTO (Project EU/AR/203/90). There was no classification proposed for inorganic nitrogen as (NH₄⁺ + NO₃⁻)-N, so it was agreed that the classification should be done according to the WQTO-proposal for NO₃⁻-N (see Table 6.1).

Table 6.1: Preliminary set of surface water quality standards for the Danube riparian countries (Water Quality Targets and Objectives for Surface Waters in the Danube Basin – Project EU/AR/203/90; Final Report (1997))

Determinand	Unit	Quality class				
		I blue	II green	III yellow	IV red	V black
Biological oxygen demand (BOD ₅)	mg/l	<3	5	9	15	>15
Ortho-Phosphate-Phosphorus (PO ₄ ³⁻ -P)	mg/l	0.05	0.1	0.2	0.5	>0.5
Nitrate-Nitrogen (NO ₃ ⁻ -N)	mg/l	1	5	10	25	>25

BOD₅ is a commonly used indicator for biodegradable organic pollution, which effects the oxygen regime in water. Nevertheless the interpretation of results has some difficulties concerning possible toxic effects which can cause decreasing of BOD₅ values. In addition, intercalibration tests within the Danubian laboratories have proved that quality of data is still not really satisfactory.

The results presented in Figure 6.1 show that at most of the monitored stations (89%) the average concentrations of BOD₅ corresponded to class I or II. All monitoring stations along the Danube River itself were within the ranges of class I and II. More polluted sites could only be found in the tributaries as 25 % of sampling stations located on them corresponded to class III (see also Table 6.2).

Comparing with the previous year, 60 % of TNMN monitoring stations corresponded to class I in 1996, while in 1997 water in 41 % of stations was within the range of class I. On the other hand, while in 1996 two monitoring stations corresponded to classes IV and V, in 1997 there were no stations with BOD₅ average values in the range of these classes.

Table 6.2: TNMN 1997 - average concentrations of BOD₅: distribution of monitoring stations according to the classification listed in Table 6.1.

Water Quality class	Monitoring sites (Danube)		Monitoring sites (tributaries)		Monitoring sites (Danube + tributaries)	
	number within class	% of total	number within class	% of total	number within class	% of total
I	12	50	6	30	18	41
II	12	50	9	45	21	48
III	0	0	5	25	5	11
IV	0	0	0	0	0	0
V	0	0	0	0	0	0

Nutrients are very important as they are responsible for eutrophication processes in lakes, rivers and the receiving sea. The concentrations of PO₄³⁻-P and inorganic nitrogen as (NH₄⁺+NO₃⁻)-N were selected from the different nutrient fractions, which are analysed within the TNMN-programme, to be presented in the following maps and graphs.

Ortho-phosphate-phosphorus was chosen to be presented instead of total phosphorus, as it is a more reliable indicator of bioavailability. Total phosphorus is highly correlated with the transport of suspended solids and discharges with extreme concentrations during flood events, which are monitored only rarely. In addition, content of total phosphorus was not measured in all monitoring stations in 1997.

Considering all monitoring stations again most of them (90 %) showed average PO₄³⁻-P concentrations within the range of class I and II. In the Danube itself the average PO₄³⁻-P concentrations of 96 % sampling stations corresponded to class I and II. Higher nutrient levels were observed on the tributaries, at 18 % of the monitoring stations located on tributaries the

average concentration for $\text{PO}_4^{3-}\text{-P}$ was above 0.1 mg/l, which is limit value for class II (see also Table 6.3).

Comparing results of classification with the previous year, in 72 % of TNMN monitoring stations concentrations of $\text{PO}_4^{3-}\text{-P}$ were in the range of classes I or II in 1996, whilst in 1997 this figure increased up to 90%. In addition, while 22 % of monitoring stations corresponded to classes IV and V in 1996, in 1997 only in 2 % of stations $\text{PO}_4^{3-}\text{-P}$ average concentrations were within the range of class IV and no stations in class V.

Table 6.3: TNMN 1997 - average concentrations of $\text{PO}_4^{3-}\text{-P}$: distribution of monitoring stations according to the classification listed in Table 6.1.

Water Quality class	Monitoring sites (Danube)		Monitoring sites (tributaries)		Monitoring sites (Danube + tributaries)	
	number within class	% of total	number within class	% of total	number within class	% of total
I	17	65	8	36	25	52
II	8	31	10	46	18	38
III	0	0	4	18	4	8
IV	1	4	0	0	1	2
V	0	0	0	0	0	0

In Figure 6.3 the average concentrations of $(\text{NH}_4^+ + \text{NO}_3^-)\text{-N}$ are presented. At most of the monitoring stations (92 %) the average concentrations measured in 1997 indicated class II. All monitoring stations in the Danube were within the range of water quality class II. In the tributaries 9 % of sampling stations corresponded to class III (see Table 6.4).

In comparison with the previous year 1996 no changes in results of $(\text{NH}_4^+ + \text{NO}_3^-)\text{-N}$ classification in TNMN monitoring stations have been identified.

The inorganic nitrogen can not be equated with the total amount of nitrogen in the river, because the total nitrogen also includes the organic fraction. Unfortunately the organic nitrogen was analysed only in stations located in the middle part of Danube River Basin. But the results seem to indicate that the organic nitrogen may play a more important role in the lower parts of the Danube than in the upper parts.

Table 6.4: TNMN 1997 - average concentrations of $(\text{NH}_4^+ + \text{NO}_3^-)\text{-N}$: distribution of monitoring stations according to the classification listed in Table 6.1.

Water Quality class	Monitoring sites (Danube)		Monitoring sites (tributaries)		Monitoring sites (Danube + tributaries)	
	number within class	% of total	number within class	% of total	number within class	% of total
I	0	0	2	9	2	4
II	26	100	18	82	44	92
III	0	0	2	9	2	4
IV	0	0	0	0	0	0
V	0	0	0	0	0	0

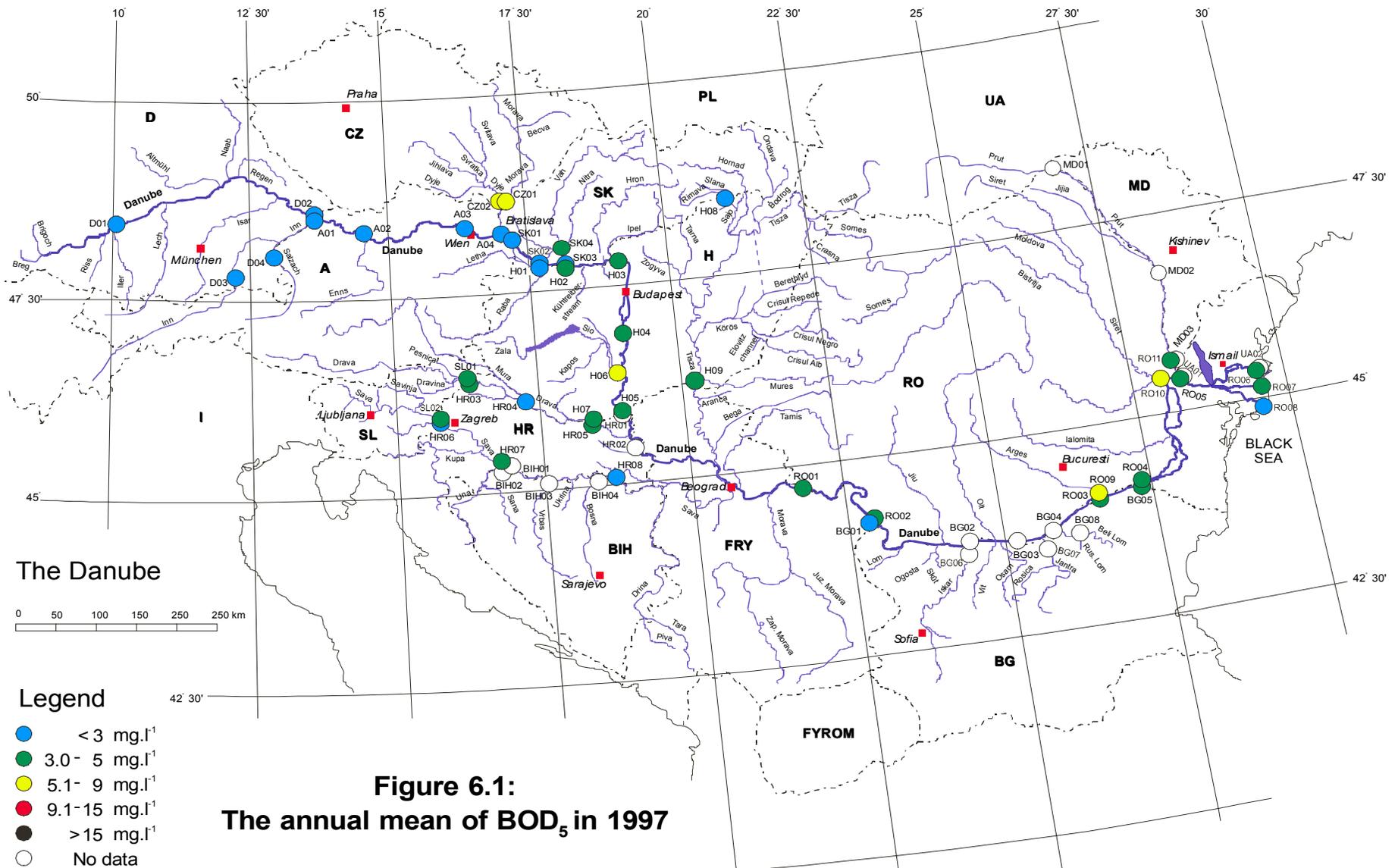


Figure 6.1:
The annual mean of BOD₅ in 1997

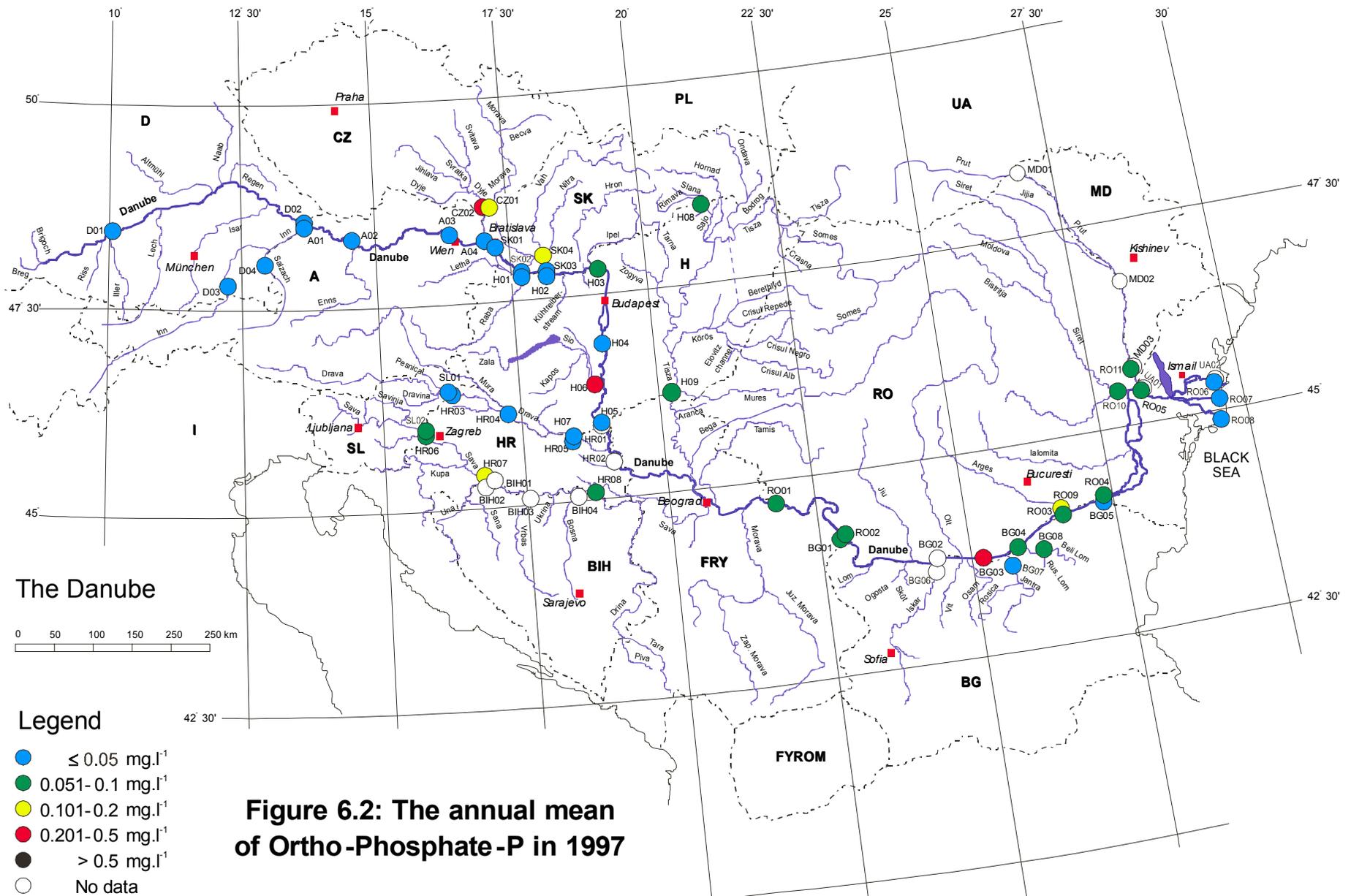
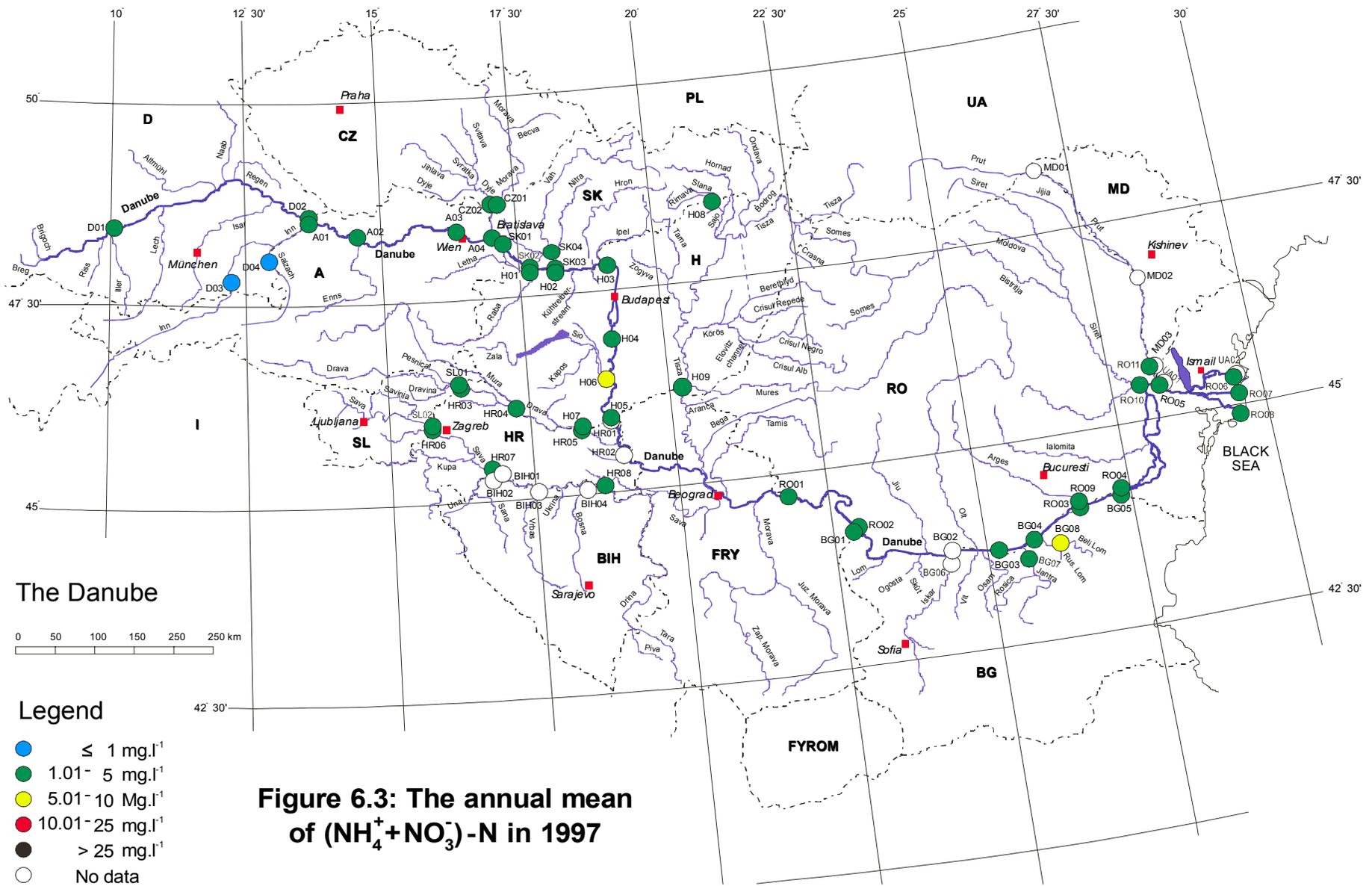


Figure 6.2: The annual mean of Ortho-Phosphate-P in 1997



7. Profiles of selected determinands

In addition to the maps presented in the previous chapter the average, maximum and minimum concentration profiles along the Danube of determinands BOD_5 , PO_4^{3-} -P and $(NH_4^+ + NO_3^-)$ -N are presented on special profile plots, one profile for each of the determinands (Figures 7.1, 7.2 and 7.3).

Each of the profiles consists of two plots. The upper plot shows bars indicating the average, maximum and minimum concentrations in the Danube River at the respective distance from the mouth (km). By green colour minimum values and by red colour maximum values are indicated on the plots. Stations close to each other or those which are monitored by two countries (transboundary stations) are shifted slightly along the X-axis.

Using the same method the lower plot shows the concentration ranges at the most downstream stations on the primary tributaries. In these graphs the bars are plotted at the river-km of the confluence of the tributary with the Danube.

If there are three sampling sites (left, middle, right) of a monitoring station only the data of the “middle” is presented in the following profiles.

Figure 7.1: The minimum, mean and maximum of BOD₅ in 1997

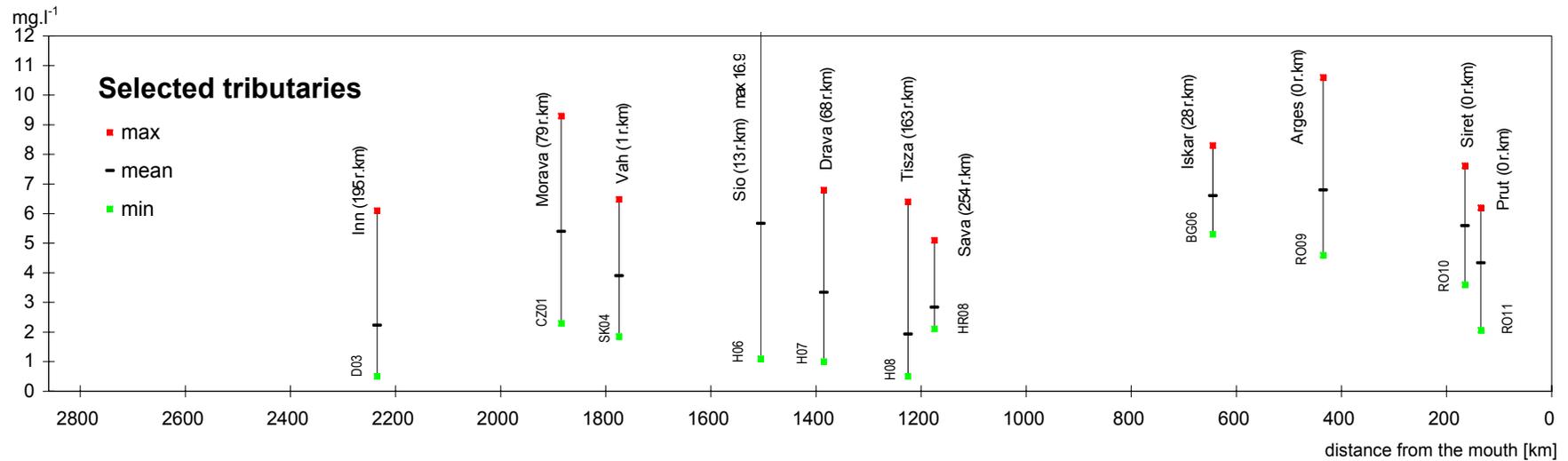
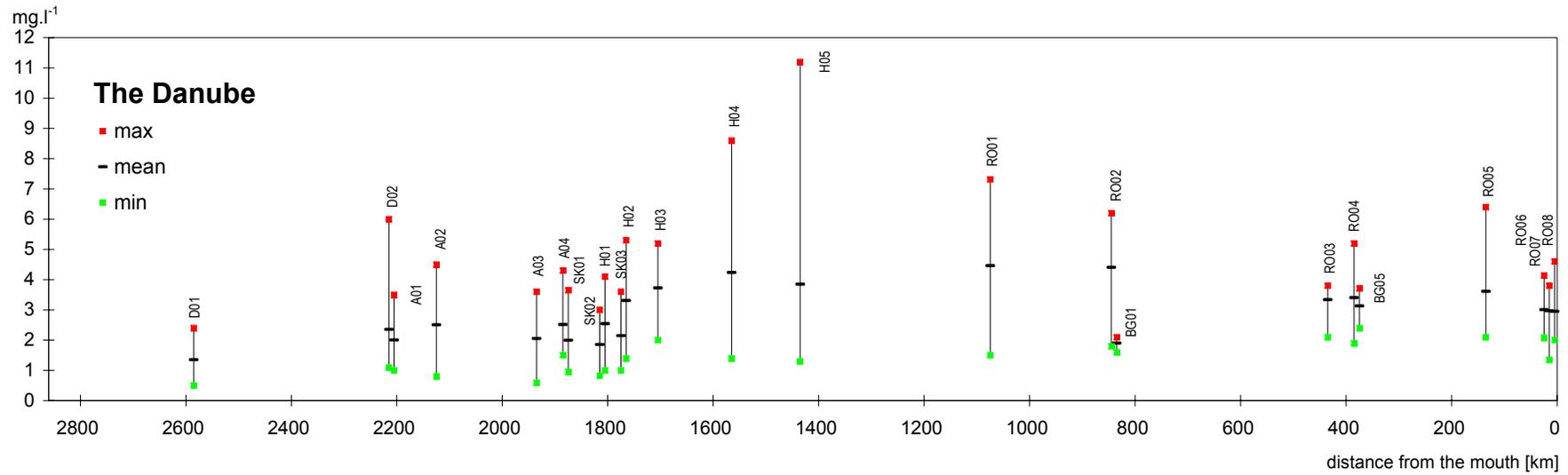


Figure 7.2: The minimum, mean and maximum of Ortho-Phosphate-P in 1997

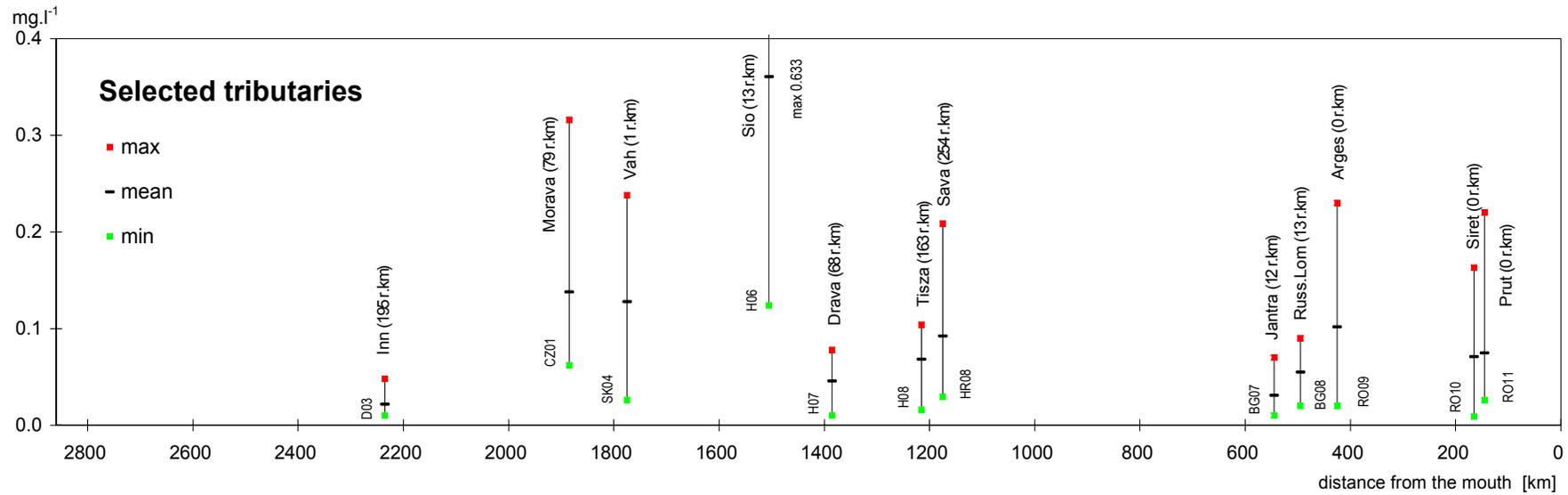
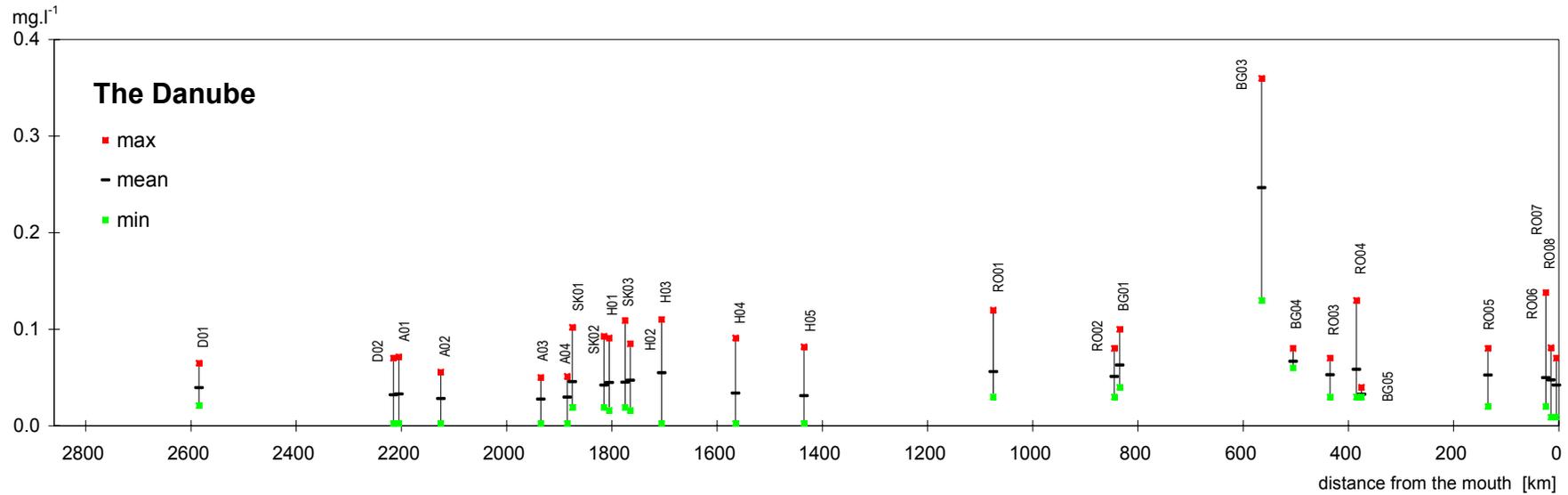
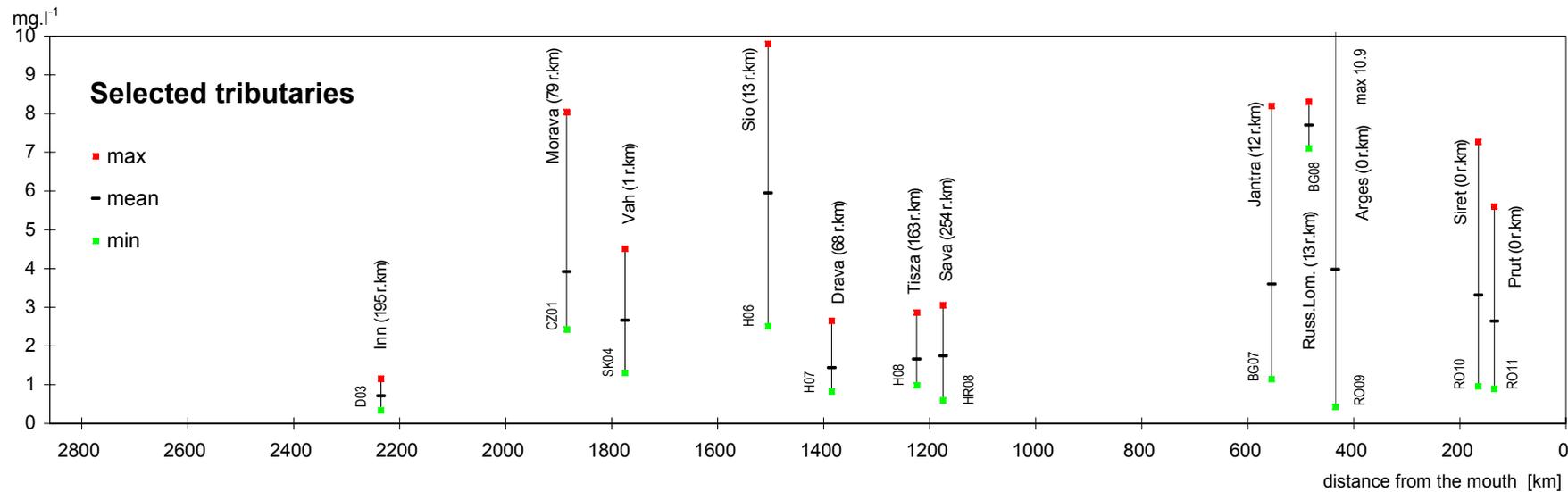
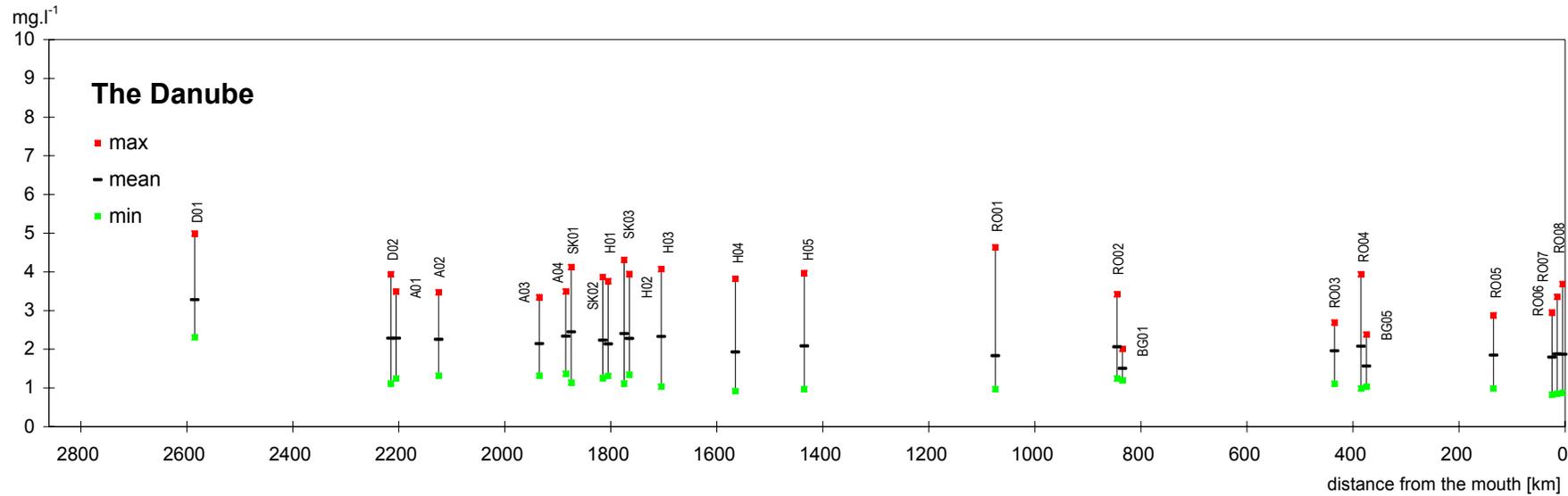


Figure 7.3: The minimum, mean and maximum of (NH₄+NO₃)-N in 1997



8. Abbreviations

Abbreviation	Explanation
AQC	Analytical Quality Control
ARP	Applied Research Programme
BD	Bucharest Declaration
CIP	Central Information Point (for information management)
DEFF	Data Exchange File Format
DRPC	Danube River Protection Convention
EPDRB	Environmental Programme for the Danube River Basin
ICPDR	International Commission for the Protection of the Danube River
IM/ESG	Information Management Expert Sub-Group
IMWG	Information Management Working Group
LM/ESG	Laboratory Management Expert Sub-Group
LMWG	Laboratory Management Working Group
LOD	Limit of Detection
M/ESG	Monitoring Expert Sub-Group
MCEP	Multi-Country Environmental Programme
MLIM/EG	Monitoring, Laboratory and Information Management Expert Group
MLIM-SG	Monitoring, Laboratory and Information Management Sub-Group
MWG	Monitoring Working Group
NIC	National Information Centre
NRL	National Reference Laboratory
PCU	Programme Coordination Unit
SAP	Strategic Action Plan
SIP	Strategic Action Plan Implementation Programme
SOP	Standard Operational Procedure
TNMN	Trans National Monitoring Network
TOR	Terms of Reference
WTV	Consortium that carried out the first MLIM-study (WRc, TNO, VKI/DHI)