Water Quality in the Danube River Basin – 2003

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International Commission for the Protection of the Danube River
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TNMN – Yearbook 2003

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The printed version of TNMN Yearbook 2003 contains only the essential background information and a basic overview of the water quality status in the Danube River Basin. The long version of the TNMN Yearbook 2003 including all figures and data is available on the attached CD-ROM.

1. Introduction

1.1. Preface

In the TNMN Yearbook 2001 for the first time all data on water quality were presented in electronic form on a CD-ROM attached to the report. This enabled better practical utilization of the data and also helped to economize the production of TNMN Yearbooks. In the Yearbook 2002, a further revision was introduced - the printed version contained only the essential background information and a basic overview of the water quality status in the Danube River Basin. A full version of the TNMN Yearbook including all figures and data tables was available on the attached CD-ROM. Because a positive feedback was achieved for that revision, the 2003 Yearbook follows the same format as previous year.

1.2. History of the TNMN

In June 1994, the Convention on Cooperation for the Protection and Sustainable Use of the Danube River (DRPC) 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. DRPC also emphasizes that the Contracting Parties shall cooperate in the field of monitoring and assessment. In this respect, the operation of the Trans National Monitoring Network (TNMN) in the Danube River Basin aims to contribute to the implementation of the DRPC. This Yearbook reports on results of the basin-wide monitoring programme and presents TNMN data for 2003.

The TNMN has been in the operation since 1996, but the first steps towards it were taken about ten years earlier. In December 1985 the governments of the Danube riparian countries signed the Bucharest Declaration. 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 containing 11 cross sections on the Danube River was established.

1.3. Objectives of the TNMN

The original objective of the TNMN was to strengthen the existing network set up by the Bucharest Declaration, to enable a reliable and consistent trend analysis for concentrations and loads of priority pollutants, to support the assessment of water quality for water use and to assist in the identification of major pollution sources.

In 2000, having the experience of the TNMN operation, the main objective of the TNMN was reformulated: to provide a structured and well balanced overall view of the status and long-term development of quality and loads in terms of relevant constituents in the major rivers of the Danube Basin in an international context.

The discussion on improvements of TNMN was influenced also by the fact that in 2000 the EU Water Framework Directive (2000/60/EC, short WFD) came into force establishing a framework for Community action in the field of water policy. At present, WFD implementation represents the highest priority for the ICPDR, providing a platform for coordination of the activities leading to the development of a Danube River Basin Management Plan. The activities focussed to the implementation of specific requirements of WFD towards monitoring and assessment of surface water status were initiated and will lead to the revision of the TNMN.

2. Description of the TNMN

2.1. Monitoring stations network

The TNMN builds on national surface water monitoring networks. To select monitoring locations for the purposes of international monitoring network in Danube River Basin, the following selection criteria for monitoring location had been set up:

- *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*

Monitoring location included in TNMN should meet at least one of the selection criteria.

The selection procedure led to preparation of a list of 61 monitoring locations to be included in TNMN Phase I. In 2001, the monitoring stations from Yugoslavia have extended the monitoring network filling the gap in water quality data in the middle part of the Danube River and related tributaries. With some other minor changes, the final list contains 78 monitoring locations.

Monitoring locations can have up to three sampling points, located on the left side, right side or in the middle of a river. More than one sampling point was proposed for the selected monitoring locations in the middle and lower part of the Danube River and for the large tributaries such as Tisza and Prut Rivers.

In 2003, data from the monitoring locations in Bosnia and Herzegovina were provided to the TNMN database for the first time. This enlarged the coverage of the network and increased the number of active locations to 76 (altogether 105 sampling sites). The samples were taken from 38 monitoring stations (65 sampling sites) located in the Danube River and from 38 monitoring stations (40 sampling sites) in tributaries.

Table 1: List of monitoring sites

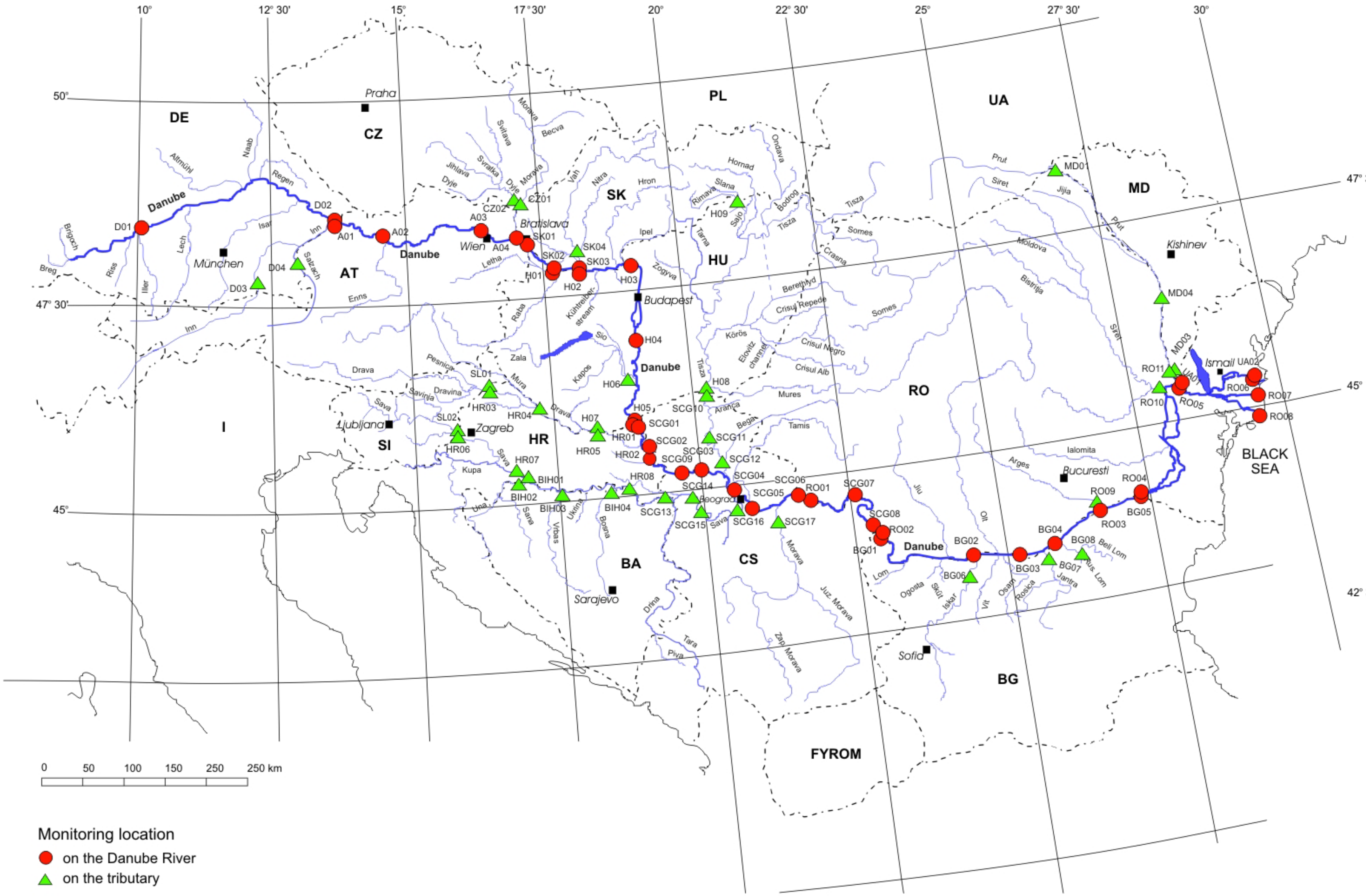
Country Code	River Name	Town/Location Name	Latitude d. m. s.	Longitude d. m. s.	Distance [Km]	Altitude [m]	Catch-ment [km^2]	DEFF Code	Loc.inprofile
D01	Danube	Neu-Ulm	48 25 31	10 1 39	2581	460	8107	L2140	L
D02	Danube	Jochenstein	48 31 16	13 42 14	2204	290	77086	L2130	M
D03	/Inn	Kirchdorf	47 46 58	12 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 12	16 59 20	79	150	9725	L2100	M
CZ02	/Morava/Dyje	Pohansko	48 48 12	16 51 20	17	155	12540	L2120	M
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	LMR
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	Dravaszabolcs	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	L
HR07	/Sava	us. Una Jasenovac	45 16 02	16 54 52	525	87	30953	L1150	L
HR08	/Sava	ds. Zupanja	45 02 17	18 42 29	254	85	62890	L1060	MR
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
SCG01	Danube	Bezdan	45 51 15	18 51 51	1427	83,15	210250	L2350	L
SCG02	Danube	Bogojevo	45 31 49	19 5 2	1367	80,41	251253	L2360	L
SCG03	Danube	Novi Sad	40 15 3	19 51 40	1258	74,52	254085	L2370	R
SCG04	Danube	Zemun	44 50 56	20 25 2	1174	70,76	412762	L2380	R
SCG05	Danube	Pancevo	44 51 25	20 36 28	1154,8	70,14	525009	L2390	L
SCG06	Danube	Banatska	44 49 6	21 20 4	1076,6	68,58	568648	L2400	M
SCG07	Danube	Tekija	44 41 56	22 25 24	954,6		574307	L2410	R
SCG08	Danube	Radujevac	44 15 50	22 41 9	851	32,45	577085	L2420	R
SCG09	Danube	Backa Palanka	45 15 13	19 31 35	1287		253737	L2430	L
SCG10	/Tisza	Martonos	46 5 59	20 3 50	152	75,54	140130	L2440	R
SCG11	/Tisza	Novi Becej	45 35 9	20 8 23	66	74,03	145415	L2450	L
SCG12	/Tisza	Titel	45 11 52	20 19 9	8,9	72,55	157147	L2460	M
SCG13	/Sava	Jamena	44 52 40	19 5 21	195	77,67	64073	L2470	L
SCG14	/Sava	Sremska	44 58 1	19 36 26	136,4	75,24	87996	L2480	L
SCG15	/Sava	Sabac	44 46 12	19 42 17	103,6	74,22	89490	L2490	R
SCG16	/Sava	Ostruznica	44 43 17	20 18 51	17		37320	L2500	R
SCG17	/Velika Morava	Ljubicevska	44 35 6	21 8 15	34,8	75,09	37320	L2510	R
RO01	Danube	Bazias	44 47	21 23	1071	70	570896	L0020	LMR
			55 57 58	24 40 54					

Country Code	River Name	Town/Location Name	Latitude d. m. s.	Longitude d. m. s.	Distance [Km]	Altitude [m]	Catch-ment [km²]	DEFF Code	Loc.inprofile
RO02	Danube	Pristol/Novo Selo Harbour	44 11 18 23 29	22 45 57 64 69	834	31	580100	L0090	LMR
RO03	Danube	us. Arges	44 4 25	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	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	/Prut	Conf.Danube Giurgiulesti	45 28 10	28 12 36	0	5	27480	L0420	M
BG01	Danube	Novo Selo Harbour/Pristol	44 09 50 58 66	22 47 36 47 58	834	35	580100	L0730	LMR
BG02	Danube	us. Iskar - Bajkal	43 42 58	24 24 45	641	20	608820	L0780	R
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	/Prut	Lipcani	48 16 0	26 50 0	658	100	8750	L2230	L
MD03	/Prut	Conf. Danube-Giurgiulesti	45 28 10	28 12 36	0	5	27480	L2270	LMR
MD04*	/Prut	Leova	46 20 0	28 10 0	216	14	23400	L2240	L
UA01	Danube	Reni	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
Altitude:	The mean surface water level in meters above sea level
Catchment:	The area in square km, from which water is drains through the station
ds.	Downstream of
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
*	Monitoring site MD04 replaces the site MD02 that was originally selected for TNMN.

Sampling location in profile:
L: Left bank
M: Middle of river
R: Right bank

Figure 1: The Danube Stationmap TNMN



Monitoring location
- on the Danube River
- on the tributary

2.2. Determinands

The list of TNMN determinands for water is presented in Table 2. The minimum sampling frequency is 12 times per year for water and twice a year for biomonitoring. The definitions of levels of interest and analytical accuracy targets are given on the attached CD-ROM.

Table 2: Determinand list for water for TNMN

Determinands in Water	Unit	Minimum likely level of interest	Principal level of interest	Target Limit of Detection	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	-	-	-	-

Determinands in Water	Unit	Minimum likely level of interest	Principal level of interest	Target Limit of Detection	Tolerance
Salmonella sp.	in 1 litre	-	-	-	-
Macrozoobenthos - no. of taxa	-	-	-	-	-
Macrozoobenthos - Saprobic index	-	-	-	-	-
Chlorophyll - a	µg/l	-	-	-	-

2.3. Analytical Quality Control (AQC)

The TNMN laboratories have a free choice of an analytical method, providing they are able to demonstrate that the method in use 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 Table 2), so that the method compliance can be checked. In addition to that, a basin-wide AQC programme is regularly organized by the ICPDR.

2.3.1. Performance testing in the TNMN laboratories:

The organisation of a basin-wide proficiency testing for the TNMN laboratories started in 1992 to support the monitoring activities under the Bucharest Declaration. Since then, the organizer of the AQC programme for the Danube River Basin is the Institute for Water Pollution Control of VITUKI, Budapest, Hungary (QualcoDanube programme).

In 2003 four distributions of test samples were organized. The number of participating laboratories was 36 with an additional laboratory (from Constanta, Romania) in the third distribution. The results and evaluation of these distributions have been published in the QualcoDanube Summary Report 2003.

2.4. TNMN Data Management

The procedure of TNMN data collection is organized at a national level. The National Data Managers (NDMs) are responsible for data acquisition from TNMN laboratories as well as for data checking, conversion into an agreed data exchange file format (DEFF) and sending it to the TNMN data management centre in the Slovak Hydrometeorological Institute in Bratislava. This centre performs a secondary check of the data and uploads them into the central TNMN database. In cooperation with the ICPDR Secretariat the TNMN data are uploaded into the ICPDR website (www.icpdr.org).

2.5. Water Quality Classification

To enable evaluation of the TNMN data an interim water quality classification scheme was developed that serves exclusively for the presentation of current status and assessment of trends of the Danube River water quality (i.e., it is not considered as a tool for the implementation of national water policies) (Table 3).

In this classification scheme five classes are used for the assessment, with target value being the limit value of class II. The class I should represent reference conditions or background concentrations. For number of determinands it was not possible to establish real reference values due to existence of many types of water bodies in Danube river basin differing in physico-chemical characteristics naturally. For synthetic substances the detection limit or minimal likely level of interest was chosen as limit value for class I. The classes III – V are on the “non-complying“ side of the classification scheme and their limit values are usually 2 to5-times the target values. They should indicate the extent of the exceedence of the target value and help to recognise the positive tendency in water quality development. For compliance testing the 90-percentile value of at least 11 measurements in a particular year should be used.

Table 3: Water Quality Classification used for TNMN purposes

Determinand	Unit	Class I	Class II TV	Class III	Class IV	Class V
		Class limit values				
Oxygen/Nutrient regime						
Dissolved oxygen*	$mg.l^{-1}$	7	6	5	4	< 4
BOD_5	$mg.l^{-1}$	3	5	10	25	> 25
COD_{Mn}	$mg.l^{-1}$	5	10	20	50	> 50
COD_{Cr}	$mg.l^{-1}$	10	25	50	125	> 125
pH	-		> 6.5* and < 8.5			
Ammonium-N	$mg.l^{-1}$	0.2	0.3	0.6	1.5	> 1.5
Nitrite-N	$mg.l^{-1}$	0.01	0.06	0.12	0.3	> 0.3
Nitrate-N	$mg.l^{-1}$	1	3	6	15	> 15
Total-N	$mg.l^{-1}$	1.5	4	8	20	> 20
Ortho-phosphate-P	$mg.l^{-1}$	0.05	0.1	0.2	0.5	> 0.5
Total-P	$mg.l^{-1}$	0.1	0.2	0.4	1	> 1
Chlorophyll-a	$\mu g.l^{-1}$	25	50	100	250	> 250
Metals (dissolved) **						
Zinc	$\mu g.l^{-1}$	-	5	-	-	-
Copper	$\mu g.l^{-1}$	-	2	-	-	-
Chromium (Cr-III+VI)	$\mu g.l^{-1}$	-	2	-	-	-
Lead	$\mu g.l^{-1}$	-	1	-	-	-
Cadmium	$\mu g.l^{-1}$	-	0.1	-	-	-
Mercury	$\mu g.l^{-1}$	-	0.1	-	-	-
Nickel	$\mu g.l^{-1}$	-	1	-	-	-
Arsenic	$\mu g.l^{-1}$	-	1	-	-	-
Metals (total)						
Zinc	$\mu g.l^{-1}$	bg	100	200	500	> 500
Copper	$\mu g.l^{-1}$	bg	20	40	100	> 100
Chromium (Cr-III+VI)	$\mu g.l^{-1}$	bg	50	100	250	> 250
Lead	$\mu g.l^{-1}$	bg	5	10	25	> 25
Cadmium	$\mu g.l^{-1}$	bg	1	2	5	> 5
Mercury	$\mu g.l^{-1}$	bg	0.1	0.2	0.5	> 0.5
Nickel	$\mu g.l^{-1}$	bg	50	100	250	> 250
Arsenic	$\mu g.l^{-1}$	bg	5	10	25	> 25
Toxic substances						
AOX	$\mu g.l^{-1}$	10	50	100	250	> 250
Lindane	$\mu g.l^{-1}$	0.05	0.1	0.2	0.5	> 0.5
p,p´-DDT	$\mu g.l^{-1}$	0.001	0.01	0.02	0.05	> 0.05
Atrazine	$\mu g.l^{-1}$	0.02	0.1	0.2	0.5	> 0.5
Trichloromethane	$\mu g.l^{-1}$	0.02	0.6	1.2	1.8	> 1.8
Tetrachloromethane	$\mu g.l^{-1}$	0.02	1	2	5	> 5
Trichloroethene	$\mu g.l^{-1}$	0.02	1	2	5	> 5
Tetrachloroethene	$\mu g.l^{-1}$	0.02	1	2	5	> 5
Biology						
Saprobic index of macrozoobenthos	-	≤ 1.8	1.81 – 2.3	2.31 – 2.7	2.71 – 3.2	> 3.2

* values concern 10-percentile value
bg background values
** for dissolved metals only guideline values are indicated
TV target value

3. Results of basic statistical processing

76 TNMN monitoring stations had been monitored in the Danube River Basin in 2003. Because some monitoring stations contain more sampling sites (usually left, middle and right side of the river), data had been collected from altogether 105 sampling sites, out of which 65 are located on the Danube River and 40 on the tributaries. The only missing data were from the two monitoring profiles in Ukraine.

The basic processing of the TNMN data includes calculation of selected statistical characteristics and water quality classification for each determinand / monitoring site. Results are presented in tables in the Annex (see the attached CD-ROM) using the following format:

Term used	Explanation
Determinand name	name of the determinand measured according to the agreed method
Unit	unit of the determinand measured
N	number of measurements
Min	minimum value of the measurements done in the year 2003
Mean	arithmetical mean of the measurements done in the year 2003
Max	maximum value of the measurements done in the year 2003
C50	50 percentile of the measurements done in the year 2003
C90	90 percentile of the measurements done in the year 2003
Class	result of classification of the determinand

When processing the TNMN data and presenting them in the tables of the Annex, the following rules have been applied:

- *If "less than the detection limit" values were present in the dataset for a given determinand, the value of detection limit was used in statistical processing of the data.*
- *If number of measurements for a particular determinand was lower than four, only minimum, maximum and mean are reported in the tables of the Annex.*
- *For the purposes of classification,* ***testing value*** *has been calculated for each determinand, which was further compared to limit values for water quality classes given in Chapter 2.5 and a corresponding class was assigned to the determinand. The testing value is equal to 90 percentile (10 percentile for dissolved oxygen and lower limit of pH value) if number of measurements in a year was at least eleven. If number of measurements in a year was lower than eleven, the testing value is represented by a maximum value from a data set (a minimum value for dissolved oxygen and lower limit of pH value).*
- *It happened in some cases that limit of detection used by a country was higher than limit value for class II, representing the target value. In these cases only statistics was calculated and presented in a table, but classification has not been done.*

An indication of water quality class for each determinand in the tables of the Annex is presented by the respective class number and highlighted by using colouring of the respective field of the table, using the colours given below:

blue	class I
green	class II
yellow	class III
orange	class IV
red	class V

- *If number of measurements for classified water quality determinand was lower than four in sampling site, the result of classification was presented in tables by light blue colour to indicate lower reliability of such results (with an exception of saprobic index).*

Keeping the agreed frequencies of measurements in sampling sites and completeness of datasets regarding the determinands have gradually improved since the start of TNMN operation. In 2003 the lower frequency has been applied only in monitoring locations in Bosnia and Herzegovina (4 times per year). But there are still inconsistencies in frequency of measurement of individual determinands, especially for dissolved phosphorus, biological determinands, heavy metals and specific organic micropollutants, mainly in the lower part of the Danube River Basin.

Table 4, created on the basis of data in tables in the Annex (see attached CD-ROM), shows in aggregated way the concentration ranges and mean annual concentrations of selected determinands representing group of oxygen regime, nutrient status, heavy metals, group of biological determinands and organic micropollutants in the Danube River and its tributaries in 2003. Information on number of monitoring locations and sampling sites with measurements of the determinands is also given there.

The statistical results indicate that in general the concentration ranges of measured determinands were larger in the tributaries than in the Danube itself except several heavy metals, in case of which higher concentrations were measured in the Danube River.

Table 4: Concentration ranges and mean annual concentrations of selected determinands in Danube River and its tributaries in 2003

Determinand name	Unit	Danube					Tributaries				
		No.of monitoring locations / No. of monitoring sites with measurements	Range of values		Mean		No.of monitoring locations / No. of monitoring sites with measurements	Range of values		Mean	
			Min	Max	Min_{avg}	Max_{avg}		Min	Max	Min_{avg}	Max_{avg}
Temperature	°C	37/64	0,0	29,2	11,0	16,7	38/40	0,0	32,4	8,1	24,3
Suspended Solids	mg/l	37/64	< 1	143	5	100	38/40	< 1	400	7	147
Dissolved Oxygen	mg/l	37/64	2,9	17,1	8,0	11,9	38/40	3,3	23,4	7,4	12,0
BOD_5	mg/l	37/64	< 0,5	8,7	1,2	4,1	34/36	0,5	18,0	1,2	7,5
COD_{Mn}	mg/l	35/62	0,6	7,5	1,7	5,3	31/33	1,0	21,0	1,8	10,8
COD_{Cr}	mg/l	30/48	< 1,0	36,0	5,5	32,0	30/32	3,0	76,0	6,5	33,4
TOC	mg/l	14/20	1,1	7,9	1,8	4,7	11/13	1,0	22,0	1,5	11,7
DOC	mg/l	6/8	< 0,1	3,4	0,3	1,8	7/7	1,2	9,6	1,9	7,7
pH		37/64	6,5	9,0	7,4	8,4	38/40	6,2	9,3	7,6	8,4
Alkalinity	mmol/l	36/63	0,9	6,5	1,5	3,6	38/40	0,8	8,9	1,3	7,7
Ammonium-N	mg/l	37/64	< 0,004	1,280	0,021	0,387	38/40	< 0,010	5,560	0,027	3,515
Nitrite-N	mg/l	37/64	< 0,003	0,407	0,014	0,090	38/40	0,001	0,193	0,004	0,113
Nitrate-N	mg/l	37/64	0,07	4,40	0,66	3,17	38/40	< 0,05	11,20	0,30	7,18
Total Nitrogen	mg/l	19/33	0,60	6,94	1,79	3,42	29/31	0,50	11,00	0,65	5,82
Organic Nitrogen	mg/l	17/25	0,01	6,07	0,04	1,93	24/26	0,03	5,45	0,21	2,19
Ortho-Phosphate-P	mg/l	37/64	0,003	4,401	0,025	0,215	36/38	< 0,002	1,888	0,006	0,424
Total Phosphorus	mg/l	37/64	0,01	5,10	0,05	0,36	35/37	0,01	3,63	0,04	1,00
Total Phosphorus - Dissolved	mg/l	10/12	0,01	0,25	0,04	0,14	5/5	0,01	0,56	0,05	0,39
Chlorophyll-a	µg/l	17/26	< 0,1	143,0	5,7	31,6	14/16	< 0,1	381,8	1,5	107,7
Conductivity @ 20°C	µS/cm	37/64	237	1353	369	634	38/40	131	1320	247	993
Calcium	mg/l	36/63	12,2	164,0	45,2	66,7	38/40	12,0	172,0	33,7	96,3
Sulphates	mg/l	35/62	4	112	20	82	34/36	4	220	15	142
Magnesium	mg/l	36/63	4,9	102,0	12,1	27,9	38/40	2,6	66,0	9,1	56,6
Potassium	mg/l	35/60	0,7	9,9	1,9	5,3	31/33	0,3	14,8	0,7	10,0
Sodium	mg/l	35/60	1,3	76,9	9,0	74,7	31/33	2,0	89,0	3,5	57,7
Manganese	mg/l	23/46	< 0,001	1,135	0,009	0,200	13/13	0,002	0,550	0,017	0,244
Iron	mg/l	23/46	< 0,010	4,482	0,078	0,985	17/17	< 0,002	9,400	0,005	4,059
Chlorides	mg/l	36/63	9	387	16	77	34/36	2	197	4	97
Macrozoobenthos- saprobic index		14/14	1,93	3,23	2,02	2,66	15/15	1,20	2,99	1,29	2,90
Macrozoobenthos - no.of taxa		9/9	3	82	5	82	8/8	2	49	3	49

Table 4: Concentration ranges and mean annual concentrations of selected determinands in Danube River and its tributaries in 2003 (cont.)

Determinand name	Unit	Danube					Tributaries				
		No.of monitoring locations / No. of monitoring sites with measurements	Range of values		Mean		No.of monitoring locations / No. of monitoring sites with measurements	Range of values		Mean	
			Min	Max	Min_{avg}	Max_{avg}		Min	Max	Min_{avg}	Max_{avg}
Zinc - Dissolved	µg/l	22/22	< 0,8	154,0	3,3	37,9	14/14	< 2,1	824,0	< 3,0	131,6
Copper - Dissolved	µg/l	22/22	0,05	182,90	1,00	13,89	14/14	< 0,06	5,42	0,47	< 3,00
Chromium - Dissolved	µg/l	23/23	0,05	16,81	0,24	< 3,00	11/11	< 0,07	6,50	0,28	2,57
Lead - Dissolved	µg/l	23/23	0,05	14,10	< 0,20	2,53	14/14	< 0,04	< 3,00	0,17	< 3,00
Cadmium - Dissolved	µg/l	22/22	< 0,02	15,06	0,02	2,10	14/14	< 0,02	< 0,50	< 0,02	< 0,50
Mercury - Dissolved	µg/l	31/32	< 0,050	< 0,300	0,058	< 0,300	20/20	< 0,030	< 0,300	< 0,030	< 0,300
Nickel - Dissolved	µg/l	22/22	0,05	9,11	0,92	2,23	14/14	0,60	15,20	1,16	3,83
Arsenic - Dissolved	µg/l	14/14	< 0,20	5,67	0,67	1,38	11/11	0,10	10,90	0,54	2,93
Aluminium - Dissolved	µg/l	12/12	< 1,0	227,0	12,0	38,2	9/9	< 0,8	345,0	7,4	41,6
Zinc	µg/l	26/47	< 0,8	400,0	3,6	62,4	20/20	< 1	1600,0	5,9	288,9
Copper	µg/l	26/47	0,05	283,60	1,56	27,95	24/24	< 0,06	177,30	0,60	33,44
Chromium - total	µg/l	26/47	0,05	83,17	0,60	< 10	21/21	< 0,07	29,60	0,57	< 10
Lead	µg/l	26/47	0,05	152,20	0,66	11,99	20/20	< 0,04	51,00	0,71	13,58
Cadmium	µg/l	26/47	< 0,02	68,39	0,03	6,79	24/24	< 0,01	7,21	0,03	2,31
Mercury	µg/l	22/38	< 0,050	6,270	0,092	0,673	14/14	< 0,030	0,380	0,030	< 0,300
Nickel	µg/l	26/47	0,05	41,37	1,00	8,15	24/24	0,05	50,14	1,50	16,14
Arsenic	µg/l	17/22	0,32	10,00	0,90	3,35	14/14	0,14	12,50	0,60	5,73
Aluminium	µg/l	14/16	< 20,0	3140,0	25,0	533,3	10/10	12,4	3990,0	56,2	1445,6
Phenol index	mg/l	36/62	< 0,001	0,100	0,001	< 0,020	31/33	< 0,001	0,024	< 0,001	< 0,020
Anionic active surfactants	mg/l	36/62	< 0,006	1,210	< 0,010	0,296	31/33	< 0,010	0,192	< 0,010	0,102
AOX	µg/l	14/14	3,1	119,0	6,9	24,7	11/11	9,0	162,0	< 10,0	122,0
Petroleum hydrocarbons	mg/l	27/45	0,002	7,410	< 0,005	2,007	31/33	< 0,005	4,900	< 0,005	1,370
PAH (sum of 6)	µg/l	8/10	< 0,001	< 0,100	0,002	< 0,100	9/9	< 0,004	< 0,100	< 0,004	< 0,100
PCB (sum of 7)	µg/l	5/7	< 0,005	0,030	0,005	0,018	5/5	< 0,002	0,085	< 0,002	0,032
Lindane	µg/l	31/52	< 0,001	0,990	< 0,001	0,192	28/28	< 0,001	0,426	< 0,001	0,114
pp´DDT	µg/l	31/52	0,001	0,110	0,001	0,021	26/26	< 0,002	< 0,050	< 0,002	< 0,050
Atrazine	µg/l	25/45	< 0,001	0,430	0,009	0,181	13/13	0,001	0,585	0,008	0,123
Chloroform	µg/l	17/19	< 0,01	1,10	0,01	0,55	11/11	< 0,01	26,10	< 0,01	13,65
Carbon tetrachloride	µg/l	17/19	< 0,01	0,10	< 0,01	0,10	10/10	< 0,01	0,30	< 0,01	0,14
Trichloroethylene	µg/l	16/18	< 0,01	0,10	0,01	0,10	10/10	< 0,01	2,50	< 0,01	0,52
Tetrachloroethylene	µg/l	16/18	< 0,01	0,20	< 0,02	0,11	11/11	< 0,01	0,20	0,01	0,12
Total Coliforms (37°C)	10^3 CFU/ 100 ml	24/51	0,00	160,00	0,01	44,58	23/25	0,00	1800,00	0,29	154,58
Faecal Coliforms (44°C)	10^3 CFU/ 100 ml	20/41	0,00	16,00	0,04	3,56	18/20	0,00	350,00	0,09	56,67
Faecal Streptococci	10^3 CFU/ 100 ml	21/46	0,00	3,20	0,00	0,99	15/17	0,00	11,00	0,00	4,29

4. Presentation of classification results

The maps presented on Figures 2 – 10 show water quality classes in TNMN monitoring locations. The locations in the Danube River and those located in tributaries are differentiated by various marks. The spot indicating water quality class on a map is of a smaller size in case the classification result in location is based on lower number of measurements than eleven. If there were data from more sampling sites (left, middle, right) at one monitoring location, only the data from the middle of a river are presented in the maps.

From this classification following conclusions may be drawn:

- *Dissolved oxygen content in water complied with the target value in 70 % of locations in the Danube River. This was worse situation than in 2002, when 85 % of locations corresponded to classes I and II. As for the tributaries, in 2003, 71 % of locations could be classified as class I and II.*
- *For BOD_5 (an indicator of biodegradable organic pollution in waters) the share of locations in the Danube River complying with the target value in 2003 was 83 % (similar as in previous year) while for the tributaries the compliance share was 66 %.*
- *CODCr (characterizes the presence of oxidizable organic compounds in waters) was measured only in 77 % of all monitoring locations. The results of classification were improved when compared to 2002, with 73 % of locations in Danube River and 50% of locations in tributaries belonging to classes I and II (in comparison to 58 % and 39 % in Danube River and tributaries, respectively, in 2002). There were no locations in class IV and V in the Danube River or tributaries.*
- *The concentrations of ammonium-N corresponded to class I and II in 60 % of locations in the Danube River and 58% of locations in the tributaries. This is comparable with the status in 2002.*
- *The results of nitrate-N classification in the Danube River are rather balanced over the years. In 2003 there were no locations representing class I from those included in TNMN, class II was observed in 60% of the monitored locations. In the tributaries, 82 % of the profiles complied with the target value.*

Regarding ortho-phosphate-P, from the Figure 7 it can be seen that while in the Danube River classes I-III were represented, all 5 classes of the classification scheme occurred in the tributaries. A situation in the Danube River is practically without changes in comparison with 2002, with 80% of locations satisfying target value. The content of ortho-phosphate-P is significantly higher in tributaries included in TNMN, with 40 % of locations corresponding to class I and II, 34% to class III, and 21% in classes IV and V. The results of ortho-phosphate P classification in tributaries in 2003 indicate worse conditions than in 2002.

The number of locations with available results on total P had increased in 2003. 75% of monitoring profiles in the Danube River corresponded to classes I and II. These results are comparable with those observed in Danube River in 2002.

The data on chlorophyll-a (an indicator of primary production closely connected to the nutrient content) were collected only from about the half of the TNMN stations. The compliance with classes I and II was observed in 35 % of TNMN stations in the Danube River and 21 % of stations in the tributaries.

Classification of heavy metals is also affected by an absence of large portion of data. In the Danube River, data on cadmium, chromium, copper, zinc, nickel and lead content are missing in 33% of stations, the data on mercury and arsenic are missing in 45% and 55% of stations, respectively. Similar absence of data has been observed also for the tributaries. In the Danube River, the compliance with the target value was achieved in the following part of stations: 50 % for cadmium, 53% for copper, 50% for zinc, 20% for mercury, 45% for arsenic, 48% for lead, 68% for chromium and 68% for nickel. All data received from the Danube on chromium and nickel complied with the target value. The complying share of the tributaries was as follows: 53% for cadmium, 11% for mercury, 55% for chromium, 53% for copper, 40% for zinc, 61% for nickel, 32% for arsenic and 29% for lead.

The target value set for p,p-DDT was achieved at 70 % of the locations in the Danube River and 53 % of the locations in tributaries. Non-compliance was observed in 10 % and 8 % of locations in the Danube River and tributaries, respectively. From the rest of the stations the data are missing.

For atrazine the major problem is with the missing data despite the percentage of TNMN locations without atrazine data had decreased from 63% in 2002 to 51 % in 2003. The available data showed that 38 % of stations on the Danube corresponded to classes I– II; the compliance share for the tributaries was 24 %.

More detailed results of classification of TNMN data in 2003 are shown in the full version of the TNMN Yearbook on the attached CD-ROM.

Figure 2: The classification of Dissolved Oxygen in 2003

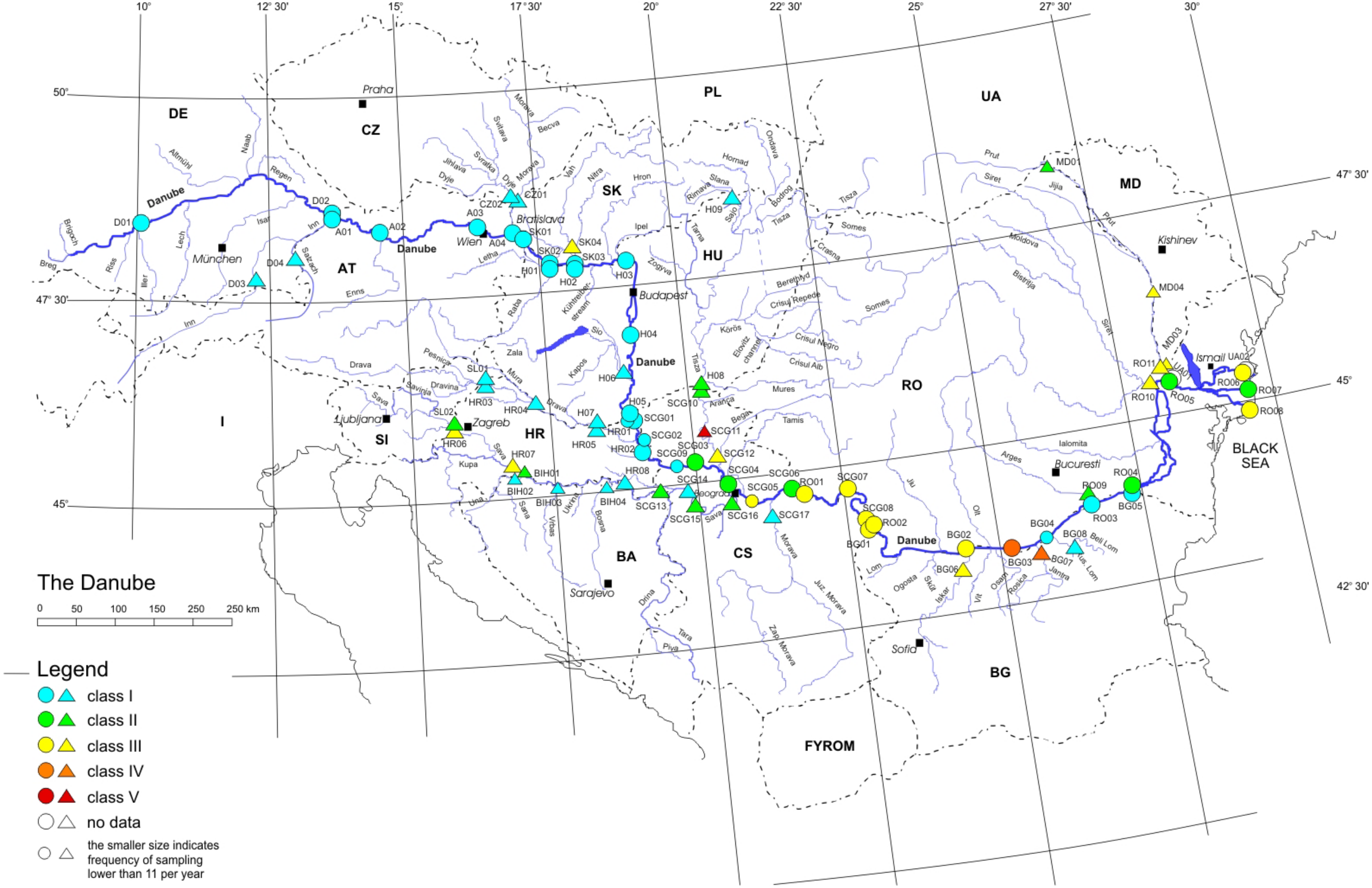


Figure 3: The classification of BOD_5 in 2003

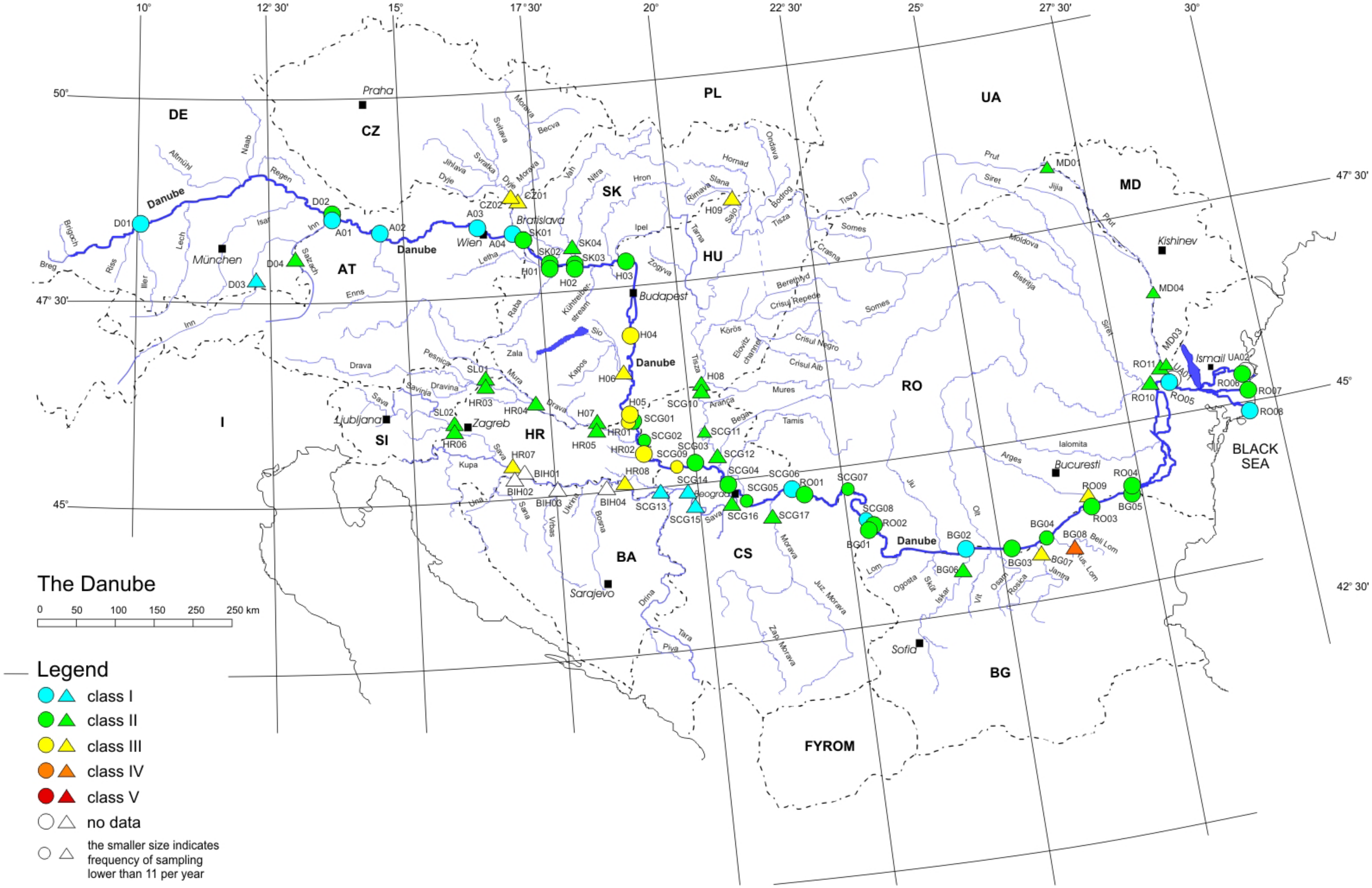


Figure 4: The classification of COD_{Cr} in 2003

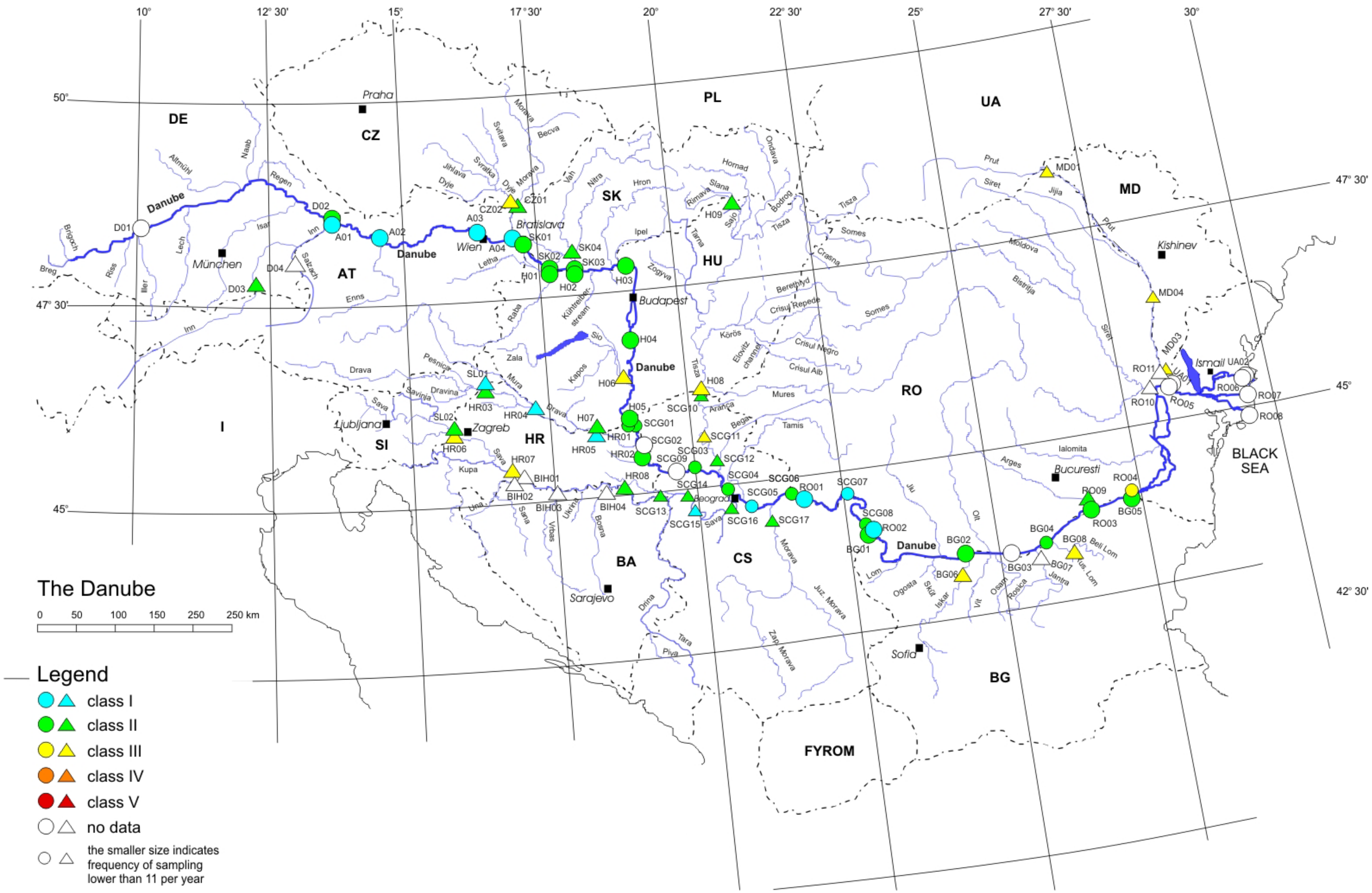


Figure 5: The classification of NH_4^+-N in 2003

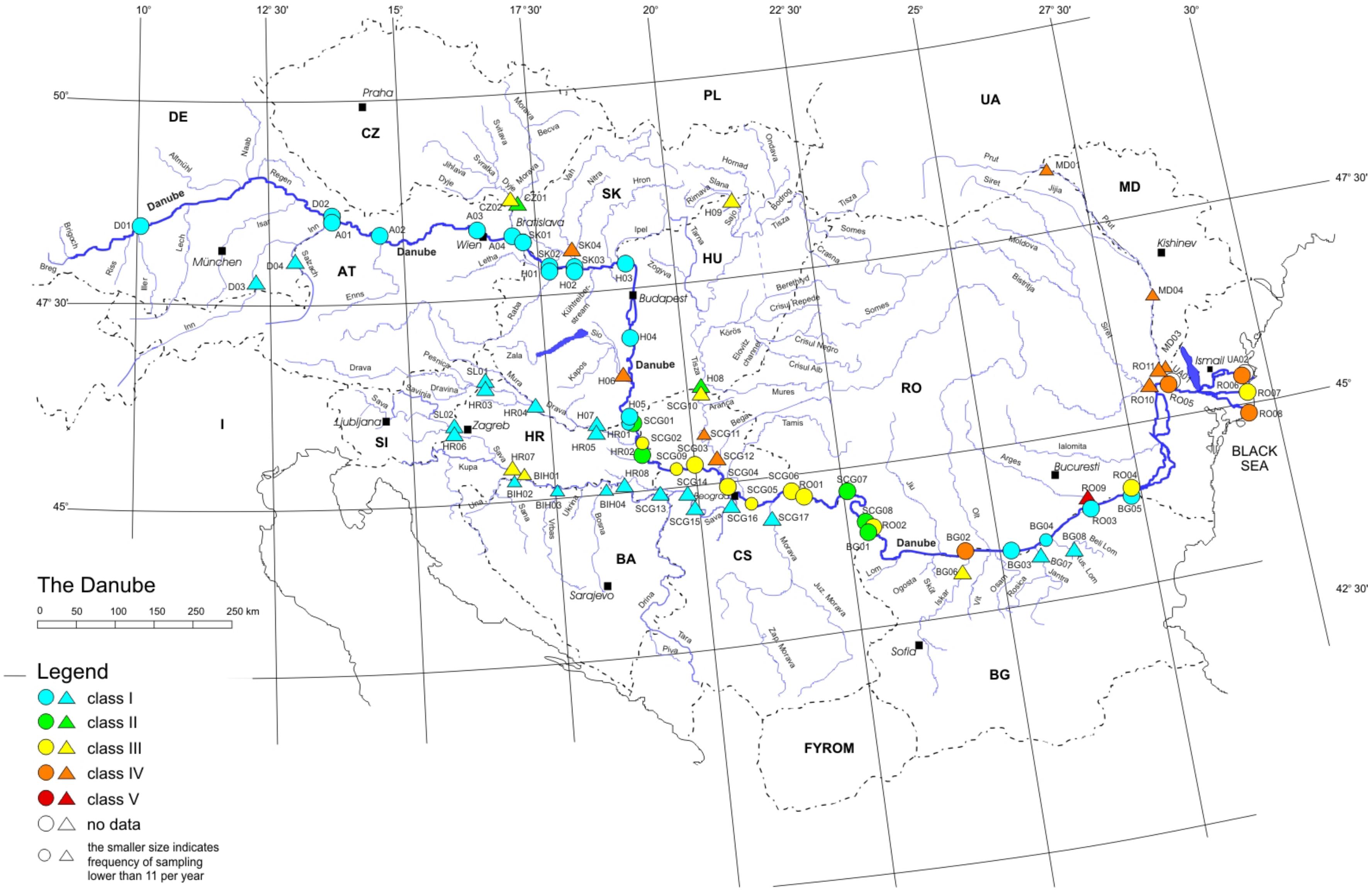


Figure 6: The classification of NO_3^--N in 2003

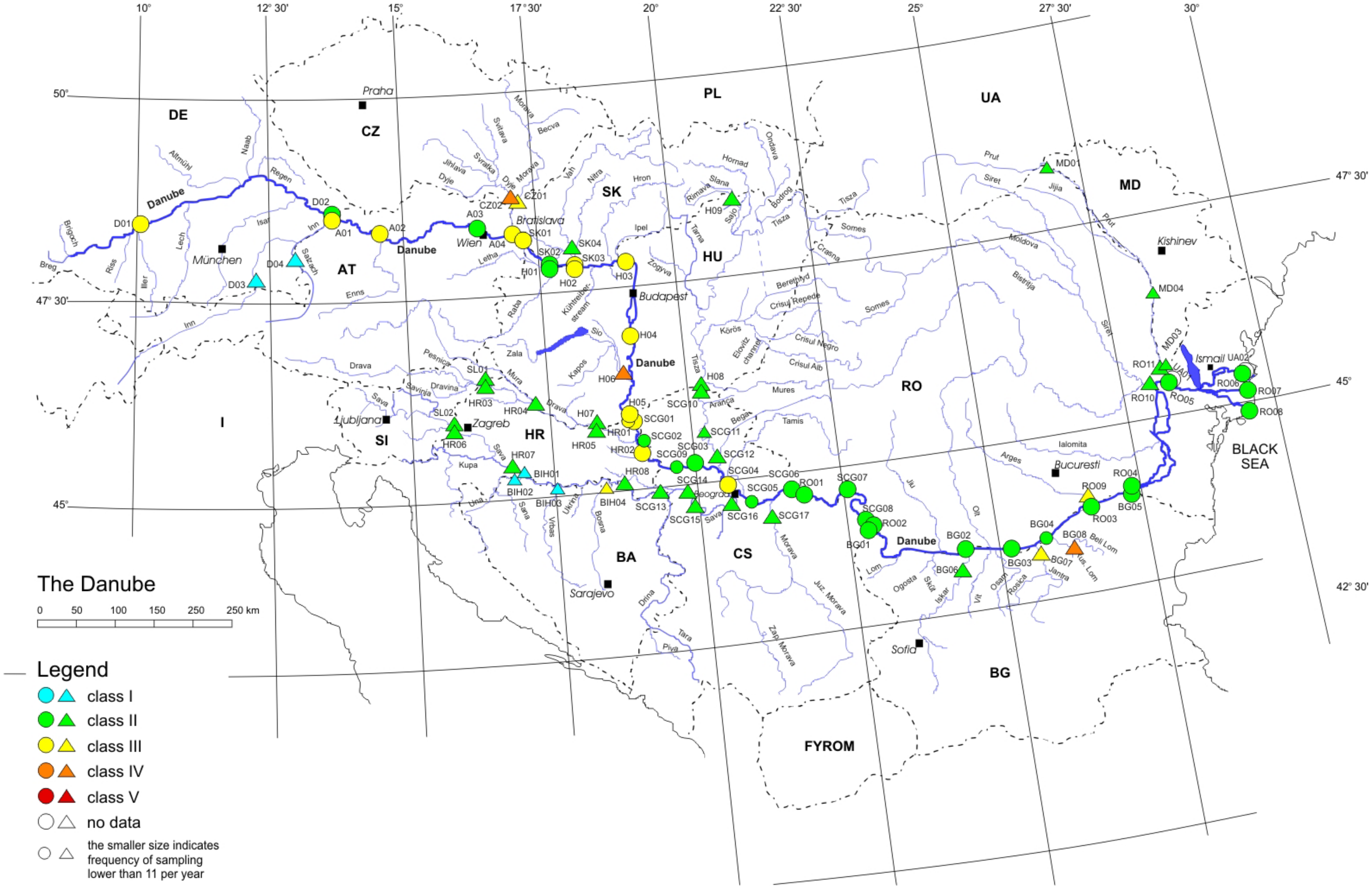


Figure 7: The classification of Ortho-Phosphate-P in 2003

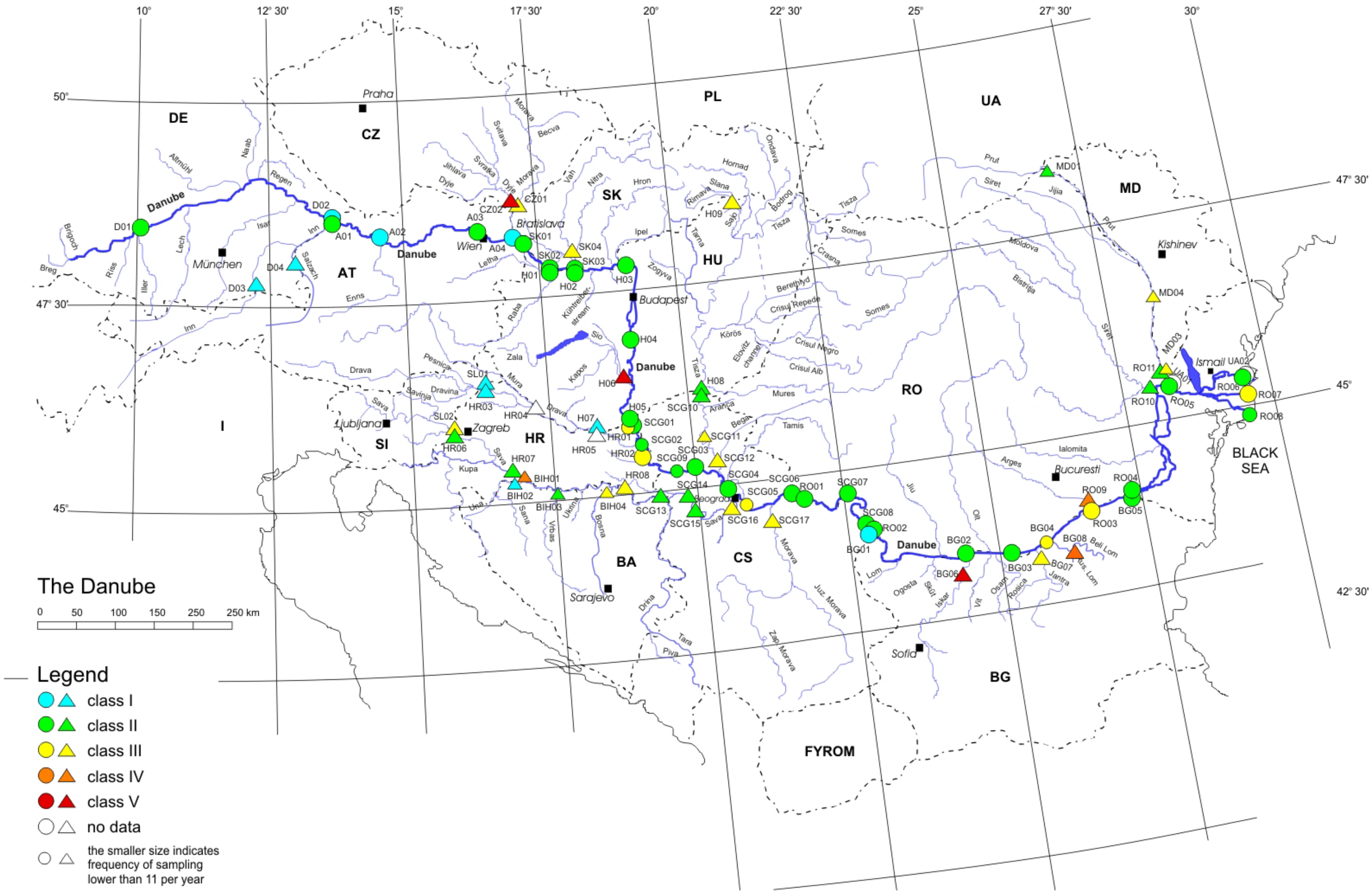


Figure 8: The classification of Total Phosphorus in 2003

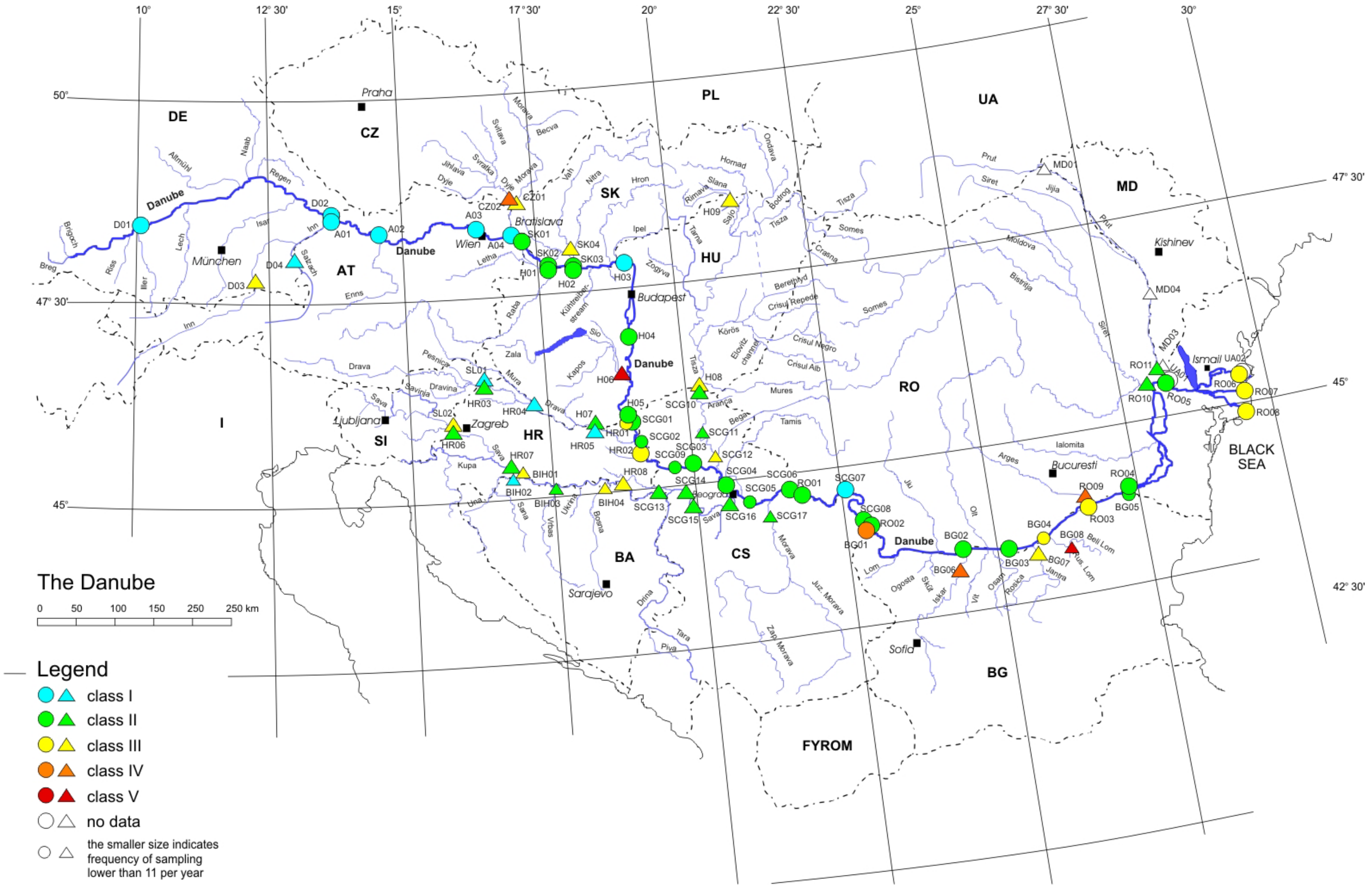


Figure 9: The classification of Chlorpphyll-a in 2003

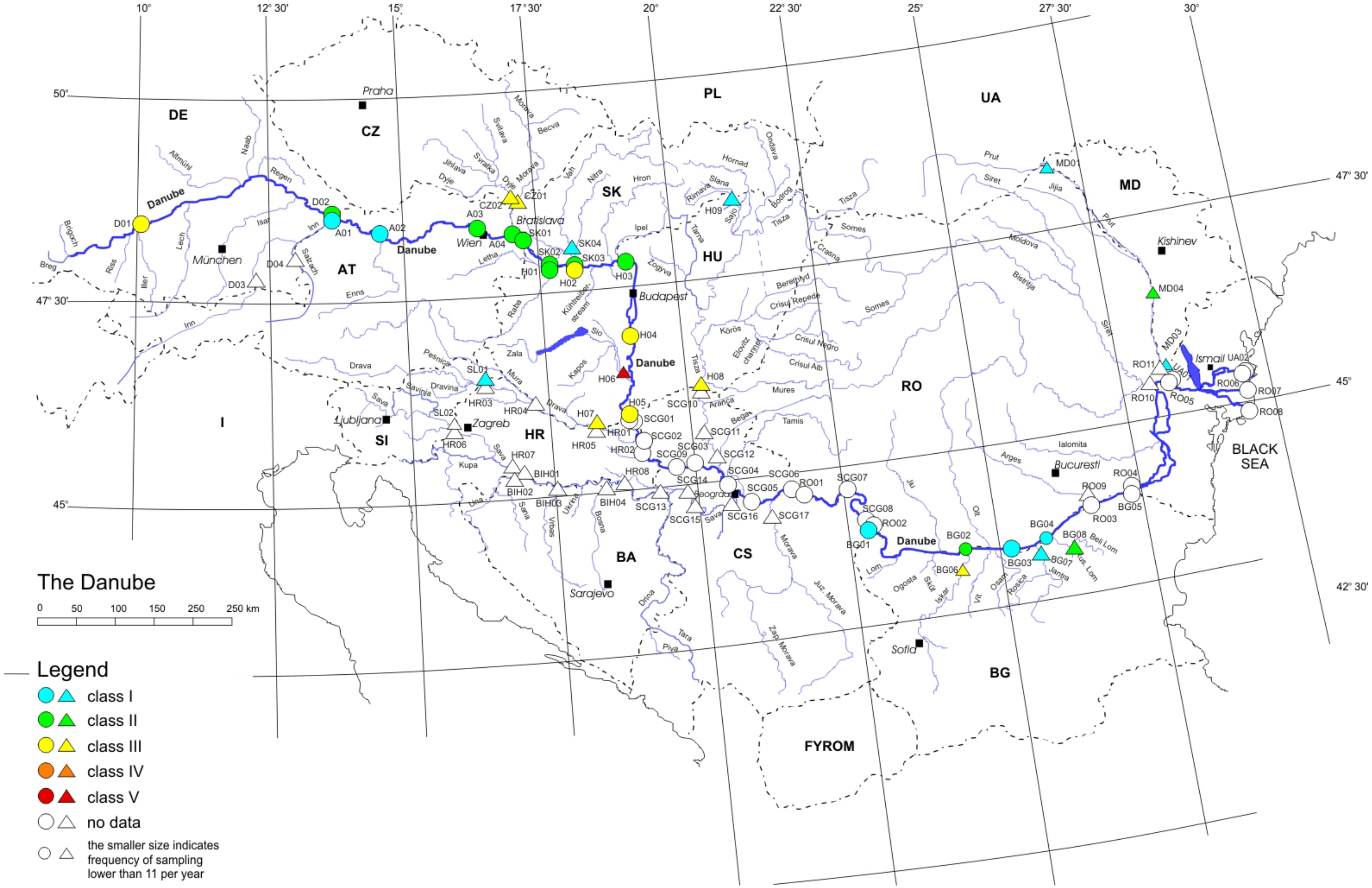
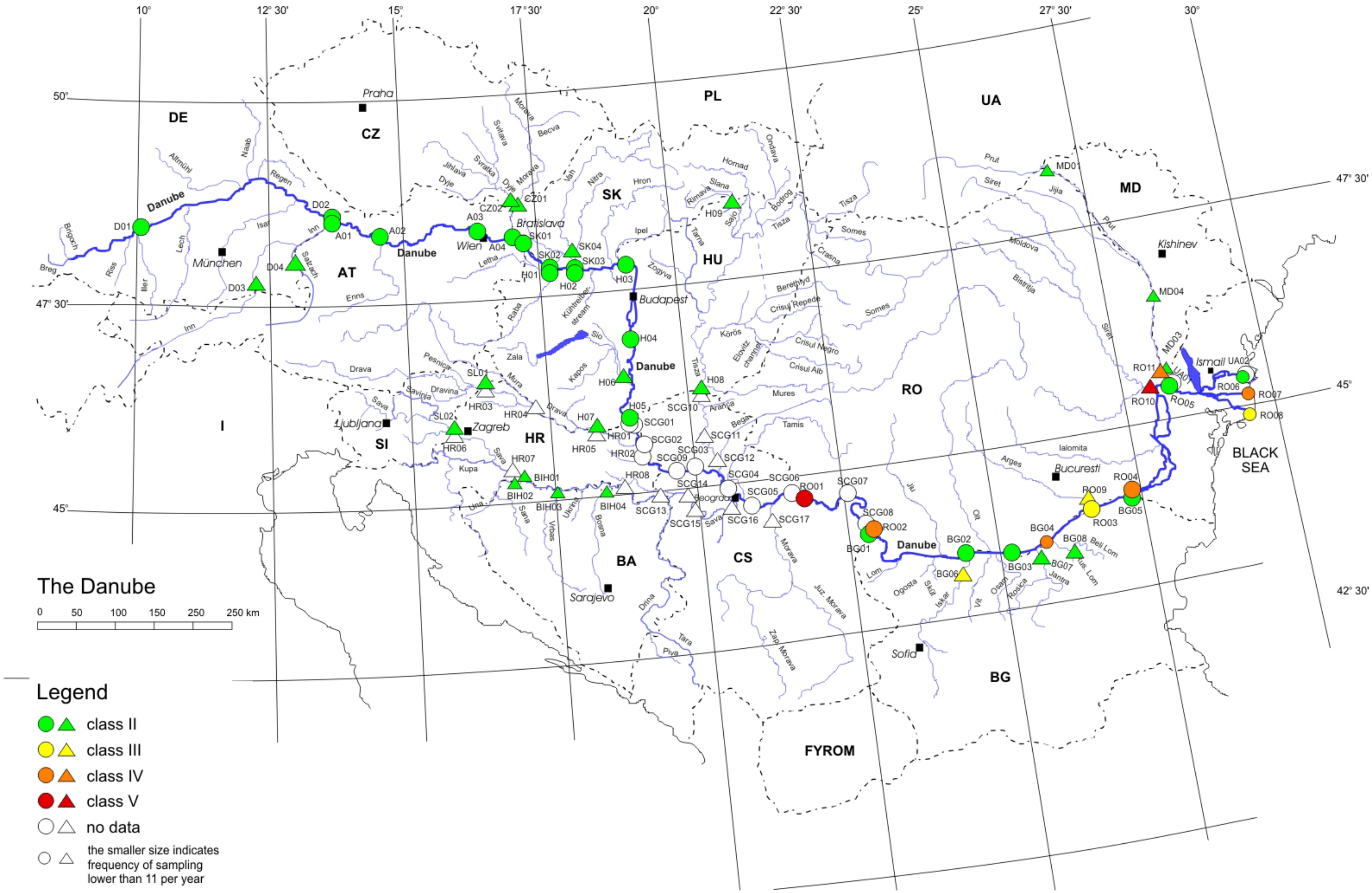


Figure 10: The classification of Cd in 2003



5. Profiles and trend assessment of selected determinands

The profiles of selected indicators along the Danube River in 2003 were as follows: the highest content of degradable organic matter was observed in the middle part of the river, whilst ammonium-N, ortho-phosphate P, total P and cadmium reached the highest values in the lower Danube part. Concentration of nitrate-N was higher in the upper part of the river.

The most polluted tributaries by the degradable organic matter in 2003 were Russenski Lom, Sio and Jantra. The tributaries / stations identified as having elevated concentrations of nutrients in 2003 were Prut, Arges, Russenski Lom, Iskar, Sio, Dyje and Sava at Una Jasenovac.

On the other hand, a general decrease of biodegradable organic pollution was detected in the Austrian and Slovak section of the Danube River as well as in some parts of the lower Danube section (Bazias, Pristol, Reni and the delta). The tributaries Inn, Dyje, Drava downstream of Botovo and Arges showed the similar tendency.

The ammonium-N concentration decrease was observed in stations in the upper part of Danube River down to Hercegszanto (H05) and in the tributaries of the upper section down to river Vah (i.e., Inn, Salzach, Morava, Dyje) and further in Sava, Arges and Siret.

Nitrate-N has a more stable concentration profile over the years when compared to the other nutrients. It decreased in several stations in the German, Austrian and Slovak part of the Danube River and also at the Danube upstream Arges. Nitrate-N decreases also in tributaries Morava, Vah, Sio and some parts of Drava.

A decreasing tendency of ortho-phosphate-P is observed at the Slovak-Hungarian section of the Danube River and also in the Danube at Novo Selo Harbour/Pristol and upstream Iskar. An improvement can be seen also in the tributaries like Iskar, Jantra, Russensko Lom and Siret.

It is necessary to mention high data variability between individual years in the lower part of the Danube River. This phenomenon complicates the accurate interpretation of temporal changes, but it also could be an indication of the fact that the situation regarding the pollution discharge into surface waters is not under control in that area. However, a significant contribution to this data variability, especially in case of the tributaries, could stem from the varying climatic and hydrological conditions in the region.

A more detailed description of the water quality along the Danube River and in the main tributaries including the respective figures is given in the full version of the TNMN Yearbook on the attached CD-ROM.

6. Load Assessment

6.1. Introduction

A view of the long-term development of loads of relevant determinands in the important rivers of the Danube Basin belongs to the major objectives of the TNMN. Therefore, the load assessment programme in the Danube River Basin started in 2000 and the countries agreed to use for its operation a Standard Operational Procedure (SOP) developed in the frame of EU Phare Project "Transboundary Assessment of Pollution Loads and Trends" (1998).

6.2. Description of load assessment procedure

The MLIM EG has agreed the following principles for the load assessment procedure:

- *load is calculated for the following determinands: BOD_5, inorganic nitrogen, ortho-phosphate-phosphorus, dissolved phosphorus, total phosphorus, suspended solids and - on voluntary basis – chlorides;*
- *minimum sampling frequency in sampling sites selected for load calculation is set at 24 per year;*
- *load calculation is processed according to the procedure recommended by the Project "Transboundary assessment of pollution loads and trends" and described in Chapter 6.4. Additionally, countries can calculate annual load by using their national calculation methods, results of which would be presented together with data prepared on the basis of the agreed method;*
- *countries should select for load assessment those TNMN monitoring sites where valid flow data is available (see Table 5).*

Table 5 shows TNMN monitoring locations selected for load assessment programme with information on hydrological stations used for obtaining flow data needed for load assessment in respective locations.

Altogether 21 monitoring locations from nine countries are included in the list. Two locations – Danube-Jochenstein and Sava –Jesenice – have been included by two neighbouring countries, therefore actual number of locations is 19, with ten locations on the Danube River itself and nine locations on the tributaries.

Table 5: List of TNMN locations selected for load assessment program

Country	River	Water quality monitoring location			Hydrological station	
		Country Code	Location	Distance from mouth (Km)	Location	Distance from mouth (Km)
Germany	Danube	D02	Jochenstein	2204	Achleiten	2223
Germany	Inn	D03	Kirchdorf	195	Oberaudorf	211
Germany	Inn/Salzach	D04	Laufen	47	Laufen	47
Austria	Danube	A01	Jochenstein	2204	Aschach	2163
Austria	Danube	A04	Wolfsthal	1874	Hainburg (Danube) Angern (March)	1884 32
Czech Republic	Morava	CZ01	Lanzhot	79	Lanzhot	79
Czech Republic	Morava/Dyje	CZ02	Pohansko	17	Breclav-Ladná	32,3
Slovak Republic	Danube	SK01	Bratislava	1869	Bratislava	1869
Hungary	Danube	H03	Szob	1708	Nagymaros	1695
Hungary	Danube	H05	Hercegszántó	1435	Mohács	1447
Hungary	Tisza	H08	Tiszasziget	163	Szeged	174
Croatia	Danube	HR02	Borovo	1337	Borovo	1337
Croatia	Sava	HR06	Jesenice	729	Jesenice	729
Croatia	Sava	HR07	Una Jesenovac	525	Una Jesenovac	525
Croatia	Sava	HR08	Zupanja	254	Zupanja	254
Slovenia	Drava	SI01	Ormoz	300	Borl HE Formin Pesnica-Zamusani	325 311 10.1(to the Drava)
Slovenia	Sava	SI02	Jesenice	729	Catez Sotla -Rakovec	737 8.1 (to the Sotla)
Romania	Danube	RO 02	Pristol-Novo Selo	834	Gruia	858
Romania	Danube	RO 04	Chiciu-Silistra	375	Chiciu	379
Romania	Danube	RO 05	Reni-Chilia arm	132	Isaccea	101
Ukraine	Danube	UA02	Vilkova-Kilia arm	18		

6.3. Monitoring Data in 2003

The monitoring frequency is an important factor for the assessment of pollution loads in water courses. Table 6 shows the number of measurements of flow and water quality determinands in TNMN locations selected for load assessment.

Concerning the data availability, there are still no data from Ukraine and flow data are missing also in two Croatian monitoring locations. In general, from most of the stations, the number of samples collected in 2003 was above 20, the frequency of 12 times per year was applied only in case of Morava, Dyje and Danube-Jochenstein (A01). But as the Danube Jochenstein is being assessed on the basis of combined data from two countries, there is no problem with insufficient sampling frequency at that station. A similar approach would be recommendable to be adopted at the two other sampling sites on the Morava (CZ/SK) and Dyje (CZ/A), which also have a transboundary character and are monitored only by Czech Republic, at present. The second location that could potentially be processed by using combined data from two countries is Sava –Jesenice, but this approach was not applied there due to the different methods of measurements used for some determinands, leading to differences in results. In addition, Croatia does not have flow data for this monitoring location.

Table 6: Number of measurements in TNMN locations selected for assessment of pollution load in 2003

Country Code	River	Location	Location in profile	River Km	Number of meausrements in 2003							
					Q	SS	N_{inorg}	$P\text{-}PO_4$	P_{total}	BOD_5	Cl	P_{diss}
D02	Danube	Jochenstein	M	2204	365	26	26	26	26	26	26	12
D03	Inn	Kirchdorf	M	195	365	24	26	26	26	25	26	0
D04	Inn/Salzach	Laufen	L	47	365	26	26	26	26	26	26	0
A01	Danube	Jochenstein	M	2204	365	12	12	12	12	12	12	12
A04	Danube	Wolfsthal	R	1874	365	24	24	24	24	24	24	24
CZ01	Morava	Lanzhot	M	79	365	11	11	11	11	11	11	0
CZ02	Morava/Dyj	Pohansko	M	17	365	12	12	12	12	12	12	0
SK01	Danube	Bratislava	M	1869	365	25	25	12	25	25	25	12
H03	Danube	Szob	L	1708	365	26	26	26	26	26	26	0
			M			26	26	26	26	26	26	0
			R			24	24	24	24	24	24	0
H05	Danube	Hercegszántó	M	1435	365	25	37	37	37	37	25	0
H08	Tisza	Tiszasziget	L	163	365	12	26	26	26	26	12	0
			M			12	26	26	26	26	12	0
			R			12	26	26	26	26	12	0
HR02	Danube	Borovo	R	1337	0	26	26	26	26	26	0	0
HR06	Sava	Jesenice/D	R	729	0	25	25	25	25	25	12	0
HR07	Sava	us Una Jesenovac	L	525	365	25	25	25	25	25	12	0
HR08	Sava	ds Zupanja	R	254	365	24	25	25	25	25	12	0
SI01	Drava	Ormoz	L	300	365	24	24	24	24	24	24	0
SI02	Sava	Jesenice	R	729	365	24	24	24	24	24	24	0
RO02	Danube	Pristol-Novo Selo	L	834	365	23	24	24	24	24	24	0
			M			23	24	24	24	24	24	0
			R			23	24	24	24	24	24	0
RO04	Danube	Chiciu-Silistra	L	375	365	24	24	24	22	24	20	0
			M			24	24	24	22	24	20	0
			R			24	24	24	22	24	20	0
RO05	Danube	Reni-Chilia arm	L	132	365	24	24	24	22	24	20	0
			M			24	24	24	22	24	20	0
			R			23	24	24	22	24	20	0
UA02	Danube	Vilkova-Kilia arm	M	18	0	0	0	0	0	0	0	0

6.4. Calculation Procedure

The loads have been calculated in accordance to the following procedure:

In case of several sampling sites in the profile, average concentration at the location is calculated for each sampling day.

In case of values "below limit of detection", value of limit of detection is used in the further calculation.

The average monthly concentrations is calculated according to the formula:

$$C_m\,[mg.l^{-1}] = \frac{\sum_{i \in m} C_i\,[mg.l^{-1}]\,.\,Q_i\,[m^3.s^{-1}]}{\sum_{i \in m} Q_i\,[m^3.s^{-1}]}$$

where C_m average monthly concentrations

C_i concentrations in the sampling days of each month

Q_i discharges in the sampling days of each month

The monthly load is calculated by using the formula:

$$L_m\,[tones] = C_m\,[mg.l^{-1}]\,.\,Q_m\,[m^3.s^{-1}]\,.\,\text{days}\,(m)\,.\,0{,}0864$$

where L_m monthly load

Q_m average monthly discharge

- *If discharges are available only for the sampling days, Q_m is calculated from those discharges.*
- *In case of months without measured values the average of the products $C_{m.}Q_m$ in the months with sampling days is used.*

The annual load is calculated as the sum of the monthly loads:

$$L_a\,[tones] = \sum_{m=1}^{12} L_m\,[tones]$$

6.5. Results

The mean annual concentrations and annual loads of suspended solids, inorganic nitrogen, ortho-phosphate-phosphorus, total phosphorus, BOD_5, chlorides and – where available – dissolved phosphorus - are presented in tables 7 to 10, separately for monitoring locations on the Danube River and monitoring locations on tributaries. Explanation of terms used in the tables 7 to 10 is as follows.

Term used	Explanation
Station Code	TNMN monitoring location code
Profile	location of sampling site in profile (L-left, M-middle, R-right)
River Name	name of river
Location	name of monitoring location
River km	distance to mouth of the river
Q_a	mean annual discharge in the year 2003
c_{mean}	arithmetical mean of the concentrations in the year 2003
Annual Load	annual load of given determinand in the year 2003

In general, the spatial pattern of annual load along the Danube River in 2003 was similar to the previous year. The load of inorganic nitrogen, total phosphorus and chlorides increased continuously along the river. In case of organic pollution, ortho-phosphate phosphorus and suspended solids the highest load was also observed in the lower part of the Danube River, but maximum was recorded at monitoring location Danube-Pristol-Novo Selo (RO02, r.km 834) with further decrease of the values downstream.

The mean annual discharge was significantly lower in 2003 in comparison with previous year, reaching on average 70 % of values observed in 2002 in both Danube River and tributaries. Suspended solids concentrations as sensitive to flow conditions were lower in 2003 too. Significantly higher concentrations in 2003 in comparison to 2002 had been observed in case of ortho-phosphate P in monitoring locations of Sava River and in Dyje River. In Sava River also higher content of total phosphorus was obvious.

Mainly as a result of lower discharges in 2003 load of suspended solids, nutrients and BOD_5 was generally much lower in comparison with 2002, this being most significant in case of suspended solids and total phosphorus.

Among the tributaries, the highest load of nutrients and BOD_5 is coming from Tisza and Sava rivers. Significant is also a high load of suspended solids in Inn (D03) having a high variation of flow and the related suspended solids content.

Table 7: Mean annual concentrations in monitoring locations selected for load assessment on Danube River

Station Code	Profile	River Name	Location	River km	Q_a	c_{mean}						
						Suspended Solids	Inorganic Nitrogen	Ortho-Phosphate Phosphorus	Total Phosphorus	BOD_5	Chlorides	Phosphorus - dissolved
					$(m^3.s^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$
D02 +A01	M	Danube	Jochenstein	2204	1153	16	1,92	0,028	0,06	1,9	16	0,040
A04	R	Danube	Wolfsthal	1874	1640	13	2,25	0,025	0,05	1,9	18	0,037
SK01	M	Danube	Bratislava	1869	1647	21	2,13	0,042	0,09	2,3	18	0,063
H03	LMR	Danube	Szob	1708	1722	11	2,27	0,053	0,08	3,3	24	
H05	M	Danube	Hercegszántó	1435	1786	19	2,02	0,043	0,12	3,7	19	
HR02	R	Danube	Borovo	1337		55	2,28	0,101	0,19	3,8		
RO02	LMR	Danube	Pristol-Novo Selo	834	3825	28	1,35	0,075	0,09	2,8	22	
RO04	LMR	Danube	Chiciu-Silistra	375	4571	13	2,12	0,036	0,09	2,0	44	
RO05	LMR	Danube	Reni-Chilia arm	132	5021	15	2,23	0,042	0,12	1,6	44	

Table 8: Mean annual concentrations in monitoring locations selected for load assessment on tributaries

Station Code	Profile	River Name	Location	River km	Q_a	c_{mean}						
						Suspended Solids	Inorganic Nitrogen	Ortho-Phosphate Phosphorus	Total Phosphorus	BOD_5	Chlorides	Phosphorus - dissolved
					$(m^3.s^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$
D03	M	Inn	Kirchdorf	195	255	55	0,55	0,011	0,09	1,2	4	
D04	L	Inn/Salzacl	Laufen	47	203	29	0,67	0,006	0,04	2,0	8	
CZ01	M	Morava	Lanzhot	79	40	18	2,28	0,120	0,22	4,1	31	
CZ02	L	Morava/Dy	Pohansko	17	32	18	3,06	0,280	0,38	4,1	44	
H08	LMR	Tisza	Tiszasziget	163	604	35	1,19	0,051	0,16	2,4	49	
SI01	L	Drava	Ormoz	300	230	13	0,99	0,006	0,04	2,6	6	
SI02	R	Sava	Jesenice	729	158	7	1,52	0,094	0,14	3,0	10	
HR06	L	Sava	Jesenice	729		7	1,79	0,164	0,30	3,0	11	
HR07	L	Sava	us. Una Jasenovac	525	348	14	1,47	0,172	0,34	4,1	13	
HR08	R	Sava	ds. Zupanja	254	651	16	0,98	0,101	0,23	3,4	16	

Table 9: Annual load in selected monitoring locations on Danube River

Station Code	Profile	River Name	Location	River km	Annual Load in 2003						
					Suspended Solids	Inorganic Nitrogen	Ortho-Phosphate Phosphorus	Total Phosphorus	BOD_5	Chlorides	Phosphorus - dissolved
					($x10^6$tonns)	($x10^3$tonns)	($x10^3$tonns)	($x10^3$tonns)	($x10^3$tonns)	($x10^6$tonns)	($x10^3$tonns)
D02 +A01	M	Danube	Jochenstein	2204	0,590	72,473	1,130	2,351	70,542	0,564	1,545
A04	R	Danube	Wolfsthal	1874	0,722	119,015	1,268	2,669	107,503	0,918	1,850
SK01	M	Danube	Bratislava	1869	1,325	114,504	2,230	4,927	131,133	0,922	3,182
H03	LMR	Danube	Szob	1708	0,664	131,538	2,966	4,465	190,768	1,333	
H05	M	Danube	Hercegszántó	1435	1,236	123,518	2,543	7,327	211,045	1,072	
HR02	R	Danube	Borovo	1337							
RO02	LMR	Danube	Pristol-Novo Selo	834	3,470	187,884	9,187	11,102	346,548	2,638	
RO04	LMR	Danube	Chiciu-Silistra	375	2,112	332,136	5,358	11,658	285,933	5,705	
RO05	LMR	Danube	Reni-Chilia arm	132	2,615	392,537	7,051	18,990	256,831	6,519	

Table 10: Annual load in selected monitoring locations on tributaries

Station Code	Profile	River Name	Location	River km	Annual Load in 2003						
					Suspended Solids	Inorganic Nitrogen	Ortho-Phosphate Phosphorus	Total Phosphorus	BOD_5	Chlorides	Phosphorus - dissolved
					($x10^6$tonns)	($x10^3$tonns)	($x10^3$tonns)	($x10^3$tonns)	($x10^3$tonns)	($x10^6$tonns)	($x10^3$tonns)
D03	M	Inn	Kirchdorf	195	0,727	3,945	0,104	0,975	8,937	0,028	
D04	L	Inn/Salzach	Laufen	47	0,189	4,032	0,039	0,269	12,051	0,042	
CZ01	M	Morava	Lanzhot	79	0,019	2,980	0,116	0,204	3,592	0,026	
CZ02	L	Morava/Dyje	Pohansko	17	0,016	4,799	0,206	0,296	3,788	0,040	
H08	LMR	Tisza	Tiszasziget	163	0,995	27,216	1,010	3,312	45,303	0,717	
SI01	L	Drava	Ormoz	300	0,102	7,013	0,046	0,273	17,526	0,041	
SI02	R	Sava	Jesenice	729	0,035	8,313	0,396	0,612	13,776	0,046	
HR06	L	Sava	Jesenice	729							
HR07	L	Sava	us. Una Jasenovac	525	0,173	18,098	1,418	3,233	37,318	0,135	
HR08	R	Sava	ds. Zupanja	254	0,345	24,146	2,058	4,309	60,605	0,284	

7. Abbreviations

Abbreviation	Explanation
AQC	Analytical Quality Control
DEFF	Data Exchange File Format
DRPC	Convention on Cooperation for the Protection and Sustainable Use of the Danube River (short: Danube River Protection Convention)
ICPDR	International Commission for the Protection of the Danube River
LOD	Limit of Detection
MLIM EG	Monitoring, Laboratory and Information Management Expert Group
NRL	National Reference Laboratory
SOP	Standard Operational Procedure
TNMN	Trans National Monitoring Network
WFD	EU Water Framework Directive

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