Water Quality in the Danube River Basin – 2004

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International Commission for the Protection of the Danube River

Internationale Kommission zum Schutz der Donau

TNMN – Yearbook 2004

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The printed version of TNMN Yearbook 2004 contains only the essential background information on TNMN and a basic overview of the water quality status in the Danube River Basin. The full version of the TNMN Yearbook 2004 including all figures and data is available on the attached CD-ROM.

1. Introduction

1.1. 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 2004.

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.

1.2. 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.

Implementation of the EU Water Framework Directive (2000/60/EC, short WFD) after 2000 necessitated the revision of the TNMN in the Danube River Basin District; in line with the WFD implementation timeline the revision process will be completed in 2007.

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.

Current TNMN network contains 78 sampling points. The 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 2004 data for 77 monitoring locations were reported, covering altogether 107 sampling sites. These consisted of 40 monitoring stations (68 sampling sites) located on the Danube River and of 37 monitoring station on the tributaries.

Table 1: List of monitoring sites

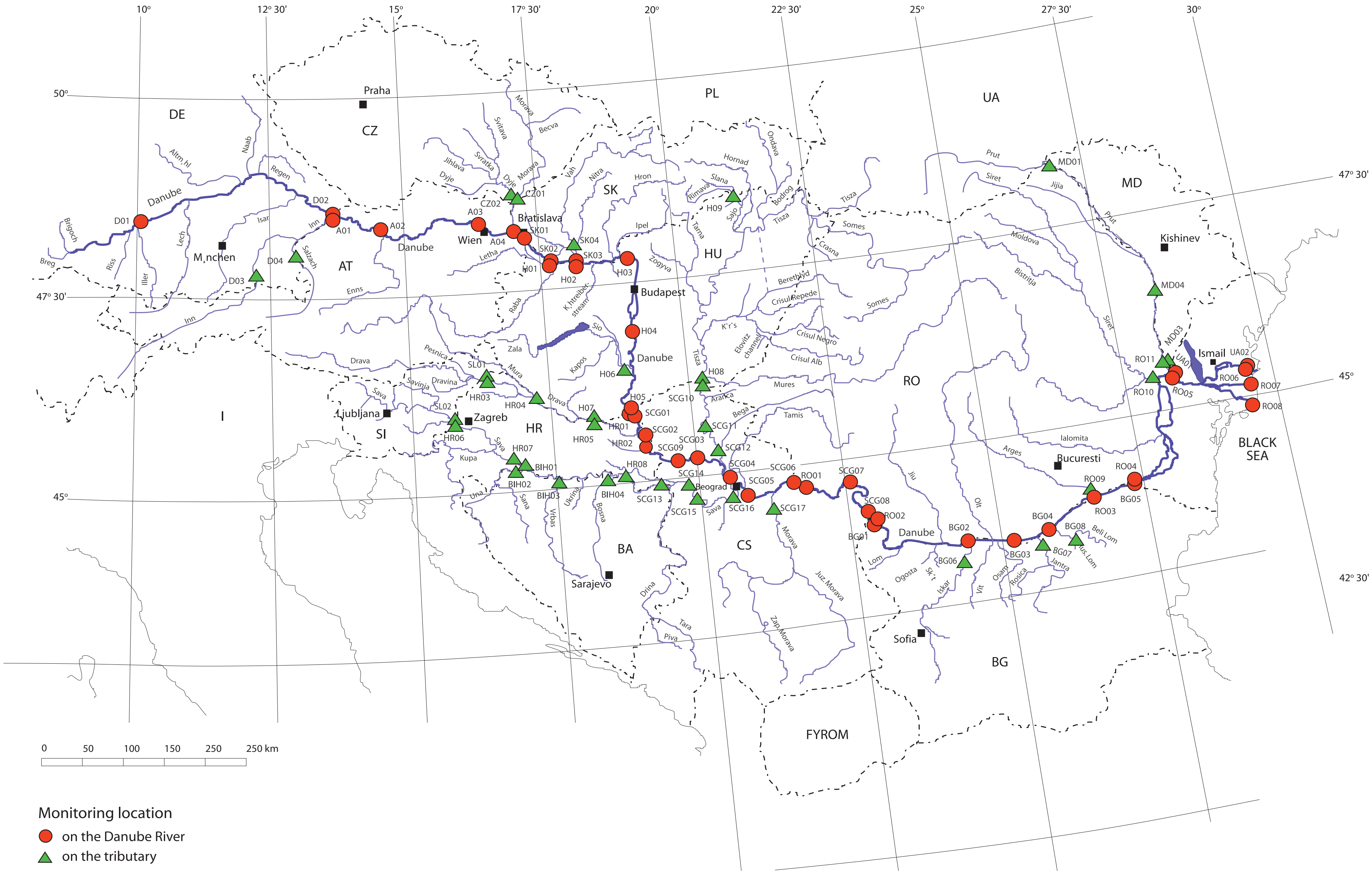
Country Code	River Name	Town/Location Name	Latitude d. m. s.	Longitude d. m. s.	Distance [Km]	Altitude [m]	Catch-ment [km^2]	DEFF Code	Loc.inprofile
D01	Danube	Neu-Ulm	48 25 31	10 1 39	2581	460	8107	L2140	L
D02	Danube	Jochenstein	48 31 16	13 42 14	2204	290	77086	L2130	M
D03	/Inn	Kirchdorf	47 46 58	12 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

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
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					
RO02	Danube	Pristol/Novo Selo Harbour	44 11	22 45	834	31	580100	L0090	LMR
			18 23 29	57 64 69					
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	22 47	834	35	580100	L0730	LMR
			50 58 66	36 47 58					
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



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.

In 2004 the AQC programme for the Danube River Basin was organized by the Institute for Water Pollution Control of VITUKI, Budapest, Hungary (QualcoDanube AQC programme). Three types of check samples were delivered to 36 laboratories in 12 Danube countries in four distributions. The results showed no serious problems in determining the general parameters. A reasonable quality improvement has been observed during the recent years in for most of nutrient and heavy metals analyses both in water and sediment samples. A substantial improvement is still needed in analysis of organic micropollutants.The results and evaluation of 2004 distributions have been published in the QualcoDanube Summary Report 2004.

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	II TV	III	IV	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	µg.l-1	25	50	100	250	> 250
Metals (dissolved) **						
Zinc	µg.l-1	-	5	-	-	-
Copper	µg.l-1	-	2	-	-	-
Chromium (Cr-III+VI)	µg.l-1	-	2	-	-	-
Lead	µg.l-1	-	1	-	-	-
Cadmium	µg.l-1	-	0.1	-	-	-
Mercury	µg.l-1	-	0.1	-	-	-
Nickel	µg.l-1	-	1	-	-	-
Arsenic	µg.l-1	-	1	-	-	-
Metals (total)						
Zinc	µg.l-1	bg	100	200	500	> 500
Copper	µg.l-1	bg	20	40	100	> 100
Chromium (Cr-III+VI)	µg.l-1	bg	50	100	250	> 250
Lead	µg.l-1	bg	5	10	25	> 25
Cadmium	µg.l-1	bg	1	2	5	> 5
Mercury	µg.l-1	bg	0.1	0.2	0.5	> 0.5
Nickel	µg.l-1	bg	50	100	250	> 250
Arsenic	µg.l-1	bg	5	10	25	> 25
Toxic substances						
AOX	µg.l-1	10	50	100	250	> 250
Lindane	µg.l-1	0.05	0.1	0.2	0.5	> 0.5
p,p´-DDT	µg.l-1	0.001	0.01	0.02	0.05	> 0.05
Atrazine	µg.l-1	0.02	0.1	0.2	0.5	> 0.5
Trichloromethane	µg.l-1	0.02	0.6	1.2	1.8	> 1.8
Tetrachloromethane	µg.l-1	0.02	1	2	5	> 5
Trichloroethene	µg.l-1	0.02	1	2	5	> 5
Tetrachloroethene	µg.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

77 TNMN monitoring stations had been monitored in the Danube River Basin in 2004. Because some monitoring stations contain more sampling sites (usually left, middle and right side of the river), data had been collected from altogether 107 sampling sites, out of which 68 are located on the Danube River and 39 on the tributaries.

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 2004
Mean	arithmetical mean of the measurements done in the year 2004
Max	maximum value of the measurements done in the year 2004
C50	50 percentile of the measurements done in the year 2004
C90	90 percentile of the measurements done in the year 2004
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).*

As regards the agreed monitoring frequencies (12 times per year) a significant discrepancy was reported by monitoring locations in Bosnia and Herzegovina (4 times per year 2004) and Ukraine (UA01 – one measurement in 2004). Other persisting problem is reduced monitoring frequency for certain determinands such as dissolved phosphorus, biological determinands, heavy metals and specific organic micropollutants, primarily 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 2004. Information on number of monitoring locations and sampling sites with measurements of the determinands is also given there.

Table 4: Concentration ranges and mean annual concentrations of selected determinands in Danube River and its tributaries in 2004

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	40/68	0.0	27.0	9.3	18.6	37/39	0.0	27.0	7.4	20.9
Suspended Solids	mg/l	30/57	< 0.5	171.0	5.3	75.2	34/37	< 0.2	310.0	3.9	129.0
Dissolved Oxygen	mg/l	40/68	0.1	16.5	7.1	11.3	37/39	0.2	18.0	7.1	11.9
BOD$_5$	mg/l	40/68	< 0.5	8.0	1.3	3.7	32/34	< 0.5	12.5	1.1	6.9
COD$_{Mn}$	mg/l	38/66	< 0.25	9.2	2.2	5.3	34/36	0.8	30.8	1.2	9.3
COD$_{Cr}$	mg/l	33/61	1.1	59.6	6.0	37.7	31/35	3.0	59.4	4.5	45.7
TOC	mg/l	9/11	< 0.5	5.1	2.1	3.4	7/7	0.8	8.5	2.1	7.1
DOC	mg/l	5/5	< 0.5	4.4	1.8	2.1	8/8	1.0	14.0	2.0	10.8
pH		40/68	6.3	9.0	7.3	8.3	37/39	7.0	8.9	7.2	8.4
Alkalinity	mmol/l	35/63	< 0.1	9.3	1.5	4.2	31/33	1.2	27.5	1.5	8.1
Ammonium-N	mg/l	40/68	< 0.004	1.820	0.010	0.634	37/39	0.005	4.000	0.017	1.894
Nitrite-N	mg/l	40/68	< 0.001	1.500	0.006	0.161	34/36	< 0.002	0.154	0.003	0.068
Nitrate-N	mg/l	40/68	0.10	4.80	0.80	2.86	37/39	0.10	8.10	0.50	6.10
Total Nitrogen	mg/l	27/39	0.59	5.30	1.50	3.30	23/23	0.35	10.10	0.80	9.60
Organic Nitrogen	mg/l	22/28	0.02	5.40	0.04	1.60	25/27	0.03	3.80	0.27	2.10
Ortho-Phosphate-P	mg/l	40/68	< 0.003	0.82	0.021	0.135	35/37	0.001	0.762	0.006	0.329
Total Phosphorus	mg/l	40/68	0.01	4.07	0.05	0.27	34/36	< 0.005	1.40	0.03	0.72
Total Phosphorus - Dissolved	mg/l	8/8	0.01	0.75	0.33	0.64	6/6	< 0.005	0.25	0.01	0.15
Chlorophyll-a	µg/l	22/27	< 0.1	99.0	6.9	18.7	12/14	0.2	323.0	1.8	54.4
Conductivity @ 20°C	µS/cm	38/66	121	833	343	489	36/38	172	1290	255	1011
Calcium	mg/l	40/68	13.5	89.0	38.9	76.9	36/38	19.7	122.0	30.3	107.8
Sulphates	mg/l	38/66	< 1.0	107.0	14.3	88.8	30/32	< 1.0	211.0	16.2	173.9
Magnesium	mg/l	40/68	4.9	1067.0	10.5	58.8	37/38	4.9	89.0	7.7	66.9
Potassium	mg/l	33/50	0.91	6.9	1.8	3.6	27/29	0.3	16.5	0.9	10.2
Sodium	mg/l	35/51	< 0.01	240.0	8.4	1113.3	27/29	1.9	73.2	2.9	56.9
Manganese	mg/l	35/53	< 0.00001	13.700	0.008	8.900	13/15	< 0.010	0.980	0.014	0.280
Iron	mg/l	23/50	< 0.010	2.900	0.051	0.780	13/15	< 0.010	6.150	0.093	1.921
Chlorides	mg/l	38/66	< 1	69.6	16.6	41.5	31/33	1.8	186.7	5.2	92.9
Macrozoobenthos- saprobic index		14/14	1.91	2.26	2.00	2.25	14/14	1.20	2.89	1.59	2.56
Macrozoobenthos - no.of taxa		11/11	2	82	7	82	10/10	2	36	3	35

Table 4: Concentration ranges and mean annual concentrations of selected determinands in Danube River and its tributaries in 2004 (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	24/24	< 0.8	122.0	2.1	42.4	15/15	< 1.64	112.0	2.8	95.0
Copper - Dissolved	µg/l	23/23	< 0.05	122.00	0.83	6.50	15/15	< 0.06	112.00	0.59	11.00
Chromium - Dissolved	µg/l	22/22	< 0.05	8.60	0.22	1.70	11/11	< 0.07	6.90	0.20	2.27
Lead - Dissolved	µg/l	23/23	< 0.05	38.70	< 0.2	5.32	15/15	< 0.04	4.65	< 0.04	4.00
Cadmium - Dissolved	µg/l	23/23	< 0.02	12.37	< 0.02	1.11	15/15	< 0.02	< 0.50	< 0.02	< 0.50
Mercury - Dissolved	µg/l	23/23	< 0.050	1.130	0.065	0.181	14/14	< 0.025	2.400	0.068	1.035
Nickel - Dissolved	µg/l	24/24	< 0.05	11.30	0.05	11.30	13/13	< 0.08	7.26	1.00	4.39
Arsenic - Dissolved	µg/l	14/14	0.45	2.00	0.83	1.23	10/10	< 0.05	6.23	0.38	3.52
Aluminium - Dissolved	µg/l	12/12	< 1.0	397.0	10.6	82.8	9/9	< 0.8	375.0	6.1	121.5
Zinc	µg/l	29/51	< 0.8	212.0	4.2	73.4	23/23	< 1.0	720.0	3.2	132.5
Copper	µg/l	29/51	0.05	91.00	1.43	18.70	23/23	0.05	126.00	0.70	19.60
Chromium - total	µg/l	28/50	< 0.05	42.17	0.20	< 10	20/20	< 0.05	37.80	0.33	< 10
Lead	µg/l	27/49	< 0.05	123.30	0.74	20.60	19/19	< 0.04	100.00	0.36	15.97
Cadmium	µg/l	27/49	< 0.02	36.59	0.02	3.20	23/23	< 0.01	2.65	0.02	< 1
Mercury	µg/l	21/40	< 0.025	21.000	0.029	2.010	14/14	< 0.025	2.400	0.068	1.035
Nickel	µg/l	27/49	< 0.05	30.60	< 1.0	4.81	23/23	< 0.05	77.90	< 1.0	12.50
Arsenic	µg/l	18/21	0.60	18.00	0.93	3.79	14/14	< 0.03	11.00	0.47	4.53
Aluminium	µg/l	13/18	< 7.0	6000.0	36.1	1080.0	10/10	5.9	22000.0	43.0	5045.0
Phenol index	mg/l	39/67	< 0.001	18.000	< 0.001	3.020	31/33	< 0.001	11.000	< 0,001	3.910
Anionic active surfactants	mg/l	37/65	< 0.006	70.000	0.010	3.408	27/29	0.010	0.220	0.010	0.096
AOX	µg/l	14/16	3.6	168.0	9.4	43.2	11/11	< 0.01	96.0	3.0	81.5
Petroleum hydrocarbons	mg/l	35/53	< 0.002	8.820	< 0.005	5.290	27/29	< 0.002	9.400	< 0.005	1.720
PAH (sum of 6)	µg/l	1/1	< 0.1	< 0.1	< 0.1	< 0.1	4/4	0.007	0.156	0.022	< 0.1
PCB (sum of 7)	µg/l	0/0					2/2	< 0.002	< 0.002	< 0.002	< 0.002
Lindane	µg/l	31/52	< 0.001	0.246	< 0.001	0.100	26/26	< 0.001	0.116	< 0.001	0.100
pp´DDT	µg/l	31/52	< 0.001	0.291	0.001	0.100	26/26	< 0.002	0.830	< 0.002	0.131
Atrazine	µg/l	32/50	< 0.001	0.744	0.009	0.240	20/20	0.001	0.509	0.002	0.001
Chloroform	µg/l	21/23	< 0.01	61.80	0.01	31.80	10/10	< 0.01	1.80	< 0.01	1.80
Carbon tetrachloride	µg/l	21/23	< 0.01	< 1.2	< 0.01	< 1.2	10/10	< 0.01	< 1.2	< 0.01	< 1.2
Trichloroethylene	µg/l	20/22	< 0.01	< 1.7	0.02	< 1.7	10/10	< 0.01	2.50	0.01	< 1.7
Tetrachloroethylene	µg/l	17/23	< 0.01	< 2.1	< 0.02	< 2.1	11/11	< 0.01	< 2.1	0.02	< 2.1
Total Coliforms (37°C)	10^3 CFU/ 100 ml	18/36	0.00	85.70	0.11	11.45	17/17	0.00	208.00	0.71	41.09
Faecal Coliforms (44°C)	10^3 CFU/ 100 ml	15/31	0.00	91.00	0.06	29.00	17/17	0.00	4000.00	0.69	516.50
Faecal Streptococci	10^3 CFU/ 100 ml	17/34	0.00	80.00	0.00	380.00	13/15	0.00	460.00	0.11	95.70

4. Presentation of classification results

The maps presented on Figures 2 – 12 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 95 % of locations in the Danube River what is a significant improvement when compared to 2003 (70 % compliance). 84 % dissolved oxygen results for tributaries also complied with the target value (compared to 71% compliance in 2003).

An outstanding situation was observed for BOD_5 *(an indicator of biodegradable organic pollution in waters)* in the Danube River having a full compliance with the target value in 2004. In tributaries 65 % of the monitored sites belonged into classes I and II.

For COD_{Cr} *(characterizes the presence of oxidizable organic compounds in waters)* 72 % of sites on the Danube River and 63 % of sites on tributaries achieved compliance with the target, which was similar to situation in previous year. For 15 % of the monitoring locations no COD_{Cr} data were available.

The concentrations of ammonium-N corresponded to classes I and II in 68 % of monitoring locations in the Danube River and 60 % of monitoring locations in tributaries. This situation is comparable with those observed in previous years.

The compliance for nitrate-N does not change significantly in the Danube River over recent years. In 2004, for 63% of sites the results belonged to classes I and II. A better situation was observed in tributaries having 84% compliance.

A slight deterioration compared to 2003 was observed for ortho-phosphate-P. In the Danube River, only for 68 % of sites the results belonged to classes I and II (in 2003 the compliance rate for ortho-phosphate-P was 80 %). For tributaries, 42 % of locations the concentration levels of ortho-phosphate-P corresponded to classes I and II.

In 75% of locations in the Danube River the concentrations of total P corresponded to classes I and II. The status was poorer in tributaries with only 42 % of locations satisfying the target value for total P.

The concentration of chlorophyll-a is an indicator of primary production, and it is closely related to nutrient content in the river. This determinand is important primarily for slow-flowing lowland rivers. Unfortunately, TNMN is still not in position to provide a representative overview of the chlorophyll-a levels as for about half of the TNMN sites this information is lacking. For the available results, class I and II was reached in 38 % of locations in the Danube River and 23 % of locations in the tributaries.

Similar data gaps are the case for the heavy metals. In 2004, the data on cadmium, chromium, copper, zinc, nickel and lead concentrations in the Danube River were missing for about one third of the locations, while concentration of mercury and arsenic were not available for 45 % and 58 % of locations, respectively. The percentage of missing data on heavy metals in the tributaries is even higher.

From the available data on heavy metals for the Danube River it could be concluded that class II was achieved as follows: at 55 % of TNMN sites for cadmium, 70 % of sites for copper, 50 % of sites for zinc, 33 % of sites for mercury, 38 % of sites for arsenic, 48 % of sites for lead, 68 % of sites for chromium and 68 % of sites for nickel. In the tributaries, the percentage of compliance with the target was as follows: 55 % for cadmium, 13 % for mercury, 55 % for chromium, 55 % for copper, 55 % for zinc, 60 % for nickel, 26 % for arsenic and 37 % for lead.

As regards the organic micropollutants, the target value for p,p-DDT was achieved at 48 % of locations for both the Danube River and its tributaries. These results are worse than those recorded in 2003. It has to be also mentioned that for 35 % of TNMN locations no data on p,p-DDT were collected.

In case of atrazine, for 55 % of locations in the Danube River the results belonged to classes I – II; for 23 % of locations no data were available. In the tributaries, the atrazine levels at 42 % of sites corresponded to classes I and II.

More detailed results of classification of TNMN data in 2004 are shown in the full version of the TNMN Yearbook on the attached CD-ROM.

Figure 2: The classification of Dissolved Oxygen in 2004

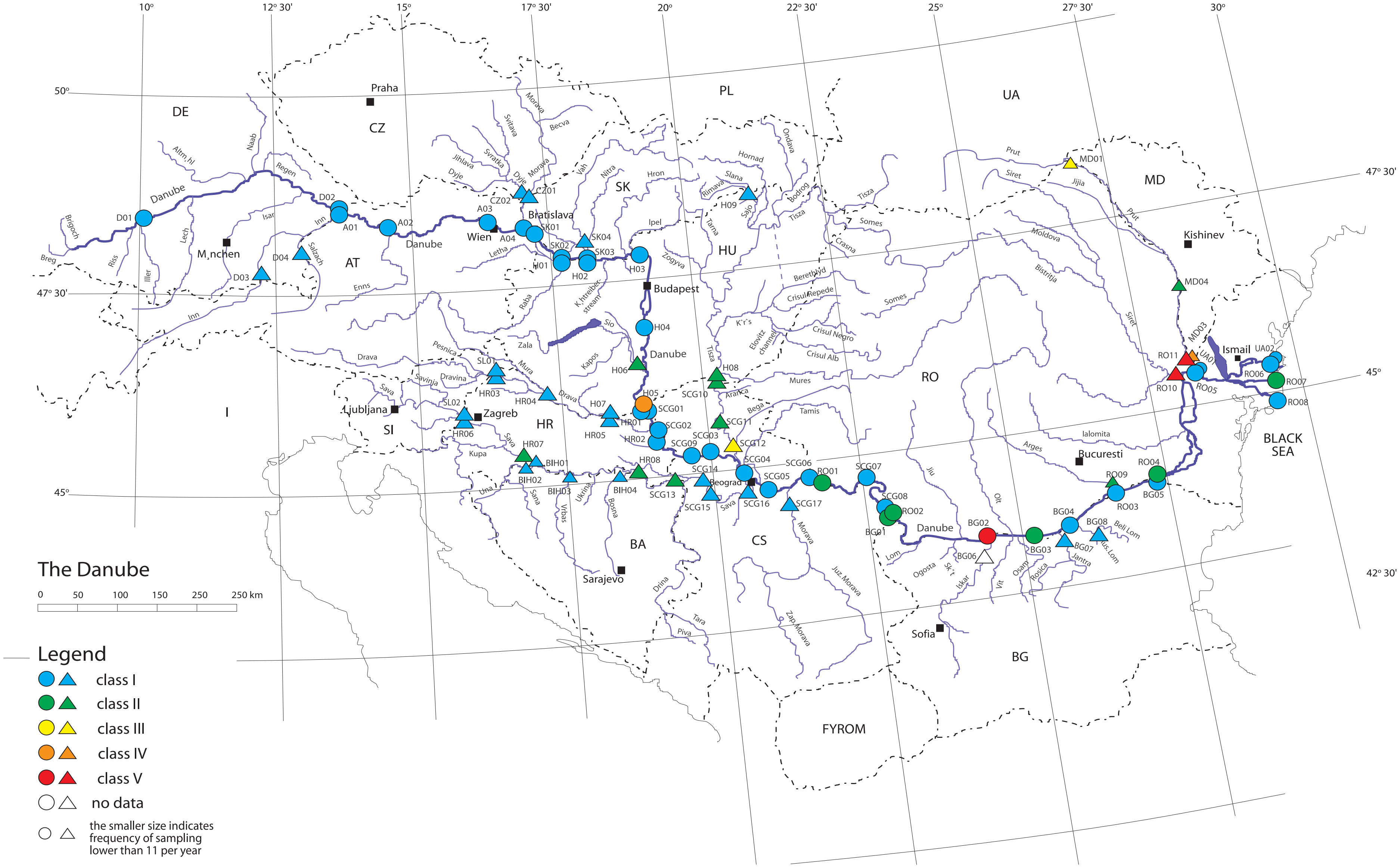


Figure 3: The classification of BOD_5 in 2004

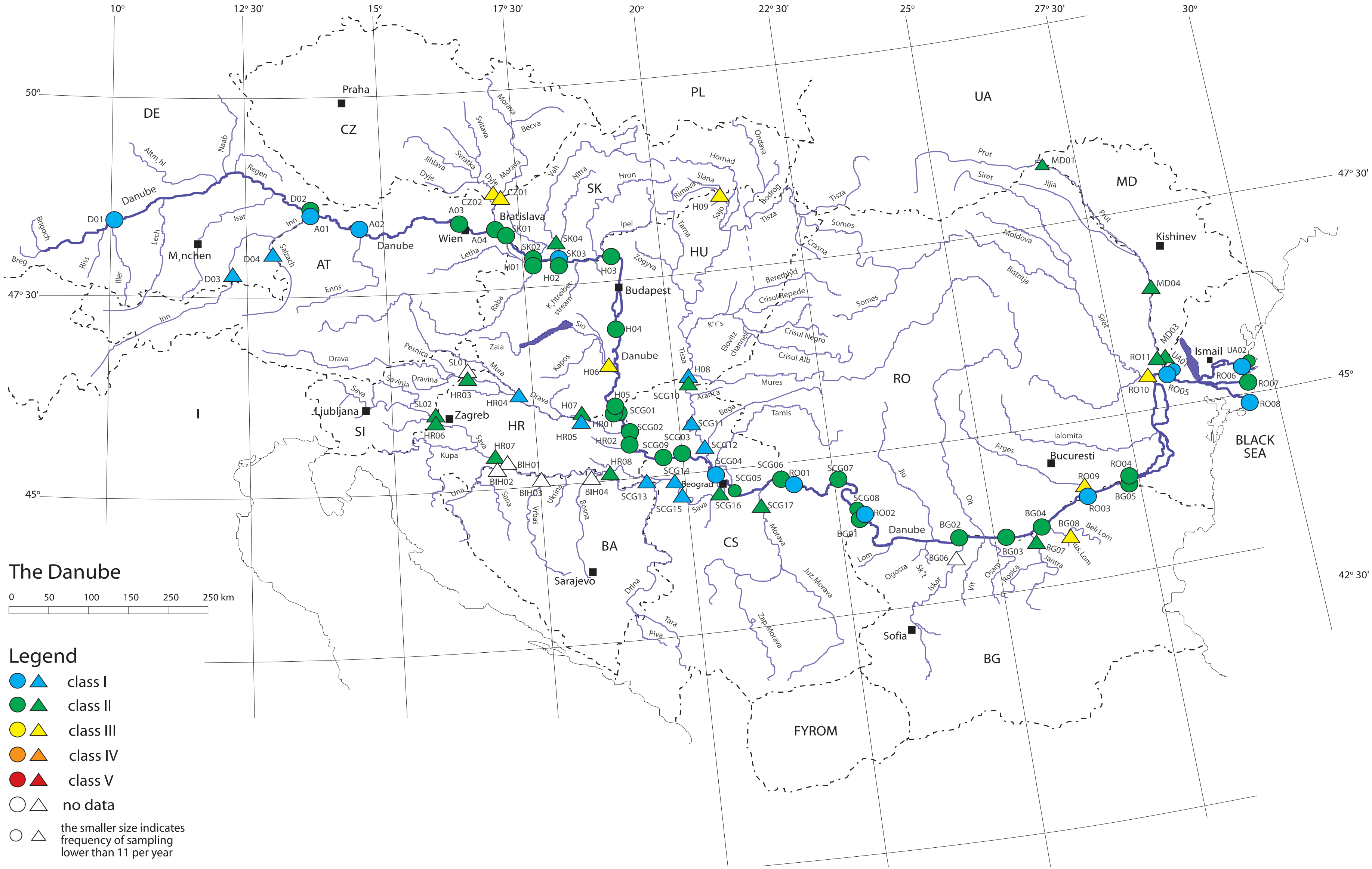


Figure 4: The classification of COD_{Cr} in 2004

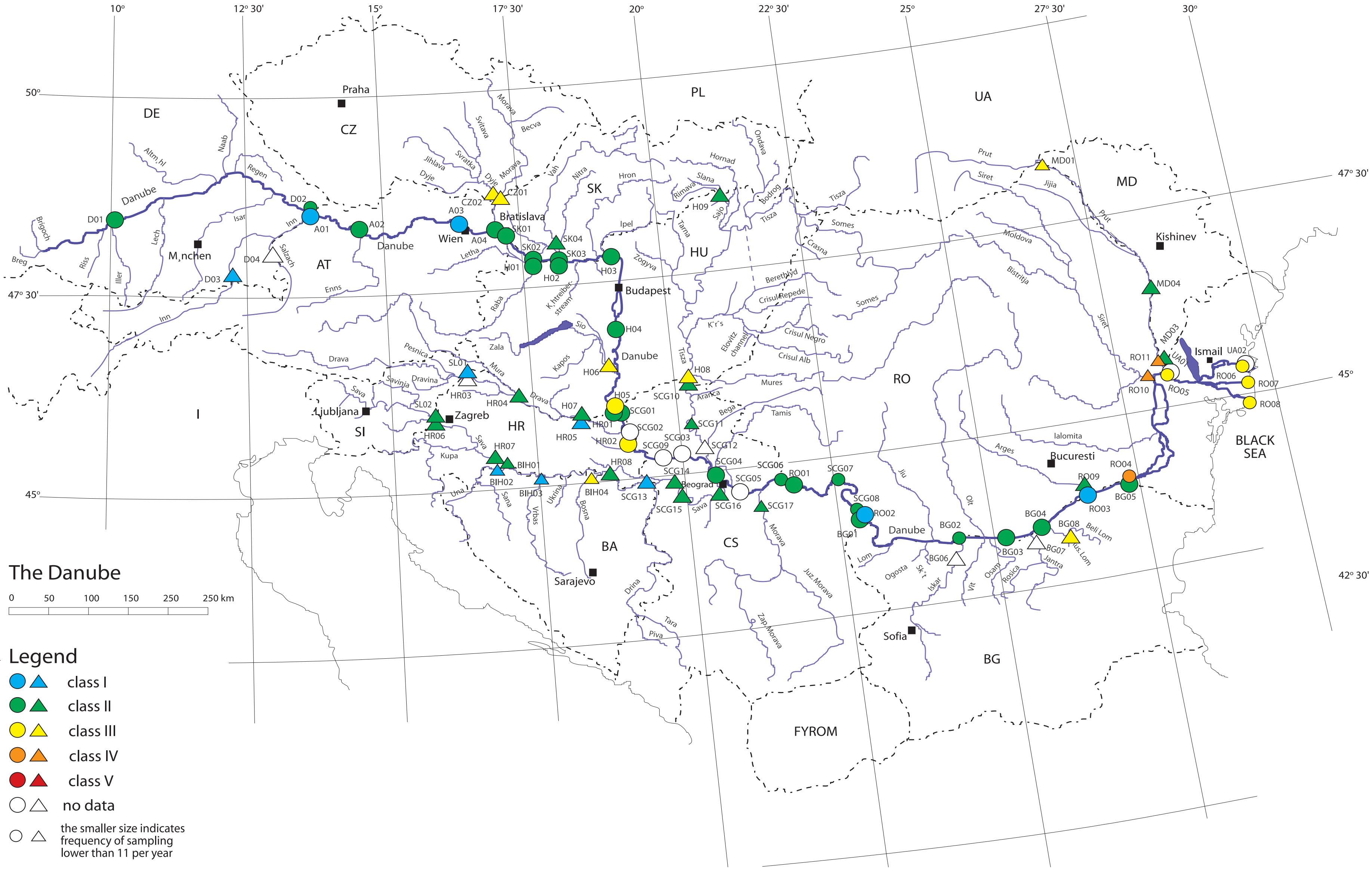


Figure 5: The classification of NH_4^+-N in 2004

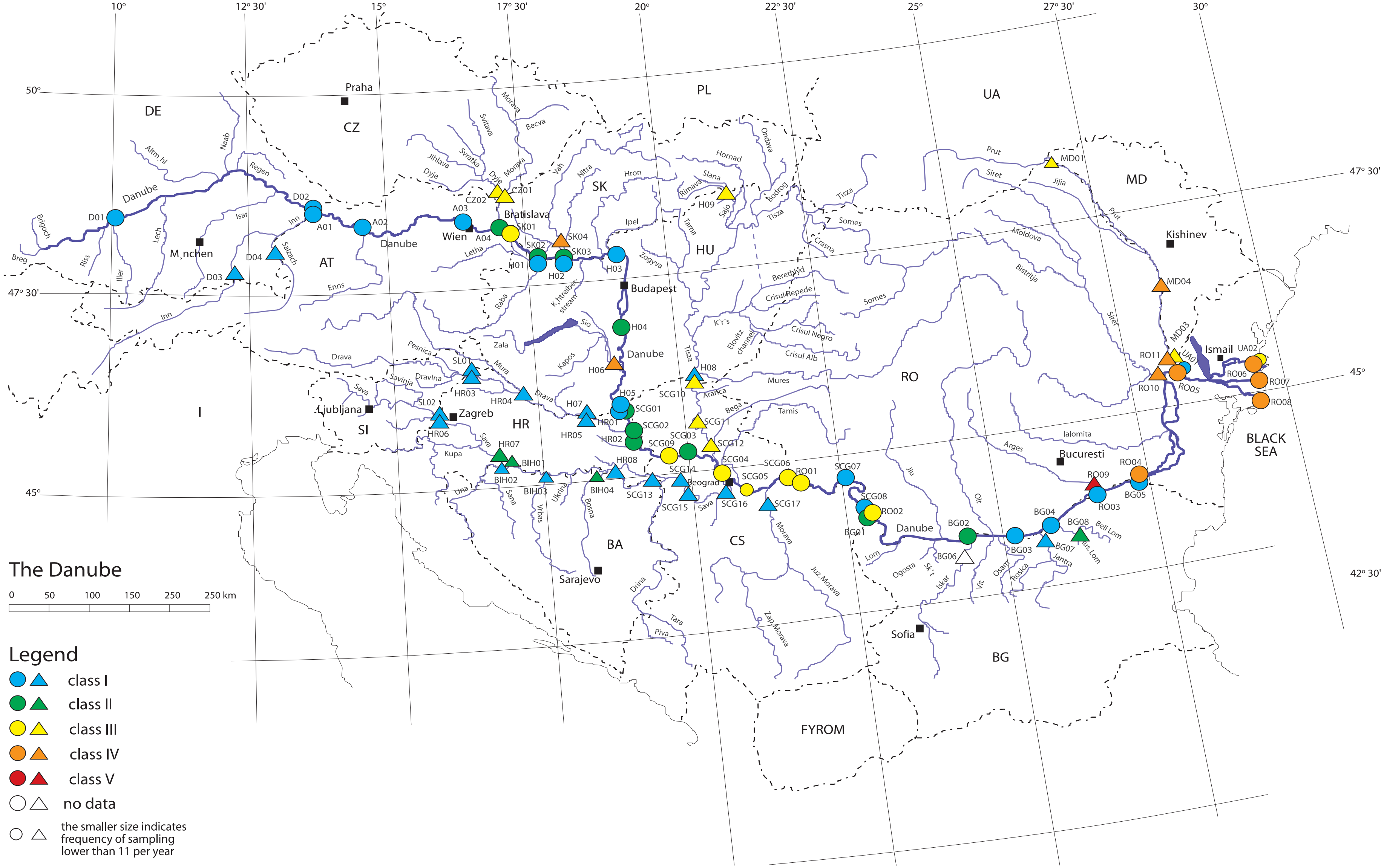


Figure 6: The classification of NO_3^--N in 2004

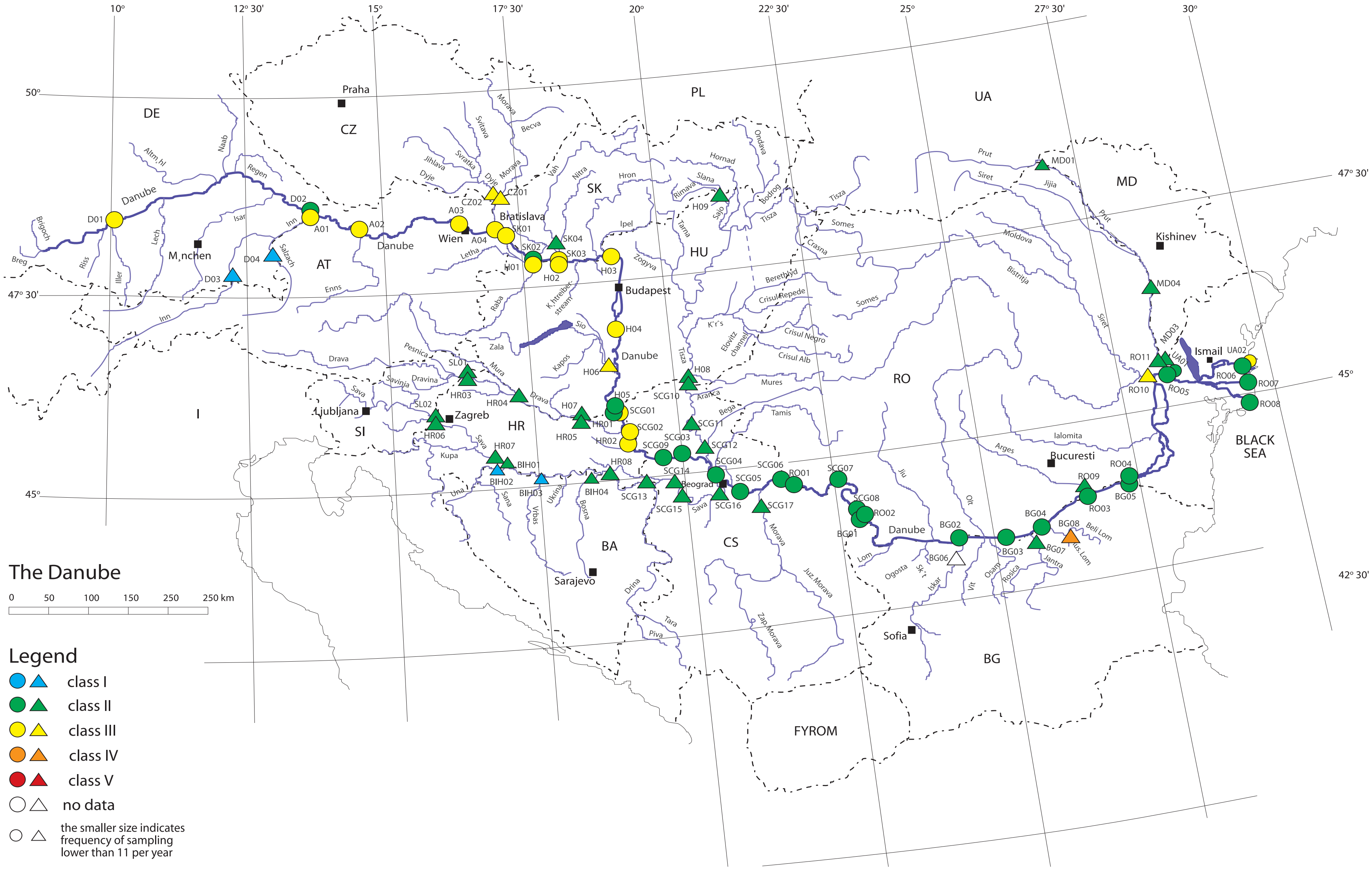


Figure 7: The classification of Ortho-Phosphate-P in 2004

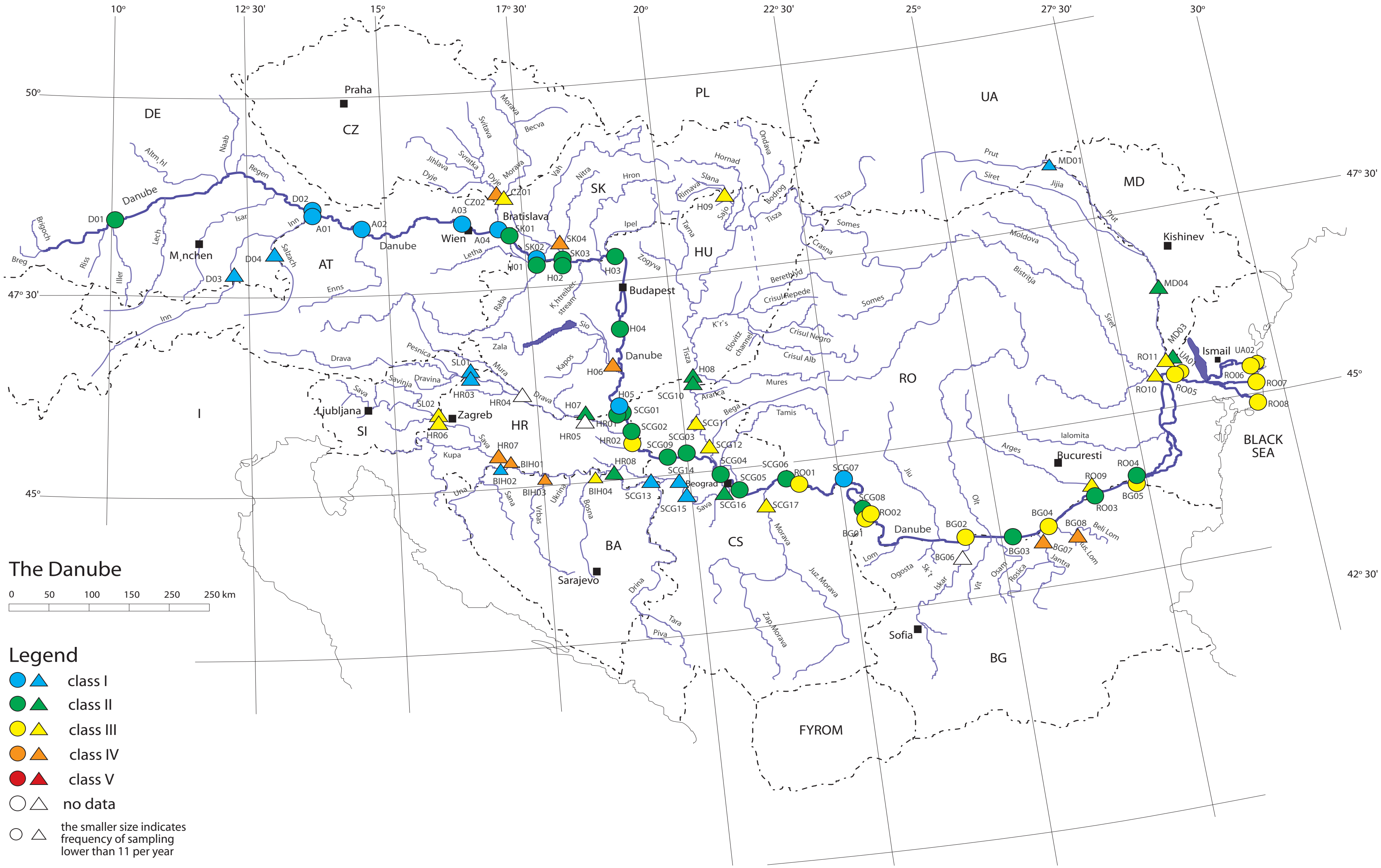


Figure 8: The classification of Total Phosphorus in 2004

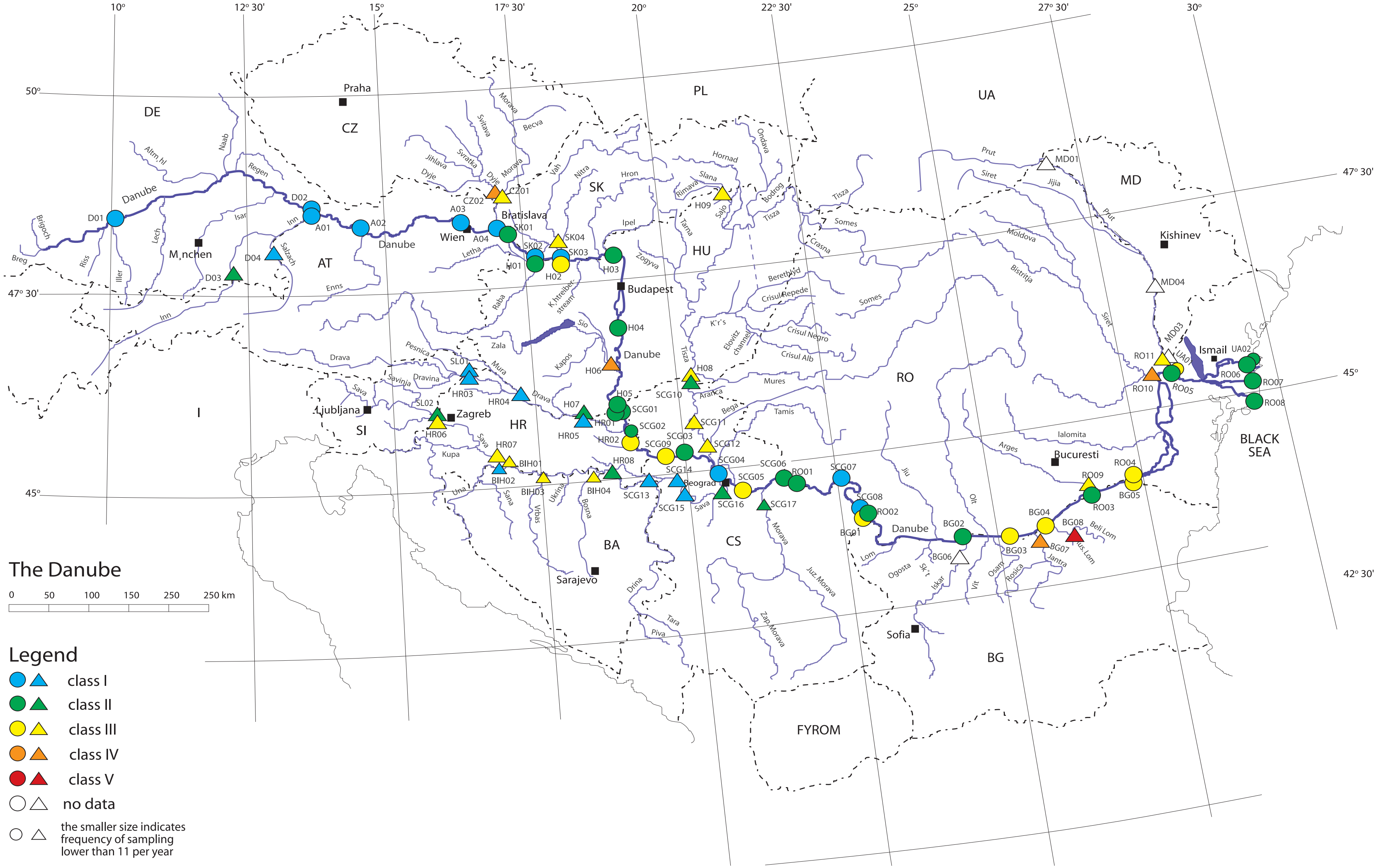


Figure 9: The classification of Chlorpphyll-a in 2004

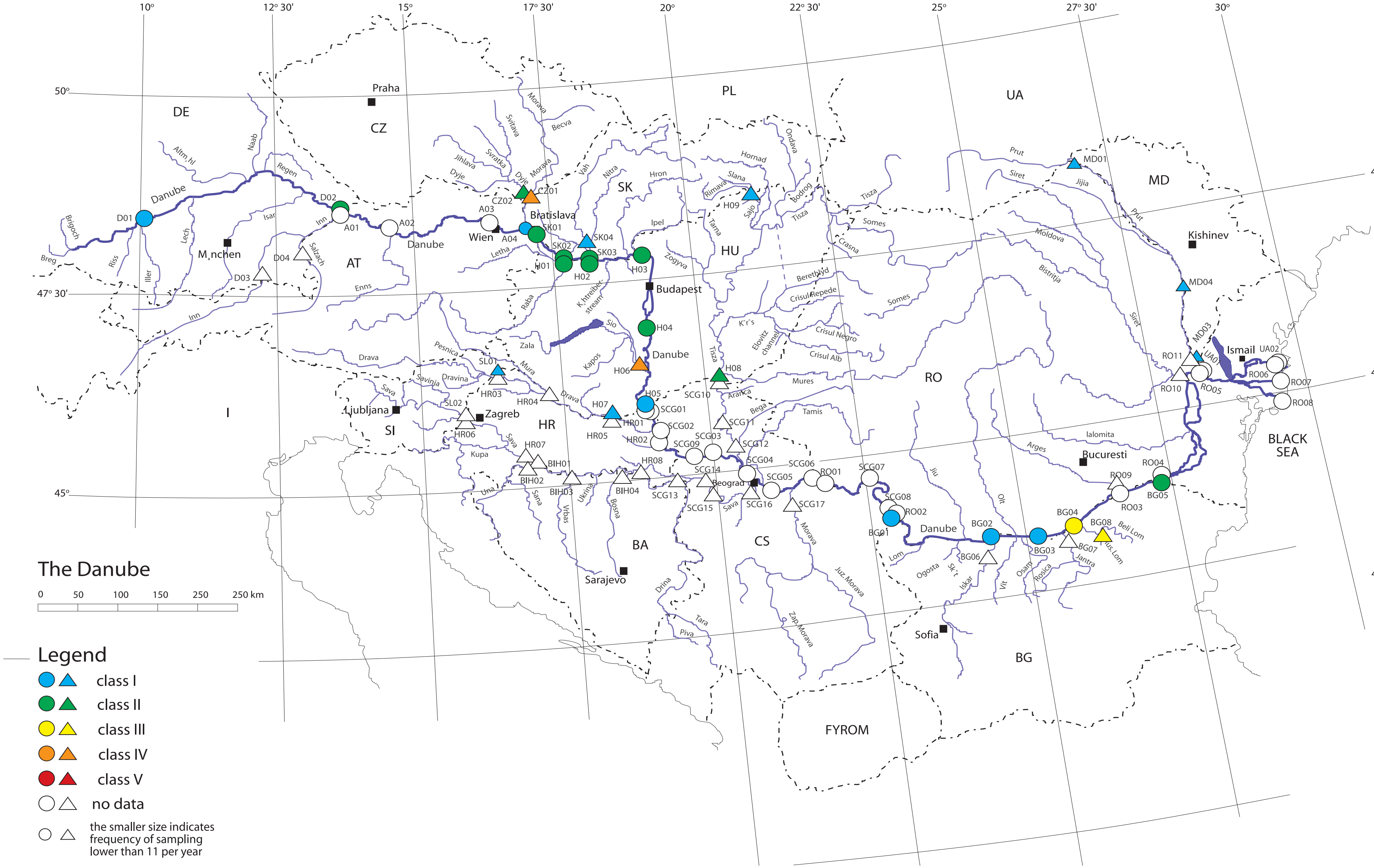


Figure 10: The classification of Cd in 2004

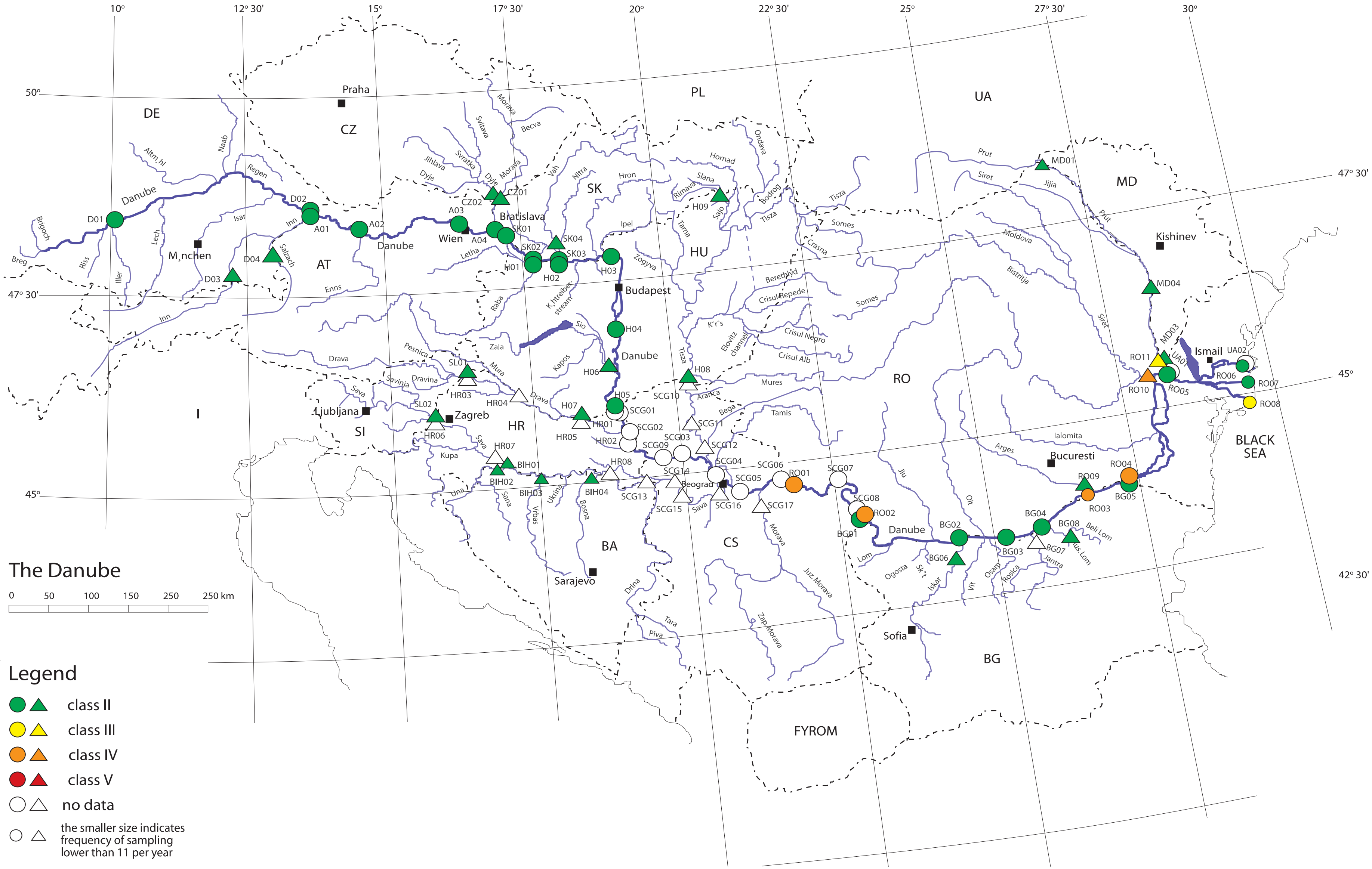


Figure 11: The classification of p,p' DDT in 2004

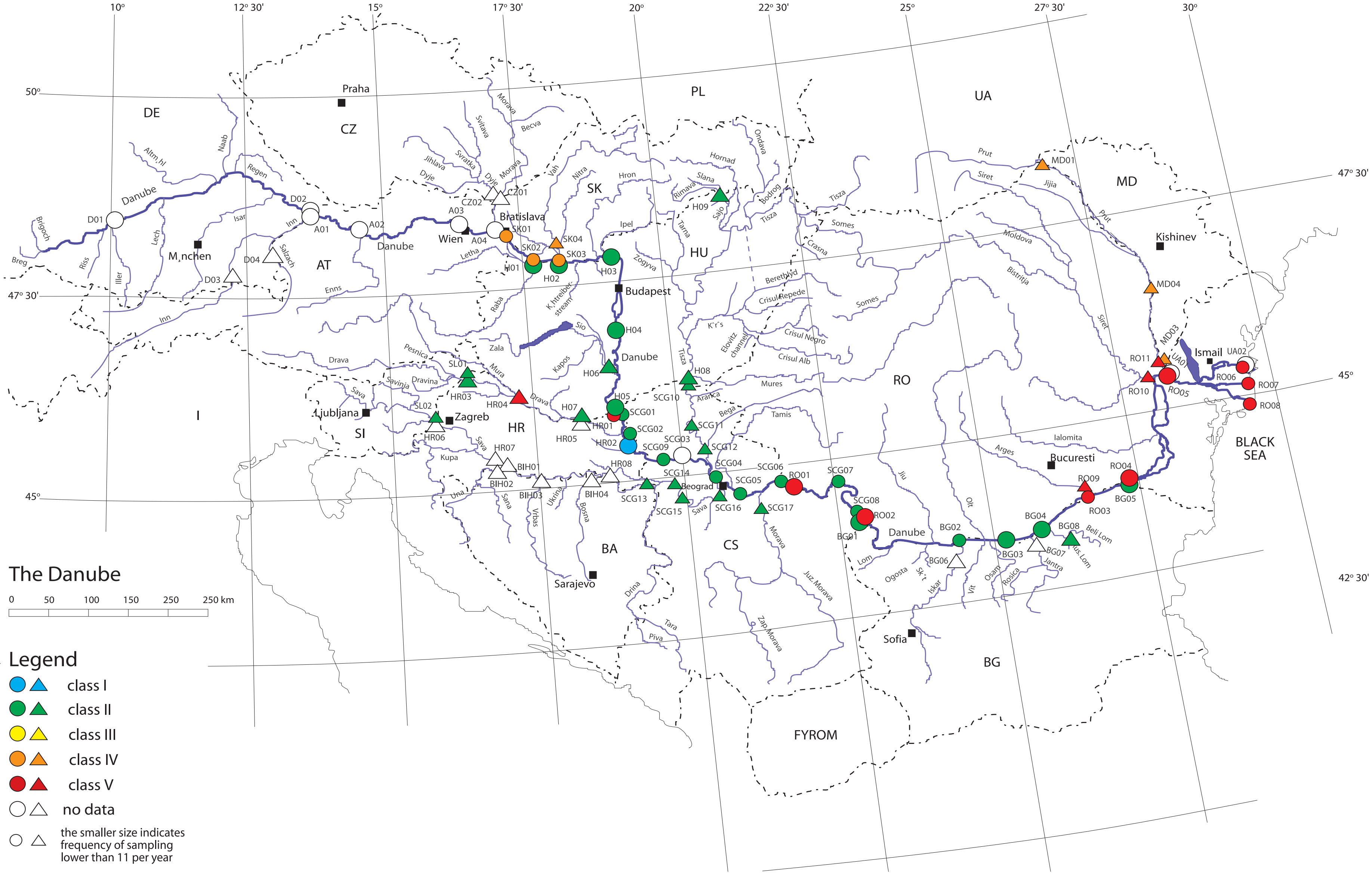
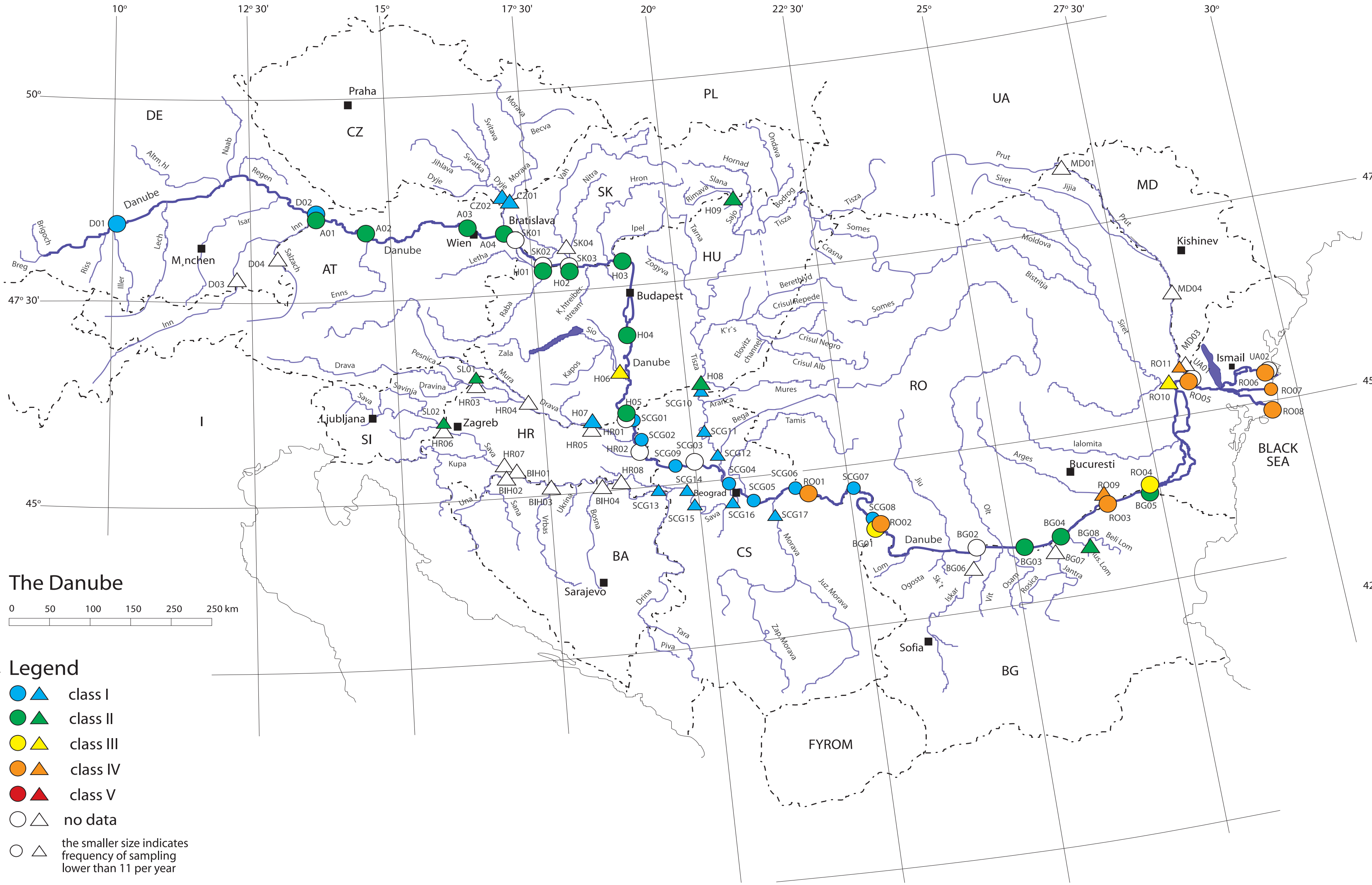


Figure 12: The classification of Atrazine in 2004



5. Profiles and trend assessment of selected determinands

To summarize the general trends of a spatial distribution of selected quality elements along the Danube River it has to be pointed out that 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 reach. The highest concentration of nitrate-N was observed in the upper part of the river.

The tributaries most polluted by degradable organic matter in 2004 were Russenski Lom, Sio, Arges and Jantra. The highest levels of nutrients were observed in Prut, Arges, Russenski Lom, Sio , Morava, Dyje, Vah and Sava.

Positive changes in water quality can be seen in several TNMN locations. Taking into account the whole period of TNMN operation, a decrease of biodegradable organic pollution can be traced in Austrian and Slovak sites on the Danube River and in some parts of the lower Danube (Bazias, Pristol, Reni). Tributaries Inn, Dyje, lower reach of Drava and Arges show the same tendency.

As for the nutrients, ammonium-N decreased in locations of the upper reach of the Danube River (in Germany and Austria). In the Slovak part, an increase in ammonium-N was observed in 2004. A decreasing tendency is apparent in the Bulgarian sites. A significant decrease is apparent in the Danube-Silistra/Chiciu (BG05), but this observation is not supported by Romanian data at the same monitoring location. The ammonium decreases also in the upper Danube tributaries Inn, Salzach, Morava, Dyje and further in Sava, Arges and Siret.

Nitrate-N content has a rather stable behaviour in the Danube River over the years. A decreasing tendency can be viewed in several locations of German and Slovak part of the Danube River and at Danube-upstream Arges (RO3) as well as in the tributaries Morava, Dyje, Vah, Sio and some parts of Drava. Similarly as for ammonium-N there are discrepancies observed between Bulgarian and Romanian data for the site Danube-Silistra-Chiciu.

Decreasing tendency of ortho-phosphate-P was observed at Slovak-Hungarian section of the Danube River and further in the sites Danube upstream Iskar, Silistra/Chiciu, downstream Svishtov and upstream Russe. An improvement of situation concerning ortho-phosphate-P can be also seen in the tributaries Iskar, Jantra, Russensko Lom and Arges.

Total phosphorus concentrations decreased in German and Austrian sites on the upper Danube, a similar situation was observed on the lower Danube at sites upstream Russe (BG04) and downstream Svishtov (BG03). Decrease of total P was also observed in the tributaries Inn, Salzach, Morava, Arges and Jantra.

Among the priority substances, cadmium concentrations have a decreasing trend in the Danube River basin. This situation can be observed in recent years at many TNMN sites.

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 a long-term development of loads of relevant determinands in the important rivers of the Danube Basin is one of the major objectives of the TNMN. That is why the load assessment programme in the Danube River Basin started in 2000. For calculation of loads a commonly agreed standard operational procedure is used.

6.2. Description of load assessment procedure

Following principles have been agreed 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;Based on the agreement with the Black Sea Commission the silicates are measured in the Romanian load assessment sites since 2004;*
- *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.

6.3. Monitoring Data in 2004

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 the TNMN load assessment sites.

In 2004 there were eight measurements for load assessment available from Ukraine; this enabled a rough calculation of loads. These are shown in tables 7 and 9. Flow data are missing in two Croatian monitoring locations. In most of the locations the number of samples was higher than 20; a frequency of 12 times per year was applied only in Morava, Dyje and Danube-Jochenstein (A01). But as the loads in the Danube at Jochenstein are being assessed on the basis of combined data from Germany and Austria, there is no problem with insufficient frequency there.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

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		

determinands, leading to differences in results. In addition, Croatia does not have flow data for this monitoring location. Regarding particular determinands, there is still lack of data on dissolved phosphorus as it was measured in four locations only. At Reni the silicate load was calculated to respond to the agreements with the Black Sea Commission.

6.4. Calculation Procedure

In case of several sampling sites in the profile, the average concentration at a site 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:

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

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

Table 6: Number of measurements in TNMN locations selected for assessment of pollution load in 2004

Country Code	River	Location	Location in profile	River km	Number of measurements in 2004								
					Q	SS	N_{inorg}	P-PO_4	P_{total}	BOD_5	Cl	P_{diss}	SiO_2
D02	Danube	Jochenstein	M	2204	366	26	26	26	26	26	26	12	0
D03	Inn	Kirchdorf	M	195	366	24	26	26	26	25	26	13	0
D04	Inn/Salzach	Laufen	L	47	366	26	26	26	26	26	26	26	0
A01	Danube	Jochenstein	M	2204	366	12	12	12	12	12	12	12	0
A04	Danube	Wolfsthal	R	1874	366	24	24	24	24	24	24	24	0
CZ01	Morava	Lanzhot	M	79	366	12	12	12	12	12	12	0	0
CZ02	Morava/Dyje	Pohansko	M	17	366	12	12	12	12	12	12	0	0
SK01	Danube	Bratislava	M	1869	366	24	24	12	24	24	24	12	0
H03	Danube	Szob	L	1708		21	21	21	21	21	21	0	0
			M		366	21	21	21	21	21	21	0	0
			R			21	21	21	21	21	21	0	0
H05	Danube	Hercegszántó	M	1435	366	13	26	26	26	26	13	0	0
H08	Tisza	Tiszasziget	L	163		12	26	26	26	26	12	0	0
			M		366	11	22	22	24	24	11	0	0
			R			12	23	23	25	25	12	0	0
HR02	Danube	Borovo	R	1337	0	26	26	26	26	26	0	0	0
HR06	Sava	Jesenice/D	L	729	0	26	26	26	26	26	12	0	0
HR07	Sava	us Una Jesenovac	L	525	366	26	26	26	26	26	12	0	0
HR08	Sava	ds Zupanja	R	254	366	26	26	26	26	26	12	0	0
SI01	Drava	Ormoz	L	300	366	24	24	24	24	0	24	0	0
SI02	Sava	Jesenice	R	729	366	25	25	25	25	25	25	0	0
RO02	Danube	Pristol-Novo Selo	L	834		24	24	24	24	20	24	0	24
			M		366	23	23	23	23	19	23	0	23
			R			24	24	24	24	24	22	0	23
RO04	Danube	Chiciu-Silistra	L	375		24	24	24	23	24	22	0	20
			M		366	24	24	24	23	24	22	0	20
			R			24	24	24	22	24	20	0	21
RO05	Danube	Reni-Chilia arm	L	132		24	24	24	22	24	24	0	22
			M		366	24	24	24	22	24	24	0	22
			R			23	24	24	22	24	24	0	23
UA02	Danube	Vilkova-Kilia arm	M	18	366	0	8	8	8	8	8	0	0

The monthly load is calculated by using the formula:

L_m [tones] = C_m [mg.l^{-1}] . Q_m [m^3.s^{-1}] . 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:

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

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 and silicates - 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 2004
c_{mean}	arithmetical mean of the concentrations in the year 2004
Annual Load	annual load of given determinand in the year 2004

There was more water in the Danube River Basin in 2004 - an average flow in the Danube was about 20 % higher than in 2003. For the tributaries this difference was about 40 %. This increased flow caused elevated loads of suspended solids and also an increase of all loads when compared to 2003. A significant increase in comparison to 2003 had been observed in the Inn and Salzach for P-PO4, total phosphorus, BOD5 and chlorides. Significantly higher ortophosphate load was detected in the Drava.

A spatial pattern of an annual load along the Danube River in 2004 was similar to the previous year. The loads of inorganic nitrogen, total phosphorus and chlorides continuously increased downstream the river. For ortho-phosphate phosphorus and suspended solids the highest load was observed in the lower part of the Danube River, with a maximum reached at monitoring site Danube-Pristol-Novo Selo (RO02, r.km 834). In case of organic pollution maximum was reached at monitoring location Chiciu-Silistra.

As regards the tributaries, the highest nutrient and BOD5 load is coming from Tisza and Sava rivers. For the other parameters the Tisza is the major contributor.

Table 7: Mean annual concentrations in monitoring locations selected for load assessment on Danube River in 2004

Station Code	Profile	River Name	Location	River km	Q_a ($m^3.s^{-1}$)	c_{mean} Suspended Solids ($mg.l^{-1}$)	Inorganic Nitrogen ($mg.l^{-1}$)	Ortho-Phosphate Phosphorus ($mg.l^{-1}$)	Total Phosphorus ($mg.l^{-1}$)	BOD_5 ($mg.l^{-1}$)	Chlorides ($mg.l^{-1}$)	Phosphorus - dissolved ($mg.l^{-1}$)	Silicates ($mg.l^{-1}$)
D02 +A01	M	Danube	Jochenstein	2204	1213	18	1.92	0.028	0.059	2.58	17.18	0.037	
A04	R	Danube	Wolfsthal	1874	1877	17	2.29	0.026	0.085	2.10	18.97	0.064	
SK01	M	Danube	Bratislava	1869	1852	26	2.38	0.043	0.088	2.28	18.83	0.053	
H03	LMR	Danube	Szob	1708	2013	18	2.35	0.06	0.10	3.37	23.55		
H05	M	Danube	Hercegszántó	1435	2025	6	1.24	0.02	0.08	2.97	18.77		
HR02	R	Danube	Borovo	1337		49	2.87	0.071	0.235	2.90			
RO02	LMR	Danube	Pristol-Novo Selo	834	5233	29	1.15	0.087	0.108	1.89	20.01		7.09
RO04	LMR	Danube	Chiciu-Silistra	375	6088	21	1.96	0.042	0.247	2.39	36.40		7.23
RO05	LMR	Danube	Reni-Chilia arm	132	6524	23	2.06	0.054	0.118	1.80	36.77		7.91
UA02	M	Danube	Vilkova-Kilia arm	18	3421		1.426	0.074	0.126	2.22	30.09		

Table 8: Mean annual concentrations in monitoring locations selected for load assessment on tributaries in 2004

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	290	31	0.59	0.008	0.065	1.1	5.03	0.012
D04	L	Inn/Salzach	Laufen	47	232	14	0.74	0.008	0.034	2.1	8.73	0.010
CZ01	M	Morava	Lanzhot	79	47	46	2.91	0.112	0.020	4.5	31.57	
CZ02	L	Morava/Dy	Pohansko	17	38	12	3.01	0.268	0.323	3.5	42.14	
H08	LMR	Tisza	Tiszasziget	163	825	29	1.39	0.06	0.17	1.9	38.31	
SI01	L	Drava	Ormoz	300	314	13	1.11	0.010	0.035	2.4	5.58	
SI02	R	Sava	Jesenice	729	324	14	1.62	0.068	0.110		7.42	
HR06	L	Sava	Jesenice	729		20	1.79	0.027	0.130	3.0	7.00	
HR07	L	Sava	us. Una Jasenovac	525	697	26	1.71	0.112	0.185	3.2	11.91	
HR08	R	Sava	ds. Zupanja	254	1165	24	1.35	0.061	0.120	2.5	13.39	

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

Station Code	Profile	River Name	Location	River km	Annual Load in 2004							
					Suspended Solids	Inorganic Nitrogen	Ortho-Phosphate Phosphorus	Total Phosphorus	BOD_5	Chlorides	Phosphorus - dissolved	Silicates
					($x10^6$tonns)	($x10^3$tonns)	($x10^3$tonns)	($x10^3$tonns)	($x10^3$tonns)	($x10^6$tonns)	($x10^3$tonns)	($x10^6$tonns)
D02 +A01	M	Danube	Jochenstein	2204	0.836	203.720	1.048	2.617	101.685	0.630	1.297	
A04	R	Danube	Wolfsthal	1874	1.239	137.605	1.385	4.569	130.668	1.112	3.294	
SK01	M	Danube	Bratislava	1869	1.780	138.968	2.360	5.420	135.638	1.091	2.965	
H03	LMR	Danube	Szob	1708	1.107	126.426	2.866	5.051	186.313	1.263		
H05	M	Danube	Hercegszántó	1435	0.386	84.244	1.423	4.958	193.592	1.239		
HR02	R	Danube	Borovo	1337								
RO02	LMR	Danube	Pristol-Novo Selo	834	4.896	199.629	13.688	17.029	311.394	3.265		1.160
RO04	LMR	Danube	Chiciu-Silistra	375	4.077	378.819	8.674	49.809	476.562	7.675		1.289
RO05	LMR	Danube	Reni-Chilia arm	132	4.846	431.769	13.047	24.609	383.385	7.551		1.694
UA02	M	Danube	Vilkova-Kilia arm	18		108.393	5.549	9.551	167.707	2.180		

Table 10: Annual load in selected monitoring locations on tributaries

Station Code	Profile	River Name	Location	River km	Annual Load in 2004						
					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	0.398	4.884	0.152	1.766	23.067	0.081	0.108
D04	L	Inn/Salzach	Laufen	47	0.153	5.013	0.112	0.634	29.950	0.107	0.144
CZ01	M	Morava	Lanzhot	79	0.081	5.991	0.178	0.280	5.597	0.041	
CZ02	L	Morava/Dyje	Pohansko	17	0.011	6.436	0.233	0.286	4.398	0.049	
H08	LMR	Tisza	Tiszasziget	163	1.116	33.612	1.388	5.098	47.183	0.409	
SI01	L	Drava	Ormoz	300	0.198	10.810	0.107	0.437		0.028	
SI02	R	Sava	Jesenice	729	0.011	6.436	0.233	0.286	4.398	0.049	
HR06	L	Sava	Jesenice	729							
HR07	L	Sava	us. Una Jasenovac	525	0.647	104.632	5.711	10.599	202.038	0.862	
HR08	R	Sava	ds. Zupanja	254	0.842	29.390	1.019	2.351	52.451	0.239	

7. Abbreviations

Abbreviation	Explanation
AQC	Analytical Quality Control
BSC	Black Sea Commission
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
MA EG	Monitoring and Assessment Expert Group (former MLIM EG)
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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