WATER QUALITY

in the Danube River Basin

TNMN Yearbook 2001

Information

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1. Introduction

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

As regards monitoring programmes, the Danube Convention states that the Contracting Parties shall cooperate in the field of monitoring and assessment. To this end they shall:

- harmonise or make consistent their monitoring and assessment methods, in particular in the field of river quality;

- develop concerted or joint monitoring systems applying stationary or mobile measurement devices, communication and data processing facilities;

- elaborate and implement joint programmes for monitoring river conditions in the Danube catchment area concerning water quantity and quality, sediments and river ecosystems, as a basis for the assessment of transboundary impacts.

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

The operation of the TransNational Monitoring Network (TNMN) aims to contribute to implementation of the Danube River Protection Convention, and in particular of its provisions cited above. This Yearbook is the sixth in a series compiled by the ICPDR, and has been prepared with the principal objective of presenting the monitoring programme and the data obtained from TNMN's operation in 2001.

In comparison with previous Yearbooks, this one is expanded in several particulars. The principal change is the inclusion of the TNMN classification, agreed upon in 2001.

Contents

2. History of TNMN

In December 1985 the Bucharest Declaration was signed by the governments of the Danube countries. One of its objectives was observation of the development of the Danube water quality, and a monitoring programme was established based on agreed methods to obtain consistent data. The monitoring network consisted of eleven cross-sections of the Danube. Cross-sections were placed on the Danube itself where the river forming the border between countries crosses this border.

In 1991 the Danube countries began preparation of the *Convention on cooperation for the protection and sustainable use of the Danube River* (DRPC), signed in 1994.

The Environmental Programme for the Danube River Basin, led by a Task Force, also began in 1991, with the main objectives of strengthening the operational basis for environmental management in the Danube River Basin, and of supporting the Danube countries in implementation of the DRPC.

In 1992, the Task Force agreed a three-year Work Plan (1992-95) comprising monitoring, laboratories and information management, and containing a programme of actions. In 1992 the Monitoring, Laboratory and Information Management Sub-Group (MLIM SG) was established.

The main outcome of the Work Plan was the Strategic Action Plan (SAP). Its approval marked the end of the first phase of the EPDRB (1992-95) and implementation was scheduled to begin in the next phase (1996-2000).

The TNMN was originally designed in 1993 during the project "Monitoring, Laboratory Analysis and Information Management for the Danube River Basin", conducted by the WTV Consortium in close cooperation with MLIM SG.

Responsibility for TNMN was assigned to MLIM SG, which consisted of three Working Groups – Monitoring WG, Laboratory Management WG and Information Management Working Group. MLIM SG would address the development of water quality monitoring network in the Danube River Basin; introduce harmonised sampling procedures and enhanced laboratory analysis capabilities; and form the core of a Danube information system on the status of in-stream water quality. The 1996 and 1997 budgets of the PHARE Multi-Country Environmental Programme allocated substantial funds to EPDRB projects to support further development of the monitoring and assessment programme and the launch of TNMN's operation.

After the DRPC came into force in October 1998, MLIM Expert Group was incorporated into the organisational structure of the International Commission for the Protection of the Danube River (ICPDR), and has been working on the basis of TORs agreed by the ICPDR Plenary Meeting. The overall objective of the MLIM EG is the creation of a strengthened and more strategic approach to monitoring, laboratory and information management for surface waters. The key role of the group is to address the organisational and operational aspects related to the monitoring of water conditions in the Danube River Basin, and to provide basic data as an input to the ICPDR information system.

3. Objectives of the TNMN

The TNMN began as a result of the work performed according to the objectives defined in the "Environmental Programme for the Danube River Basin - Programme Work Plan", which states that the monitoring network for the Danube shall strengthen the existing network set up by the Bucharest Declaration, be capable of supporting reliable and consistent trend analysis for concentrations and loads for priority pollutants, support the assessment of water quality for water use, and assist in identification of major pollution sources.

In 2000, after several years of TNMN's operation, discussions were held on possible improvements to TNMN based on the experience so far gained. It was agreed that the main objective of TNMN should be a structured and well-balanced overall view of the situation and long-term development of quality and loads in terms of relevant constituents for the major rivers in the Danube River Basin. The international aspect of TNMN is of high importance.

The discussion on improvements to TNMN was further influenced by the entry into force in 2000 of the EU Water Framework Directive (Directive 2000/60/EC), establishing a framework for Community action in the field of water policy. Its implementation represents the highest priority for the ICPDR, which will provide a platform for coordination of activities leading to the development of a River Basin Management Plan for the Danube River Basin. TNMN will be considerably influenced in the near future as a result of WFD implementation establishing specific requirements on monitoring of surface water status.

4. Description of the TNMN

4.1 Monitoring stations network

The monitoring network within the framework of TNMN builds on national surface water monitoring networks. To select monitoring locations for the purposes of an international monitoring network in the Danube River Basin, the following concrete selection criteria for monitoring locations were established:

- located just upstream/downstream of an international border;

- located upstream of confluences between the Danube and main tributaries or main tributaries and larger sub-tributaries (mass balances);

- located downstream of the largest point sources;

- located according to control of water use for drinking water supply.

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

The selection procedure has led to preparation of a final list of 61 monitoring locations to be included in TNMN Phase I. Although monitoring locations in Bosnia and Herzegovina constitute a part of the monitoring network, so far no data has been provided by them. However, in 2001 monitoring stations in Yugoslavia extended the monitoring network. Their data was provided for the first time in that year, filling the gap in water quality data in the middle part of the Danube River and related tributaries. This results in a final list of 79 monitoring stations.

Each monitoring location may 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 selected monitoring locations in the middle and lower part of the Danube River and for large tributaries such as the Tisza and Prut rivers.

An updated list of monitoring locations is shown in Table 4.1.1 and in Figure 4.1. Table 4.1.1 contains basic information characterising the locations provided by the countries, including latitude, longitude, distance from the mouth, altitude and catchment area. As in previous Yearbooks, it should be mentioned that certain characteristics given for monitoring stations included in the list by two neighbouring countries are in some cases still not harmonised.

In 2001 data was provided from 71 monitoring stations, consisting of 100 sampling sites. Samples were taken from 37 monitoring stations (64 sampling sites) located on the Danube River itself and from 34 monitoring station (36 sampling sites) on tributaries.

4. Description of the TNMN

Table 4.1.1: List of monitoring sites

Station list

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. in profile
D01	Danube	Neu-Ulm	48 25 31	10 1 39	2581	460	8107	L2140	L
D02	Danube	Jochenstein	48 31 16	13 42 14	2204	290	77086	L2130	M
D03	/Inn	Kirchdorf	47 46 58	12 7 39	195	452	9905	L2150	M
D04	/Inn/Salzach	Laufen	47 56 26	12 56 4	47	390	6113	L2160	L
A01	Danube	Jochenstein	48 31 16	13 42 14	2204	290	77086	L2220	M
A02	Danube	Abwinden-Asten	48 15 21	14 25 19	2120	251	83992	L2200	R
A03	Danube	Wien-Nussdorf	48 15 45	16 22 15	1935	159	101700	L2180	R
A04	Danube	Wolfsthal	48 8 30	17 3 13	1874	140	131411	L2170	R
CZ01	/Morava	Lanzhot	48 41 12	16 59 20	79	150	9725	L2100	R
CZ02	/Morava/Dyje	Pohansko	48 48 12	16 51 20	17	155	12540	L2120	R
SK01	Danube	Bratislava	48 8 10	17 7 40	1869	128	131329	L1840	M
SK02	Danube	Medvedov/Medve	47 47 31	17 39 6	1806	108	132168	L1860	M
SK03	Danube	Komarno/Komarom	47 45 17	18 7 40	1768	103	151961	L1870	M
SK04	/Váh	Komarno	47 46 41	18 8 20	1	106	19661	L1960	M
H01	Danube	Medve/Medvedov	47 47 31	17 39 6	1806	108	131605	L1470	M
H02	Danube	Komarom/Komarno	47 45 17	18 7 40	1768	101	150820	L1475	M
H03	Danube	Szob	47 48 44	18 51 42	1708	100	183350	L1490	LMR
H04	Danube	Dunafoldvar	46 48 34	18 56 2	1560	89	188700	L1520	LMR
H05	Danube	Hercegszanto	45 55 14	18 47 45	1435	79	211503	L1540	LMR
H06	/Sio	Szekszard-Palank	46 22 42	18 43 19	13	85	14693	L1604	M
H07	/Drava	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	R
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	L
SCG04	Danube	Zemun	44 50 56	20 25 2	1174	70,76	412762	L2380	R
SCG05	Danube	Pncevo	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	L
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 Pal	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

4. Description of the TNMN

RO01	Danube	Bazias	44 47 55,57,58	21 23 24,40,54	1071	70	570896	L0020	LMR
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-Chilia/Kilia arm	45 28 50	28 13 34	132	4	805700	L0430	LMR
RO06	Danube	Vilkova-Chilia arm/Kilia arm	45 24 42	29 36 31	18	1	817000	L0450	LMR
RO07	Danube	Sulina - Sulina arm	45 9 41	29 40 25	0	1	817000	L0480	LMR
RO08	Danube	Sf.Gheorghe-Ghorghe arm	44 53 10	29 37 5	0	1	817000	L0490	LMR
RO09	/Arges	Conf. Danube	44 4 35	26 37 4	0	14	12550	L0250	M
RO10	/Siret	Conf. Danube Sendreni	45 24 10	28 1 32	0	4	42890	L0380	M
RO11	/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
MD02	/Prut	Leuseni	46 48 0	28 9 0	292	19	21890	L2250	M
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	M
UA01	Danube	Reni - Kilia arm/Chilia arm	45 28 50	28 13 34	132	4	805700	L0630	M
UA02	Danube	Vilkova-Kilia arm/Chilia arm	45 24 42	29 36 31	18	1	817000	L0690	M

Key to Table 4.1.1.

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 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

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

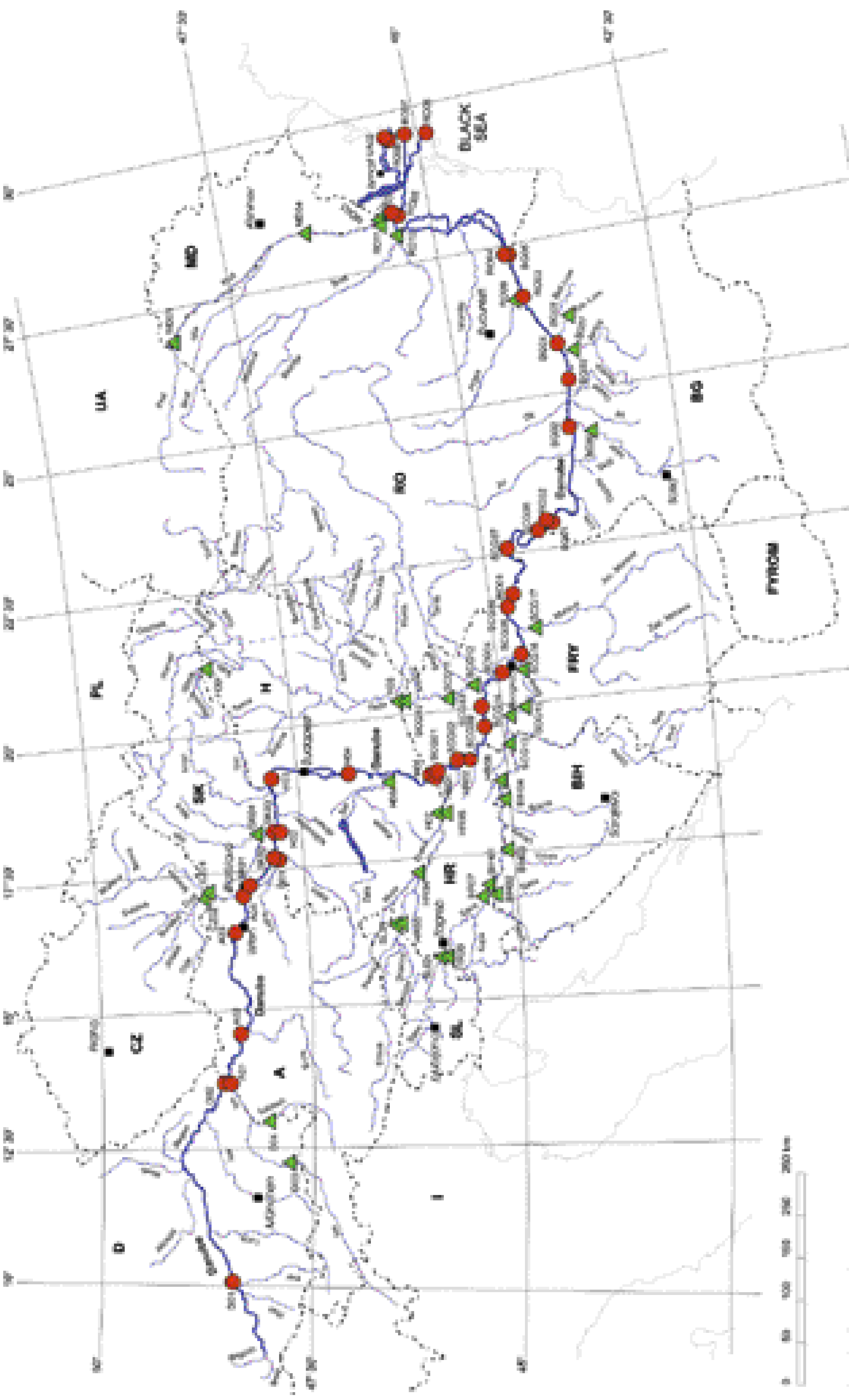


Figure 4.1:
The Danube Stationmap TNMN

4. Description of the TNMN

4.2 Determinands

The determinand list was based on the list from the Bucharest Declaration, which was extended/ reduced with determinands recommended according to EC directives and the riparian countries' own demands. The list was divided into 10 groups, each group being given a sampling frequency according to the different locations. It was further specified how many sampling points (left, middle, right) each site should include, and this together with allocation of determinand groups and sampling frequencies according to the location of each site gave a full definition for each of the sites.

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

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

- The minimum likely level of interest is the lowest concentration considered likely to be encountered or important in the TNMN.

- The principal level of interest is the concentration at which it is anticipated that most monitoring will be carried out.

- The required limit of detection is the target limit of detection (LOD) which laboratories are asked to achieve. This has been set, wherever practicable, at one third of the minimum level of interest. This is intended to ensure that the highest possible precision is achieved at the principal level of interest and that relatively few "less-than results" will be reported for samples at or near the lowest level of interest. Where performance of current analyses is unlikely to meet the criterion of a LOD of one third of the lowest level of interest, the LOD has been revised to reflect best practice. In these cases, the targets have been entered in italics.

- The tolerance indicates the largest allowable analytical error consistent with correct interpretation of the data and with current analytical practice. The target is expressed as "x concentration units or P%". The larger of the two values applies for any given concentration. For example, if the target is 5 mg/l or 20% - at a concentration of 20 mg/l - the maximum tolerable error is 5 mg/l (20% is 4 mg/l); at a concentration of 100 mg/l, the tolerable error is 20 mg/l (i.e. 20%) because this value exceeds the fixed target of 5 mg/l.

- Analytical accuracy targets for sediments are defined for <63 µm size fraction.

Sediments comprise suspended solids and bottom sediments.

4. Description of the TNMN

Table 4.2.1: 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	m3/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)	103 CFU/100 ml	-	-	-	-
Faecal Coliforms (44 C)	103 CFU/100 ml	-	-	-	-
Faecal Streptococci	103 CFU/100 ml	-	-	-	-
Salmonella sp.	in 1 litre	-	-	-	-
Macrozoobenthos	no. of taxa	-	-	-	-
Macrozoobenthos	Sapr. index	-	-	-	-
Chlorophyll – a	µg/l	-	-	-	-

4. Description of the TNMN

Table 4.2.2: Determinand list for sediments of TNMN

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

4.3 Analytical quality control (AQC)

The analytical methodologies for the determinands applied in TNMN are based on a list containing reference and optional analytical methods. The National Reference Laboratories (NRLs) have been provided with a set of ISO standards (reference methods) reflecting the determinand lists, but taking into account current practice in environmental analytical methodology in the EU. It has been decided not to require each laboratory to use the same method, provided that the laboratory is able to demonstrate that the method in use (optional method) meets the required performance criteria.

Therefore the minimum concentrations expected and the tolerance required of actual measurements have been defined for each determinand (as reported in tables 4.2.1 and 4.2.2), in order to enable laboratories to determine whether the analytical methods currently in use are acceptable.

It is good practice that targets for analytical accuracy define the standard of accuracy necessary for the task in hand. Therefore two key concentration levels - the minimum level of interest and the principal level of interest - have been defined for each determinand. These levels define the aims of the monitoring programme and can be used to establish the performance required from analytical systems used in the laboratories involved in the TNMN, with the assumption that the aims of the programme will be satisfied provided that:

- relatively few results are reported as "less than" the minimum level;
- accuracy achieved at the principal level is not worse than ± 20% of the principal level.

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

4.3.1 Performance testing in the Danube laboratories

The organisation of inter-laboratory comparison in the Danube laboratories dates from 1992, when Danube monitoring was agreed under the Bucharest Declaration. The Institute for Water Pollution Control of VITUKI Plc., Budapest, Hungary, undertook responsibility for organising the first study under the name of QualcoDanube. Since the first distribution in 1993 when only three determinands were analysed – pH, conductivity and total hardness – the range of determinands has grown, as has the number of participating laboratories. In 1996 the QualcoDanube proficiency testing scheme was extended to the National Reference Laboratories (NRL) in the TransNational Monitoring Network (TNMN), and the second distribution in 1996 already included all Danube laboratories - 11 NRLs and 18 national laboratories - implementing TNMN. This distribution was further extended to six Black Sea laboratories responsible for pollution monitoring in their area.

In addition to the QualcoDanube, another inter-laboratory comparison, the AQUACHECK performance testing scheme, organized by WRc (UK), was conducted for the NRLs, and aimed principally at analysis of specific micropollutants.

In 2001 four QualcoDanube distributions were made, and synthetic water and sediment samples were analysed by the participating laboratories. The Youden-pair evaluation technique is usually applied. The results and their evaluation during the four distributions have been published in the relevant report (QualcoDanube, AQC for Water Labs in the Danube River Basin, Summary Report 2001, VITUKI Plc., Budapest).

The inter-laboratory comparative results are discussed below separately for the different determinands. It may be considered a success that results were provided by 31 out of 33 laboratories. Most of the laboratories reported results for nutrients, general parameters, some organic parameters and cyanide. In this year more laboratories gave results for lindane than in 2001. Results of heavy metals analysis in sediment were provided by 18-23 laboratories and 16 laboratories reported results of nutrients.

4.3.1.1 Results of performance testing of water samples

General determinands

Chlorides, sulphates, total hardness, potassium, sodium, calcium, magnesium, pH and conductivity were analysed. In general the results were relatively good but were influenced by slight systematic error.

4. Description of the TNMN

Determinands characterising organic pollution

COD_{Mn}, COD_{Cr}, BOD, TOC and MBAS, as well as atrazine, lindane and petroleum hydrocarbons, phenol index, were determined by the participating laboratories. COD, BOD and MBAS were analysed by the majority of laboratories (27-31). The results of these determinations were relatively good but influenced by strong systematic error, especially in the cases of BOD, MBAS and COD_{Mn}.

The percentage of satisfactory results has grown slightly in the cases of BOD and MBAS (i.e., 50-64 % in 2000 and 57-71 % in 2001).

TOC was analysed three times. At surface water level the reported values were influenced mainly by systematic error and altogether 68-76 % were acceptable, while at wastewater level the results were quite good with slight systematic error (acceptable results were 77-94 %).

Phenol index showed good agreement except in the results of three laboratories.

Atrazine, lindane and petroleum hydrocarbons were distributed as extracts. Eight laboratories reported results for atrazine, which data were relatively close to the assigned value.

Lindane was measured by 12 laboratories. The results were rather varied as against the previous year, but were not as far below the theoretical value as in 2000.

Petroleum hydrocarbons were analysed by relatively few laboratories, and the results showed strong systematic error.

Nutrients

These determinands were distributed twice in 2001. The reported values were quite good with slight systematic error.

Non-specific determinand

Cyanide: results reported by 25 laboratories showed strong effect of systematic error and significant random error. Nearly one third of results were rejected, similarly to the data in 2000.

Heavy metals

Samples were distributed both at surface water and wastewater level for Cd, Cr, Cu and Hg determination.

The best results were achieved in copper determination independent of concentration level (satisfactory results: 90-96 %).

Analytical results of chromium and cadmium were influenced by strong systematic error and significant random error (especially in the case of chromium).

Mercury was analysed three times during 2001. Results at surface water level showed significant systematic error and one third of results were rejected. However, results at wastewater level were surprisingly good.

Further heavy metals were analysed at surface water level only, e.g., nickel, zinc, manganese. The results were relatively good, influenced by systematic error.

Metals such as molybdenum, antimony and selenium were analysed once during this period and some of these were not distributed in the previous year.

The reported data of lead and zinc were satisfactory, as were those of iron.

Aluminium showed significant systematic and random error. Antimony was measured by nine laboratories and the reported results were influenced by strong systematic error, while results of selenium and molybdenum were quite good. Arsenic was determined by 15 laboratories and results were relatively good.

4.3.1.2 Results of performance testing of sediment samples

During 2001 the following parameters were tested: ignition loss, nutrients, organic micropollutants (lindane, DDT, petroleum hydrocarbons, PAHs, PCBs), and heavy metals (Cd, Cr, Cu, Ni, Pb, Zn, Hg).

The results of ignition loss showed relatively high random and systematic error. Sixteen laboratories measured nutrients and the reported data of total-P were quite good, but approximately a quarter of results were rejected in the case of total-N. Other results agreed well with the assigned value.

Among the organic micropollutants, lindane and DDT showed significant systematic error, as did petroleum hydrocarbons.

Results of PCBs and PAHs deviated from the assigned value significantly in both positive and negative directions.

Seven heavy metals were analysed in sediment samples. In the case of cadmium and copper, the results were worse than in 2000, showing not only systematic but also random error.

Results from lead, nickel and zinc analysis were quite good, but the results were influenced by strong systematic error. Analytical results of mercury showed significant systematic and random error.

Few laboratories reported results for total phosphorus and nitrogen – only nine for total P and twelve for total N. The measured values were influenced by slight systematic error. In the case of total P, only one result was outside the error limit. It appeared that the same laboratory had made an incorrect calculation, as in the case of total N.

4.3.1.3 Conclusions

The four QualcoDanube distributions in 2001 provided information on the performance of the participating water laboratories in the Danube River Basin. The overall output of the results is the demonstration of the comparability of the analytical data on the studied determinands, as well as the possible methodological problems during the analysis.

Due to budgetary reasons real surface water samples were not included in QualcoDanube distributions in 2001.

4. Description of the TNMN

In general the results of general parameters and nutrients in water were relatively good, but influenced by slight systematic error. Results of cyanide, as a non-specific parameter, were similar to the previous year; nearly one third of results were rejected.

Results of organic pollutants were different. Determinands COD_{Cr} and TOC were relatively good, phenol index was successful, but COD_{Mn}, BOD and MBAS were influenced by strong systematic error.

In the case of organic micropollutants performance was rather poor, especially for lindane and petroleum hydrocarbons, while the results of atrazine were relatively close to assigned value.

The analyses of DDT, lindane, PAH, PCBs and petroleum hydrocarbons in sediment were not successful, each determinand showing significant random and systematic error.

The poor results of these organic pollutants were most likely due to analysis and not only to sample pre-treatment, because the results were wrong independently of matrix (during the period in 2000 DDT was distributed as extract and the results of analysis were similar to the results of sediment in 2001).

The results of metals were quite different. The best results were achieved for copper. The results of other metals like lead, zinc, iron, manganese, nickel, arsenic, selenium and molybdenum were relatively good, while antimony was influenced by strong systematic error. Chromium, cadmium, aluminium and mercury at surface water level showed significant systematic and random error, and antimony was influenced by strong systematic error.

In the area of nutrients significant improvement has been achieved, as with heavy metals, but it should be mentioned that a small number of laboratories reported extreme (high or low) results.

The results obtained in 2001 underline the importance of continuing inter-laboratory comparison studies, especially for micropollutants.

4. Description of the TNMN

4.4 TNMN Data Management

The importance of TNMN data management was recognised in the earliest stages of TNMN's operation, and a well-defined structure for data storage was prepared. The data are organised in a system of connected tables containing information relating to monitoring locations, determinands, methods of sampling, methods of analysis, remarks, information on samples taken and results of analysis. From 1996 on, several sections of the database were modified with the purpose either of adjusting the system to new requirements, or increasing the efficiency of the system.

The procedure of TNMN data collection begins at national level in each country. Nominated National Data Managers (NDMs) are responsible for collection of data from National Reference Laboratories and other national laboratories involved in TNMN where the data from sampling and analysis are generated. In the next stage the NDMs are responsible for data checking, preparation in agreed data exchange file format (DEFF), and transmission to the Centre in the Slovak Hydrometeorological Institute in Bratislava. Here the data are checked again and suspicious data are subjected to consultation with NDMs. After the consultation process the data from TNMN are merged and stored for further use in one relational database, and are also included in the information system of ICPDR - DANUBIS.

Collection of TNMN data began in 1996, data having been regularly collected from Germany, Austria, the Czech Republic, Slovakia, Hungary, Slovenia, Croatia, Bulgaria and Romania. Data from Ukraine and Moldova have been available since 1998, but Ukraine did not provide data for year 2001.

In 2001, data from Yugoslavia were provided for the first time. No data were available from Bosnia and Herzegovina in the period from the start of TNMN's operation till 2001.

4.5 Water Quality Classification

The first attempt to produce a proposal for joint water quality classification for the Danube River Basin was made in 1997 by PHARE Applied Research Project EU/AR/203/90 "Water Quality Targets and Objectives for Surface Waters in the Danube Basin" (WRRC VITUKI, 1997). The classification proposed by the project has not been applied for evaluation of results from TNMN; it was used only partially, in utilisation of its limit values for illustration of BOD_5, PO_4^{3-}-P and NO_3^--N concentrations in maps in the previous TNMN Yearbooks 1996-2000.

In 1999 the EU PHARE Programme contributed to the EPDRB by initiating the project "Danube River Basin Water Quality Enhancement". One of its objectives was to make a proposal for a unified water quality classification for the entire Danube River Basin region based on:

- review of existing water quality and sediment quality classification methods in Danube countries;

- review of EU legislation;

- experience within the different countries.

4. Description of the TNMN

The activity was realised by IWACO BV Consultants for water and environment in Rotterdam. Although attention was paid to WFD, it was concluded that to achieve ecologically based and regionally differentiated water quality criteria according to WFD in the Danube River Basin would require considerable effort and time. In the meantime an interim water quality classification scheme was proposed. This proposal was further discussed and adjusted by the Monitoring, Laboratory and Information Management Sub-Group, and approved finally in 2001.

The classification scheme as presented in Table 4.5.1 is intended to serve international purposes for the presentation of current status and improvements of water quality in the Danube River and its main tributaries, and is not to be a tool for implementation of national water policy.

The classification scheme covers 37 determinands. Five classes are used for assessment, with target value being the limit value of class II. Class I should represent reference conditions or background concentrations. For a number of determinands it was not possible to establish real reference values, due to the existence of many types of water bodies in the Danube River Basin differing naturally in physico-chemical characteristics. For synthetic substances the detection limit or minimal likely level of interest was chosen as limit value for class I.

Classes III-V are on the "non-complying" side of the classification scheme and their limit values are usually 2-5 times the target values. These should indicate the seriousness of exceeding the target value, and help recognition of the positive tendency in water quality development.

For compliance testing 90-percentile value of at least 11 measurements in a particular year is used.

This Yearbook 2001 contains evaluation of water quality data in accordance with the classification scheme as in the first in the series of Danube Yearbooks.

Table 4.5.1: 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	$\mu g.l^{-1}$	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 – 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

5. Tables of data from statistical processing

The determinands measured in 2001, the sixth year of TNMN's operation, covered the main physical, chemical, biological and microbiological water quality characteristics including the major anions and cations, nutrients, oxygen regime determinands, selected organic micropollutants, heavy metals and characteristic biological and microbiological determinands.

The basic processing of the data includes calculation of selected statistical characteristics and classification of water quality determinands in each monitoring site.

Data available from 100 sampling points are presented in tables in Annex 1, separately for each sampling site and according to the following legend. Tables for those stations where no data were available are excluded from the Yearbook.

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 2001
Mean	Arithmetical mean of the measurements done in the year 2001
Max	Maximum value of the measurements done in the year 2001
C50	50 percentile of the measurements done in the year 2001
C90	90 percentile of the measurements done in the year 2001
Class	result of classification of the determinand

If values less than the detection limit were present in the dataset for a given determinand, the value of detection limit was used in statistical processing of the data.

For the purposes of classification, the "testing value" has been calculated for each determinand, which is further compared to limit values for water quality classes and a corresponding class assigned to determinand. The testing value is equal to 90 percentile (10 percentile for dissolved oxygen and lower limit of pH value), if the number of measurements in a year was at least eleven. If the 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 occurred in certain cases that the limit of detection used by a country was higher than limit value for class II, representing the target value. In these cases only statistics were calculated and presented in a table, while classification was not made.

Water quality class for each determinand in the tables of Annex I is indicated by use of colouring of the respective field of the table, using the colours given below.

5. Tables of data from statistical processing

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

The trend of improvement of availability of TNMN – as regards coverage of the proposed network of monitoring stations - continued in 2001. Comparing the list of monitoring sites in Table 4.1.1 with the data obtained, it can be said that in general countries provide data from all monitoring stations included in the list of TNMN stations. Exceptions are Ukraine and Bosnia and Herzegovina, from which no data were available. Newly included monitoring sites from Yugoslavia are largely covered – out of seventeen designated monitoring stations only one is missing.

The agreed sampling frequency for physico-chemical determinands is a minimum of 12 times per year. The required frequencies are generally kept for basic physico-chemical determinands, and number of measurements below 11 is seldom.

This is very important because the majority of these determinands show typical seasonal variability and/or depend heavily on discharge. A sole exception is in the case of Moldavia, which still has rather low frequencies in this group of determinands. The weak points are dissolved fractions of phosphorus and heavy metals, measurements of which have been agreed by experts as obligatory determinands instead of concentrations in total water samples, and the group of specific organic micropollutants and biological determinands.

Table 5.1 shows the concentration ranges and mean annual concentrations of selected determinands characterising oxygen regime, nutrient status on the Danube River itself and tributaries in 2001, as well as heavy metals.

The statistical results indicate that in general the concentration ranges of measured determinands were larger in the tributaries than in the Danube itself.

5. Tables of data from statistical processing

Table 5.1: Concentration ranges and mean annual concentrations of selected determinands in the Danube River and its tributaries in 2001.

Determinand	Danube River		Tributaries		Remark
	Annual mean values	Concentration range	Annual mean values	Concentration range	
Dissolved Oxygen	7.0-11.4	4.8-15.2	7.6-12.0	4.3-19.3	
BOD$_5$	0.99-4.86	0.34-11.9	1.14-5.80	0.30-12.20	QualcoDanube - systematic error
COD$_{Cr}$	5.14-21.27	3.5-59.0	5.78-28.54	2.8-71.0	
COD$_{Mn}$	2.24-7.56	0.9-42.7	1.13-9.73	0.5-27.0	QualcoDanube - systematic error
PH	7.65-8.28	6.7-9.0	7.28-8.31	6.70-9.12	
Conductivity	340-455	227-752	241-1005	148-1231	
Ammonium - N	0.032-0.520	0.01-2.12	0.033-2.302	0.003-5.4	
Nitrite - N	0.001-0.092	0.001-0.443	0.001-0.092	0.001-0.40	
Nitrate - N	0.72-3.06	0.05-4.8	0.52-6.05	0.05-10.8	
N$_{org}$	0.16-1.73	0.04-3.34	0.22-1.41	0.02-2.60	Data available only from Czech Republic. Slovakia, Hungary, Croatia
P$_{total}$	0.05-0.50	0.006-1.22	0.023-0.837	0.009-1.64	
Ortho-Phosphate – P	0.017-0.519	0.003-2.210	0.005-1.481	0.003-3.36	
P$_{diss}$	0.035-0.066	0.005-0.104	0.022-0.121	0.008-0.182	
Arsenic - total	0.88-5.50	0.50-10.0	1.05-5.21	0.30-13.00	
Arsenic - dissolved	0.67-1.41	0.50-3.00	1.0-4.0	0.50-8.00	
Cadmium - total	0.03-3.44	0.01-18.69	0.03-5.50	0.02-34.00	QualcoDanube – significant systematic and random error
Cadmium - dissolved	0.05-0.99	0.02-2.72	0.03-0.35	0.02-2.50	
Chromium - total	0.35-10.0	0.20-47.0	0.10-10.0	0.10-22.40	QualcoDanube – significant systematic and random error
Chromium - dissolved	0.19-3.27	0.10-10.7	0.23-1.48	0.10-9.40	
Copper - total	1.98-30.25	0.12-77.87	0.02-31.67	0.02-86.85	
Copper - dissolved	1.20-34.80	0.60-98.00	0.36-32.67	0.20-105.00	
Lead - total	0.47-8.01	0.04-22.00	0.05-11.18	0.05-59.0	
Lead - dissolved	0.65-10.23	0.20-40.6	0.57-7.635	0.20-21.00	
Mercury - total	0.05-0.13	0.01-0.58	0.015-2.83	0.01-5.00	QualcoDanube – significant systematic and random error
Mercury - dissolved	0.06-0.43	0.03-0.50	0.038-0.50	0.03-0.50	
Nickel - total	0.85-6.73	0.02-29.38	0.50-36.71	0.20-76.20	
Nickel - dissolved	0.25-3.08	0.10-9.00	0.20-4.69	0.20-28.0	
Zinc - total	5.49-108.8	1.0-324.0	2.5-145.6	0.8-301.0	
Zinc - dissolved	4.68-33.50	1.0-177.0	4.21-49.2	1.0-136.0	

6. Presentation of results of classification

In order to present results from classification and show these results in an aggregated mode for the whole Danube River basin, the maps have been prepared for selected determinands. This chapter emerges from the results of classification given in the Tables of Chapter 5.

The selection of determinands for presentation has been conducted intentionally to present either characteristic basic determinands of the main group of determinands characterising water quality (dissolved oxygen, BOD_5, COD_{Cr} representing oxygen regime determinands, ammonium-nitrogen, nitrate-nitrogen, ortho-phosphate phosphorus and total phosphorus to characterising nutrient content, chlorophyll-a as an indicator of eutrophication), or – in the case of the group of heavy metals and organic micropollutants – a few selected determinands to represent this group, although the spatial pattern of the particular substances from these groups may be different.

The maps presented in Figures 6.1-6.12 show water quality classes based on the testing values. The colours indicate water quality classes from I to V in accordance with the Table given in Chapter 5. The maps differentiate between monitoring stations on the Danube River itself and on the tributaries. To recognise the results based on data with frequencies lower than eleven, the spot indicating water quality class on a map is of smaller size. Where there are data from three sampling sites (left, middle, right) of one monitoring station, only the data of the "middle" are shown on the maps.

In addition to the maps, Figures 6.1.13-6.1.24 show percentage of monitoring stations in water quality classes, mainly to illustrate what is the share of stations fulfilling requirements on target value (i.e. the percentage corresponding to classes I and II) and what is their percentage occurring on the non-complying side.

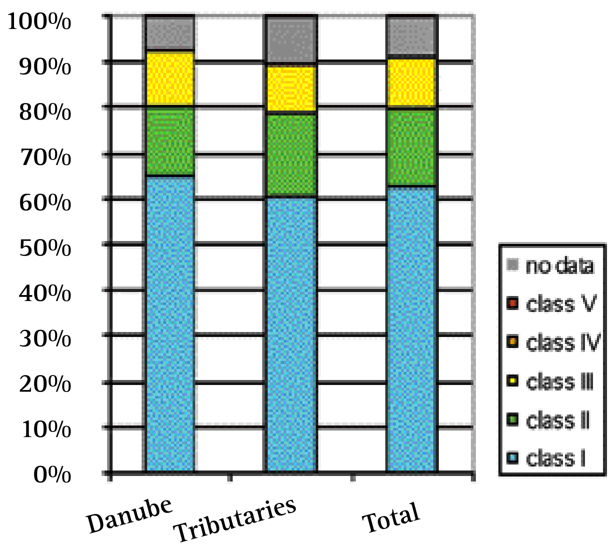


Figure: 6.1.13: Distribution of water quality class for dissolved oxygen

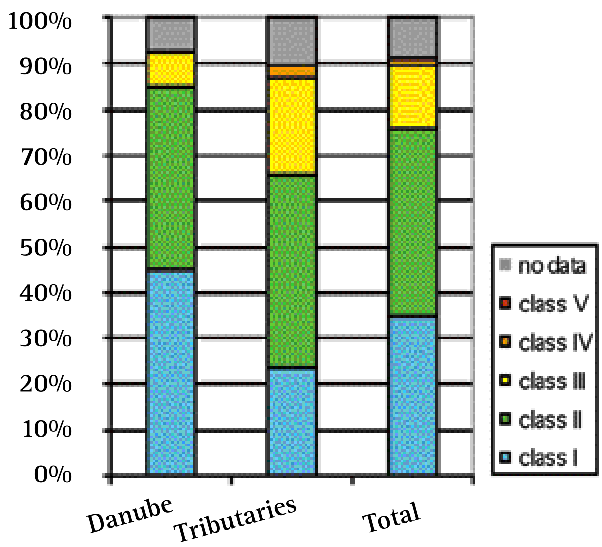
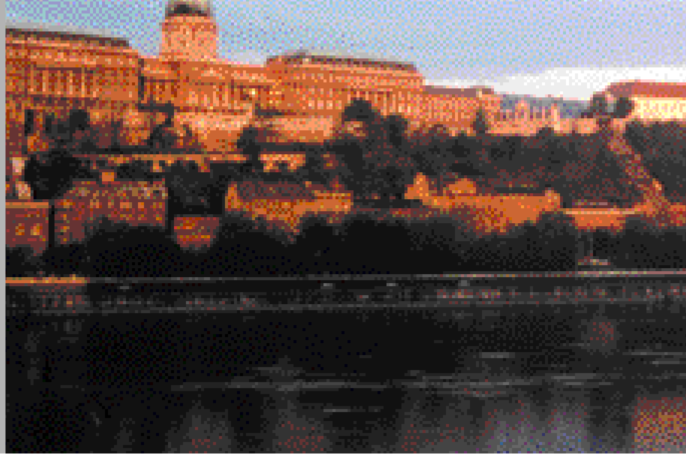


Figure: 6.1.14: Distribution of water quality class for BOD_5



6. Presentation of results of classification

Dissolved oxygen belongs to the basic determinands of water quality. Antropogenic activities can affect its content in waters in both directions – decrease in the case of pollution by degradable organic matter, or increase in the case of eutrophication processes. Figure 6.1.13 shows that concentration of oxygen satisfies the requirements given by the target value in 80 % of monitoring stations on the Danube River, while only 12 % of stations correspond to class III. Almost the same situation occurs in tributaries, of which 79 % correspond to classes I and II. In 9 % of all monitoring sites there are no data.

BOD_5 is used as indicator of biodegradable organic pollution in waters. In the Danube itself, 85 % correspond to classes I and II, while class III is represented by 7.5 % of monitoring sites. A worse situation is observable in the case of tributaries, where the percentage of stations satisfying the target value is 66 %, and classes III and IV are represented by 24 % of stations (see also Figure 6.1.14).

CODCr also belongs to basic determinands, characterising presence of oxygen-consuming compounds in waters. Examining Figure 6.1.15, a relatively high percentage of all stations do not have measurements of this determinand – 36 %. Compliance with target value is observed in 65 % of monitoring stations in the Danube River and 39.5 % of stations at tributaries. No station is lower than class III, to which 2.5 % of stations in the Danube River and 21 % in tributaries belong.

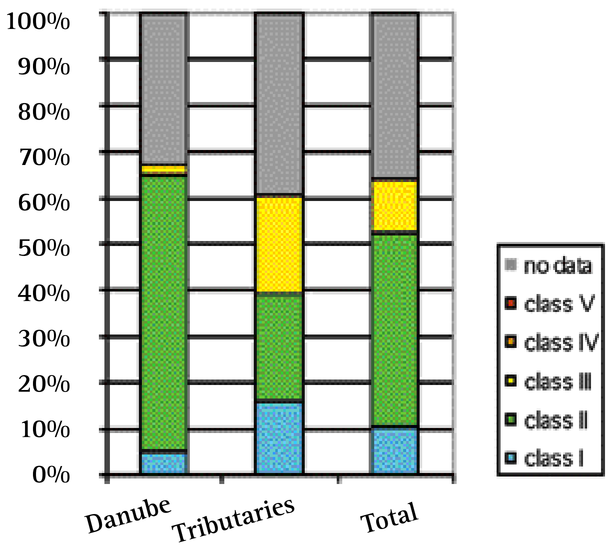


Figure: 6.1.15: Distribution of water quality class for COD_{Cr}

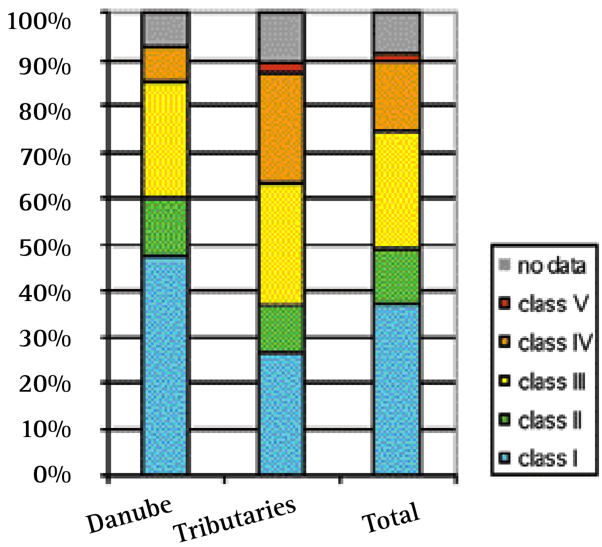


Figure: 6.1.16: Distribution of water quality class for Ammonium -N

6. Presentation of results of classification

The situation regarding nutrient content in the waters of the Danube and its larger tributaries is very important from the international perspective, because nutrients are responsible for eutrophication processes in rivers and in the receiving sea.

Figure 6.1.16 reveals that in the case of ammonium-N in the Danube River itself, 60 % of stations correspond to classes I and II and are therefore in compliance with the target value set for the determinand. In tributaries this figure is significantly lower - 37 %. Classes III and IV are represented by 32.5 % of stations on the Danube River. In the case of tributaries 26 % correspond to class III and a further 26 % to the worst quality classes IV and V.

Distribution of stations in water quality classes from the point of view of nitrate-N content is illustrated in Figure 6.1.17. It may be concluded that the majority of stations belong to classes I and II, satisfying target value for nitrate-N – 65 % of stations on the Danube River and 68 % of stations on the tributaries. Class III is represented by 27.5 % on the Danube River, and classes III and IV on tributaries are represented by 21 % of stations.

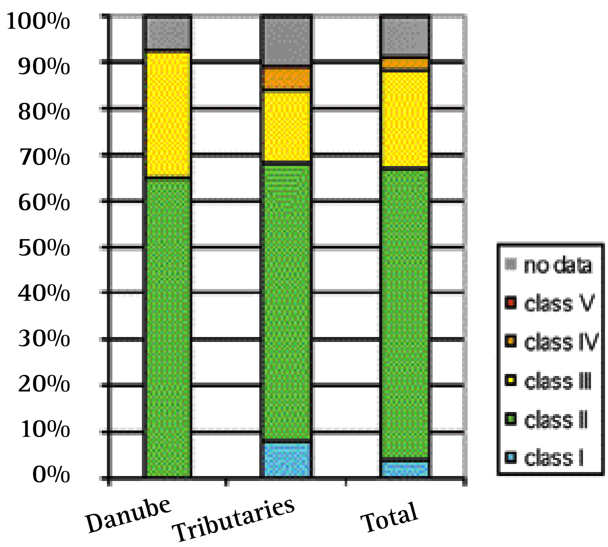


Figure: 6.1.17: Distribution of water quality class for Nitrate-N

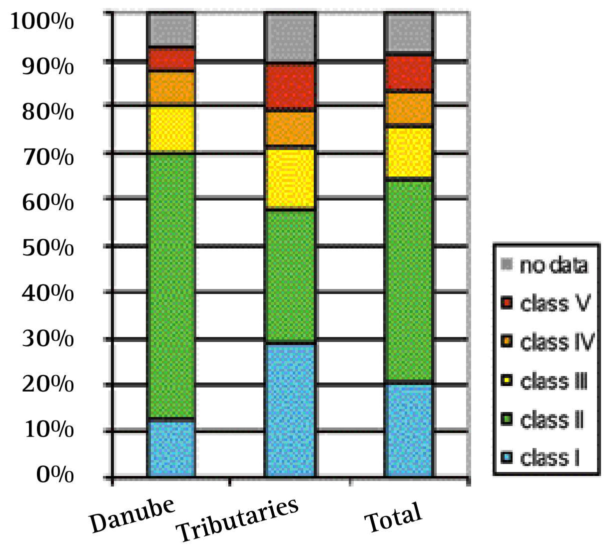


Figure: 6.1.18: Distribution of water quality class for Ortho-phosphate-P

Looking at the distribution of water quality classes for ortho-phosphate-P, all five classes are represented in both the Danube River and its tributaries. Again, the situation is slightly better on the Danube River itself, taking into account percentage of stations belonging to classes I and II.

6. Presentation of results of classification

These classes are reached by 70 % of stations on the Danube River and by 58 % of stations on the tributaries. The worst class V is represented by 7.5 % of stations on the Danube River and 10.5 % of stations on tributaries (see also Figure 6.1.18).

Assessment of total phosphorus content in waters results in the conclusion that 72.5 % of Danube stations correspond to classes I and II, therefore complying with the target value. In tributaries this figure is 47 %. Class III is represented by 17.5 % of stations on the Danube River, and class V by 2.5 % (no class IV). In tributaries 24 % of stations are in class III and 18.5 % in classes IV and V (see Figure 6.1.19).

Content of chlorophyll-a as an indicator of primary production is closely connected to assessment of nutrient content. The distribution of quality classes in stations monitored in TNMN is shown in Figure 6.1.20. It is evident that measurement of this determinand still does not feature in the majority of stations included in TNMN, although the information that it provides is of great value. The extent of measurement does not give a representative picture of the situation in the river basin; however, it may be affirmed that 40 % of stations on the Danube River correspond to classes I and II and 5 % to class III. In the tributaries, only 21 % of stations correspond to classes I and II, and 8 % to classes III and IV.

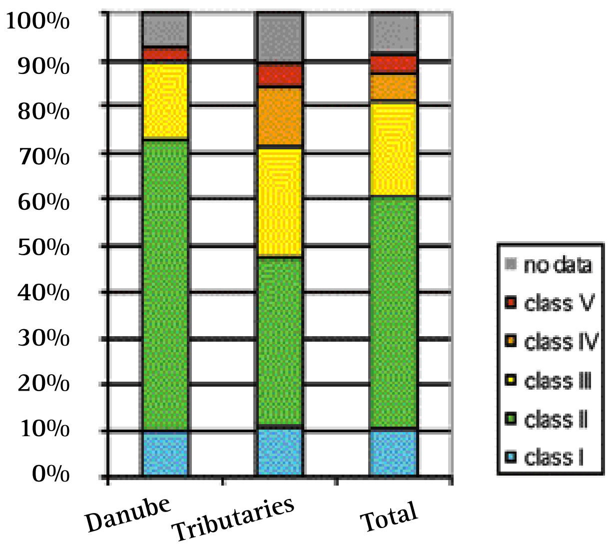


Figure: 6.1.19: Distribution of water quality class for P_{total}

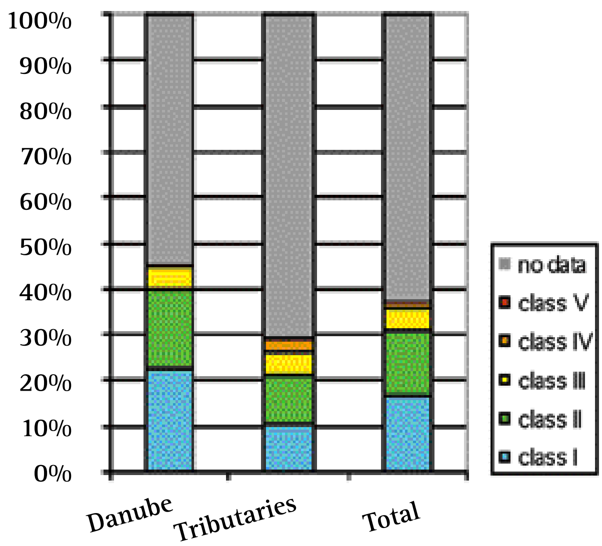


Figure: 6.1.20: Distribution of water quality class for Chlorophyll-a

6. Presentation of results of classification

From the group of heavy metals, cadmium and mercury were selected for presentation. Again, a large number of stations can be found without measurements of these determinands (see Figure 6.1.21). Regarding cadmium 47.5 % of stations correspond to class II (class I has not been established for heavy metals) in the Danube River, with the same percentage for tributaries (47 %). Classes IV and V are represented by 22.5 % of stations located on the Danube River, while the tributaries show 10.5 % of stations in classes III – V.

In the case of mercury, data from only 40 % of stations are available (Figure 6.1.22). It can be concluded that class II is represented by 23 % of all stations, whilst on the non-complying side (classes III – V) the figure is 17 % of TNMN stations.

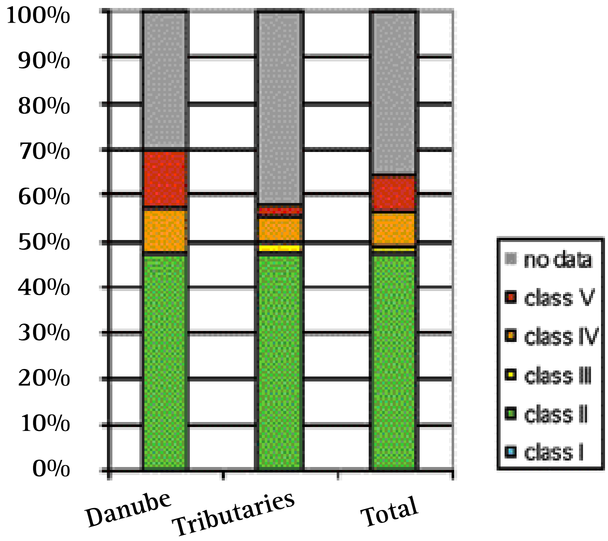


Figure: 6.1.21: Distribution of water quality class for Cadmium

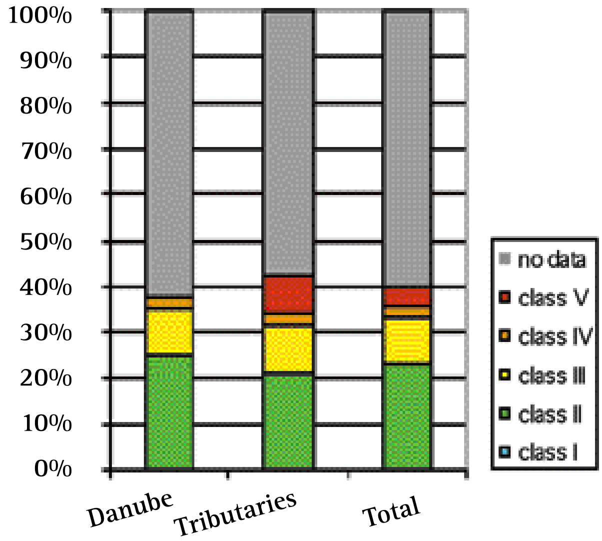


Figure: 6.1.22: Distribution of water quality class for Mercury

From the group of micropollutants, atrazine and DDT were selected for illustration. It may be seen from Figures 6.1.23 and 6.1.24 that assessment of determinands from this group is influenced by a large number of stations from which there are no data. On the basis of available information it may be concluded that in case of atrazine, 38.5 % of stations corresponded to class I and class II, and 11.5 % to classes III – V. Regarding DDT, 36 % of stations correspond to classes I and II, and 11.5 % to classes III – V.

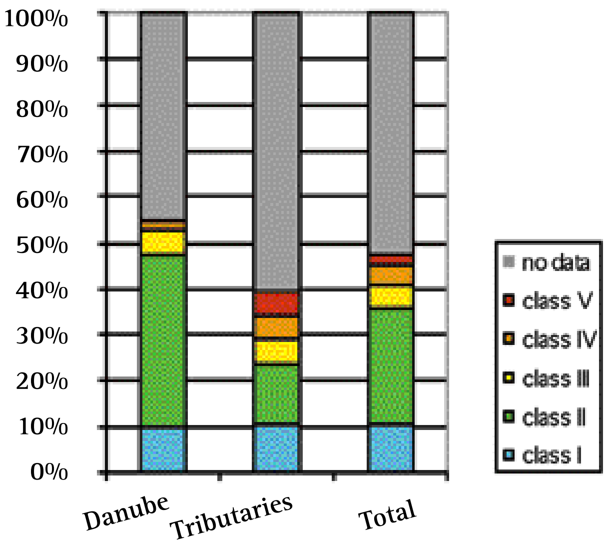


Figure: 6.1.23: Distribution of water quality class for DDT

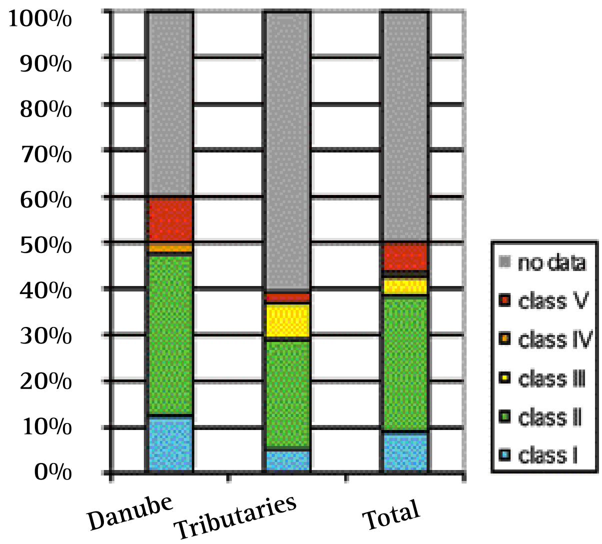


Figure: 6.1.24: Distribution of water quality class for Atrazine

It may be concluded that the situation appears to be worse in tributaries. Taking into account the fact that the number of monitoring stations on the Danube River and tributaries was almost the same in 2001 (39 : 38), in the majority of above-mentioned selected determinands, there is a lower percentage of monitoring stations complying to target values in tributaries than in the Danube River, while the number of monitoring stations in the worst classes IV and V is higher in the case of tributaries.

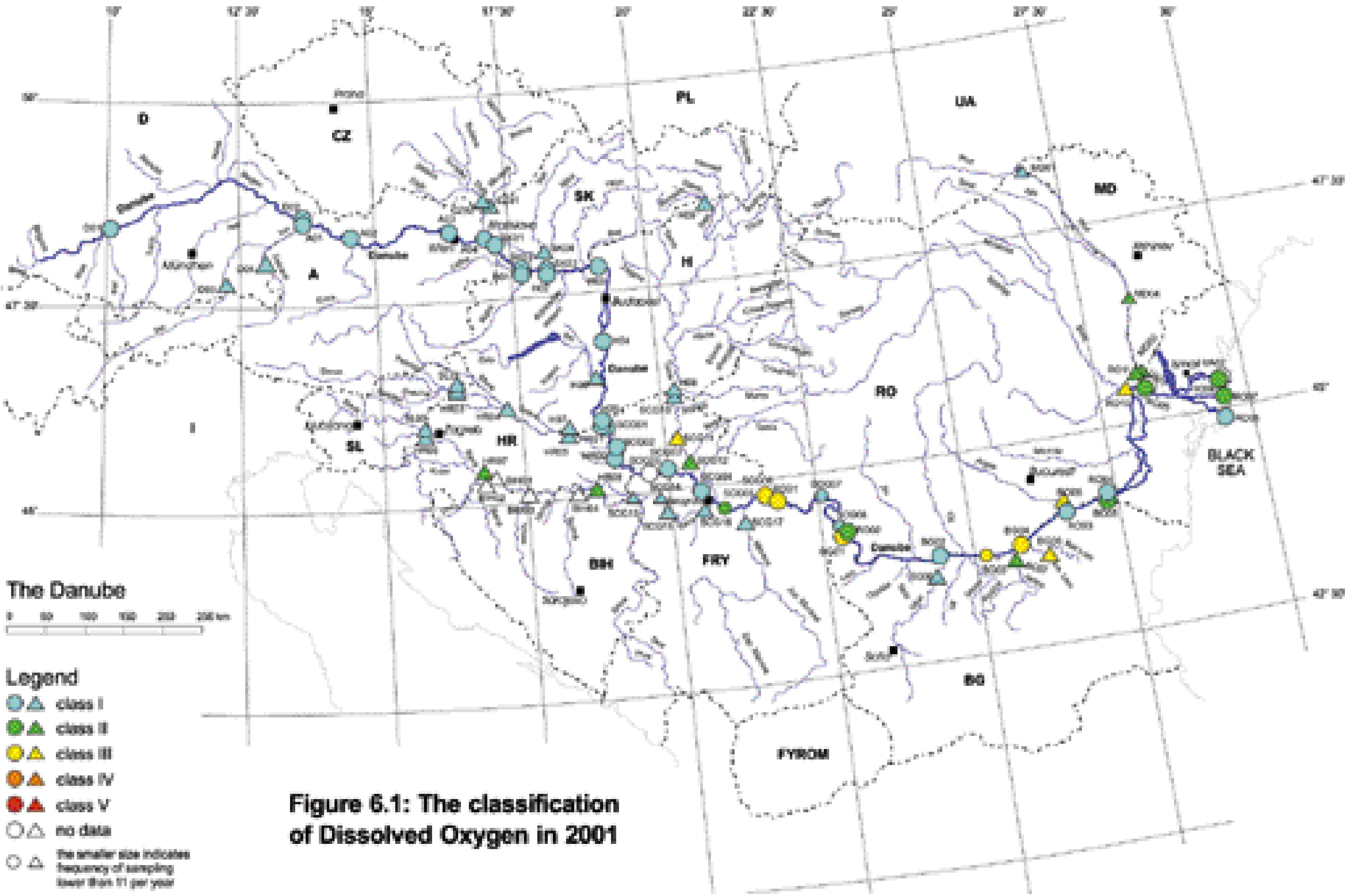


Figure 6.1: The classification of Dissolved Oxygen in 2001

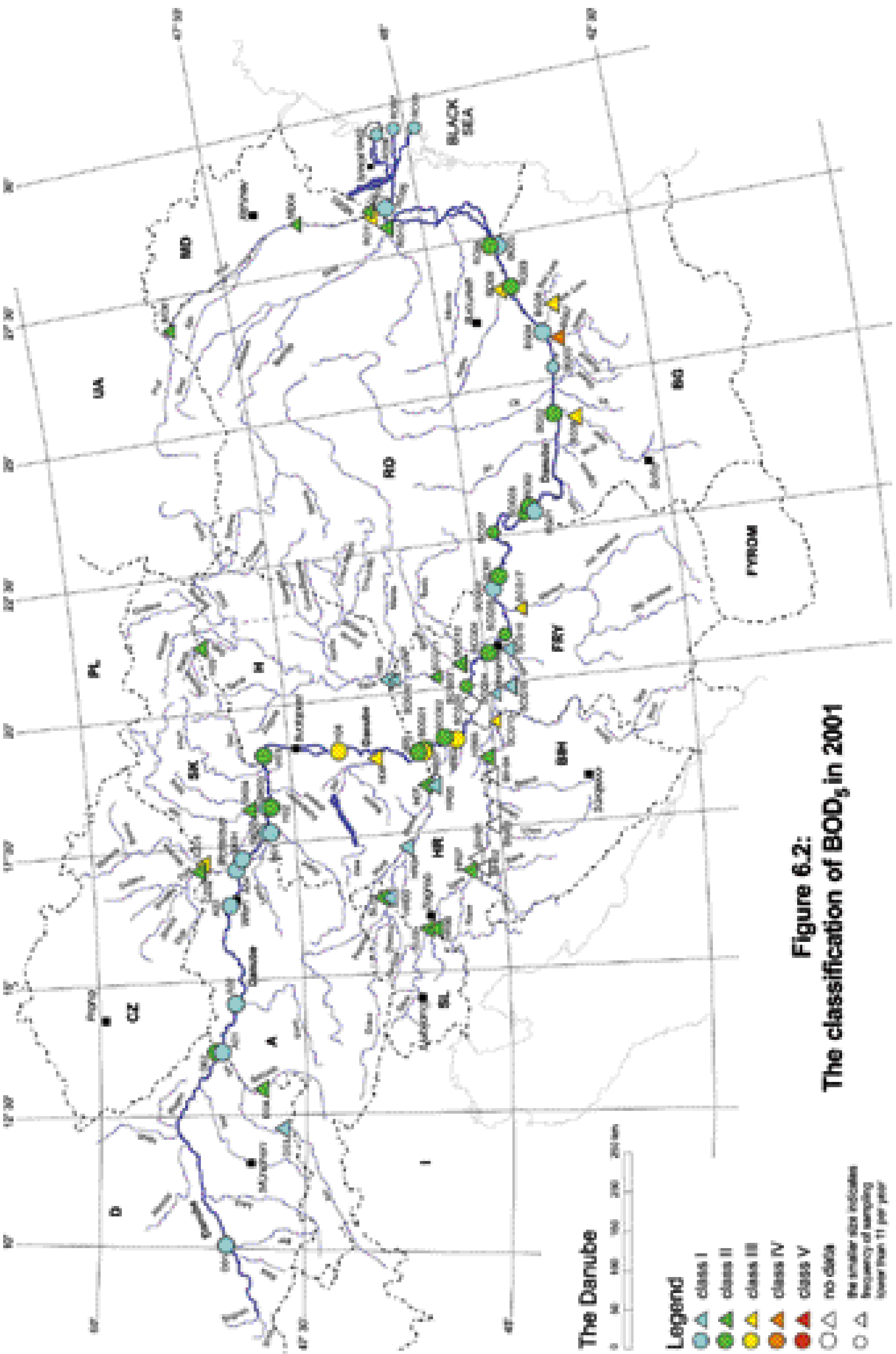


Figure 6.2:
The classification of BOD_5 in 2001

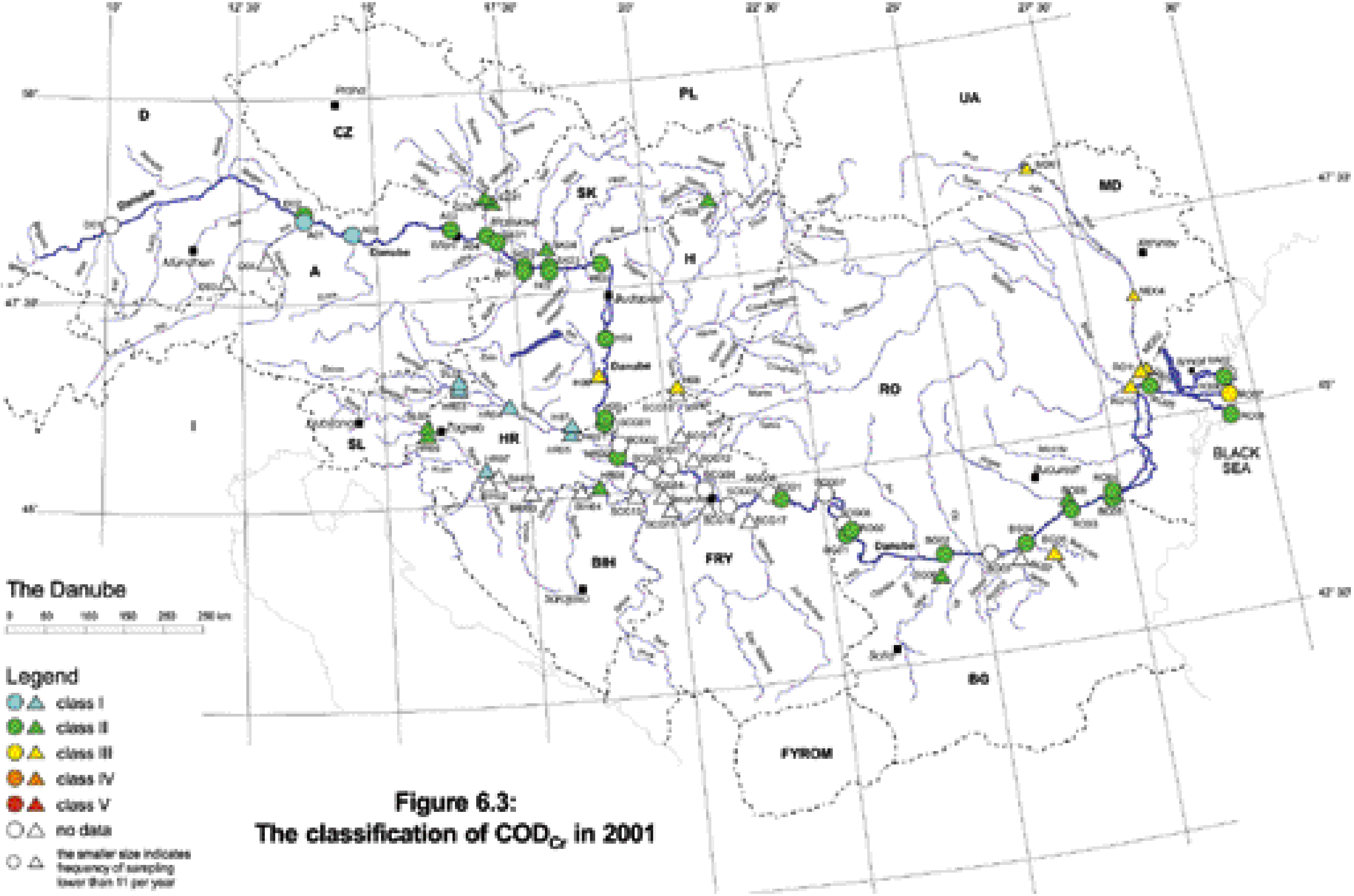


Figure 6.3:
The classification of COD_{Cr} in 2001

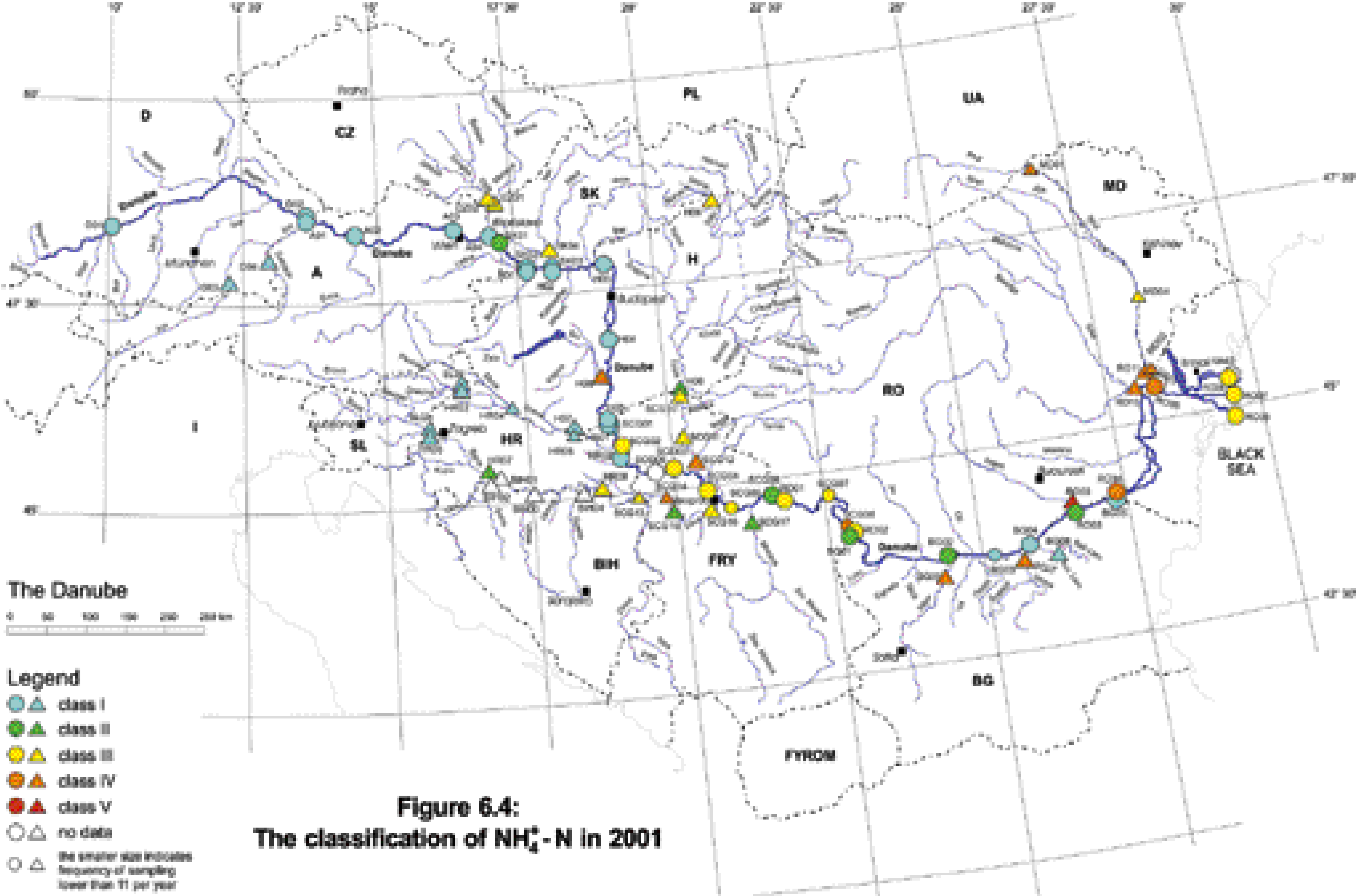


Figure 6.4:
The classification of NH_4^+- N in 2001

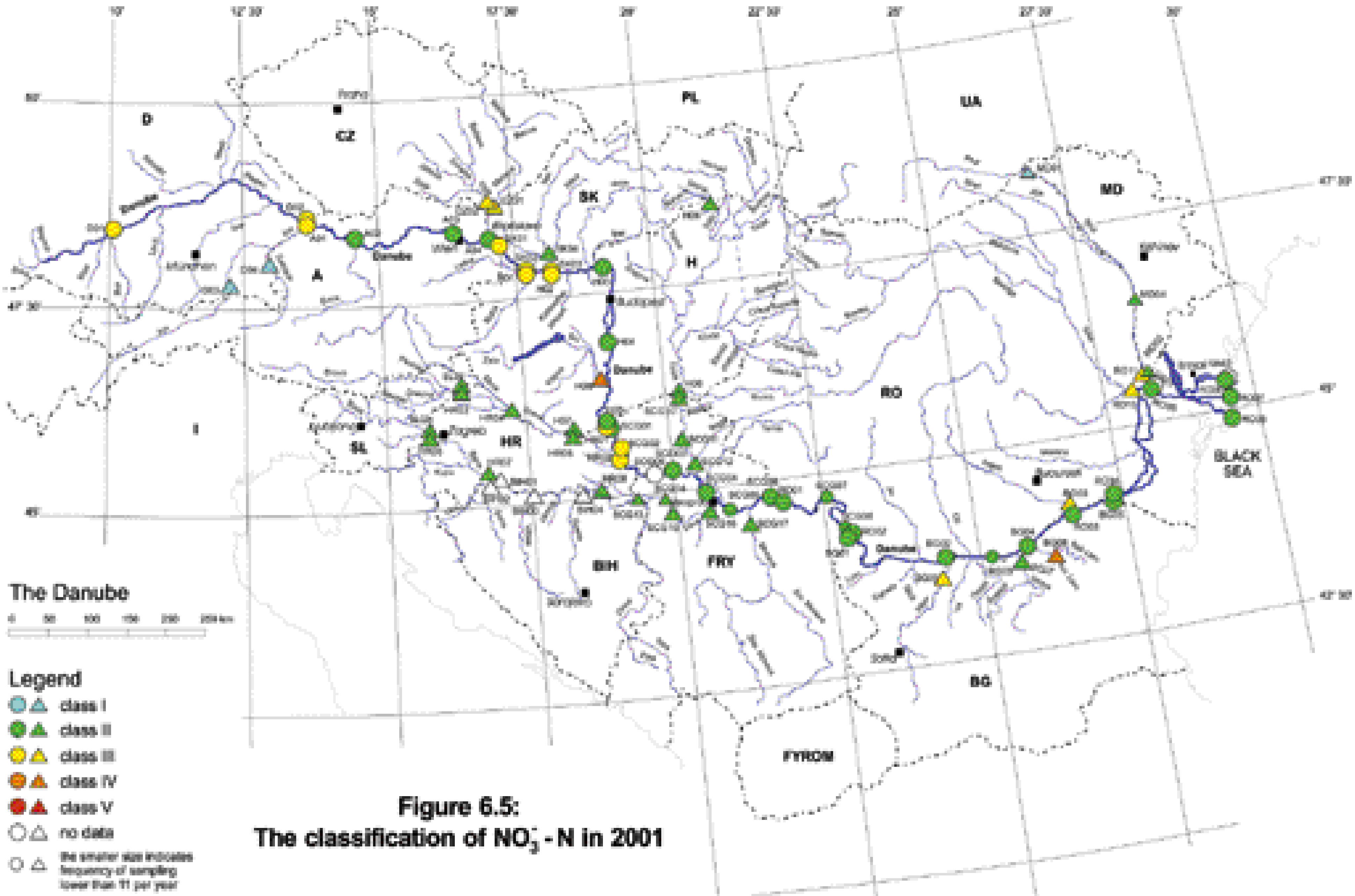


Figure 6.5:
The classification of NO_3^- - N in 2001

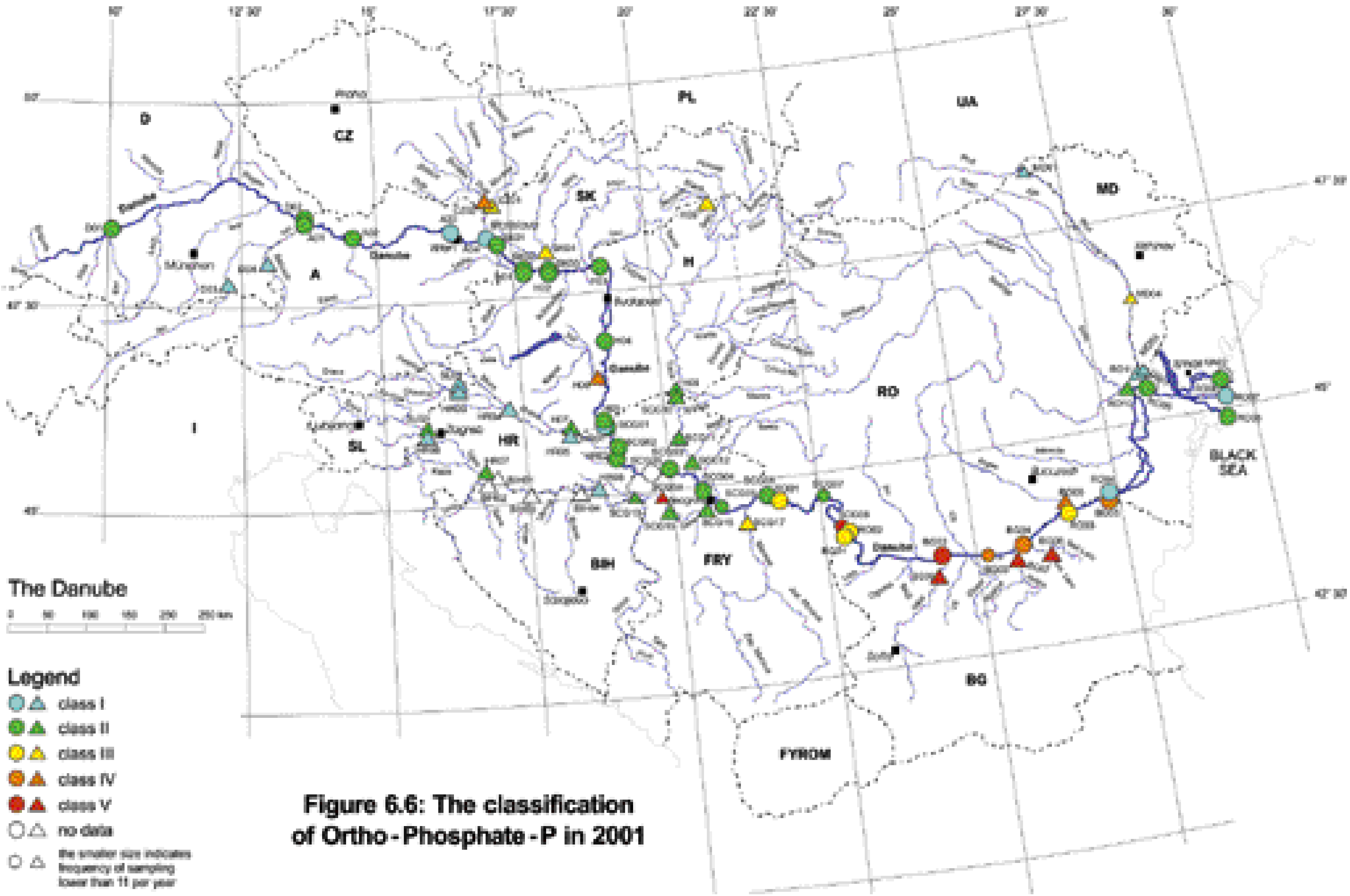


Figure 6.6: The classification of Ortho-Phosphate-P in 2001

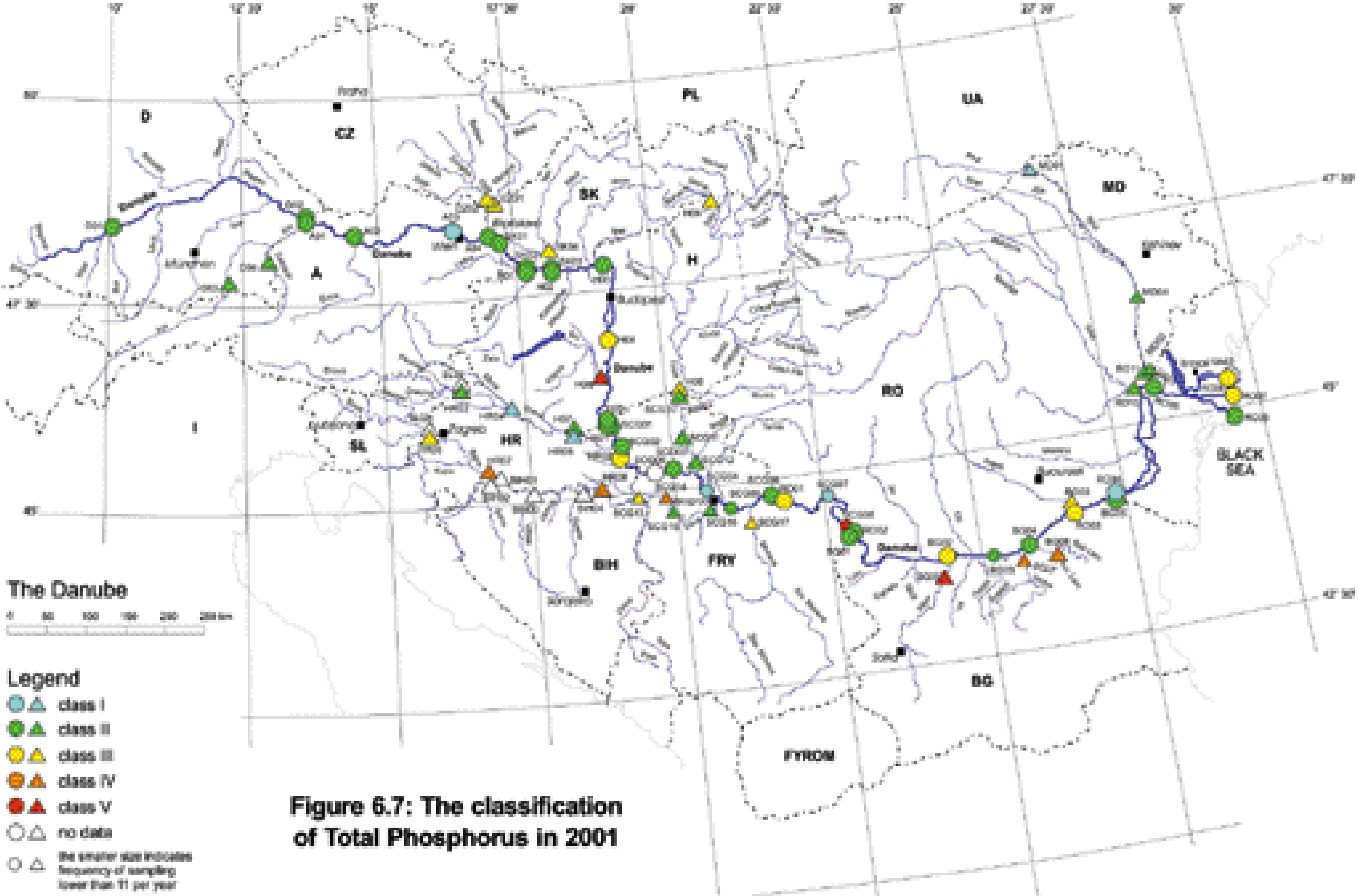


Figure 6.7: The classification of Total Phosphorus in 2001

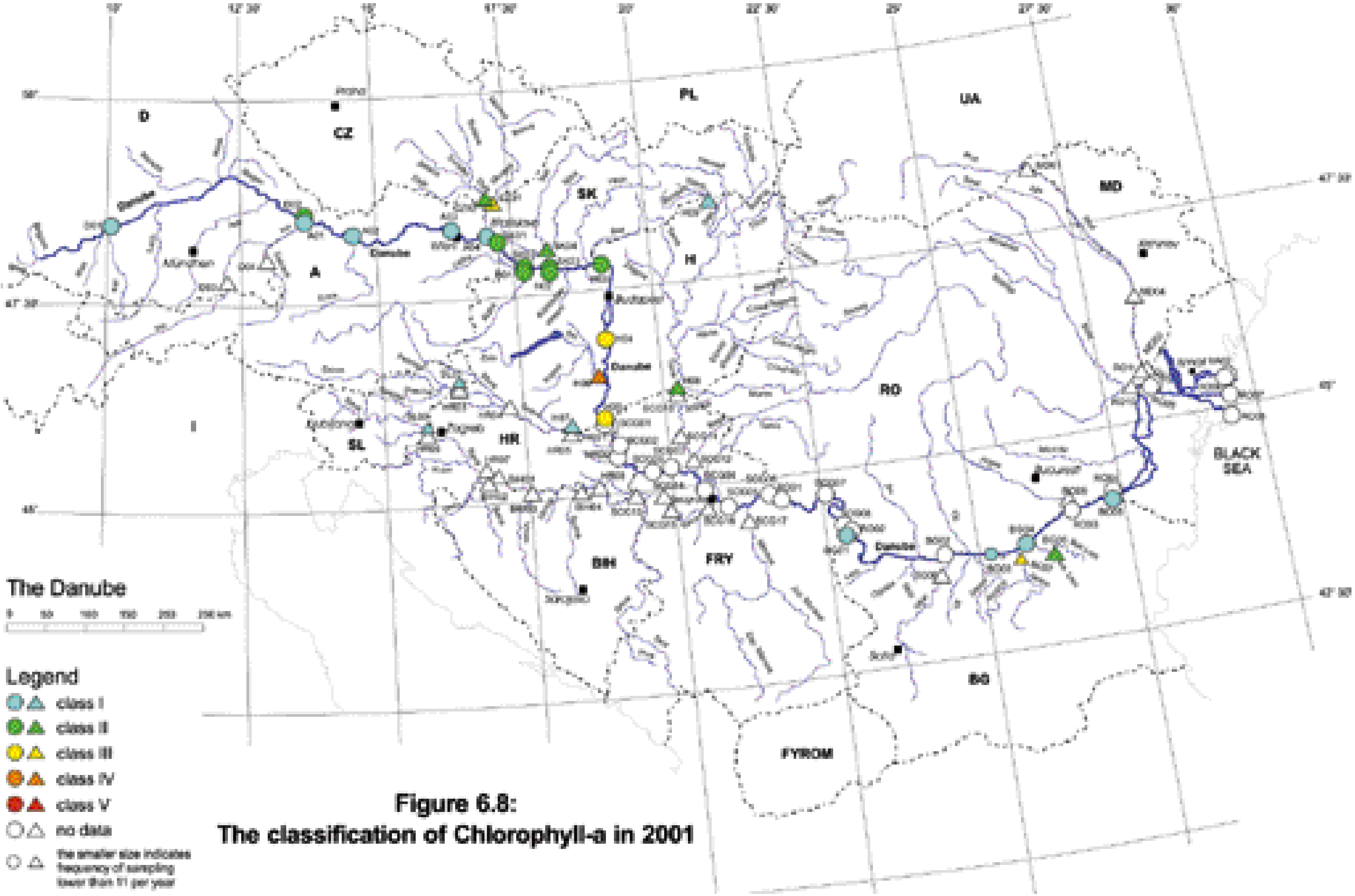


Figure 6.8:
The classification of Chlorophyll-a in 2001

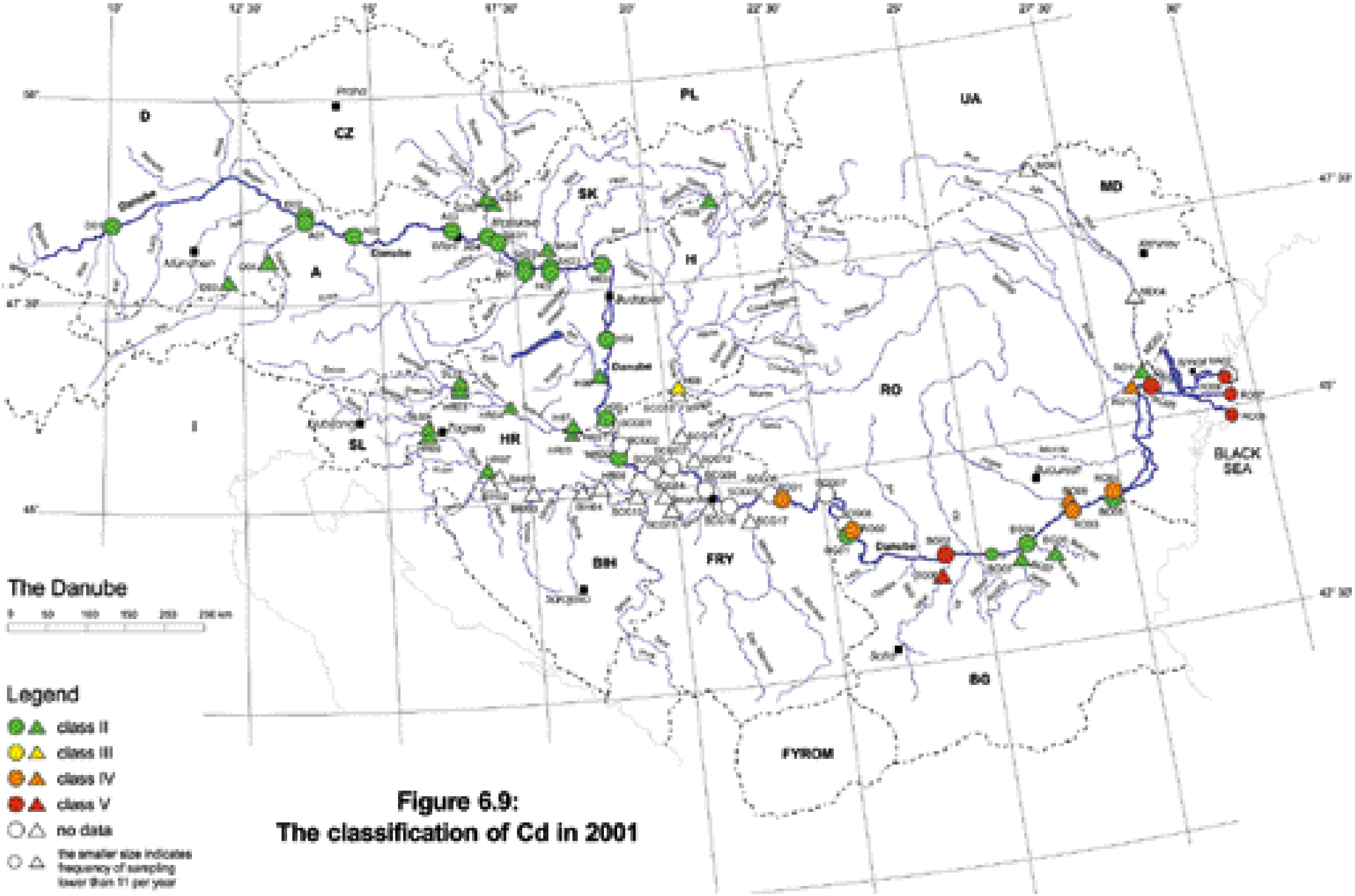


Figure 6.9:
The classification of Cd in 2001

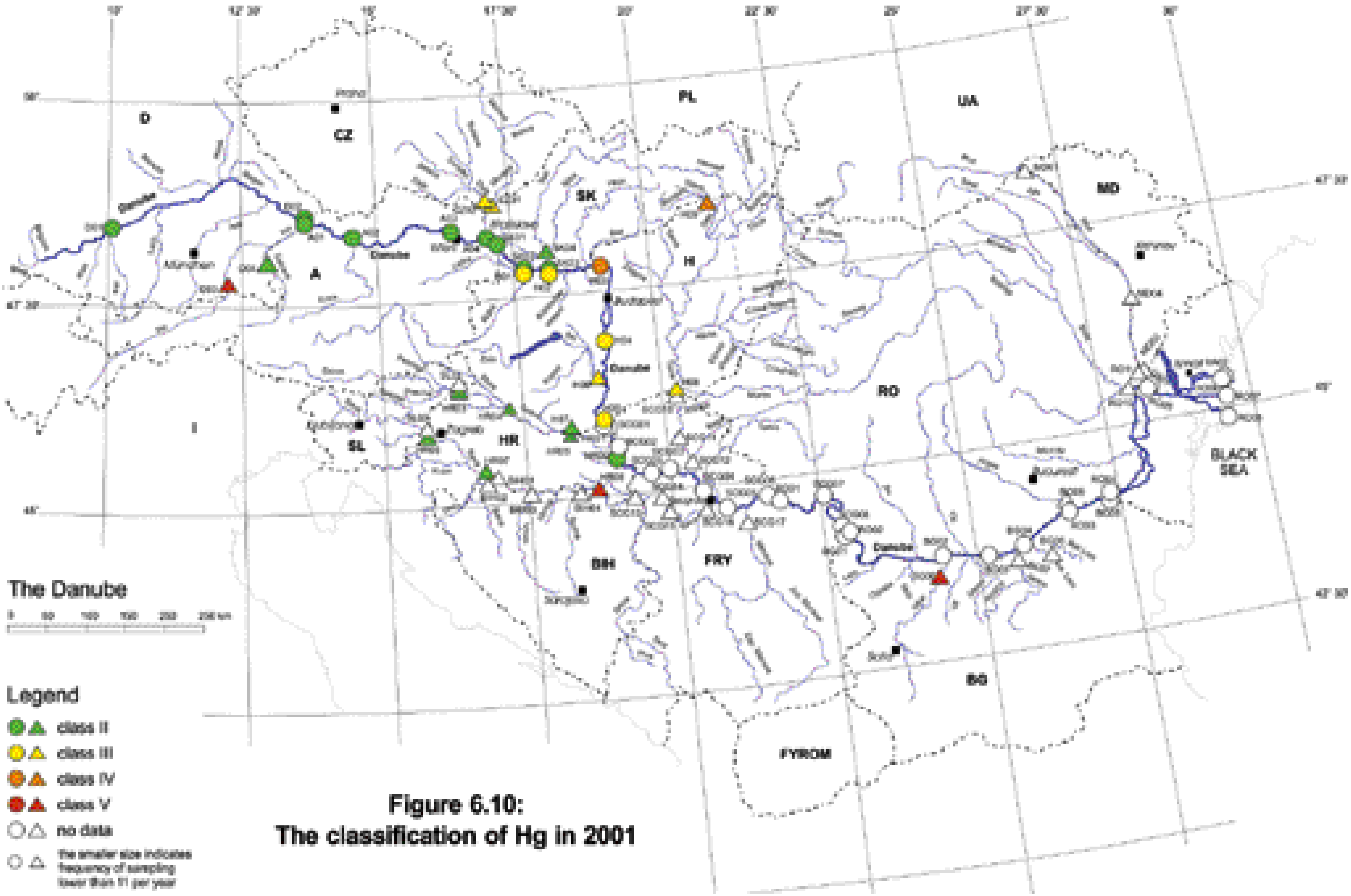


Figure 6.10: The classification of Hg in 2001

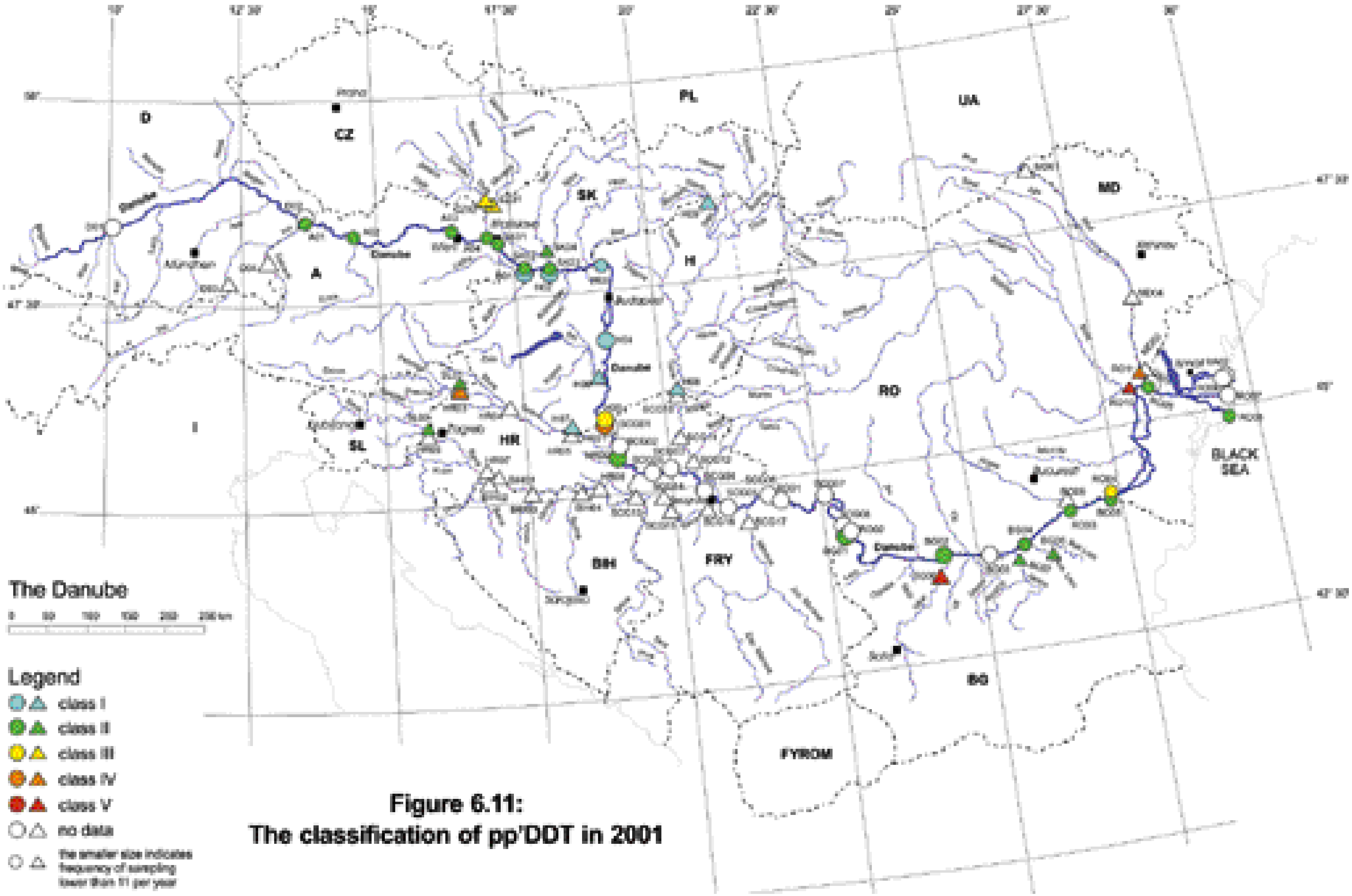


Figure 6.11:
The classification of pp'DDT in 2001

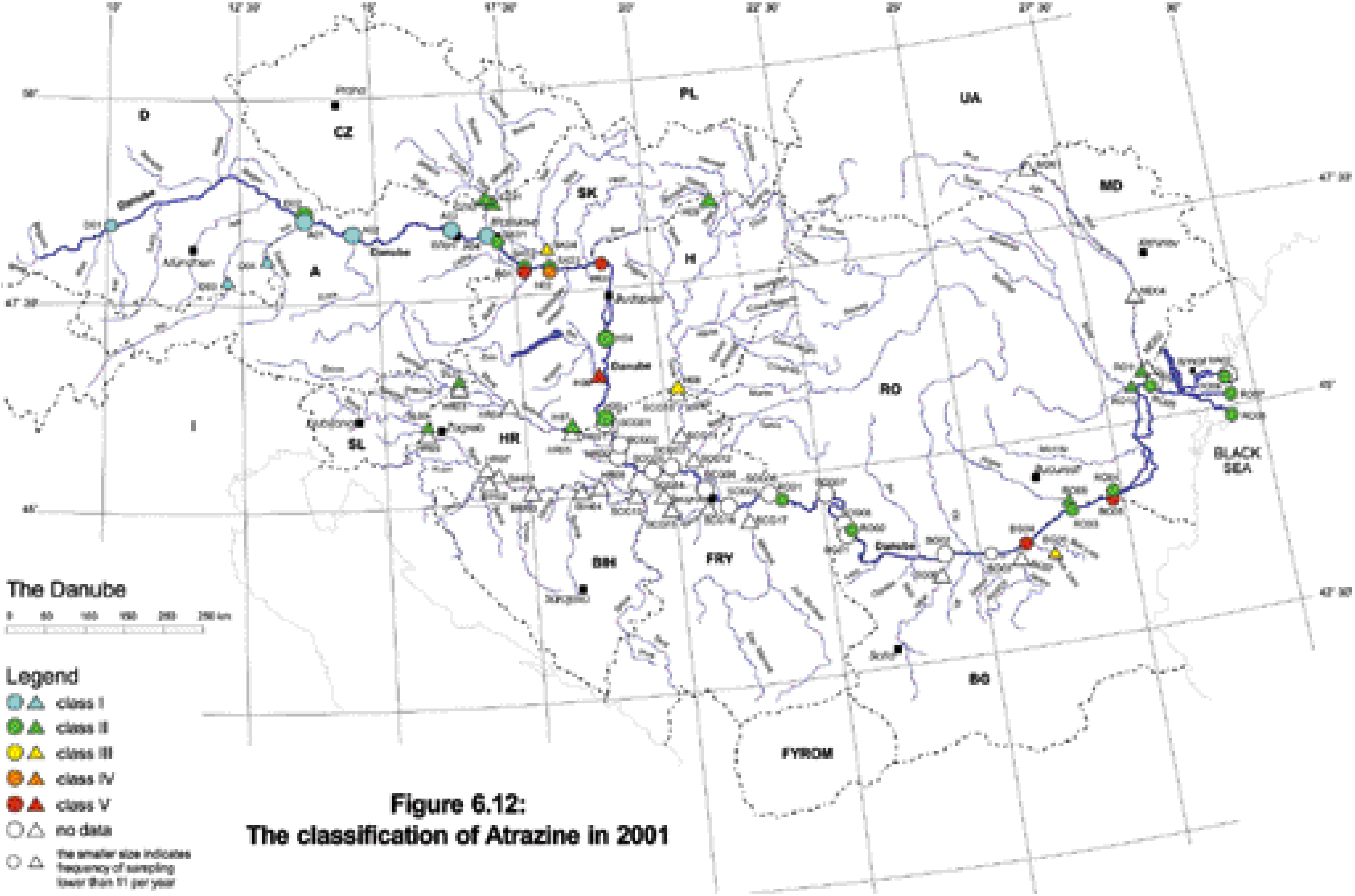


**Figure 6.12:
The classification of Atrazine in 2001**

7. Profiles and trend assessment of selected determinands

To present the variation of water quality along the river and in the main tributaries, the average, maximum and minimum concentration profiles along the Danube of determinands dissolved oxygen, BOD_5, COD_{Cr}, NH_4^+-N, NO_3^--N, PO_4^{3-}-P, total phosphorus, chlorophyll-a, cadmium, mercury, p,p´DDT and atrazine are presented on special profile plots, one profile for each of the determinands (Figures 7.1 – 7.12). In order to illustrate the temporal changes of water quality in TNMN monitoring stations during the period of TNMN operation from 1996-2001, Figures 7.13 – 7.28 show 90 percentiles (10 percentile in case of dissolved oxygen) of yearly data sets for selected determinands. The 90 percentile as a statistical characteristic used for this assessment is presented only for those monitoring stations where frequency of measurements was higher than 5 in the respective year. If there are three sampling sites (left, middle, right) of a monitoring station, only the data of the "middle" is presented in the Figures. Each of Figures 7.1 – 7.12 consists of two plots. The upper plot shows bars indicating the average, maximum and minimum concentrations in the Danube River at the respective distance from the mouth (km). Green indicates the minimum values on the plots and red the maximum values. Stations close to each other or those monitored by two countries (transboundary stations) are shifted slightly along the X-axis.

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

Observations from assessment of the five-year period, presented in the Synthesis Report, were confirmed by the figures – the highest pollution by biodegradable organic matter in the middle part of the Danube, increasing of content of ammonium-N, ortho-phospate-P, and total P from upper to lower part of the Danube River (with some exceptions of extreme values), and significant increase of cadmium content in the lower part of the Danube River. Level of nitrate-N is relatively stable, but after delivery of the data from Yugoslavia the intermediate decrease in this section of the Danube River was observed. Regarding organic pollution and nutrient content, the majority of tributaries are more polluted than the Danube River itself at the location of their confluence, concentrations show higher variation, and situations with extreme values are observed.

Positive changes in water quality are observable in several stations of TNMN. Decrease in biodegradable organic pollution can be seen in the Austrian and Slovakian section of the Danube River, further at Danube-Hercegszanto, and in the lower section of the River downstream of Danube-Chiciu/Silistra. Tributaries Inn, Dyje, Drava, Arges and Siret show the same tendency.

As for nutrients, ammonium-N decreases in the upper part down to Danube-Szob and in tributaries of the upper section down to river Vah. Nitrate-N decreases in several stations of the German-Austrian section of the river basin, at Danube-Szob, but also in tributaries Morava, Dyje, Vah, Drava and at Sava–us. Una Jasenovac. Regarding ortho-phosphate-P, decreasing tendency is observed in the shared Slovak-Hungarian section of the Danube River, in tributaries of the upper part of the river, further in Drava, Siret and from stations located on Sava River at Sava–us. Una Jasenovac.

Figure 7.1: The minimum, mean and maximum of Dissolved Oxygen in 2001

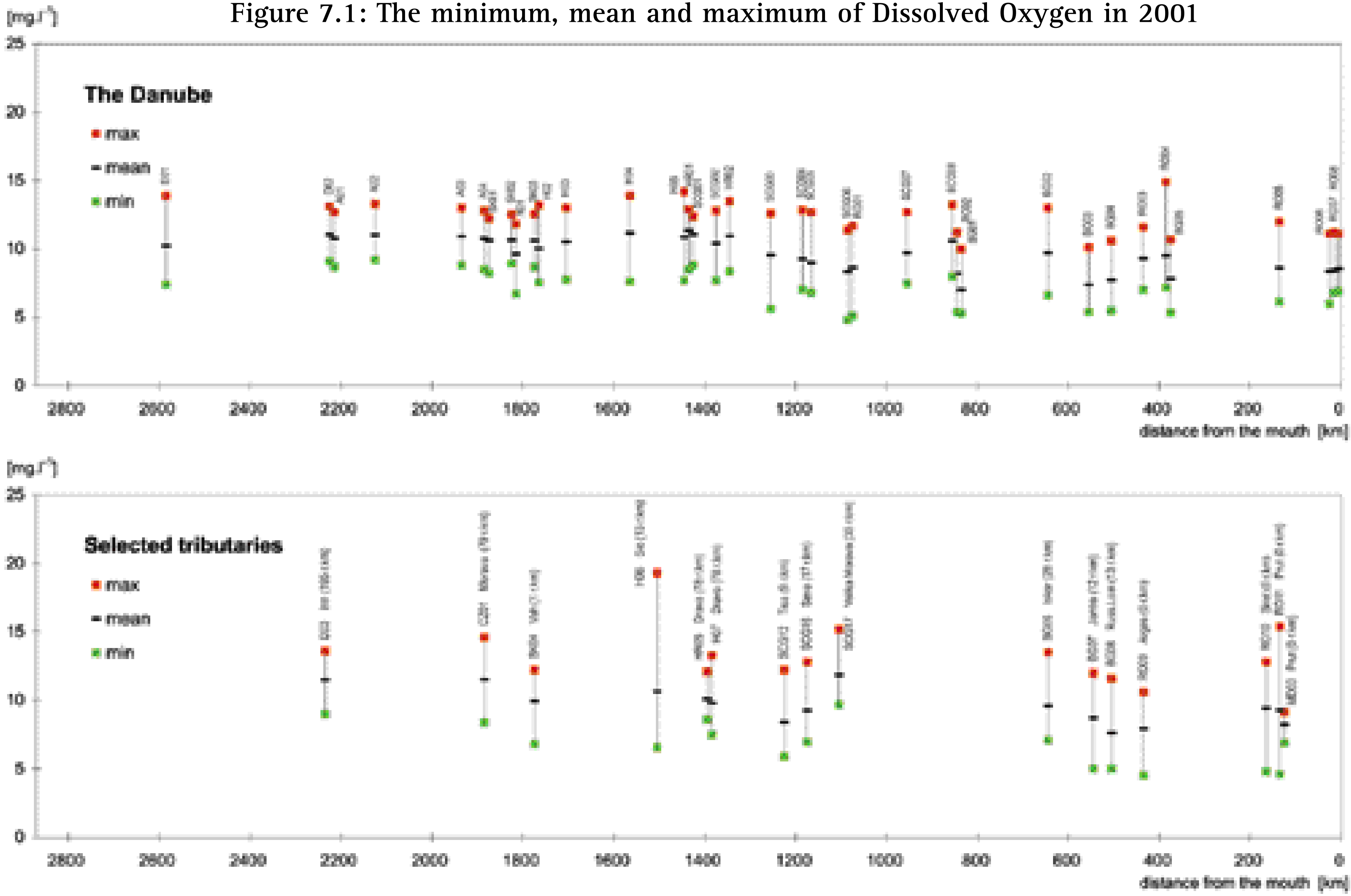


Figure 7.2: The minimum, mean and maximum of BOD_5 in 2001

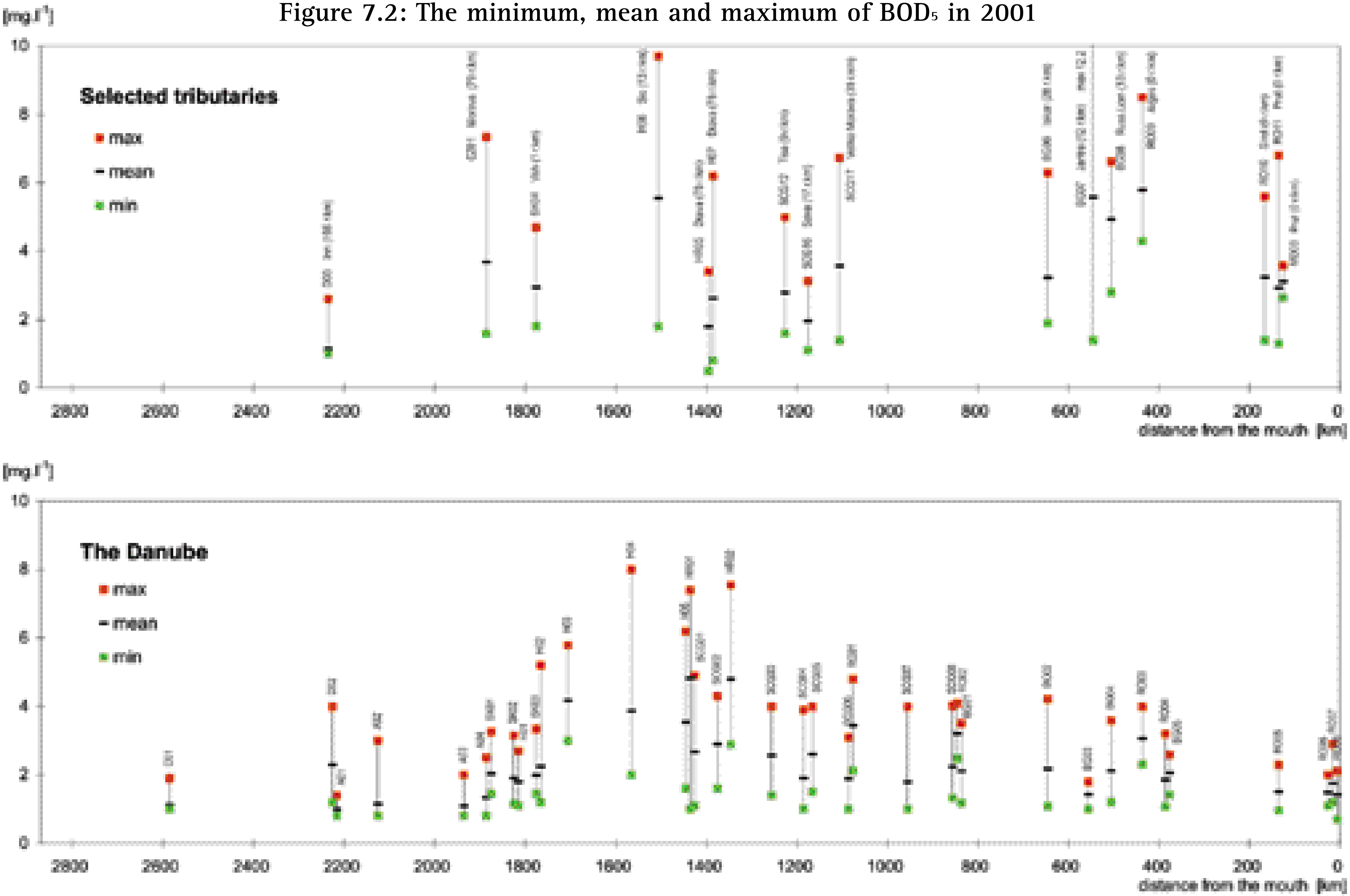


Figure 7.3: The minimum, mean and maximum of COD_{Cr} in 2001

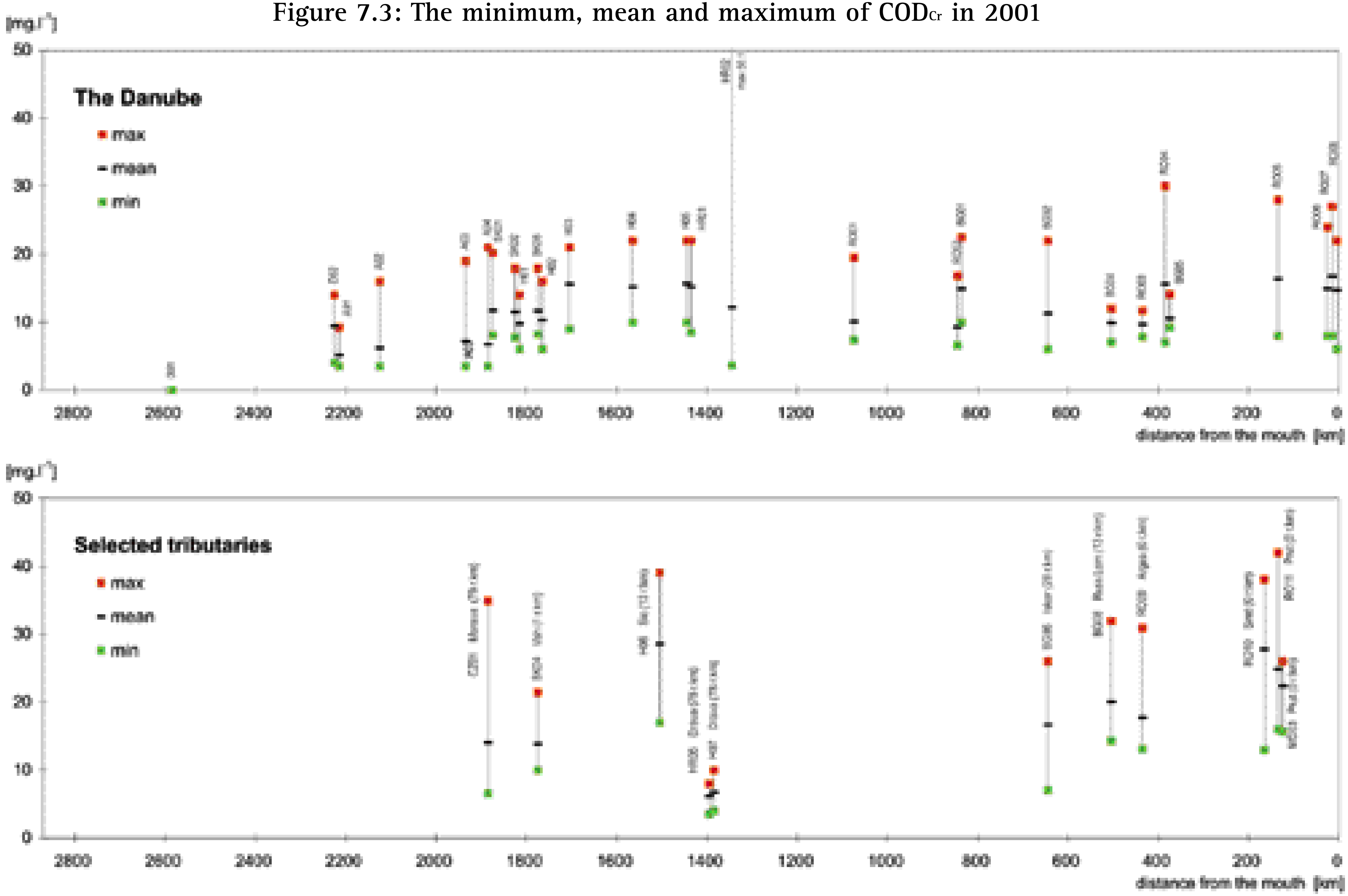


Figure 7.4: The minimum, mean and maximum of NH_4-N in 2001

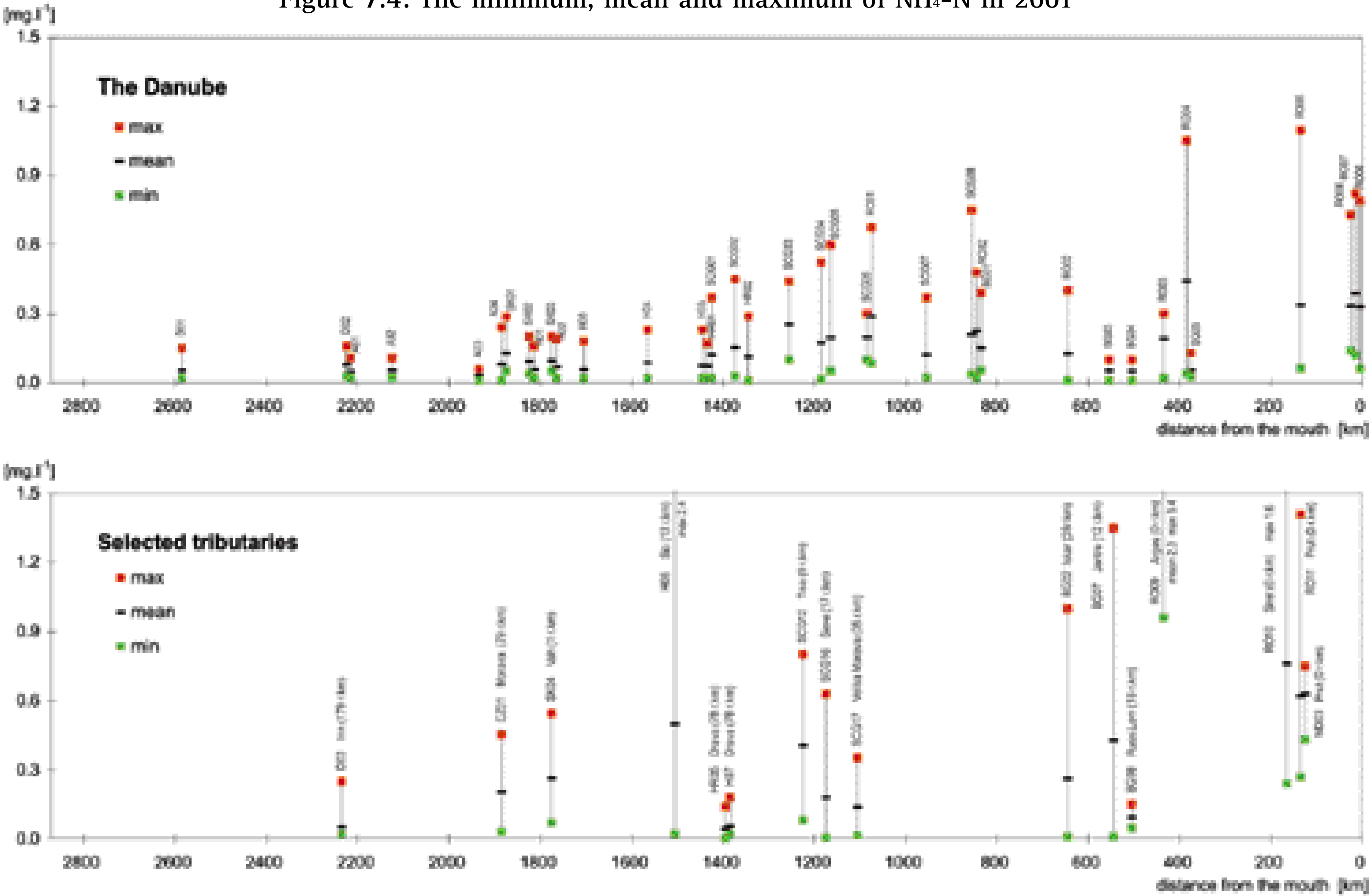


Figure 7.5: The minimum, mean and maximum of NO_3-N in 2001

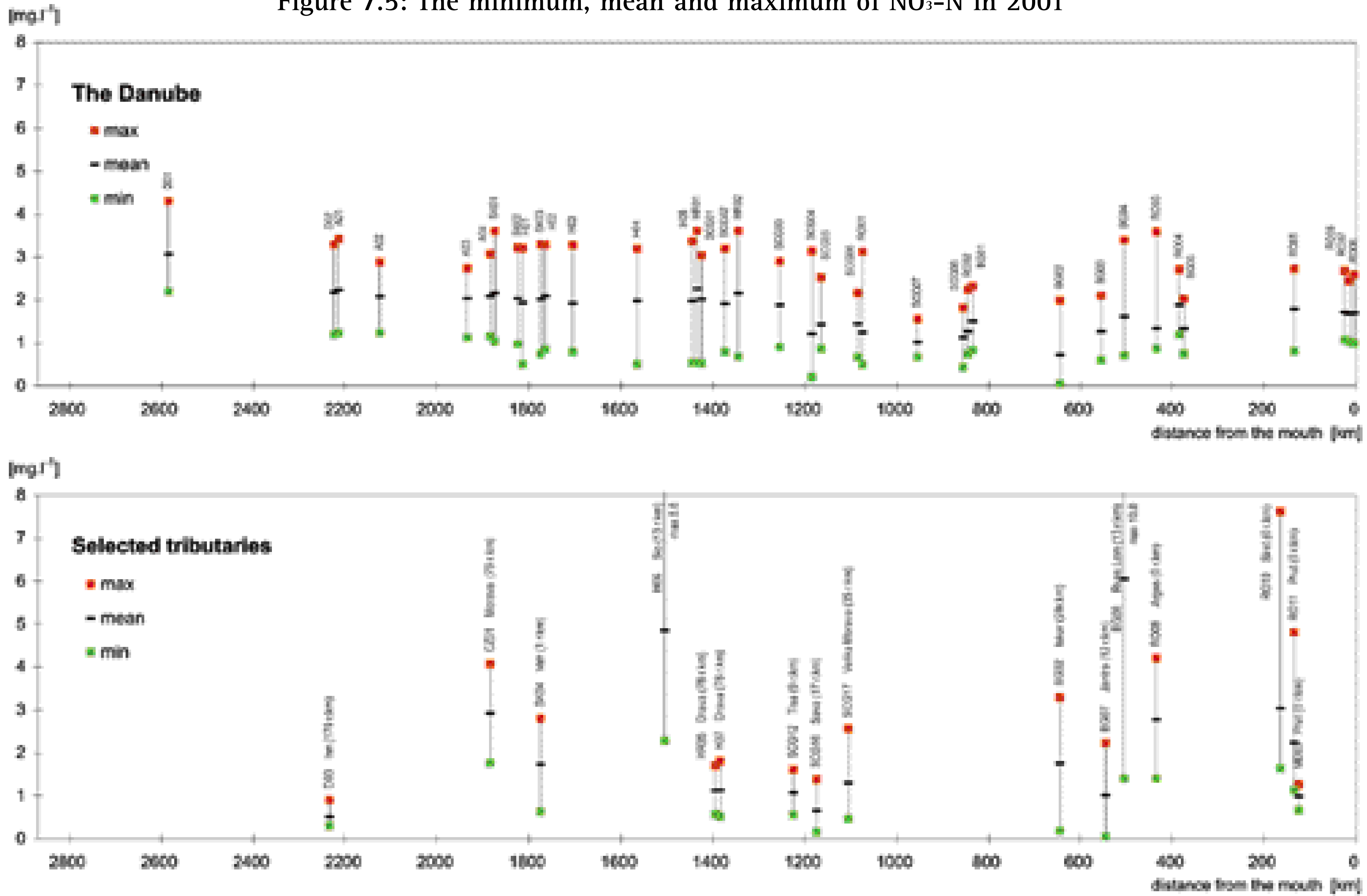


Figure 7.6: The minimum, mean and maximum of Ortho-Phosphate-P in 2001

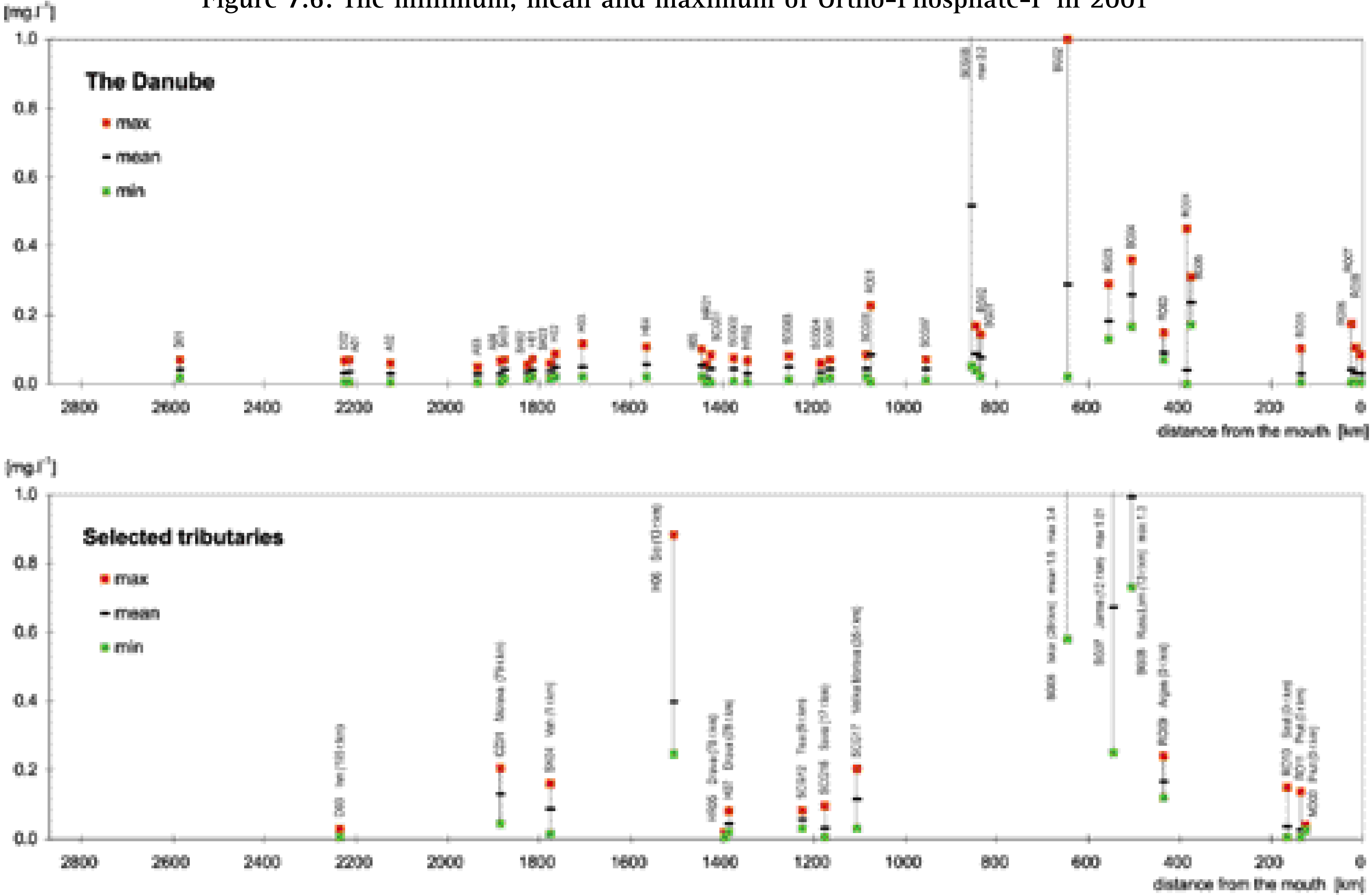


Figure 7.7: The minimum, mean and maximum of Total Phosphorus in 2001

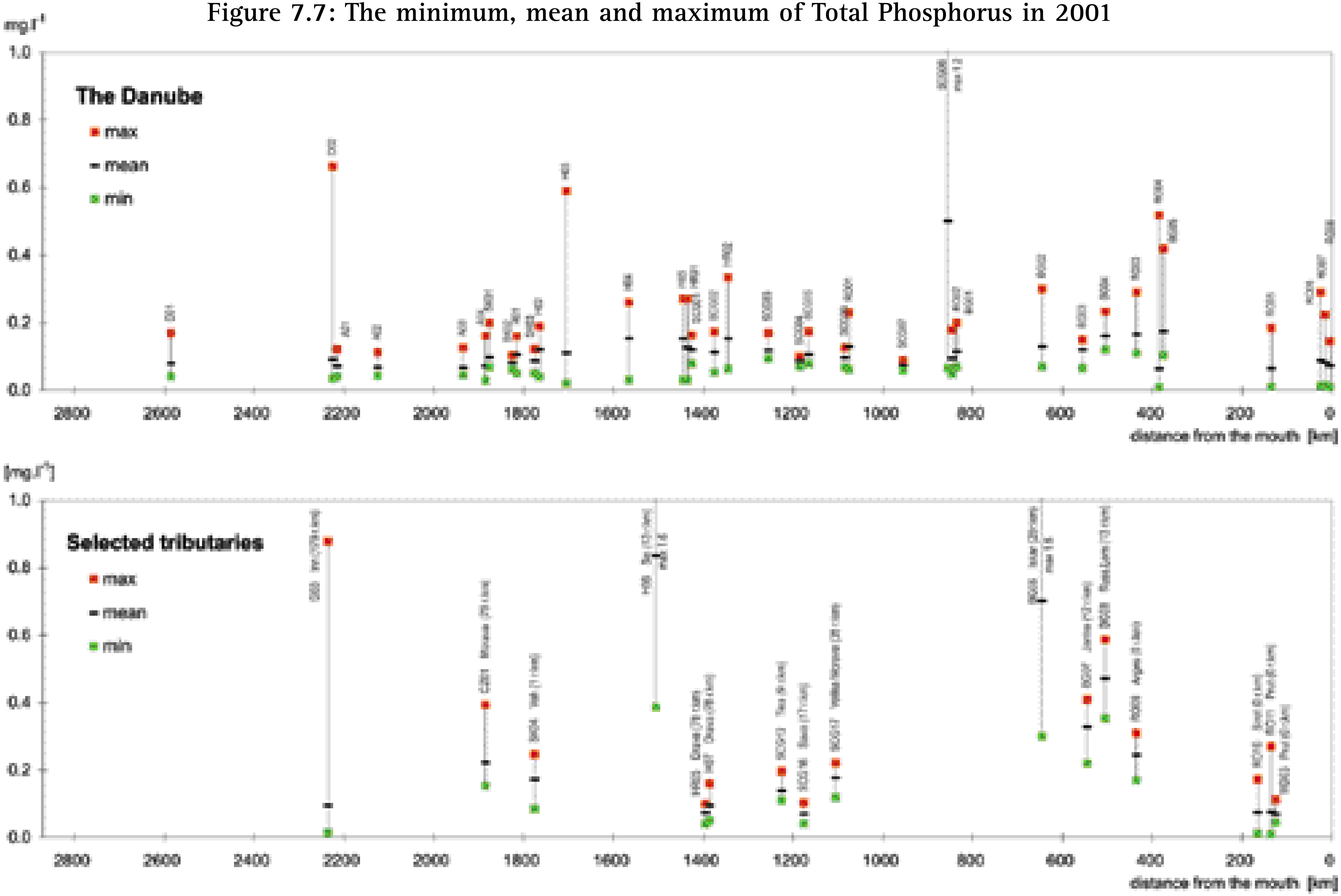


Figure 7.8: The minimum, mean and maximum of Chlorophyll-a in 2001

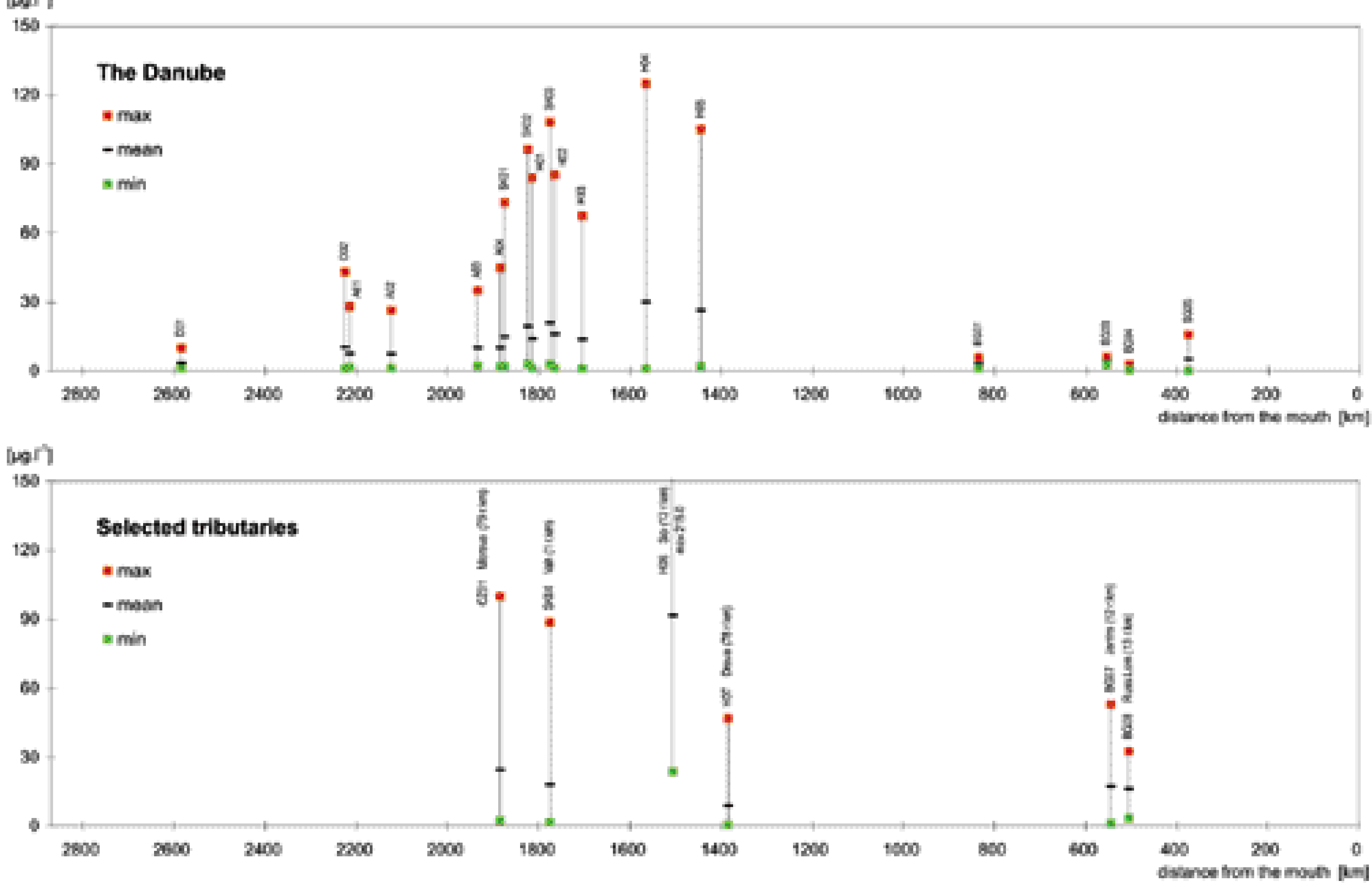


Figure 7.9: The minimum, mean and maximum of Cd in 2001

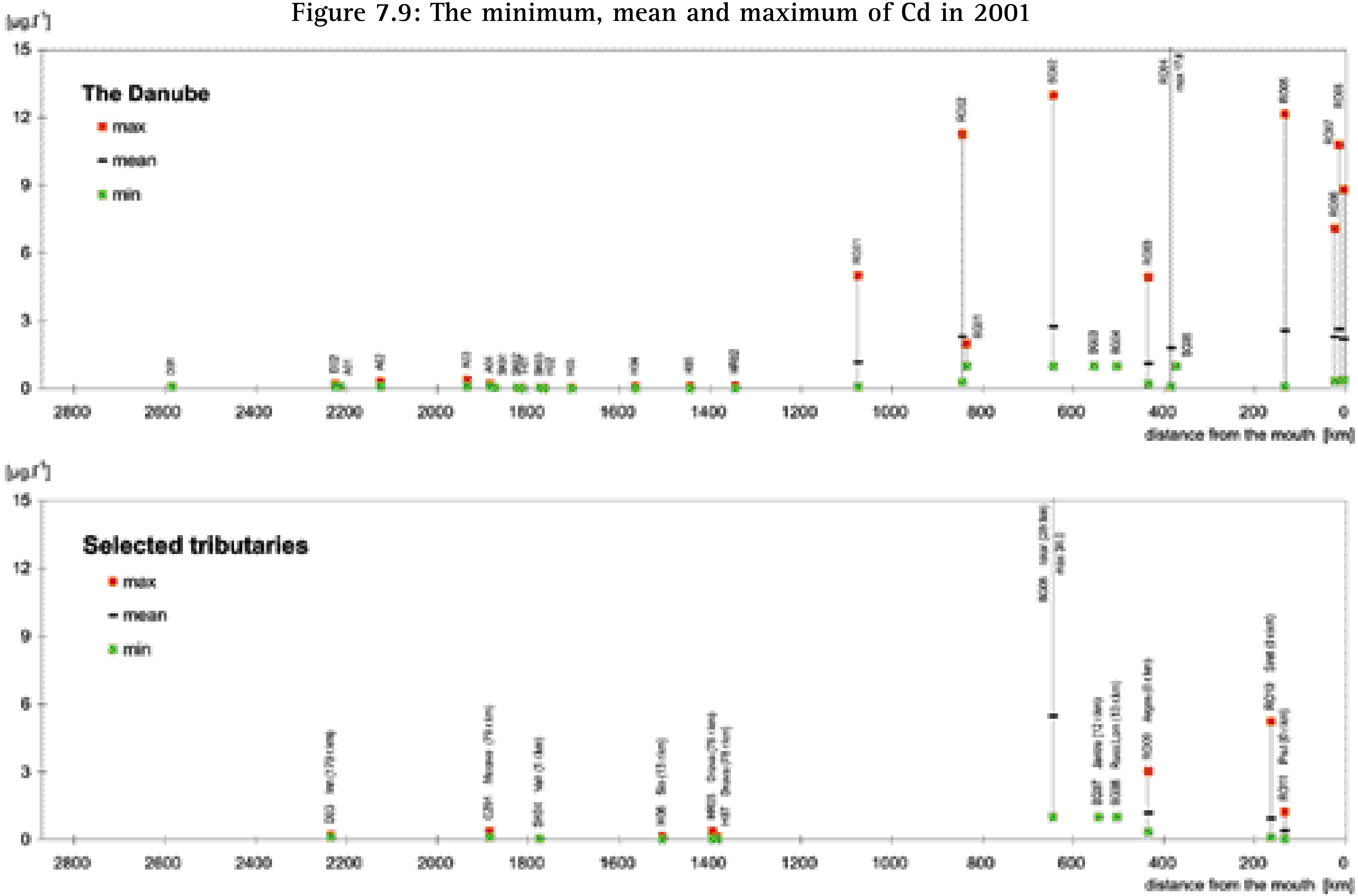


Figure 7.10: The minimum, mean and maximum of Hg in 2001

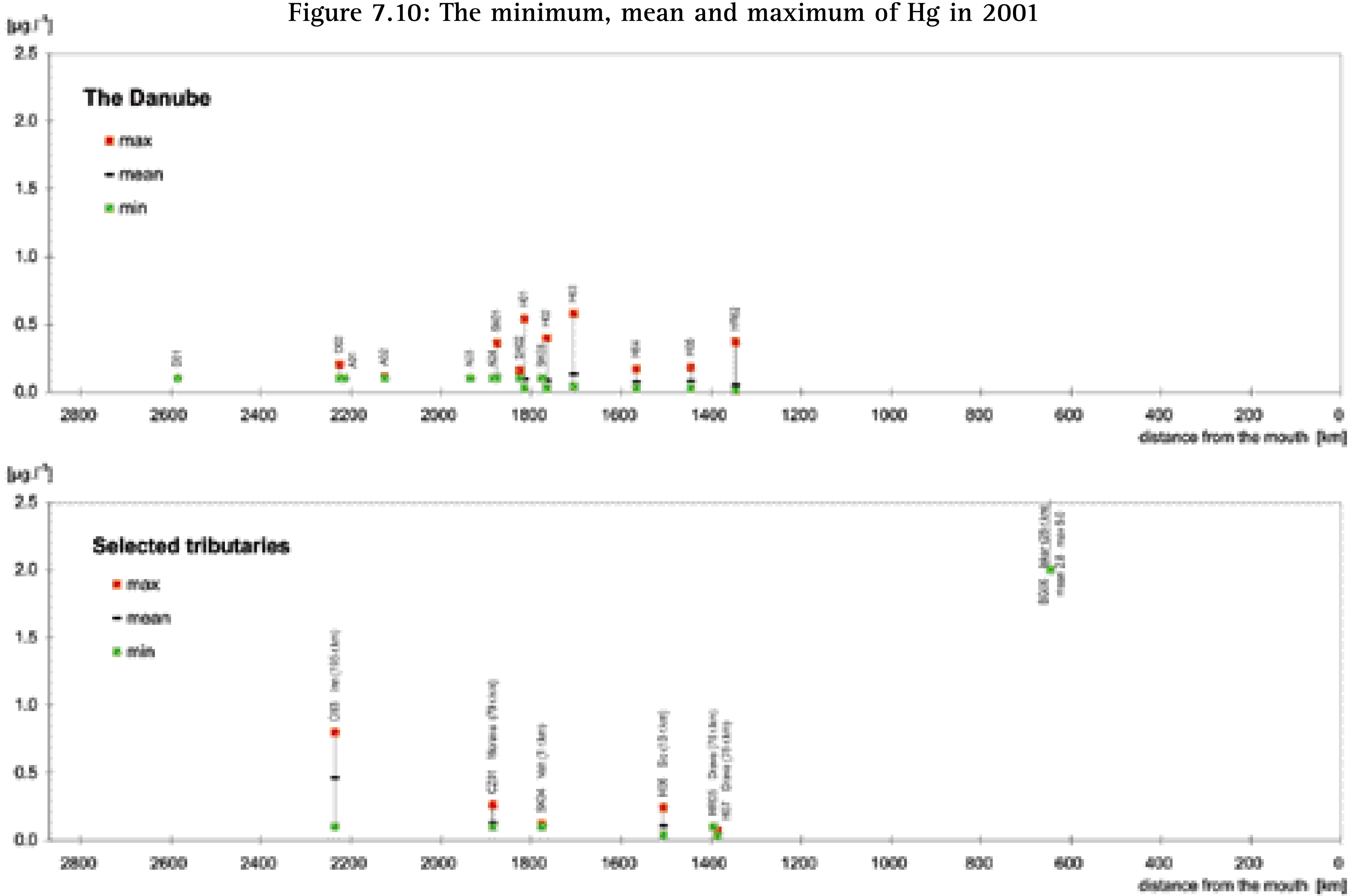


Figure 7.11: The minimum, mean and maximum of pp'DDT in 2001

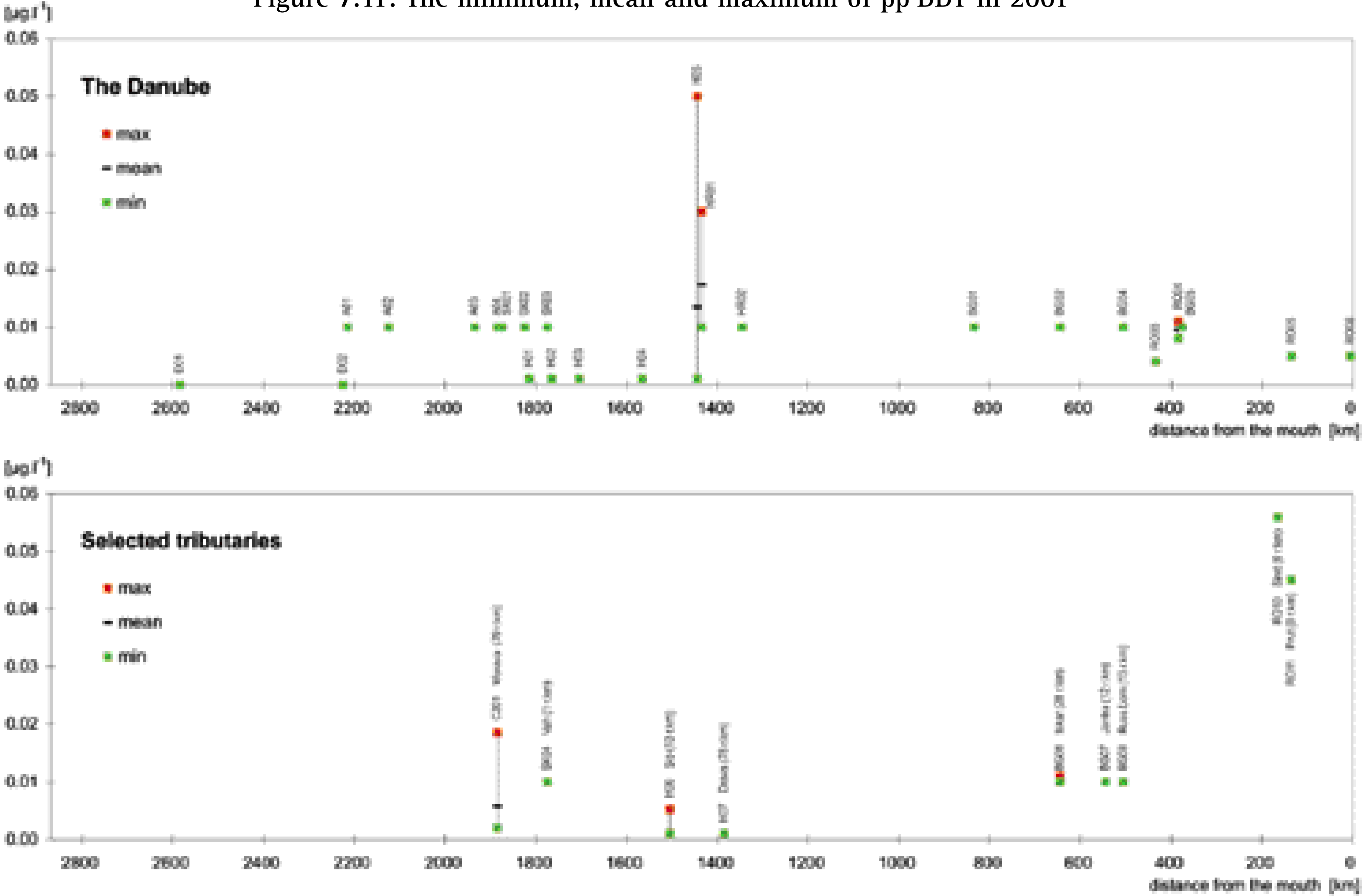


Figure 7.12: The minimum, mean and maximum of Atrazine in 2001

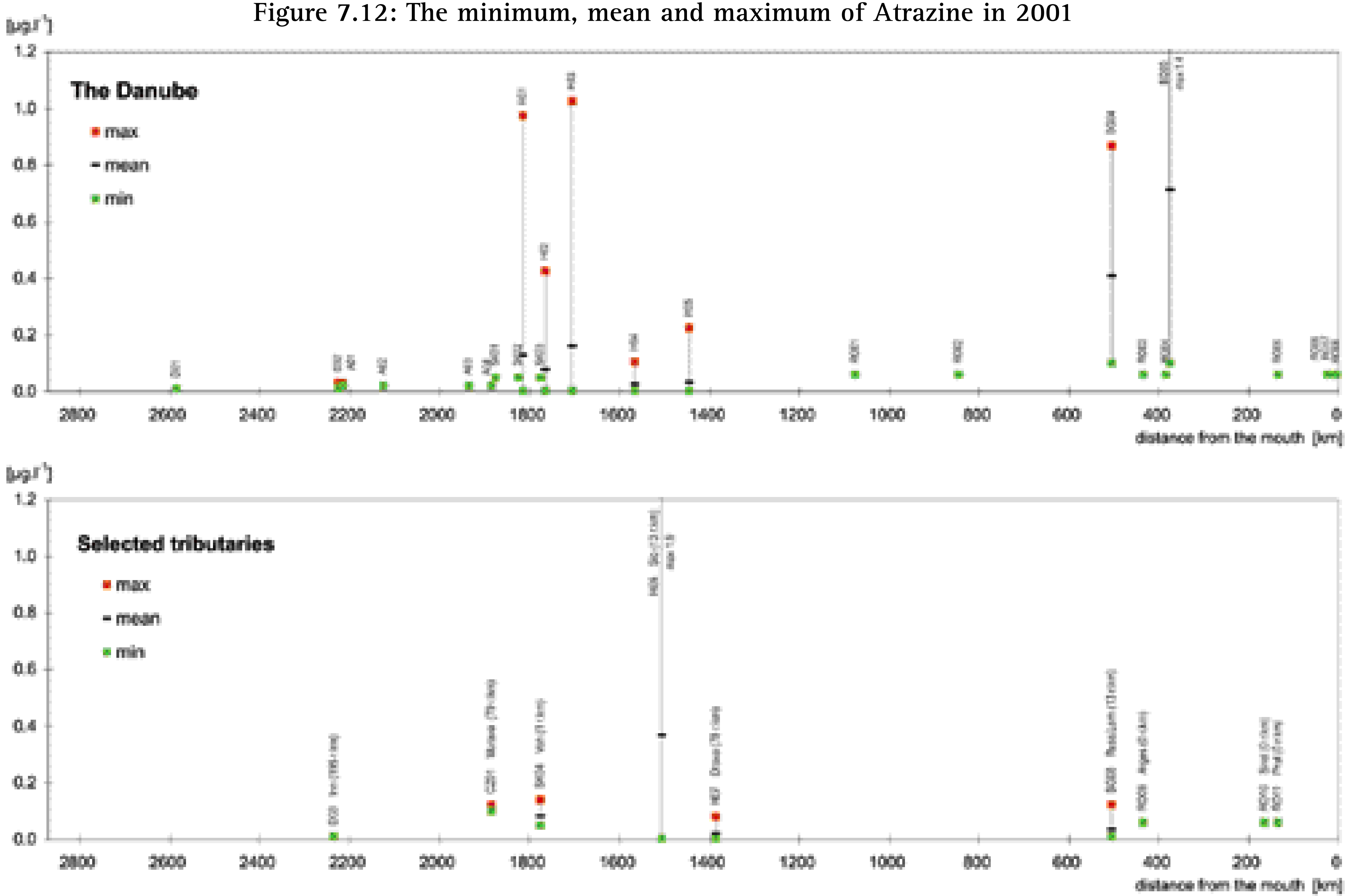


Figure 7.13: Temporal trends of dissolved oxygen in Danube River

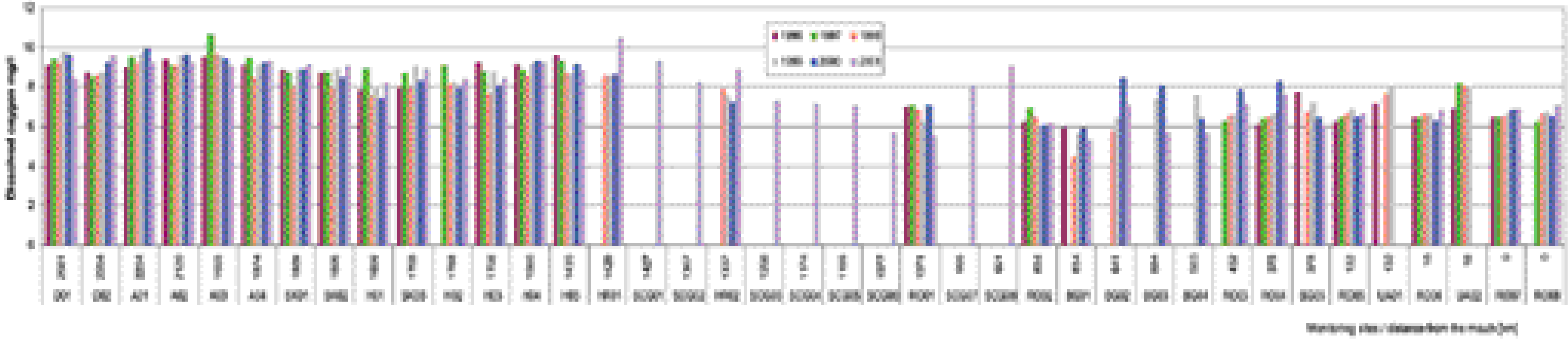


Figure 7.14: Temporal trends of dissolved oxygen in tributaries

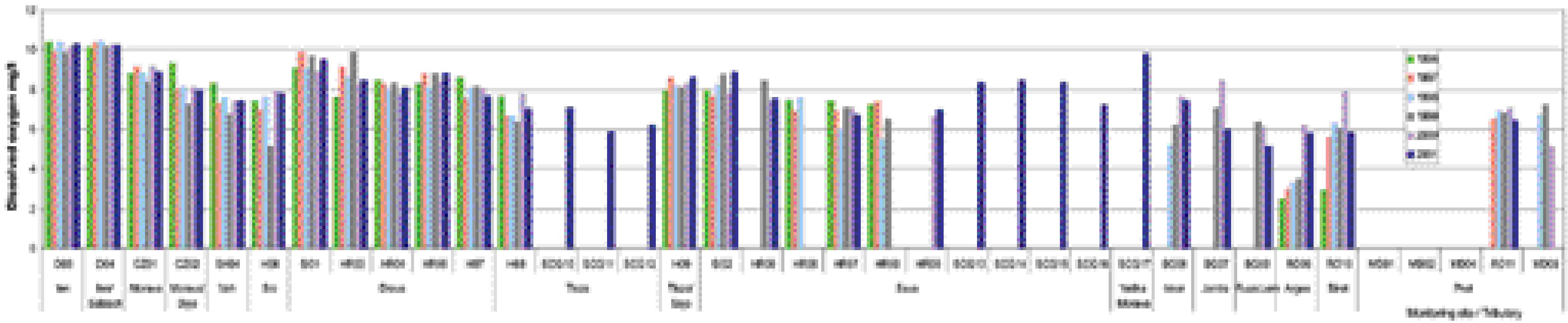


Figure 7.15: Temporal trends of BOD5 in Danube River

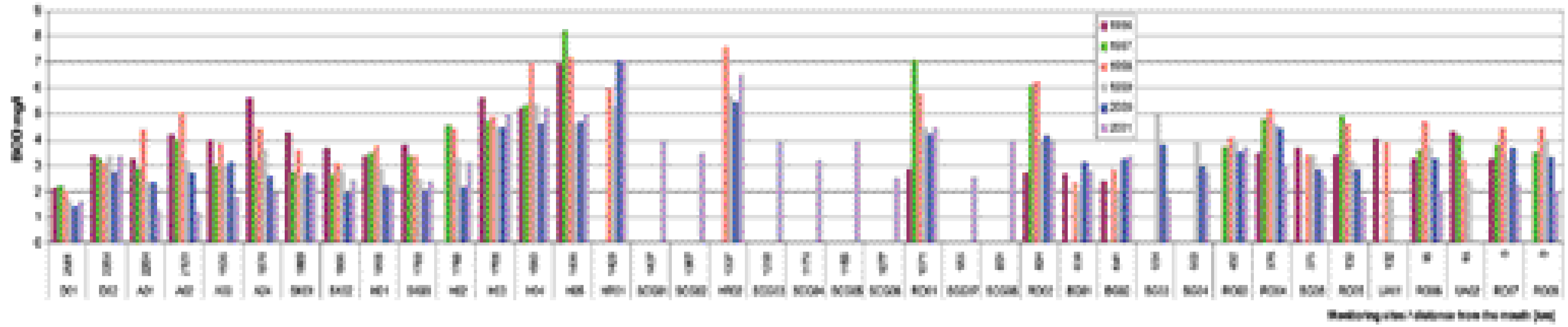


Figure 7.16: Temporal trends of BOD5 in tributaries

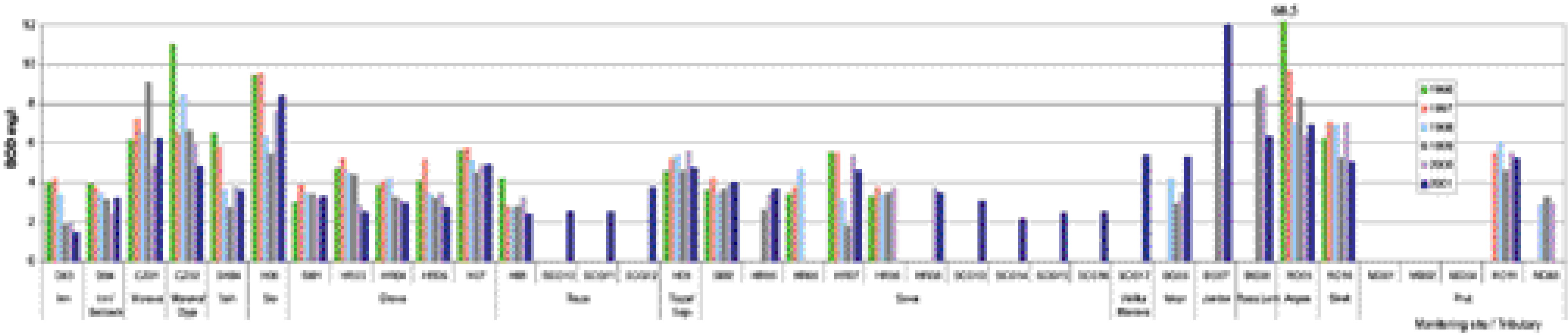


Figure 7.17: Temporal trends of CODCr in Danube River

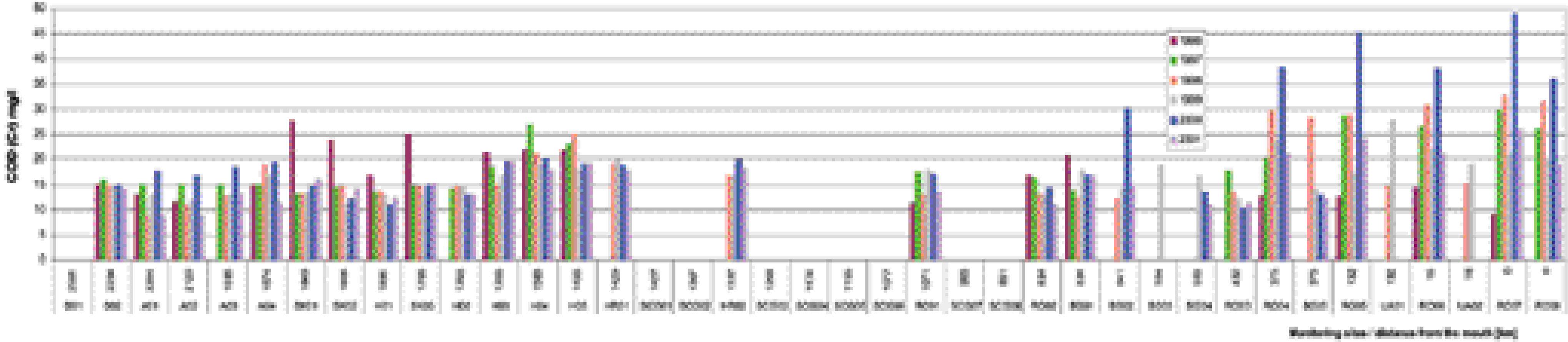


Figure 7.18: Temporal trends of CODCr in tributaries

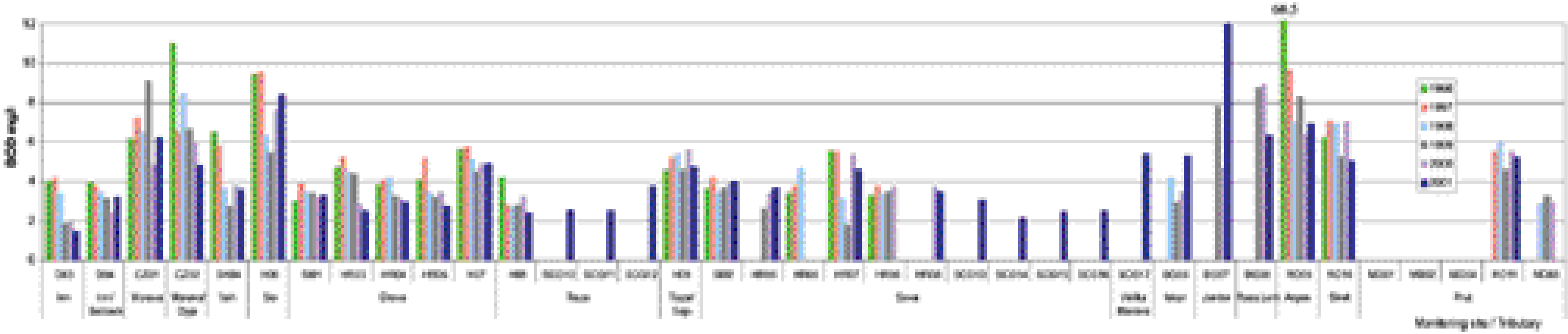


Figure 7.19: Temporal trends of ammonium-nitrogen in Danube River

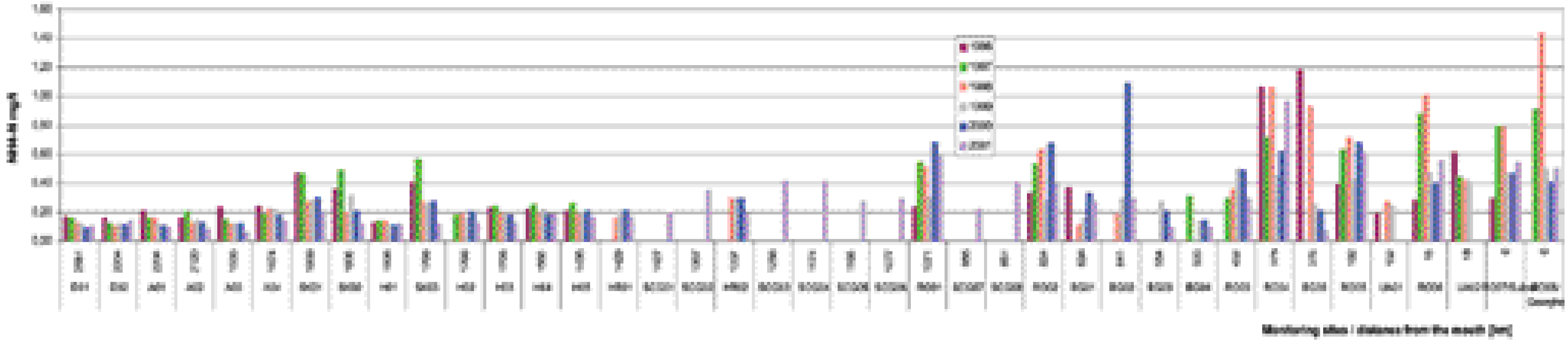


Figure 7.20: Temporal trends of ammonium-nitrogen in tributaries

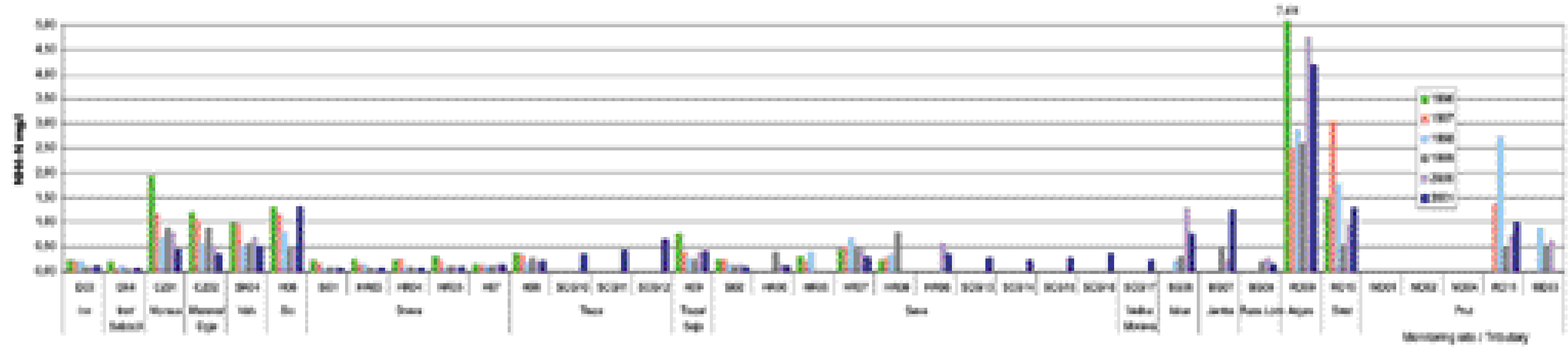


Figure 7.21: Temporal trends of nitrate-nitrogen in Danube River

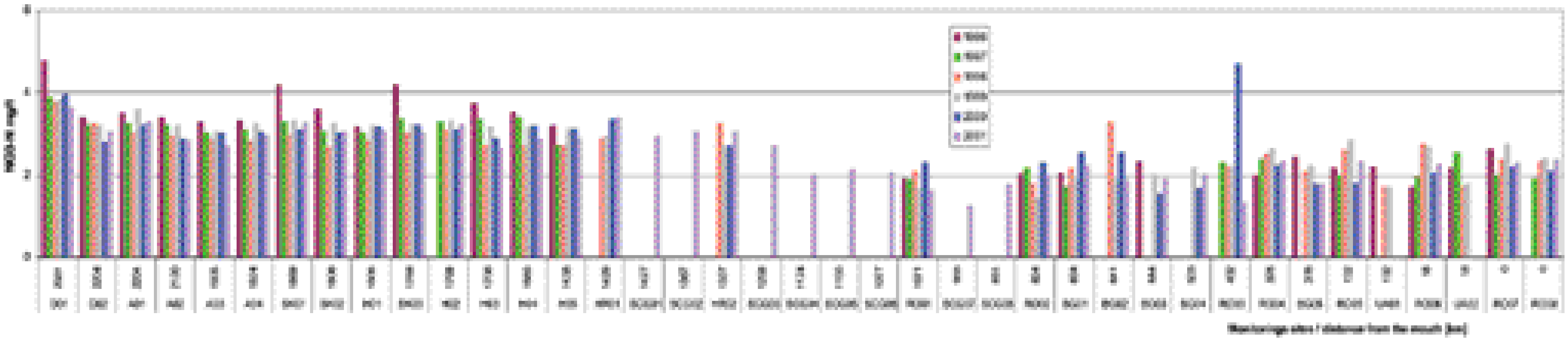


Figure 7.22: Temporal trends of nitrate-nitrogen in tributaries

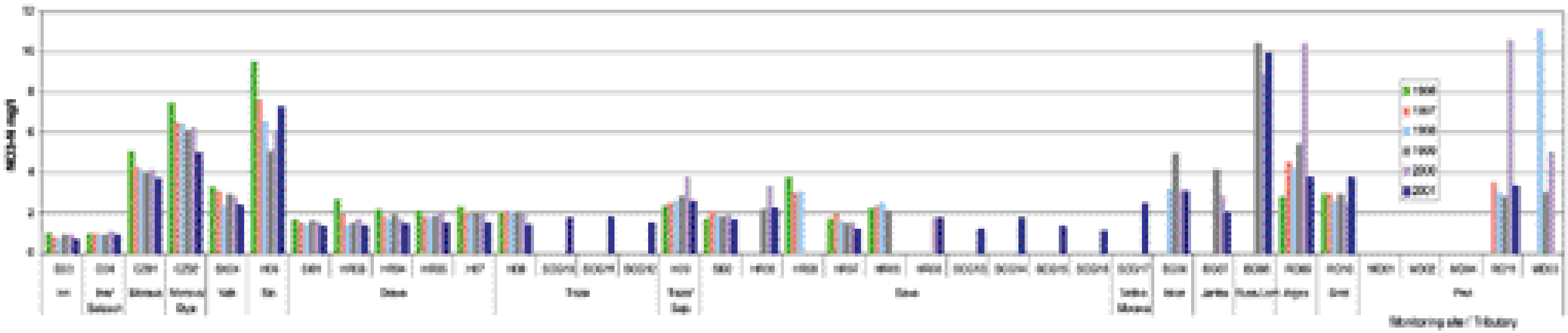


Figure 7.23: Temporal trends of ortho-phosphate-phosphorus in Danube River

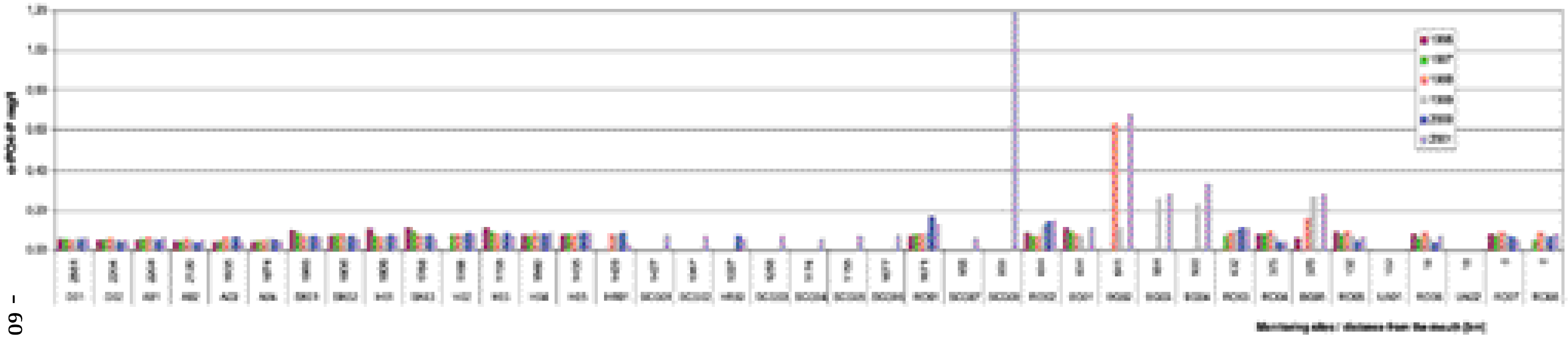


Figure 7.24: Temporal trends of ortho-phosphate-phosphorus in tributaries

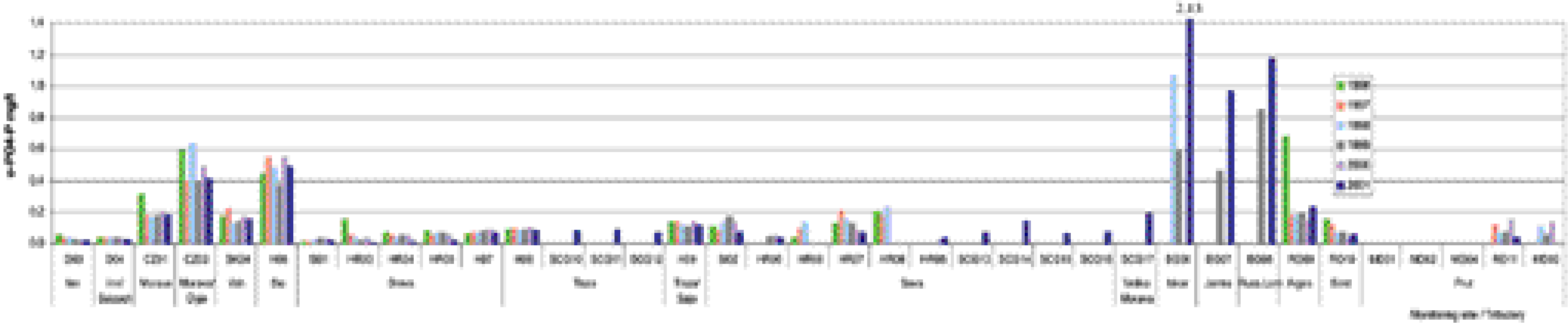


Figure 7.25: Temporal trends of total phosphorus in Danube River

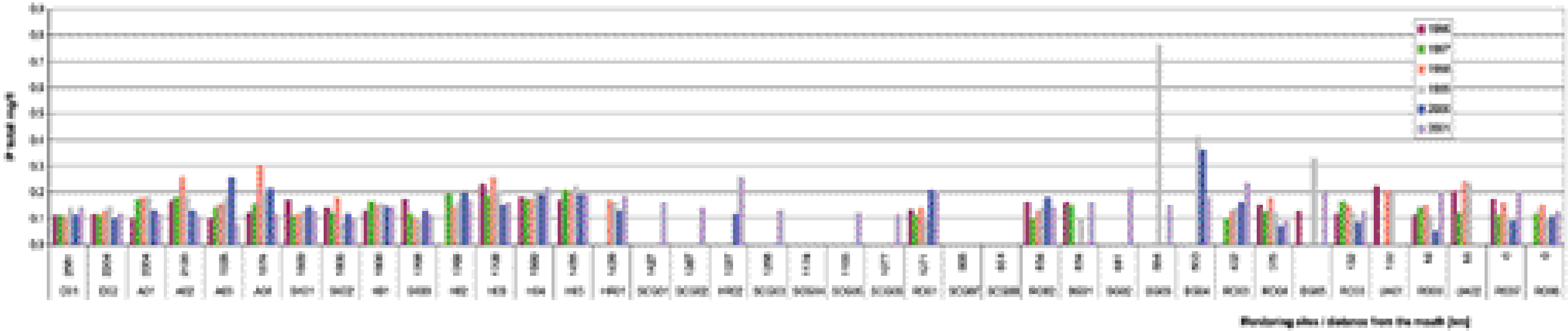


Figure 7.26: Temporal trends of total phosphorus in tributaries

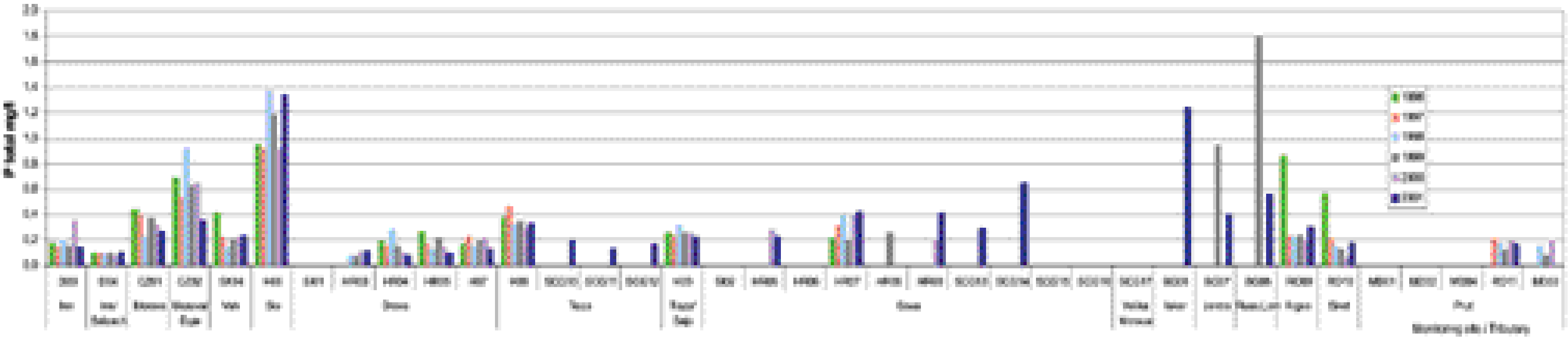


Figure 7.27: Temporal trends of cadmium in Danube River

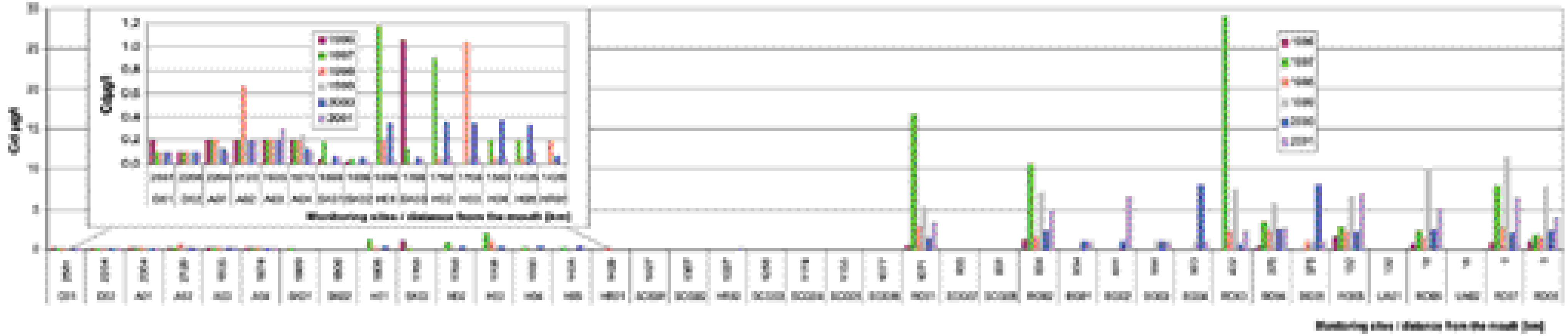
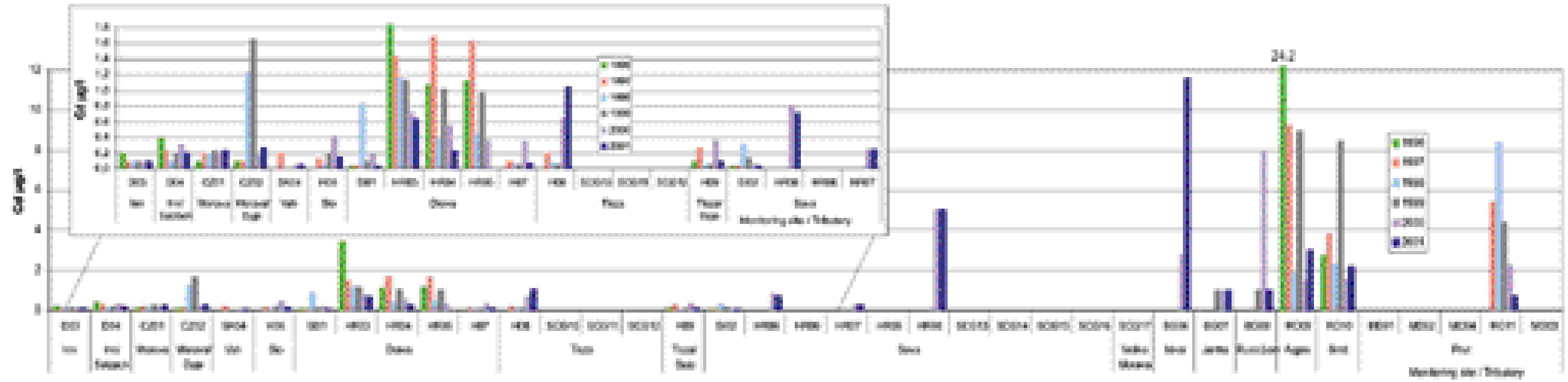


Figure 7.28: Temporal trends of cadmium in tributaries



8. Load Assessment

8.1 Introduction

One of the main objectives of TNMN is to produce reliable and consistent trend analysis of concentrations and loads of substances diluted in water or attached to sediments. Load assessment in the Danube River is necessary to estimate the influx of polluting substances to the Black Sea and to provide an information basis for both policy development and assessment.

Within the framework of EU PHARE Project "Transboundary Assessment of Pollution Loads and Trends", a Standard Operational Procedure (SOP) was developed for load assessment. The countries agreed to use this SOP as a common and cost-effective approach for load assessment in the Danube River and its tributaries.

8.2 Description of load assessment procedure

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 a discretionary 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" (1998). 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 8.2.1).

8. Load Assessment

Table 8.2.1: List of TNMN stations selected for load assessment program.

Contry	River	Water quality monitoring station			Hydrological station	
		Contry Code	Location	Distance from the mouth (km)	Location	Distance from the 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)	1884
					Angern (March)	32
Czech Republic	Morava	CZ01	Lanzhot	79	Lanzhot	79
Czech Republic	Morava/Dyje	CZ02	Pohansko	17	Breclav-Ladná	32,3
Slovakia	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	325
					HE Formin	311
					Pesnica-Zamusani	10.1 (to the Drava)
Slovenia	Sava	SI02	Jesenice	729	Catez	737
					Sotla -Rakovec	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		

8.3 Monitoring Data 2001

In the second year of the load assessment programme, the agreed requirements on the programme have still not been fully met. Although slight improvements have been observed in the frequency of measurements, several monitoring stations still have lower measurement frequency than the required minimum. Data on dissolved phosphorus are available only for seven monitoring stations, located in Germany, Austria, Slovakia and Slovenia. Thus load of dissolved phosphorus was calculated there and is included in the Tables with results, but is not presented in the charts showing load in the context of the whole river basin.

8. Load Assessment

Table 8.3.1: Number of measurements in TNMN stations selected for assessment of pollution load in 2001.

Contry Code	River	Location	River Km	Number of							
				Q	SS	N_{inorg}	$P\text{-}PO_4$	P_{total}	BOD_5	Cl	P_{diss}
D02	Danube	Jochenstein	2204	365	26	26	26	26	26	26	27
D03	Inn	Kirchdorf	195	357	25	24	24	24	24	25	0
D04	Inn/Salzach	Laufen	47	360	26	26	26	26	26	26	26
A01	Danube	Jochenstein	2204	365	12	12	12	12	12	12	12
A04	Danube	Wolfsthal	1874	365	25	25	25	25	25	25	25
CZ01	Morava	Lanzhot	79	365	12	12	12	12	12	12	0
CZ02	Morava/Dyje	Pohansko	17	365	12	12	12	12	12	12	02
SK01	Danube	Bratislava	1869	365	25	25	25	25	24	25	12
H03	Danube	Szob	1708	365	26	26	26	26	26	26	0
H05	Danube	Hercegszanto	1435	365	23	36	36	36	36	23	0
H08	Tisza	Tiszasziget	163	365	13	26	26	26	26	13	0
HR02	Danube	Borovo	1337	0	26	26	26	26	26	0	0
HR06	Sava	Jesenice/D	729	365	26	26	26	26	26	12	0
HR07	Sava	us Una Jesenovac	525	365	26	26	26	26	26	12	0
HR08	Sava	ds Zupanja	254	365	26	26	26	26	26	12	0
SI01	Drava	Ormoz	300	365	24	24	24	0	24	24	24
SI02	Sava	Jesenice	729	365	24	24	24	0	24	24	24
RO02	Danube	Pristol-Novo Selo	834	365	19	21	21	15	20	21	0
RO04	Danube	Chiciu-Silistra	375	365	23	23	23	21	20	23	0
RO05	Danube	Reni-Chilia arm	132	365	23	23	23	21	23	23	0
UA02	Danube	Vilkov-Kilia arm	18	0	0	0	0	0	0	0	0

The frequency of measurements is crucial for assessment of pollution loads, and Table 8.3.1 shows the number of available data of discharge and selected determinands in 2001. Data from stations Danube-Jochenstein and Sava-Jesenice are included in the list by two neighbouring countries. Those from Danube-Jochenstein were combined in the process of load calculation, but calculation of load in location Sava-Jesenice was done separately from the data measured by Slovenia and Croatia. The reason for this is significant differences in the case of some determinands due to the use of differing methods of measurement. The harmonisation of the methods at bilateral level is in process.

8. Load Assessment

8.4 Calculation Procedure

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

- In the case of several sampling sites in the profile, average concentration at the station is calculated for each sampling day;

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

- The average monthly concentrations are calculated according to the formula:

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

where

C_m average monthly concentrations

C_i concentrations on the sampling days of each month

Q_i discharges on the sampling days of each month;

- The monthly load is calculated by using the formula:

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

where

L_m monthly load

Q_m average monthly discharge

- If discharges are available only for the sampling days, Qm is calculated from those discharges.

- In the case of months without measured values the average of the products Cm.Qm in the months with sampling days is used;

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

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

8.5 Results

The mean annual concentrations and annual loads of suspended solids, inorganic nitrogen, ortho-phosphate-phosphorus, total phosphorus, BOD5, chlorides and – where available – dissolved phosphorus are presented in Tables 8.5.1 to 8.5.4, separately for monitoring stations located on the Danube River and monitoring stations located on tributaries. Explanation of terms used in Tables 8.5.1 - 8.5.4 is to be found in the following legend.

8. Load Assessment

Term used	Explanation
Station Code	TNMN monitoring station code
Profile	location of sampling site in profile (L-left, M-middle, R-right)
River Name	name of river
Location	name of monitoring site
River km	distance to mouth of the river
Q_a	mean annual discharge in the year 2001
c_{mean}	arithmetical mean of the concentrations in the year 2001
Annual Load	annual load of given determinand in the year 2001

The mean annual discharge and annual loads of suspended solids, inorganic N, ortho-phosphate P, total P, BOD5 and chlorides are presented on the plots, prepared separately for monitoring stations located on the Danube River and stations located on its primary tributaries (Figures 8.5.1 – 8.5.12). Looking at the Figures with calculated values of annual load, it is necessary to restate that in accordance with results of QualcoDanube proficiency testing comparability of BOD data analysed by laboratories included in the TNMN network is still not satisfactory.

Figures 8.5.1 – 8.5.12 show that the spatial pattern of annual load along the Danube River is similar to the previous year. In the Danube River itself, load of organic pollution and nutrients generally increases from the upper to the lower part of the river. An annual load of suspended solids decreases in the middle part of the Danube River due to reduced flow velocity through damming, and reaches its maximum at the beginning of the lower Danube River section (at monitoring station RO02). Similarly, the highest annual load values of BOD_5, ortho-phosphate-P and total P are observed there.

In the case of tributaries, as in year 2001 discharge data have been available from the most downstream station on Sava River (HR08 – Sava-ds. Zupanja), and in the Figures load from this location is shown instead of Sava-Jesenice. Therefore while in the previous year the Tisza River showed the highest load among the tributaries, in 2001 the highest load of inorganic N, total P and BOD_5 is observed in Sava River. Regarding ortho-phosphate phosphorus and suspended solids, the highest contribution to the load of the Danube comes from the Tisza River.

Table 8.5.1: Mean annual concentrations in monitoring stations 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 Phos-phorus	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	1627.6	53	2.25	0.032	0.09	2.0	15	0.036
A04	R	Danube	Wolfsthal	1874	2218.2	25	2.20	0.029	0.07	1.3	16	0.039
SK01	M	Danube	Bratislava	1869	2231.3	27	2.32	0.042	0.10	2.0	17	0.066
H03	LMR	Danube	Szob	1708	2382.3	22	2.00	0.063	0.13	4.4	22	
H05	M	Danube	Hercegszántó	1435	2432.5	24	2.07	0.053	0.15	3.5	18	
RO02	LMR	Danube	Pristol-Novo Selo	834	5421.8	45	1.61	0.100	0.11	3.4	20	
RO04	LMR	Danube	Chiciu-Silistra	375	5919.4	15	2.35	0.029	0.05	1.9	31	
RO05	LMR	Danube	Reni-Chilia arm	132	6304.3	19	2.22	0.028	0.06	1.5	32	

Table 8.5.2: Mean annual concentrations in monitoring stations 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 Phos-phorus	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	320.3	57	0.57	0.011	0.09	1.1	4	
D04	L	Inn/Salzach	Laufen	47	252.6	28	0.72	0.018	0.06	2.2	7	0.022
CZ01	M	Morava	Lanzhot	79	67.2	22	3.17	0.131	0.22	3.7	25	
CZ02	L	Morava/Dyje	Pohansko	17	32.1	17	3.55	0.218	0.27	3.9	44	
H08	LMR	Tisza	Tiszasziget	163	921.4	113	1.21	0.063	0.23	1.8	31	
SI01	L	Drava	Ormoz	300	294.4	11	1.02	0.012		2.2	4	0.023
SI02	R	Sava	Jesenice	729	276.8	31	1.44	0.056		2.8	6	0.074
HR06	L	Sava	Jesenice	729	188.2	13	1.60	0.026	0.17	2.2	7	
HR07	L	Sava	us. Una Jasenovac	525	585.0	12	1.01	0.040	0.23	2.5	8	
HR08	R	Sava	ds. Zupanja	254	1102.4	38	1.68	0.016	0.22	2.5	15	

Table 8.5.3: Annual load in selected monitoring stations on Danube River.

Station Code	Profile	River Name	Location	River Km	Annual Load						
					Suspended Solids	Inorganic Nitrogen	Ortho-Phosphate Phosphorus	Total Phos-phorus	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	4.1	116	1.6	5.9	106	0.7	1.8
A04	R	Danube	Wolfsthal	1874	1.9	152	2.0	5.2	89	1.1	2.7
SK01	M	Danube	Bratislava	1869	2.3	159	3.0	7.3	145	1.1	4.4
H03	LMR	Danube	Szob	1708	1.7	149	4.7	9.6	336	1.6	
H05	M	Danube	Hercegszántó	1435	2.0	157	4.0	12.1	268	1.4	
RO02	LMR	Danube	Pristol-Novo Selo	834	8.0	286	16.9	18.4	584	3.4	
RO04	LMR	Danube	Chiciu-Silistra	375	2.7	429	5.3	9.9	378	5.7	
RO05	LMR	Danube	Reni-Chilia arm	132	3.7	437	5.2	13.1	303	6.3	

Table 8.5.4: Annual load in selected monitoring stations on tributaries.

Station Code	Profile	River Name	Location	River Km	Annual Load						
					Suspended Solids	Inorganic Nitrogen	Ortho-Phosphate Phosphorus	Total Phos-phorus	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	1.17	5.1	0.10	1.62	11.0	0.03	
D04	L	Inn/Salzach	Laufen	47	0.37	5.3	0.13	0.64	17.1	0.05	0.16
CZ01	M	Morava	Lanzhot	79	0.05	6.7	0.27	0.49	7.7	0.05	
CZ02	L	Morava/Dyje	Pohansko	17	0.02	4.0	0.19	0.27	4.2	0.04	
H08	LMR	Tisza	Tiszasziget	163	3.59	35.4	1.60	6.47	48.8	0.83	
SI01	L	Drava	Ormoz	300	0.12	9.1	0.12		19.6	0.04	0.22
SI02	R	Sava	Jesenice	729	0.53	11.8	0.38		25.2	0.04	0.52
HR06	L	Sava	Jesenice	729	0.14	8.2	0.15	0.94	11.4	0.02	
HR07	L	Sava	us. Una Jasenovac	525	0.21	18.8	0.63	3.87	40.7	0.13	
HR08	R	Sava	ds. Zupanja	254	1.63	60.4	0.61	7.65	90.9	0.42	

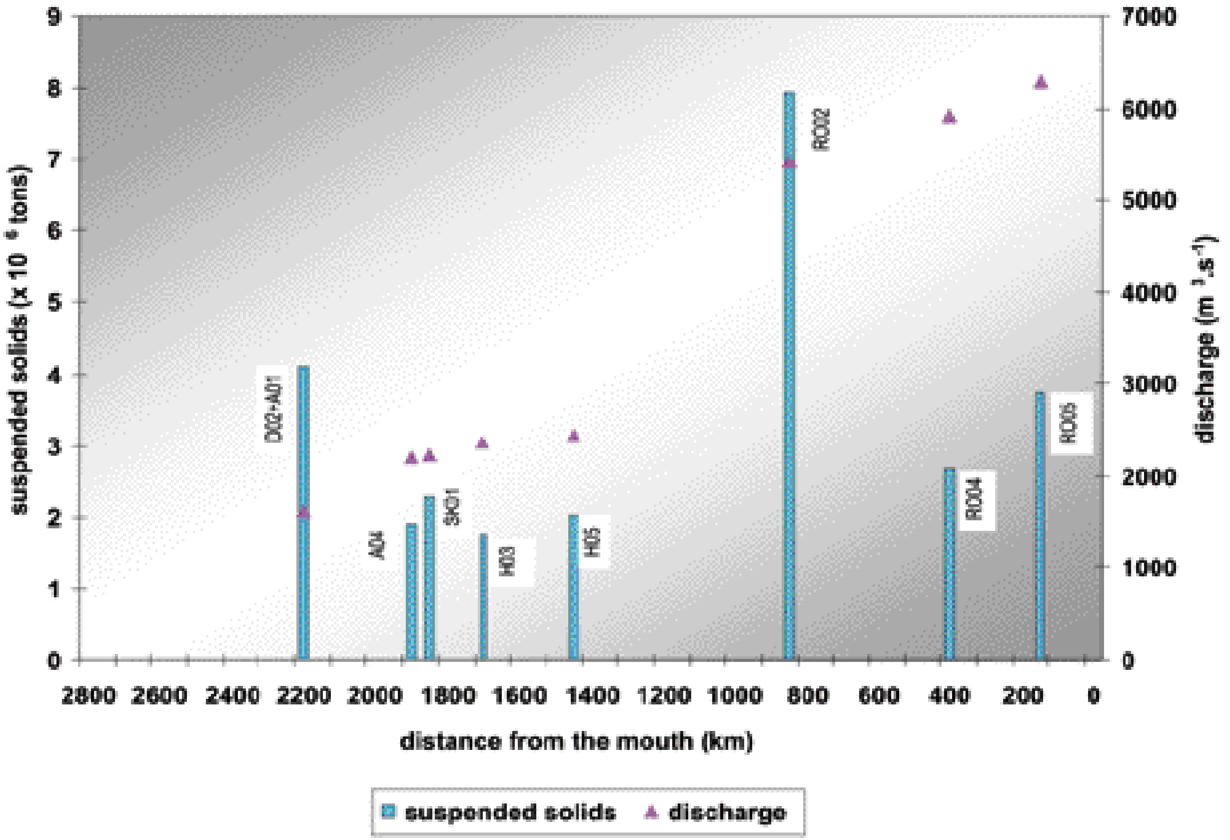


Figure 8.5.1: Annual load of suspended solids at monitoring stations along the Danube River.

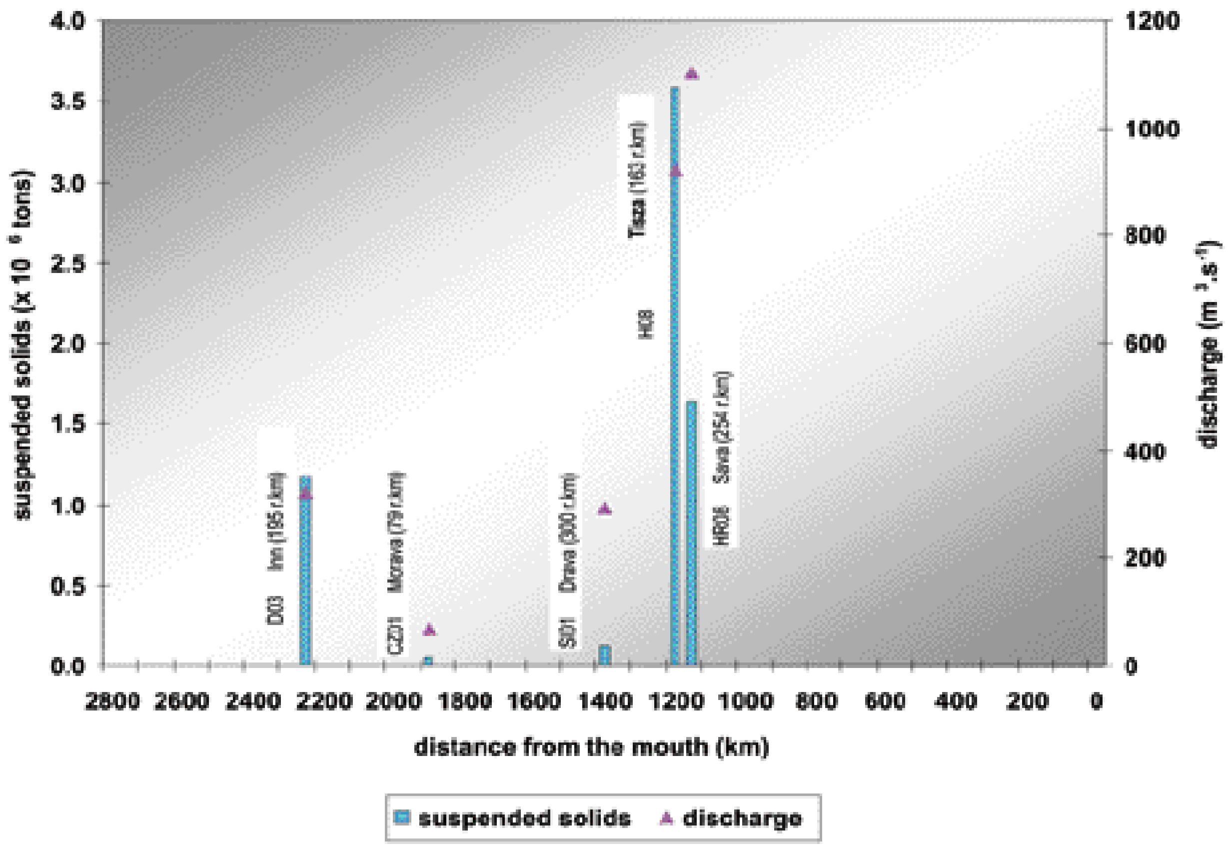


Figure 8.5.2: Annual load of suspended solids at monitoring stations on tributaries.

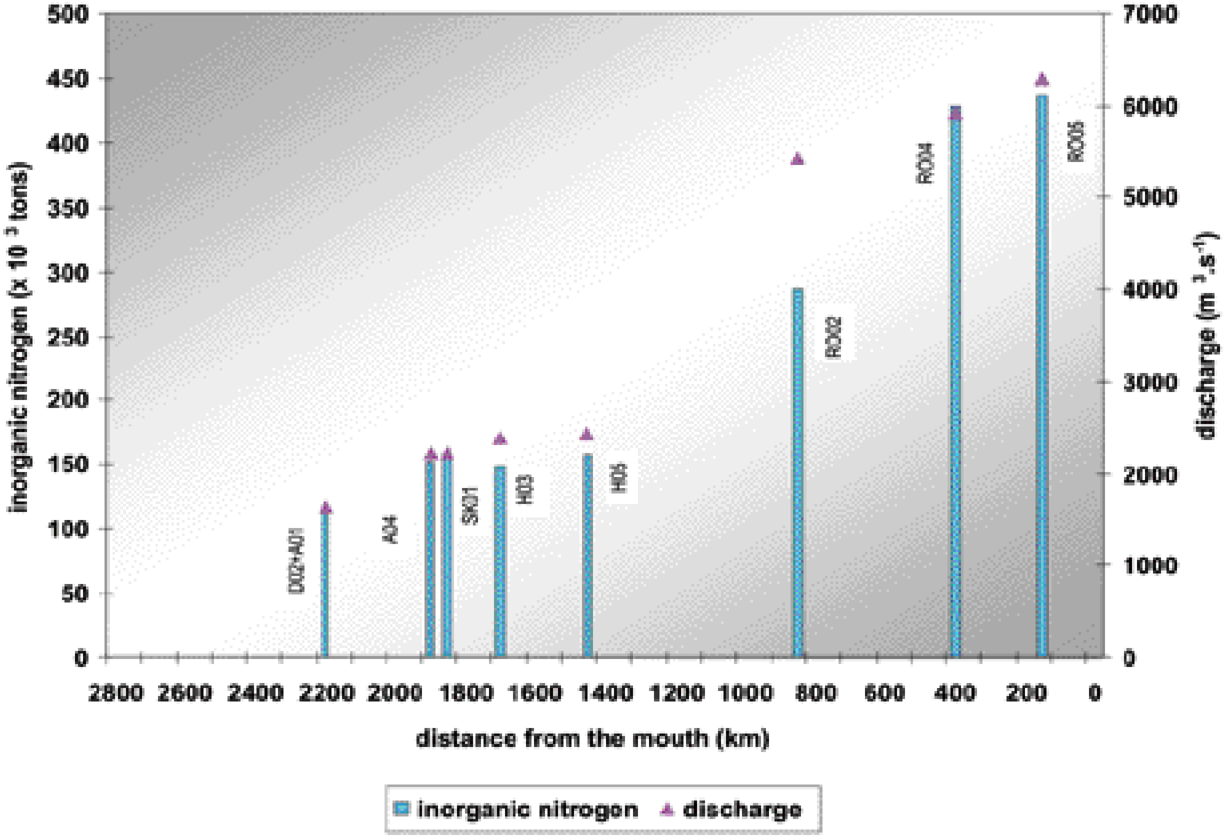


Figure 8.5.3: Annual load of inorganic nitrogen at monitoring stations along the Danube River.

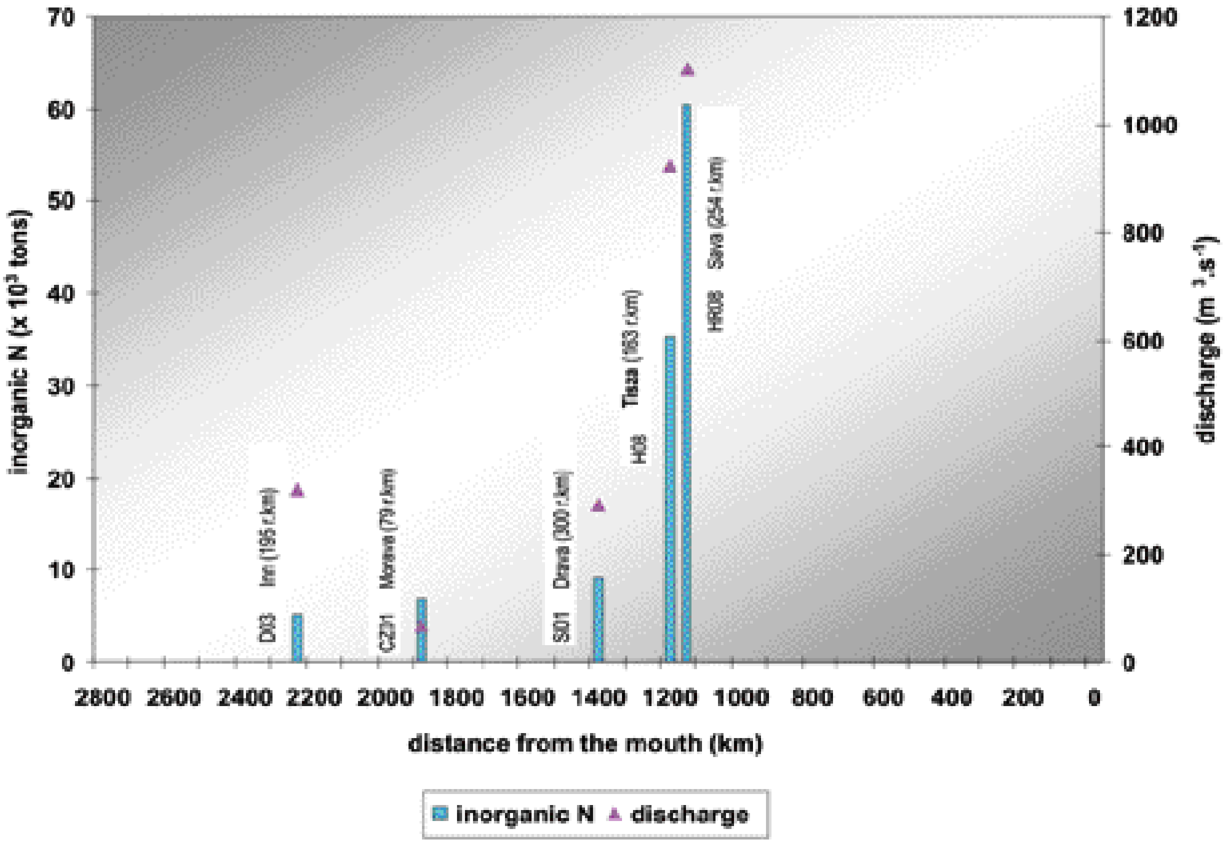


Figure 8.5.4: Annual load of inorganic nitrogen at monitoring stations on tributaries.

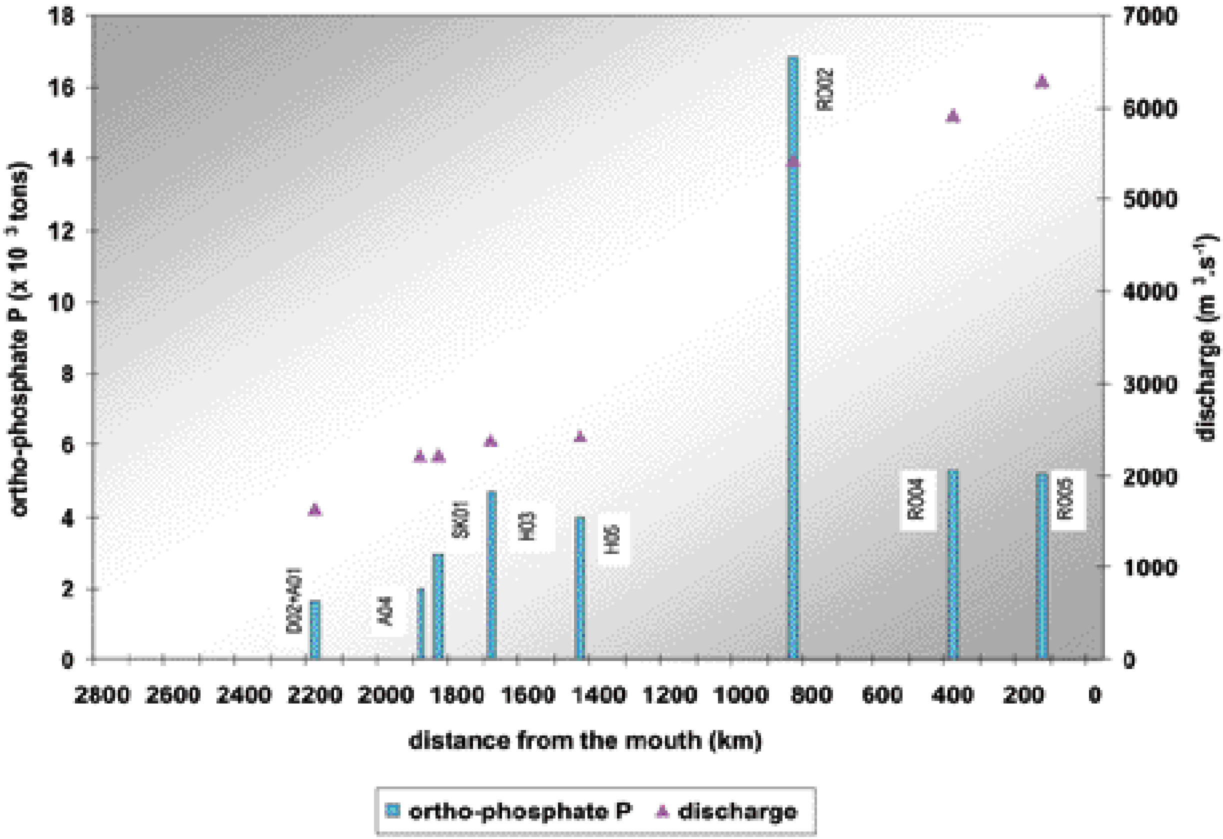


Figure 8.5.5: Annual load of ortho-phosphate-P at monitoring stations along the Danube River.

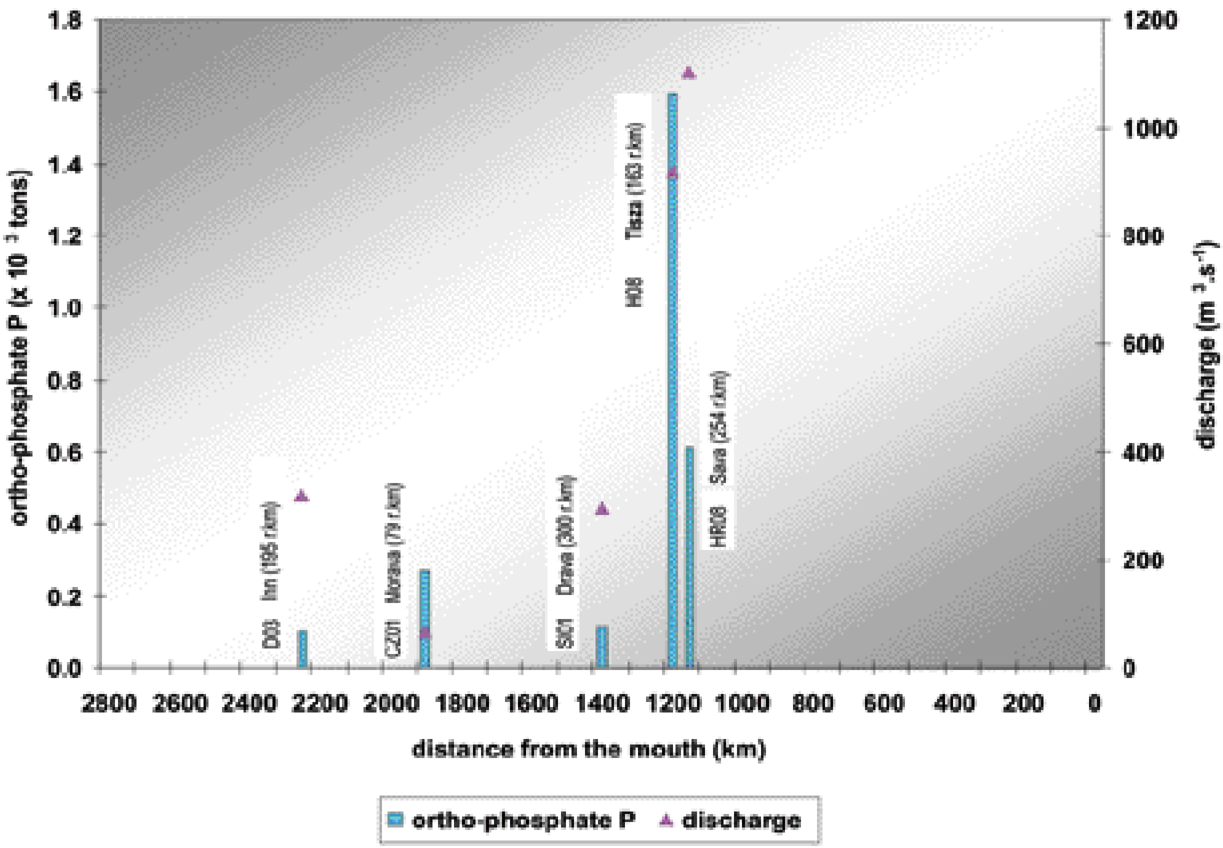


Figure 8.5.6: Annual load of ortho-phosphate-P at monitoring stations on tributaries.

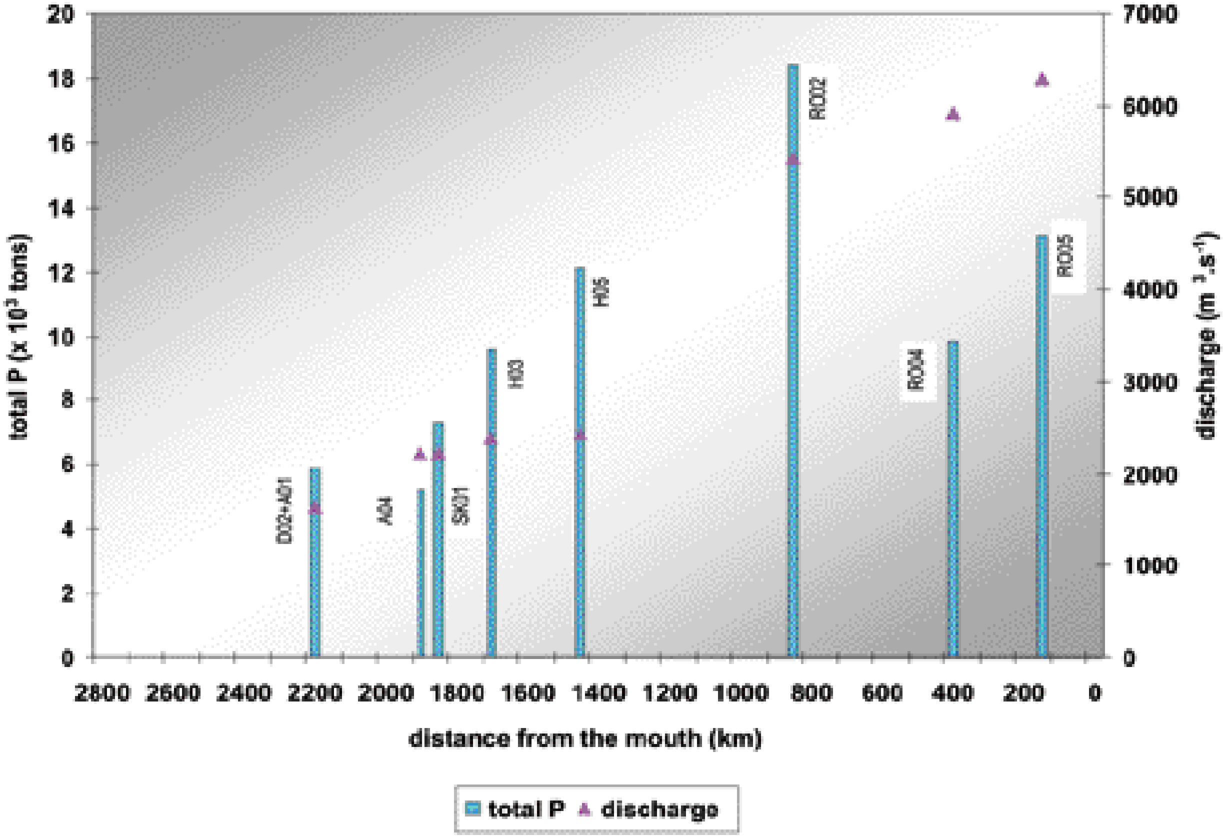


Figure 8.5.7: Annual load of total phosphorus at monitoring stations along the Danube River.

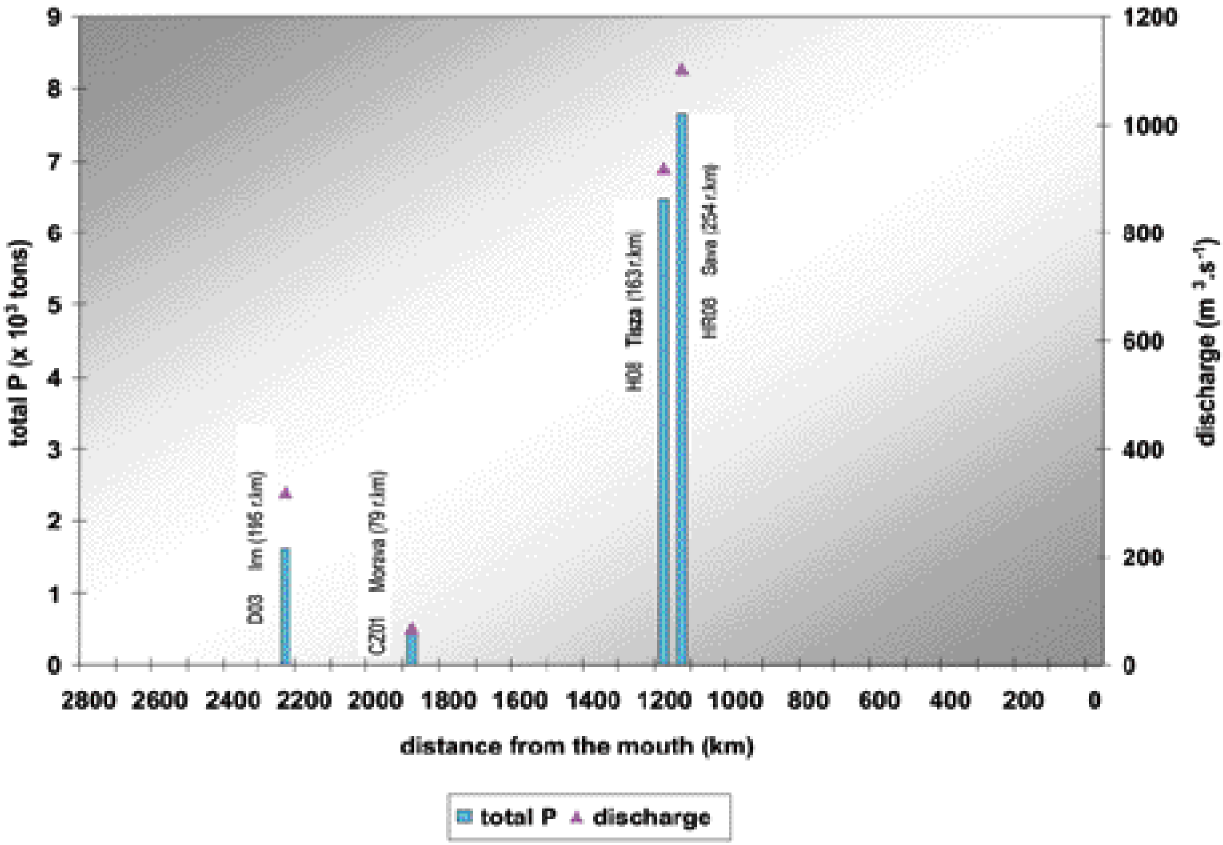


Figure 8.5.8: Annual load of total phosphorus at monitoring stations on tributaries.

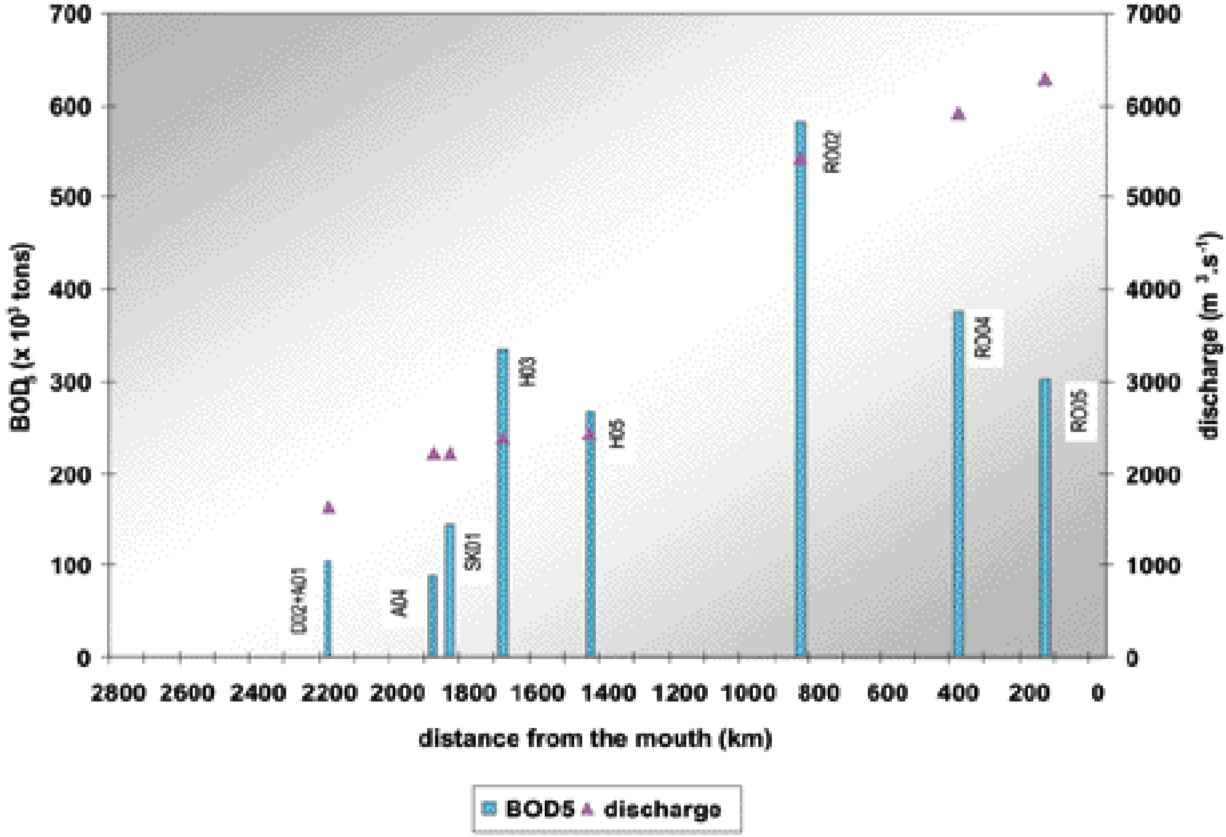


Figure 8.5.9: Annual load of BOD_5 at monitoring stations along the Danube River.

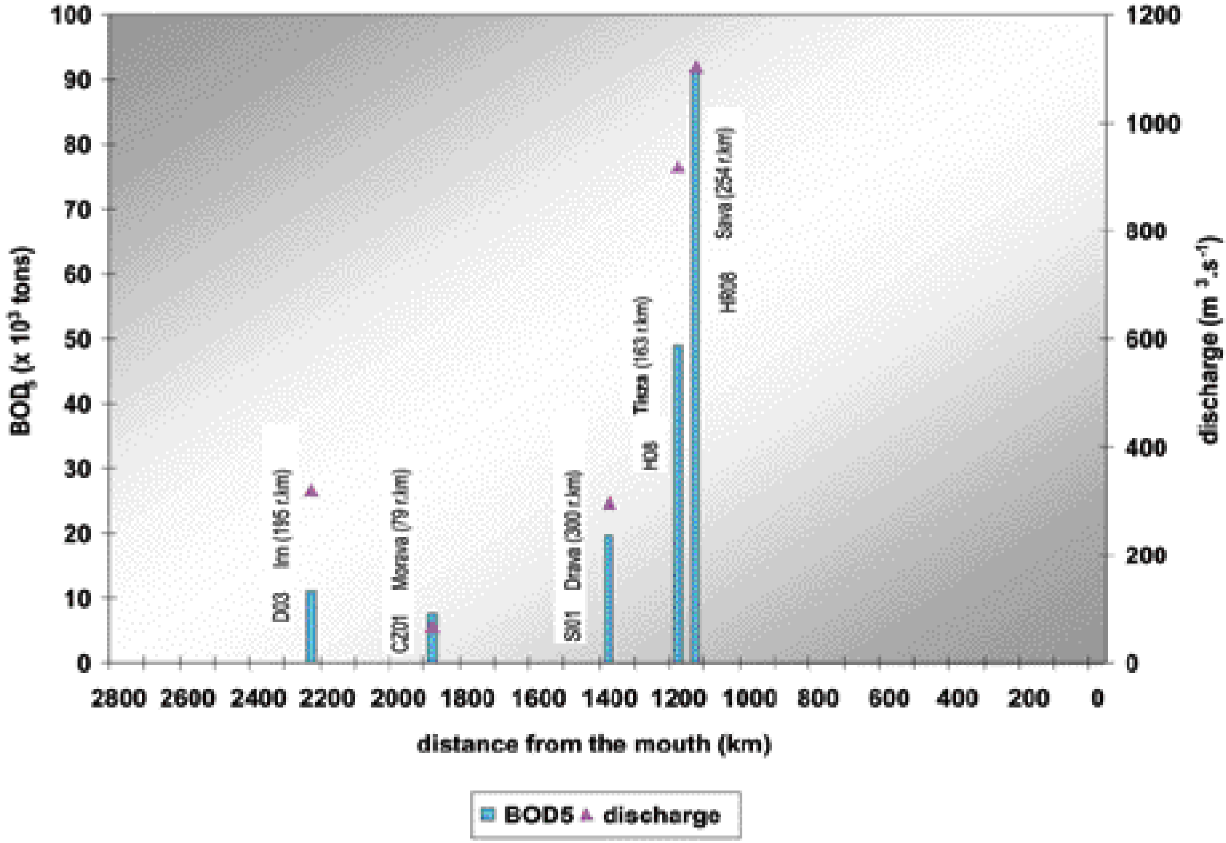


Figure 8.5.10: Annual load of BOD_5 at monitoring stations on tributaries.

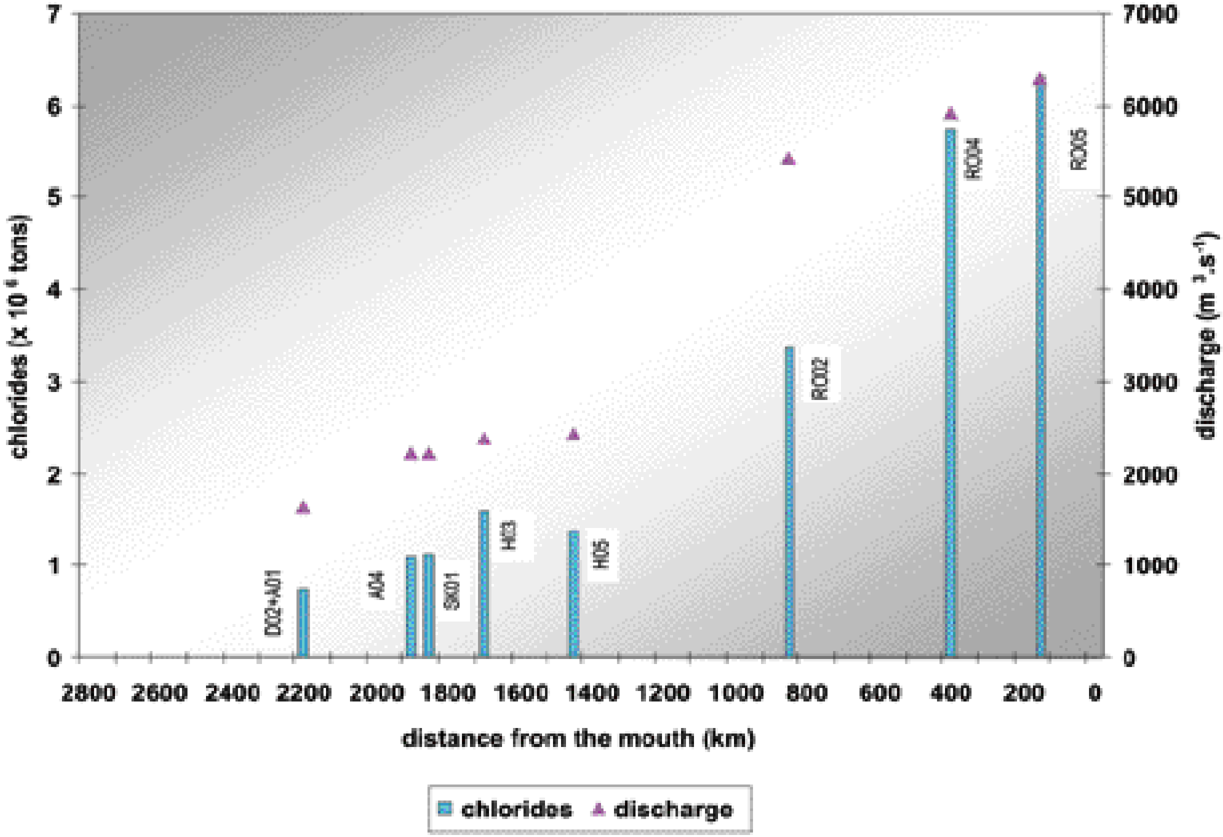


Figure 8.5.11: Annual load of chlorides at monitoring stations along the Danube River.

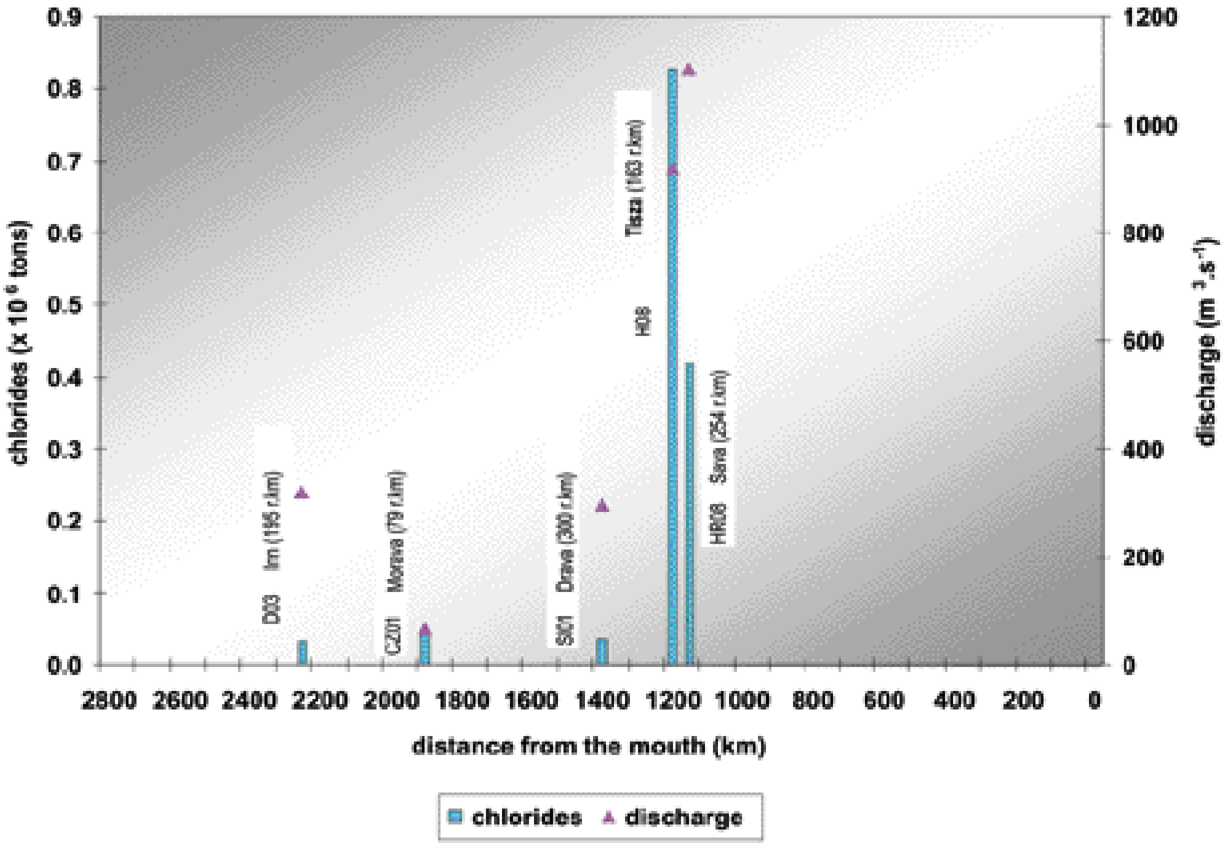


Figure 8.5.12: Annual load of chlorides at monitoring stations on tributaries.

9. Abbreviations

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