Water Quality in the Danube River Basin - 2007

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International Commission for the Protection of the Danube River
Internationale Kommission zum Schutz der Donau

TNMN – Yearbook 2007

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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. The 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 2007.

The TNMN has been in operation since 1996, although the first steps towards its creation 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 of the Danube River was established.

1.2. Revision of the TNMN to meet the objectives of EU WFD

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 has been completed in 2007.

The major objective of the revised TNMN is to provide an overview of the overall status and long-term changes of surface water and – where necessary – groundwater status in a basin-wide context with a particular attention paid to the transboundary pollution load. In view of the link between the nutrient loads of the Danube and the eutrophication of the Black Sea, it is necessary to monitor the sources and pathways of nutrients in the Danube River Basin District and the effects of measures taken to reduce the nutrient loads into the Black Sea.

To meet the requirements of both EU WFD and the Danube River Protection Convention the revised TNMN for surface waters consists of following elements:

- Surveillance monitoring I: Monitoring of surface water status
- Surveillance monitoring II: Monitoring of specific pressures
- Operational monitoring

- Investigative monitoring

Surveillance monitoring II is a joint monitoring activity of all ICPDR Contracting Parties that produces annual data on concentrations and loads of selected parameters in the Danube and major tributaries.
Surveillance monitoring I and the operational monitoring is based on collection of the data on the status of surface water and groundwater bodies in the DRB District to be published in the DRBM Plan once in six years.
Investigative monitoring is primarily a national task but at the basin-wide level the concept of Joint Danube Surveys was developed to carry out investigative monitoring as needed, e.g. for harmonization of the existing monitoring methodologies, filling the information gaps in the monitoring networks operating in the DRB, testing new methods or checking the impact of "new" chemical substances in different matrices. Joint Danube Surveys are carried out every 6 years.
A new element of the revised TNMN is monitoring of groundwater bodies of basin-wide importance. More information on this issue is provided in the respective chapter in this Yearbook.

Detailed description of the revised TNMN is given in the Summary Report to EU on monitoring programmes in the Danube River Basin District designed under WFD Article 8.

This Yearbook presents the results of the Surveillance monitoring II: Monitoring of specific pressures.

2. Description of the TNMN Surveillance Monitoring II: Monitoring of specific pressures

2.1. Objectives

Surveillance Monitoring II aims at long-term monitoring of specific pressures of basin-wide importance. Selected quality elements are monitored annually. Such denser monitoring programme is needed to identify the specific pressures in the Danube River Basin District in order to allow a sound and reliable long-term trend assessment of specific quality elements and to achieve a sound estimation of pollutant loads being transferred across states of Contracting Parties and into the Black Sea.
Surveillance Monitoring II is based on the set-up of the original TNMN and is fitted to respond to pressures of basin-wide importance. The monitoring network is based on the national monitoring networks and the operating conditions are harmonized between the national and basin-wide levels to minimise the efforts and maximise the benefits.

2.2. Selection of monitoring sites

The selection of monitoring sites is based on the following criteria:

- Monitoring sites that have been monitored in the past and are therefore suitable for long-term trend analysis; these include sites
  - located just upstream/downstream of an international border,
  - located upstream of confluences between Danube and main tributaries or main tributaries and larger sub-tributaries (to enable estimation of mass balances),
  - located downstream of the major point sources,
  - located to control important water uses.

- Sites required to estimate pollutant loads (e.g. of nutrients or priority pollutants) which are transferred across bounders of Contracting Parties, and which are transferred into the marine environment.

The sites are located in particular on the Danube and its major primary or secondary tributaries near crossing boundaries of the Contracting Parties. List of monitoring sites is in the Table 1.

Table 1: List of monitoring sites

No.	Country code	DEFF Code	New TNMN code	River	Name of site	Locations	x- coord.	y-coord.	River-km	Altitude	Catch-ment
1	DE	L2130	DE2	Danube	Jochenstein	M	13.703	48.520	2 204	290	77 086
2	DE		DE5	Danube	Dillingen	L	10.499	48.568	2 538	420	11 315
3	DE	L2150	DE3	/Inn	Kirchdorf	M	12.126	47.782	195	452	9 905
4	DE	L2160	DE4	/Inn/Salzach	Laufen	L	12.933	47.940	47	390	6 113
5	AT	L2220	AT1	Danube	Jochenstein	M	13.703	48.521	2 204	290	77 086
6	AT		AT5	Danube	Enghagen	R	14.512	48.240	2 113	241	84 869
7	AT	L2180	AT3	Danube	Wien-Nussdorf	R	16.371	48.262	1 935	159	101 700
8	AT		AT6	Danube	Hainburg	R	16.993	48.164	1 879	136	130 759
9	CZ	L2100	CZ1	/Morava	Lanzhot	M	16.989	48.687	79	150	9 725
10	CZ	L2120	CZ2	/Morava/Dyje	Pohansko	M	16.885	48.723	17	155	12 540
11	SK	L1840	SK1	Danube	Bratislava	LMR	17.104	48.139	1 869	128	131 329
12	SK	L1860	SK2	Danube	Medvedov	M	17.652	47.794	1 806	108	132 168
13	SK	L1870	SK3	Danube	Komarno/Komarom	M	18.120	47.751	1 768	103	151 961
14	SK	L1960	SK4	/Váh	Komarno	M	18.142	47.761	1	106	19 661
15	HU	L1470	HU1	Danube	Medve/Medvedov	M	17.652	47.792	1 806	108	131 605
16	HU	L1475	HU2	Danube	Komarom/Komarno	LMR	18.121	47.751	1 768	101	150 820
17	HU	L1490	HU3	Danube	Szob	LMR	18.964	47.787	1 708	100	183 350
18	HU	L1520	HU4	Danube	Dunafoldvar	LMR	18.934	46.811	1 560	89	188 700
19	HU	L1540	HU5	Danube	Hercegszanto	LMR	18.814	45.909	1 435	79	211 503
20	HU	L1604	HU6	/Sio	Szekszard-Palank	M	18.720	46.380	13	85	14 693
21	HU	L1610	HU7	/Drava	Dravaszabolcs	M	18.200	45.784	78	92	35 764
22	HU	L1770	HU8	/Tisza/Sajo	Sajopuspoki	M	20.340	48.283	124	148	3 224
23	HU	L1700	HU9	/Tisza	Tiszasziget	LMR	20.105	46.186	163	74	138 498
24	HU		HU10	/Tisza	Tiszabecs	M	22.830	48.102	757	114	9707
25	HU		HU11	/Tisza/Szamos	Csenger	M	22.404	47.513	45	113	15283
26	HU		HU12	/Tisza/Hármas-Körös/Sebes-Körös	Korosszakal	M	21.392	47.011	59	92	2489
27	HU		HU13	/Tisza/Hármas-Körös/Kettős-Körös/Fekete-Körös	Sarkad	M	21.255	46.414	16	85	4302
28	HU		HU14	/Tisza/Hármas-Körös/Kettős-Körös/Fehér-Körös	Gyulavari	M	21.201	46.374	9	85	4251
29	HU		HU15	/Tisza/Maros	Nagylak	R	20.421	46.094	51	80	30149
30	SI	L1390	SI1	/Drava	Ormoz	LM	16.155	46.403	300	192	15 356
31	SI	L1330	SI2	/Sava	Jesenice	R	15.693	45.861	729	135	10 878
32	HR	L1315	HR1	Danube	Batina	MR	16.938	46.241	1 429	86	210 250
33	HR	L1320	HR2	Danube	Borovo	R	18.201	45.783	1 337	89	243 147
34	HR	L1300	HR9	/Drava	Ormoz	LM	16.155	46.403	300	192	15356

No.	Country code	DEFF Code	New TNMN code	River	Name of site	Locations	x- coord.	y-coord.	River-km	Altitude	Catch-ment
35	HR	L1240	HR4	/Drava	Botovo	LM	18.829	45.875	227	123	31 038
36	HR	L1250	HR5	/Drava	Donji Miholjac	MR	16.691	46.419	78	92	37 142
37	HR	L1220	HR6	/Sava	Jesenice	R	18.696	45.040	729	135	10 834
38	HR	L1150	HR7	/Sava	Upstream Una Jasenovac	L	16.369	45.484	525	87	30 953
39	HR	L1060	HR8	/Sava	Zupanja	L	16.953	45.251	254	85	62 890
40	RS	L2350	RS1	Danube	Bezdan	L	18.854	45.864	1 427	83	210 250
41	RS	L2360	RS2	Danube	Bogojevo	L	19.084	45.529	1 367	80	251 253
42	RS	L2370	RS3	Danube	Novi Sad	R	19.842	45.225	1 258	75	254 085
43	RS	L2380	RS4	Danube	Zemun	R	20.417	44.849	1 174	71	412 762
44	RS	L2390	RS5	Danube	Pancevo	L	20.594	44.856	1 155	70	525 009
45	RS	L2400	RS6	Danube	Banatska Palanka	M	21.345	44.826	1 077	69	568 648
46	RS	L2410	RS7	Danube	Tekija	R	22.424	44.700	955	0	574 307
47	RS	L2420	RS8	Danube	Radujevac	R	22.686	44.263	851	32	577 085
48	RS	L2430	RS9	Danube	Backa Palanka	L	19.386	45.234	1 287	0	253 737
49	RS	L2440	RS10	/Tisza (Tisa)	Martonos	R	20.087	46.114	152	76	140 130
50	RS	L2450	RS11	/Tisza (Tisa)	Novi Becej	L	20.140	45.586	66	74	145 415
51	RS	L2460	RS12	/Tisza (Tisa)	Titel	M	20.320	45.205	9	73	157 147
52	RS	L2470	RS13	/Sava	Jamena	L	20.320	45.205	195	78	64 073
53	RS	L2480	RS14	/Sava	Sremska Mitrovica	L	19.608	44.966	136	75	87 996
54	RS	L2490	RS15	/Sava	Sabac	R	19.704	44.770	104	74	89 490
55	RS	L2500	RS16	/Sava	Ostruznica	R	20.317	44.732	17	0	37 320
56	RS	L2510	RS17	/Velika Morava	Ljubicevski Most	R	21.138	44.585	35	75	37 320
57	BA		BA5	/Sava	Gradiska	M	17.256	45.143	457	86	39 150
58	BA		BA6	/Sava/Una	Kozarska Dubica	M	16.850	45.210	16	94	9 130
59	BA		BA7	/Sava/Vrbas	Razboj	M	17.456	45.050	12	100	6 023
60	BA		BA8	/Sava/Bosna	Modrica	M	18.316	44.961	24	114	10 500
61	BA		BA9	/Sava/Drina	Foca	M	18.836	43.342	234	442	3 884
62	BA		BA10	/Sava/Drina	Badovinci	M	19.341	44.774	16	90	19 226
63	BA		BA11	/Sava	Raca	M	19.333	44.887	190	80	64 125
64	BA		BA12	/Sava/Una	Novi Grad	M	16.295	44.986	70	137	4 573
65	BA		BA13	/Sava/Bosna	Usora	M	18.073	44.664	78	148	7 313
66	BG	L0730	BG1	Danube	Novo Selo harbour	LMR	22.785	44.165	834	35	580 100
67	BG		BG9	Danube	Lom	R	23.270	43.835	741	24	588 860
68	BG		BG10	Danube	Orjahovo	R	23.997	43.729	679	22	607 260
69	BG	L0780	BG2	Danube	Bajkal	R	24.400	43.711	641	20	608 820
70	BG		BG11	Danube	Nikopol	R	25.927	43.701	598	21	648 620
71	BG	L0810	BG3	Danube	Svishtov	R	25.345	43.623	554	16	650 340
72	BG	L0820	BG4	Danube	Upstream Russe	R	25.907	43.793	503	12	669 900
73	BG	L0850	BG5	Danube	Silistra	LMR	27.268	44.125	375	7	698 600
74	BG		BG12	/Iskar	mouth	M	24.461	43.706	4	27	8 646
75	BG		BG13	/Vit	Guljantzi	M	24.728	43.644	7	29	3 225
76	BG		BG14	/Jantra	mouth	M	25.579	43.603	4	25	7 869
77	BG		BG15	/Russenski Lom	mouth	M	25.936	43.813	1	17	2 974
78	RO	L0020	RO1	Danube	Bazias	LMR	21.384	44.816	1 071	70	570 896
79	RO		RO18	Danube	Gruia/Radujevac	LMR	22.684	44.270	851	32	577 085
80	RO	L0090	RO2	Danube	Pristol/Novo Selo Harbour	LMR	22.676	44.214	834	31	580 100
81	RO	L0240	RO3	Danube	Upstream Arges	LMR	26.619	44.056	432	16	676 150
82	RO	L0280	RO4	Danube	Chiciu/Silistra	LMR	27.268	44.128	375	13	698 600
83	RO	L0430	RO5	Danube	Reni	LMR	28.232	45.463	132	4	805 700
84	RO	L0450	RO6	Danube	Vilkova-Chilia arm/Kilia arm	LMR	29.553	45.406	18	1	817 000
85	RO	L0480	RO7	Danube	Sulina - Sulina arm	LMR	29.530	45.183	0	1	817 000
86	RO	L0490	RO8	Danube	Sf. Gheorghe-Ghorghe arm	LMR	29.609	44.885	0	1	817 000
87	RO	L0250	RO9	/Arges	conf. Danube	M	26.474	44.228	0	14	12 550
88	RO	L0380	RO10	/Siret	Conf. Danube Sendreni	M	28.009	45.415	0	4	42 890
89	RO	L0420	RO11	/Prut	Conf. Danube Giurgiulesti	M	28.203	45.469	0	5	27 480
90	RO		RO12	/Tisza/Somes	Dara	M	22.720	47.815	3	118	15 780
91	RO		RO13	/Tisza/Hármas-Körös/Sebes-Körös/Crisul Repede	Cheresig	M	21.692	47.030	3	116	2 413
92	RO		RO14	/Tisza/Hármas-Körös/Kettős-Körös/Crisul Negru	Zerind	M	21.517	46.627	13	86.4	3 750

No.	Country code	DEFF Code	New TNMN code	River	Name of site	Locations	x- coord.	y-coord.	River-km	Altitude	Catch-ment
93	RO		RO15	/Tisza/Hármas-Körös/Kettős-Körös/Crisul Alb	Varsand	M	21.339	46.626	0.2	88.9	4 240
94	RO		RO16	/Tisza/Mures	Nadlac	M	20.727	46.145	21	85.6	27 818
95	RO		RO17	/Tisza/Bega	Otelec	M	20.847	45.620	7	46	2 632
96	RO		RO19	/Jiu	Zaval	M	23.845	43.842	9	30.9	10 046
97	RO		RO20	/Olt	Islaz	M	24.797	43.744	3	32	24 050
98	RO		RO21	/Ialomita	Downstream Tandarei	M	27.665	44.635	24	8.5	10 309
99	MD	L2230	MD1	/Prut	Lipcani	L	26.483	48.152	658	100	8 750
100	MD	L2270	MD3	/Prut	Conf. Danube-Giurgiulesti	LMR	28.124	45.285	0	5	27 480
101	MD		MD5	/Prut	Costesti Reservoir	L	27.145	47.513	557	91	11 800
102	MD		MD6	/Prut	Braniste	L	27.145	47.475	546	63	12 000
103	MD		MD7	/Prut	Valea Mare	L	27.515	47.075	387	55	15 200
104	UA	L0630	UA1	Danube	Reni	M			132	4	805 700
105	UA	L0690	UA2	Danube	Vylkove	M			18	1	817 000
106	UA		UA4	/Tisza	Tchop	M	22.18333	48.4167	342	92	33000
107	UA		UA5	/Tisza/Bodrog/Latoritsa	Strazh	M	22.21667	48.45	144	97	4418
108	UA		UA6	/Prut	Tarasivtsi	M	26.3364	48.834	262	122	9836
109	UA		UA7	/Siret	Porubne	M	26.0295	47.9814	100	303	2070
110	UA		UA8	/Uzh	Storozhinets	R	22.2	48.6167	106	112	1582

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

Danube River Basin District:
Transnational Monitoring Network - Surface Waters

*Surveillance Monitoring 2 provides an assessment of long-term trends of specific pollutants and of loads of substances transferred downstream the Danube.

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This ICPDR product is based on national information provided by the Contracting Parties to the ICPDR (AT, BA, BG, CZ, DE, HR, HU, MD, RO, RS, SI, SK, UA) and CH, except for the following: EuroGlobalMap v2.1 from EuroGeographics was used for national borders of AT, CZ, DE, HR, HU, MD, RO, SI, SK and UA; ESRI data was used for national borders of AL, ME, MK; data from the European Commission (Joint Research Center) was used for the outer border of the DRBD of AL, IT, ME and PL.

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2.3. Quality elements

2.3.1. Parameters indicative of selected biological quality elements

To cover pressures of basin-wide importance as organic pollution, nutrient pollution and general degradation of the river, following biological quality elements have been agreed for SM2:

- Phytoplankton (chlorophyll-a)
- Benthic invertebrates (mandatory parameters: Saprobic index and number of families once yearly, both Pantle&Buck and Zelinka&Marvan SI are acceptable; optional parameters: ASPT and EPT taxa)
- Phytobenthos (benthic diatoms – an optional parameter)

2.3.2. Priority pollutants and parameters indicative of general physico-chemical quality elements

The list of parameters for assessment of trends and loads and their monitoring frequencies are given in Table 2

Table 2: Determinand list for water for TNMN

	Surveillance Monitoring 2	
	Water	Water
	concentrations	load assessment
Parameter		
Flow	anually / 12 x per year	daily
Temperature	anually / 12 x per year	
Transparency (1)	anually / 12 x per year	
Suspended Solids (5)	anually / 12 x per year	anually / 26 x per year
Dissolved Oxygen	anually / 12 x per year	
pH (5)	anually / 12 x per year	
Conductivity @ 20 °C (5)	anually / 12 x per year	
Alkalinity (5)	anually / 12 x per year	
Ammonium (NH_4^+-N) (5)	anually / 12 x per year	anually / 26 x per year
Nitrite (NO_2^- -N)	anually / 12 x per year	anually / 26 x per year
Nitrate (NO_3^- -N)	anually / 12 x per year	anually / 26 x per year
Organic Nitrogen	anually / 12 x per year	anually / 26 x per year
Total Nitrogen	anually / 12 x per year	anually / 26 x per year
Ortho-Phosphate (PO_4^{3-} -P) (2)	anually / 12 x per year	anually / 26 x per year
Total Phosphorus	anually / 12 x per year	anually / 26 x per year
Calcium (Ca^{2+}) (3, 4, 5)	anually / 12 x per year	
Magnesium (Mg^{2+}) (4, 5)	anually / 12 x per year	
Chloride (Cl^-)	anually / 12 x per year	
Atrazine	anually / 12 x per year	
Cadmium (6)	anually / 12 x per year	
Lindane (7)	anually / 12 x per year	
Lead (6)	anually / 12 x per year	
Mercury (6)	anually / 12 x per year	
Nickel (6)	anually / 12 x per year	
Arsenic (6)	anually / 12 x per year	
Copper (6)	anually / 12 x per year	
Chromium (6)	anually / 12 x per year	
Zinc (6)	anually / 12 x per year	
p,p´-DDT and its derivatives (7)	see below	
CODCr (5)	anually / 12 x per year	
CODMn (5)	anually / 12 x per year	
Dissolved Silica		anually / 26 x per year
BOD5	anually / 12 x per year	

(1) Only in coastal waters
(2) Soluble reactive phosphorus SRP
(3) Mentioned in the tables of the CIS Guidance document but not in the related mind map
(4) Supporting parameter for hardness-dependent eqs of PS metals
(5) Not for coastal waters
(6) Measured in a dissolved form. Measurement of total concentration is optional
(7) ; In areas with no risk of failure to meet the environmental objectives for DDT and lindane the monitoring frequency is 12 x per a RBMP period; in case of risk the frequency is 12 x year

2.4. Analytical Quality Control (AQC)

The TNMN laboratories are free to choose 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 in the past for each determinand , so that method compliance can be checked. In addition, a basin-wide AQC programme is regularly organized by the ICPDR.
In 2007 the AQC programme for the Danube River Basin was organized by the Directorate of Environmental Control and Nature Conservation of VITUKI, Budapest, Hungary (QualcoDanube AQC programme). Water check samples for the analysis of general parameters, nutrients, metals, heavy metals and organic pollutants were delivered to 49 laboratories in four distributions. Furthermore sediment samples were tested for nutrients, metals, heavy metals and organic determinands.

Despite the high number of new participants, overall performance remained good in case of most of the parameters (e.g. general parameters such as chloride or potassium in surface water, COD_{Mn}, phenol index, or metals iron, calcium or manganese in sediment) or even improved compared to previous years (arsenic in surface water). For other determinands (such as nutrients Kjeldahl or ammonium nitrogen in surface water, as well as heavy metals like cadmium, chromium or nickel in both matrices), results were markedly poorer than previously. Similarly to previous years, the most problematic of analyses are those of organic pollutants, though positive change is shown for some group parameters (AOX, anionic active surfactans and phenol index).

In case of micropollutants no improvement could be observed for pesticide determinations. However, in case of micropollutants PAHs and especially PCBs, reduction in occurrence of random error is evident compared to previous years.
Detailed results of the four distributions and their evaluation have been published elsewhere (QualcoDanube, AQC in Water Analytical Laboratories in the Danube River Basin, Summary Report 2007, VITUKI, Budapest).

2.5. 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).

3. Results of basic statistical processing

141 sites at 109 TNMN monitoring stations were monitored in the Danube River Basin in 2007 (some monitoring stations contain two or three sampling sites - left, middle and/or right side of the river). The data was collected from 74 sampling sites at 44 stations on the Danube river and from 67 sampling sites at 65 stations at the tributaries.

The basic processing of the TNMN data includes the calculation of selected statistical characteristics for each determinand/monitoring site. Results are presented in tables in the Annex I 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 2007
Mean	arithmetical mean of the measurements done in the year 2007
Max	maximum value of the measurements done in the year 2007
C50	50 percentile of the measurements done in the year 2007
C90	90 percentile of the measurements done in the year 2007

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, then the value of the detection limit was used in statistical processing of the data.*
- *If the number of measurements for a particular determinand was lower than four, then only the minimum, maximum and mean are reported in the tables of the Annex.*
- *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, then 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).*

As regards the agreed monitoring frequencies (12 times per year), a significant discrepancy was reported for some monitoring locations in Bosnia and Herzegovina (4 times per year in 2007). Another persisting problem is the 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 3, created on the basis of data in tables in the Annex I, shows in an aggregated way the concentration ranges and mean annual concentrations of selected determinands in the Danube River and its tributaries in 2007. These include indicators of the oxygen regime, nutrients, heavy metals, biological determinands and organic micropollutants.
Table 3 also includes information about the number of monitoring locations and sampling sites providing measurements of the determinands.

* For some heavy metals in Table 3, the statistical values for dissolved form are in certain cases higher than those for the total content. The reason is that not all countries report on the dissolved metals which leads to differences in the processed statistical values.

Table 3: Concentration ranges and mean annual concentrations of selected determinands in the Danube River and its tributaries in 2007

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	44/72	1.9	31.5	11.4	18.0	65/67	0.4	32.5	8.8	20.4
Suspended Solids	mg/l	44/74	< 1	524	6	111	63/65	< 0.1	1826	2.25	234.4
Dissolved Oxygen	mg/l	43/71	3.9	15.7	6.2	11.3	64/66	< 0.2	17.2	4.1	11.5
BOD_5	mg/l	43/69	< 0.2	13.4	0.8	7.5	65/67	< 0.2	32.0	1.0	12.5
COD_{Mn}	mg/l	37/63	1.1	27.6	2.0	18.6	40/40	< 0.3	64.0	1.4	25.6
COD_{Cr}	mg/l	36/64	2.3	68.0	4.0	27.3	56/58	1.9	120.0	3.1	48.3
TOC	mg/l	34/41	0.7	16.4	1.7	6.8	24/24	0.7	33.4	1.4	8.4
DOC	mg/l	6/6	1.2	4.9	2.0	3.0	3/3	0.7	5.0	1.5	4.2
pH		44/72	3.7	8.9	7.7	8.5	59/59	6.5	9.1	7.1	8.5
Alkalinity	mmol/l	36/62	1.1	18.7	1.6	4.5	54/56	0.9	18.9	1.3	5.5
Ammonium-N	mg/l	43/73	< 0.01	1.05	0.03	0.45	65/67	0.01	7.79	0.01	4.37
Nitrite-N	mg/l	44/74	<0.002	0.280	0.003	0.049	65/67	< 0.0003	0.460	0.003	0.101
Nitrate-N	mg/l	44/74	< 0.05	5.90	0.92	3.24	65/67	0.03	29.57	0.25	8.04
Total Nitrogen	mg/l	28/51	0.6	5.4	1.2	3.3	47/49	< 0.3	8.3	0.7	5.4
Organic Nitrogen	mg/l	27/32	0.01	5.00	0.13	3.20	41/43	0.01	3.84	0.10	1.99
Ortho-Phosphate-P	mg/l	41/71	0.002	0.794	0.011	0.782	59/61	< 0.002	1.130	0.007	1.484
Total Phosphorus	mg/l	40/68	<0.01	1.64	0.046	0.57378	52/54	< 0.003	2.138	0.014	0.723
Total Phosphorus - Dissolved	mg/l	9/10	0.0060	0.0900	0.0320	0.0548	17/17	< 0.005	0.308	0.011	0.135
Chlorophyll-a	µg/l	36/46	0.10	110.20	2.00	39.38	39/41	0.03	250.00	0.30	74.46
Conductivity @ 20°C	µS/cm	44/70	241	951	347	495	57/58	31	2250	46	1613
Calcium	mg/l	37/63	33.8	96.0	45.0	82.8	54/56	23.0	108.2	29.9	85.6
Sulphates	mg/l	35/57	<1.0	111.0	2.6	57.0	45/45	1.0	148.0	14.6	133.4
Magnesium	mg/l	37/63	5.0	72.4	11.4	48.4	54/56	2.6	76.0	5.1	40.1
Potassium	mg/l	31/54	0.5	62.1	1.9	56.3	29/29	0.1	17.5	1.1	9.2
Sodium	mg/l	32/54	5.0	73.5	9.0	26.2	35/35	<0.12	77.00	5.15	51.82
Manganese	mg/l	29/43	< 0.001	0.462	0.009	0.124	36/36	< 0.001	1.29	0.01	0.24
Iron	mg/l	30/44	< 0.01	3.40	0.02	1.27	35/35	0.02	10.44	0.04	2.12
Chlorides	mg/l	43/71	7.4	236.6	14.0	51.7	55/57	2.0	341.0	5.7	243.3
Silicates (SiO2)	mg/l	11/31	0.003	13.720	0.004	7.051	4/6	0.002	23.374	0.007	8.715
Macrozoobenthos- saprobic index		12/12	2.0	2.5	2.0	2.5	19/19	1.2	2.3	1.0	2.3
Macrozoobenthos - no.of taxa		11/11	13	48	16	48	15/15	1	63	2.5	63

Table 3: Concentration ranges and mean annual concentrations of selected determinands in the Danube River and its tributaries in 2007 (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	20/42	< 0.8	28.0	2.6	20.0	42/44	< 0.5	316	1	163.75
Copper - Dissolved	µg/l	21/43	< 0.5	30.2	1.0	8.1	44/46	0.01	65	0.01	18.9
Chromium - Dissolved	µg/l	19/42	< 0.1	8.0	0.2	2.6	42/44	< 0.06	51	0.23	24.5
Lead - Dissolved	µg/l	19/39	0.1	7.0	0.7	1.9	34/36	< 0.05	109	0.09	49.25
Cadmium - Dissolved	µg/l	19/40	< 0.046	3.70	0.01	1.39	33/35	< 0.006	3.6	0.011	0.97
Mercury - Dissolved	µg/l	21/45	< 0.01	19.10	0.02	1.68	27/29	< 0.01	3	0.01	0.5
Nickel - Dissolved	µg/l	21/43	< 0.2	5.0	0.6	5.0	35/37	< 0.14	16.9	0.22	5.2
Arsenic - Dissolved	µg/l	21/43	0.4	7.6	0.6	3.0	32/34	< 0.2	13	0.47	5.99
Aluminium - Dissolved	µg/l	7/17	< 7	180.0	19.0	59.6	2/2	47	108	60.11	71.59
Zinc *	µg/l	30/44	< 0.8	791.0	2.6	20.0	40/40	< 1.0	3025.0	< 1.0	181.0
Copper	µg/l	30/44	< 0.7	193.0	1.0	46.3	41/41	0.3	240.0	< 1.0	41.4
Chromium - total	µg/l	31/44	< 0.6	21.0	0.7	10.0	37/37	< 0.05	100.00	0.61	32.50
Lead	µg/l	27/41	0.08	132.00	0.80	18.76	34/34	< 0.05	109.00	0.65	49.25
Cadmium	µg/l	26/40	< 0.09	9.00	0.10	2.71	33/33	< 0.006	38.000	0.019	5.023
Mercury	µg/l	20/30	< 0.01	1.50	0.06	0.25	25/25	< 0.005	1.000	0.009	0.500
Nickel	µg/l	26/33	< 0.7	104.0	1.0	16.8	30/30	0.5	105.0	0.5	24.8
Arsenic	µg/l	24/28	< 0.02	19.00	0.81	4.32	27/27	< 0.01	12.00	0.38	7.00
Aluminium	µg/l	8/18	< 20	1400	20	257	4/4	< 20	1410	163	398
Phenol index	mg/l	29/38	< 0.001	0.110	< 0.001	0.022	36/36	< 0.0008	0.2810	< 0.0008	0.0640
Anionic active surfactants	mg/l	30/54	< 0.005	0.350	< 0.010	0.228	40/40	< 0.005	0.500	< 0.010	0.190
AOX	µg/l	9/9	< 2	35.5	7.19167	17.74	5/5	8.9	45.0	10.0	22.5
Petroleum hydrocarbons	mg/l	19/43	< 0.002	1.000	0.008	0.344	27/27	< 0.002	34	< 0.0055	3.12178
PAH (sum of 6)	µg/l	0/0					0/0				
PCB (sum of 7)	µg/l	0/0					3/3	< 0.01	< 0.01	< 0.01	< 0.01
Lindane	µg/l	24/50	< 0.001	< 0.05	< 0.001	< 0.05	31/33	< 0.0005	2.46	< 0.0005	0.400
pp´DDT	µg/l	26/45	< 0.001	0.0550	< 0.001	< 0.05	39/41	< 0.0005	0.055	< 0.0005	< 0.05
Atrazine	µg/l	26/41	< 0.001	0.5000	0.0010	0.5000	31/33	< 0.001	0.890	< 0.006	0.500
Chloroform	µg/l	16/39	< 0.01	226.952	0.010	23.190	12/12	< 0.01	7.80	< 0.01	3.11
Carbon tetrachloride	µg/l	13/35	< 0.01	3.311	< 0.01	0.576	8/8	< 0.01	0.61	< 0.01	0.30
Trichloroethylene	µg/l	14/36	< 0.01	4.452	0.014	0.646	11/11	< 0.01	0.40	< 0.01	0.40
Tetrachloroethylene	µg/l	14/36	< 0.01	0.250	0.020	0.250	8/8	< 0.01	0.25	0.02	0.25

4. Profiles and trend assessment of selected determinands

The 90 percentiles (C90) of selected determinands (dissolved oxygen, BOD_5, CODcr, $N\text{-}NH_4$, $N\text{-}NO_3$, $P\text{-}PO_4$, Ptotal and Cd) measured in last ten years are displayed in the Figures 4.1-4.16. Due to revision of the TNMN in 2006 following monitoring points on the Danube were replaced : AT2 rkm 2120 to AT5 rkm 2113, AT4 rkm 1874 to AT6 rkm 1879, DE1 rkm 2581 to DE5 rkm 2538. Among tributaries the site HR3 rkm 288 was replaced by HR9 rkm 300 BG8 rkm 54 to BG14 rkm 4 and BG8 rkm 13 to BG15 rkm 1.
To indicate the long-term trends in the upper, middle and lower Danube a more detailed analysis for selected parameters (BOD_5, $N\text{-}NO_3$, Ptotal) is provided for the sites SK1 Bratislava, HU5 Hercegszanto and RO5 Reni (Figures 4.26-4.33).

As regards a general spatial distribution of key water quality parameters along the Danube River in 2007, the highest concentrations of biodegradable organic matter were observed in the middle and lower parts of the river, while ammonium-N, ortho-phosphate P, total P and cadmium reached their highest concentration values in the lower part of the Danube. The concentration of nitrate-N was highest in the upper Danube. Sio, Morava, Jantra, Russenski Lom, Siret and Prut were the tributaries showing the highest polution by the biodegradable organic matter in 2007. Arges, Russenski Lom, Jantra and Siret had elevated levels of nutrients in 2007.

The highest values of dissolved oxygen were observed in the upper part of the Danube while in the lower Danube dissolved oxygen levels decrease (Figure 4.1).

Taking into account the entire period of TNMN operations positive changes in water quality can be seen at several TNMN stations. A decrease of biodegradable organic matter has been recorded in the upper Danube and at some stations of the lower Danube (Bazias, Pristol, Reni and in the delta, see Figure 4.3). The BOD levels in the tributaries Dyje, Inn, Sava, Arges, Siret and Vah have also a decreasing tendency (Figure 4.4). In all representative monitoring points (SK1-Bratislava, HU5 Hercegszanto and RO5 Reni) has BOD decreasing tendency in last years (Figure 4.17-4.19).

Concerning nutrients, a decreasing concentration of ammonium-N was recorded in the upper Danube. During the entire period of TNMN operation, concentration of ammonium was decreasing in the upper Danube tributaries (Inn, Salzach, Morava, Dyje) as well as in the Sava and Siret rivers (see Figure 4.8).

The level of nitrate-N concentrations is rather stable during recent years. However a decrease was observed at several stations in the upper and middle Danube (Figure 4.9). Among tributaries nitrate-N has a decreasing tendency in the tributaries Dyje, Vah, Tisza/Sajo, Sio, Sava and Arges (Figure 4.10). The nitrate-N concentrations are relatively stable in the representative sites SK1-Bratislava, HU5 Hercegszanto and RO5 Reni (Figure 4.20-4.22).

In the last decade a decreasing tendency of ortho-phosphate-P concentrations is mostly seen in the upper part of the Danube (Figure 4.11) and it was observed also in the tributaries Morava, Vah, Sio and Siret (Figure 4.12).
P-total concentrations also declined in the last decade in the upper Danube (Figure 4.13) and in the tributaries Morava, Inn, Russenski Lom, Tisza and Sava (see Figure 4.14). In all representative monitoring points (SK1-Bratislava, HU5 Hercegszanto and RO5 Reni) P-total concentration has decreasing tendency over the last decade (Figure 4.23-4.25).

The cadmium concentration is constant or slightly decreasing in the whole Danube river as well as in its tributaries (Figures 4.15 and 4.16). Small deviation was observed in Serbian part of Danube for the year 2007.

The 90 and 10 percentiles of selected determinands (N-NH_4, P-PO_4, CODcr, BOD_5) measured in 2007 are displayed in the Figures 4.26-4.33. They indicate the margins of a usual annual concentration range for a given parameter and site. In graphs for tributaries there are rkm of Danube, where tributary discharge to the Danube river.

From Figure 4.26 it is apparent that lower concentrations of N-NH_4 were observed in the upper part of Danube. Among tributaries the highest values were observed in Bega and Arges (Figure 4.27).
The highest values of percentiles of P-PO_4 were observed in the lower and middle part of the Danube (Figure 4.28). As well as in the following tributaries: Dyje, Bega, Latoritsa, Iskar, Vit, Olt, Jantra (Figure 4.29).
As has been shown in Figure 4.30 the maximal values of COD_{cr} percentiles were found in the lower Danube and in tributaries Tisza, Iskar, Vit and Ialomita (Figure 4.31).

The highest values of BOD_5 were in lower part of Danube in Bulgarians monitoring points BG1, BG2 and BG11 (Figure 4.32). In tributaries the highest values were observed in Morava, Sio, Bega, Jiu, Iskar, Vit (Figure 4.33).

As regards the annual differences between C90 and C10 an insignificant variation was observed for N-NH_4 and P-PO_4 in the upper Danube and in the upper and middle section tributaries. Small differences were recorded for BOD_5 in the tributaries. The significant differences were observed for COD_{cr} and BOD_5 along the whole Danube and for N-NH_4 and P-PO_4 in the middle and lower Danube. Large variation of N-NH_4 and P-PO_4 was also observed in the lower Danube tributaries (for P-PO_4 also in Bega, Dyje and Latoritsa). For COD_{cr} 10 and 90 percentiles differed reasonably in majority of the Danube tributaries.

Figure 4.1.: Temporal changes of dissolved oxygen (c10) in the Danube river.

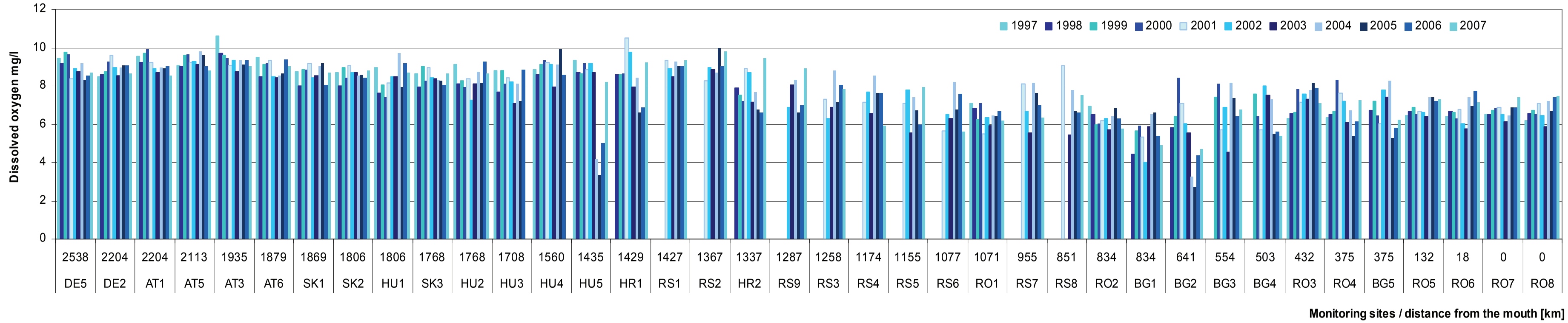


Figure 4.2.: Temporal changes of dissolved oxygen (c10) in tributaries.

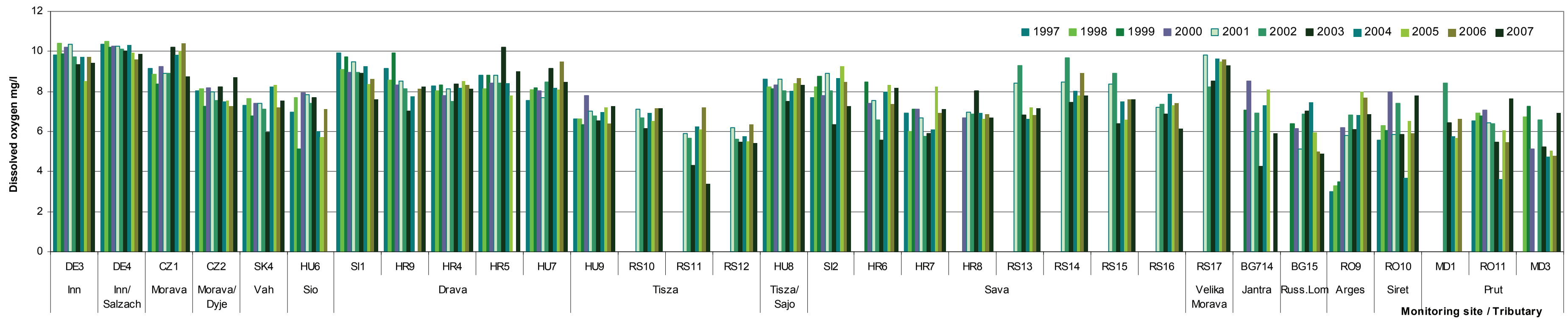


Figure 4.3.: Temporal changes of BOD_5 (c90) in the Danube river.

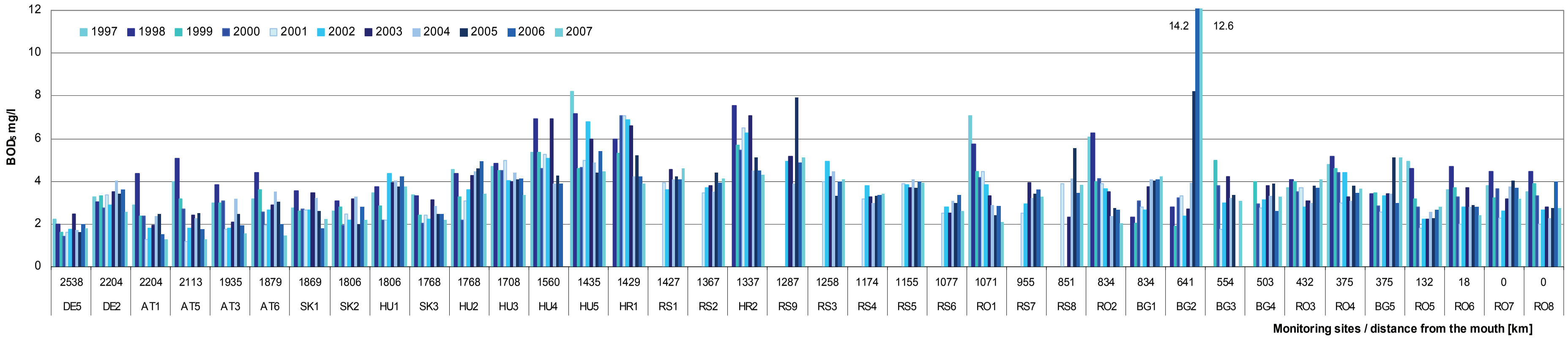


Figure 4.4.: Temporal changes of BOD_5 (c90) in tributaries.

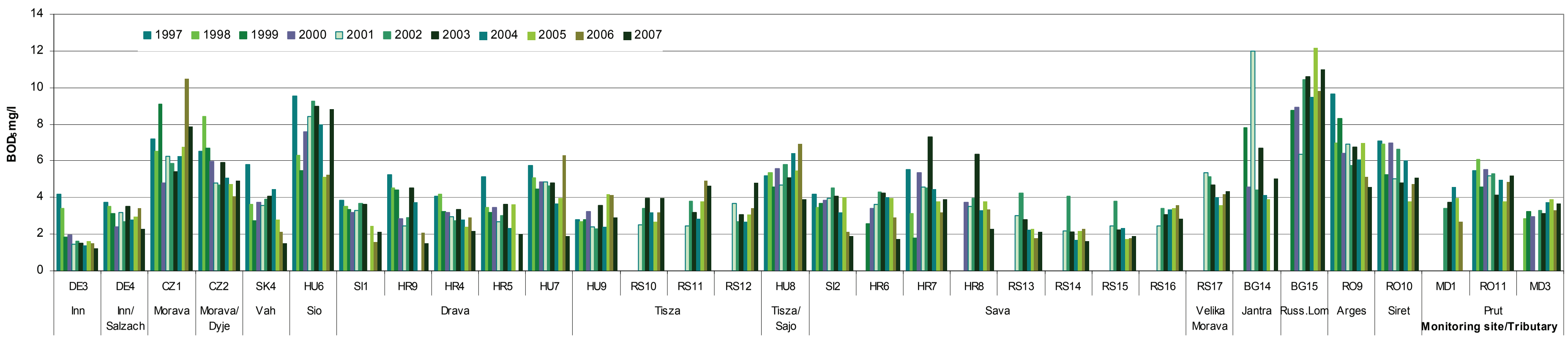


Figure 4.5.: Temporal changes of COD_{Cr} (c90) in the Danube river.

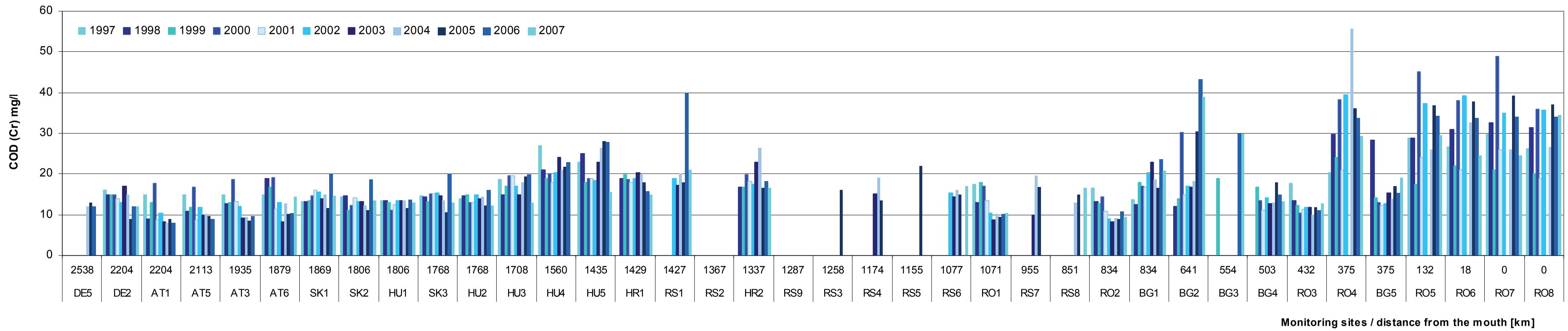


Figure 4.6.: Temporal changes of COD_{Cr} (c90) in tributaries.

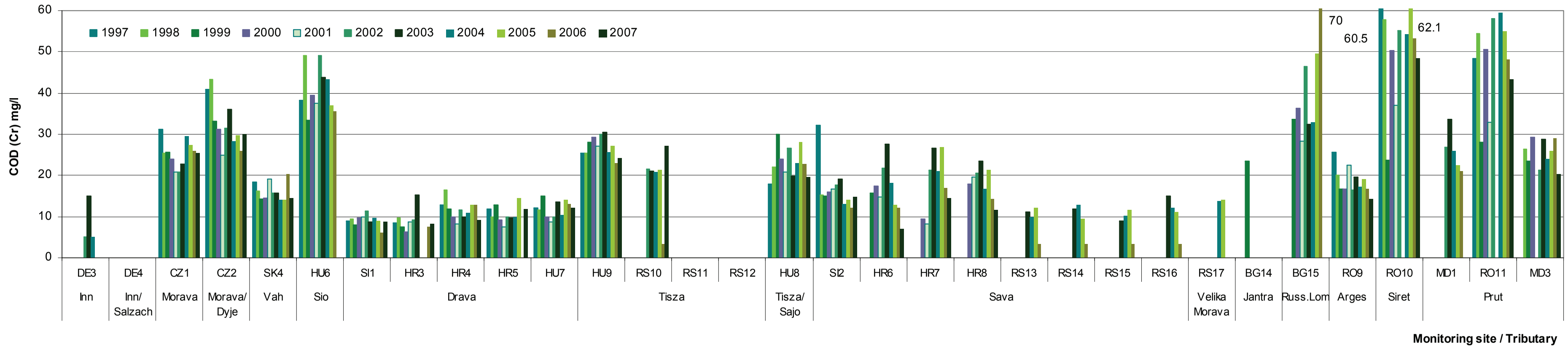


Figure 4.7.: Temporal changes of ammonium-nitrogen (c90) in the Danube river.

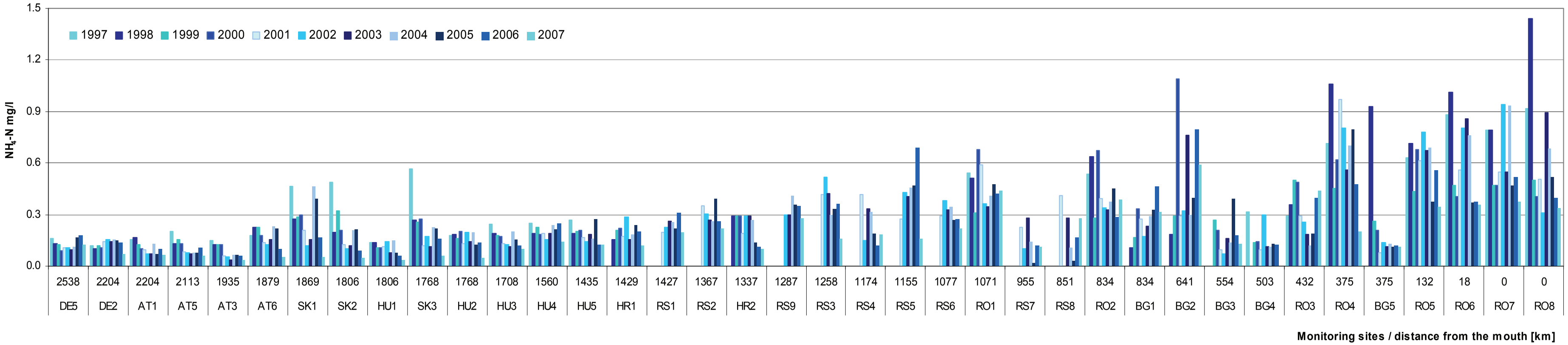


Figure 4.8.: Temporal changes of ammonium-nitrogen (c90) in tributaries.

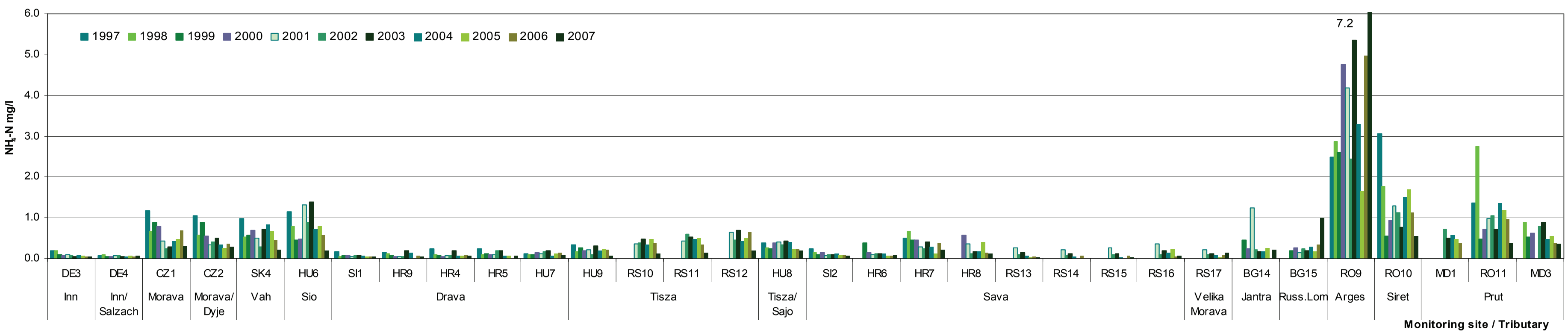


Figure 4.9.: Temporal changes of nitrate-nitrogen (c90) in the Danube river.

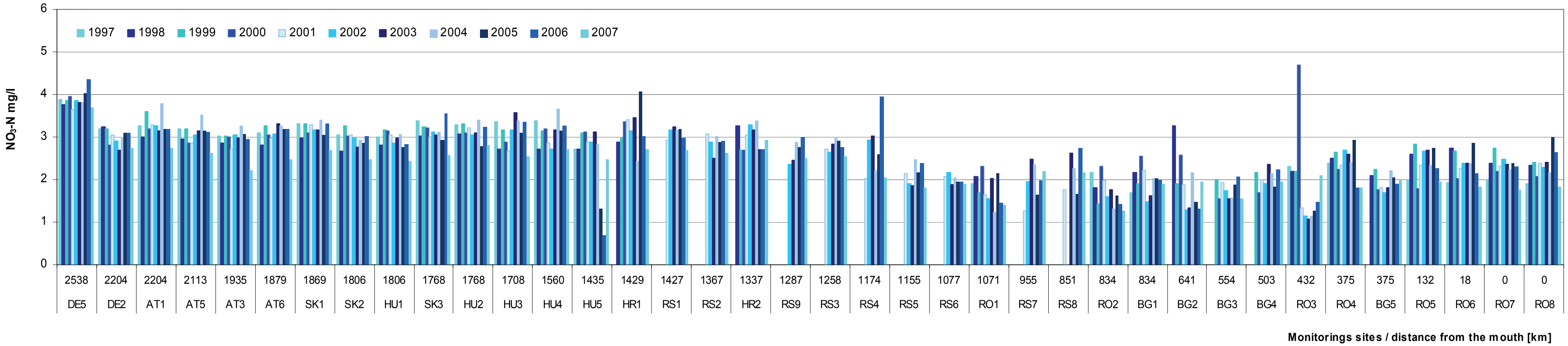


Figure 4.10.: Temporal changes of nitrate-nitrogen (c90) in tributaries.

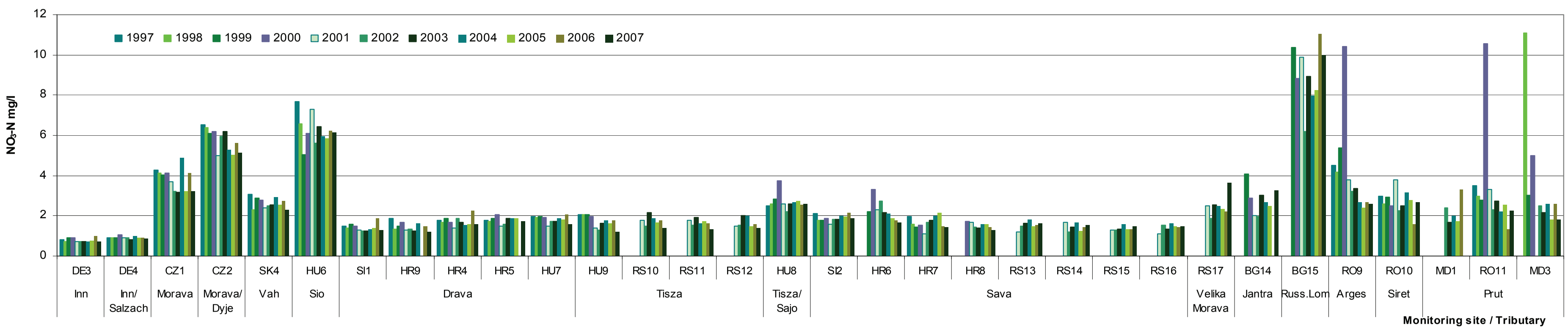


Figure 4.11: Temporal changes of ortho-phosphate-phosphorus (c90) in the Danube river.

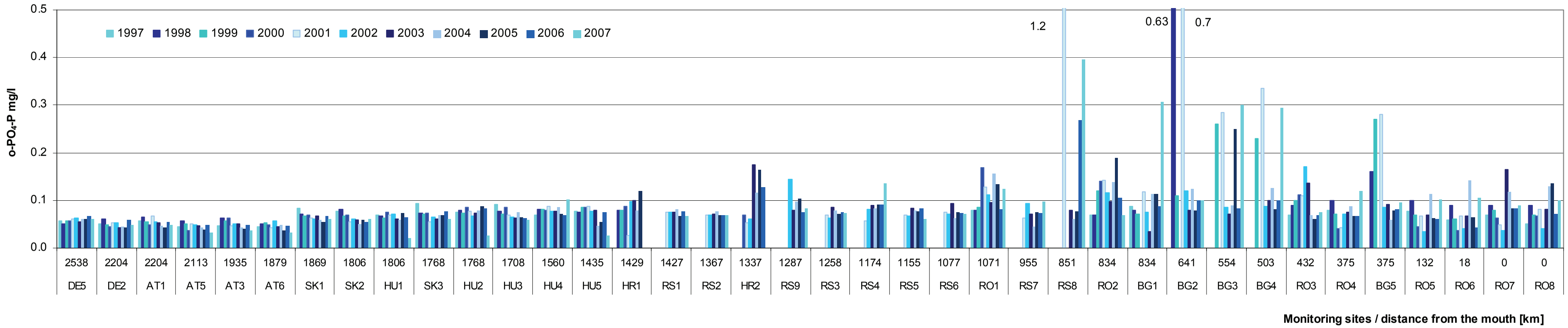


Figure 4.12: Temporal changes of ortho-phosphate-phosphorus (c90) in tributaries

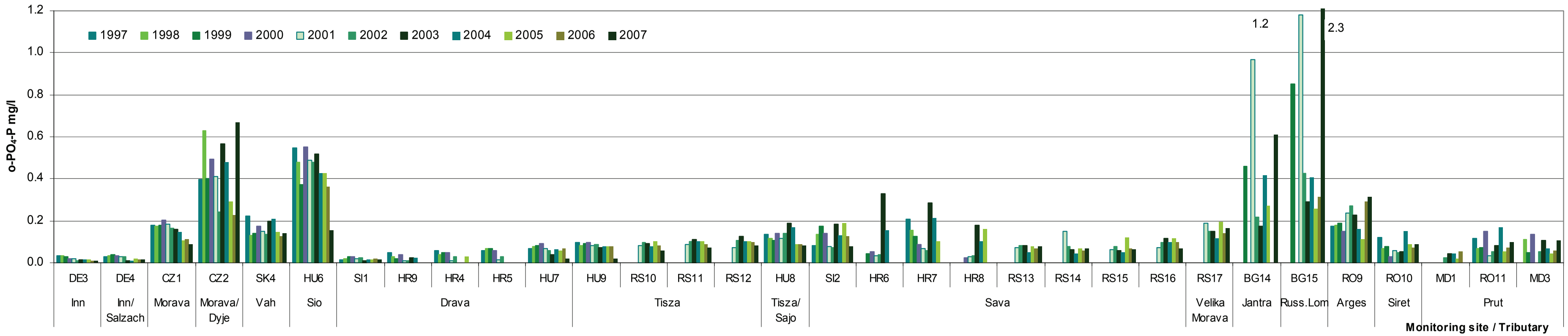


Figure 4.13: Temporal changes of total phosphorus (c90) in the Danube river.

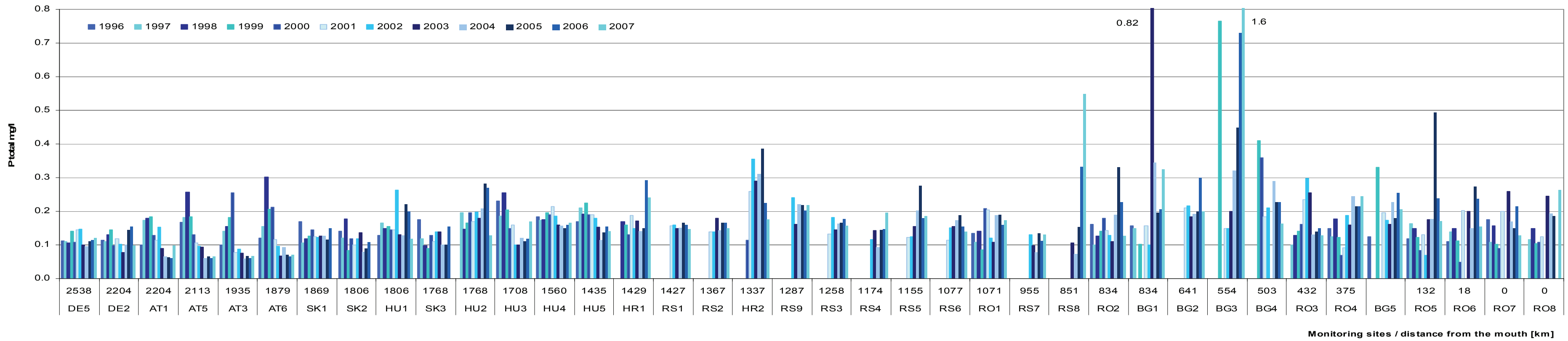


Figure 4.14: Temporal changes of total phosphorus (c90) in tributaries.

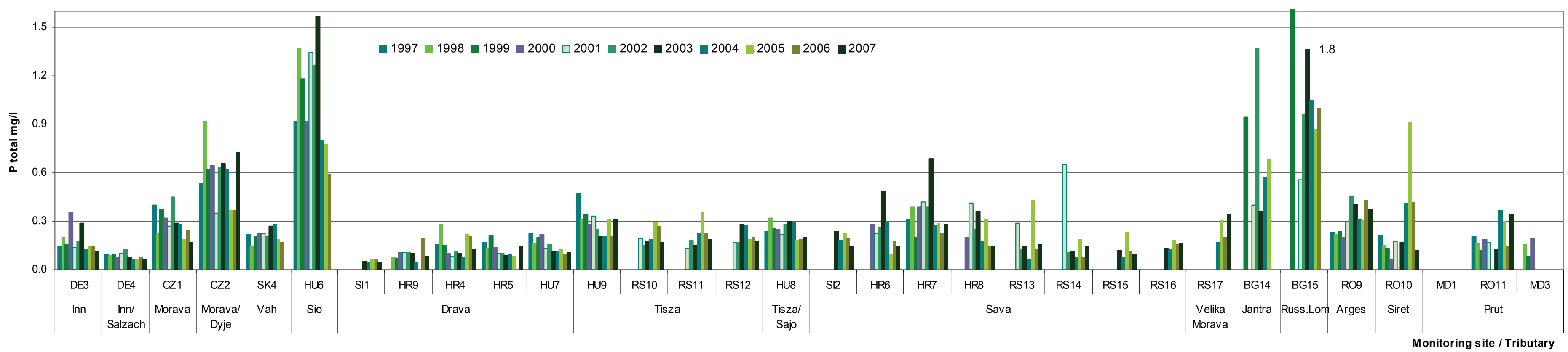


Figure 4.15: Temporal changes of cadmium (c90) in the Danube river.

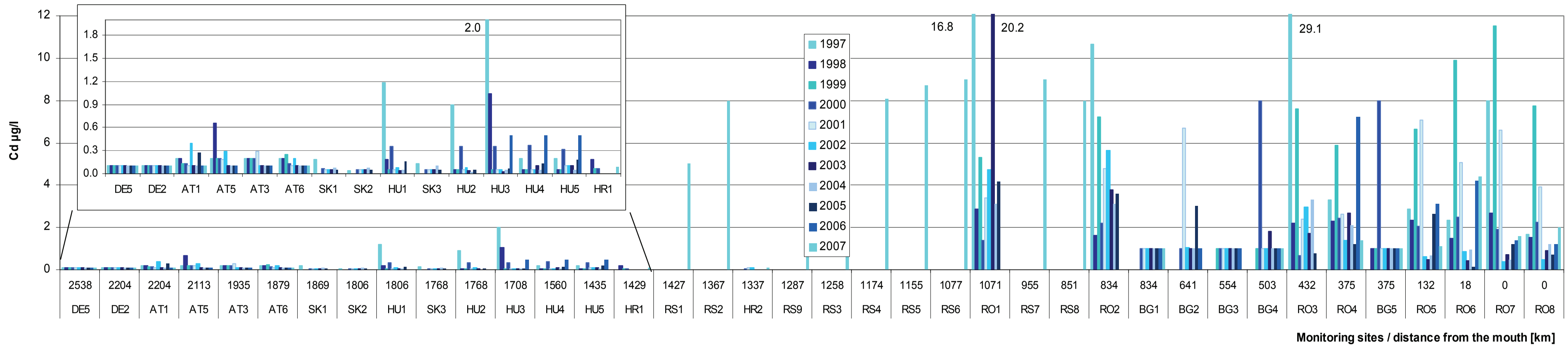


Figure 4.16: Temporal changes of cadmium (c90) in tributaries.

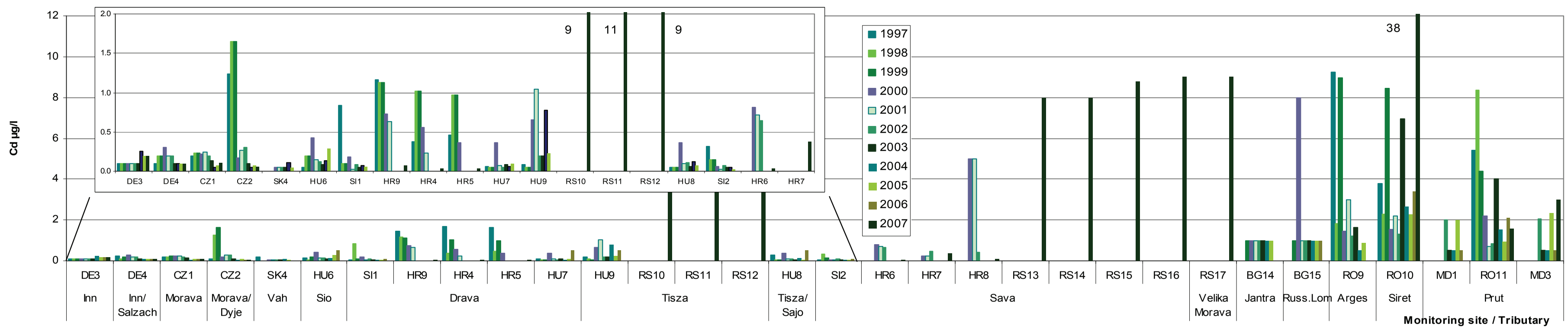


Figure 4.17: Temporal changes of BOD_5 (c90) in Bratislava

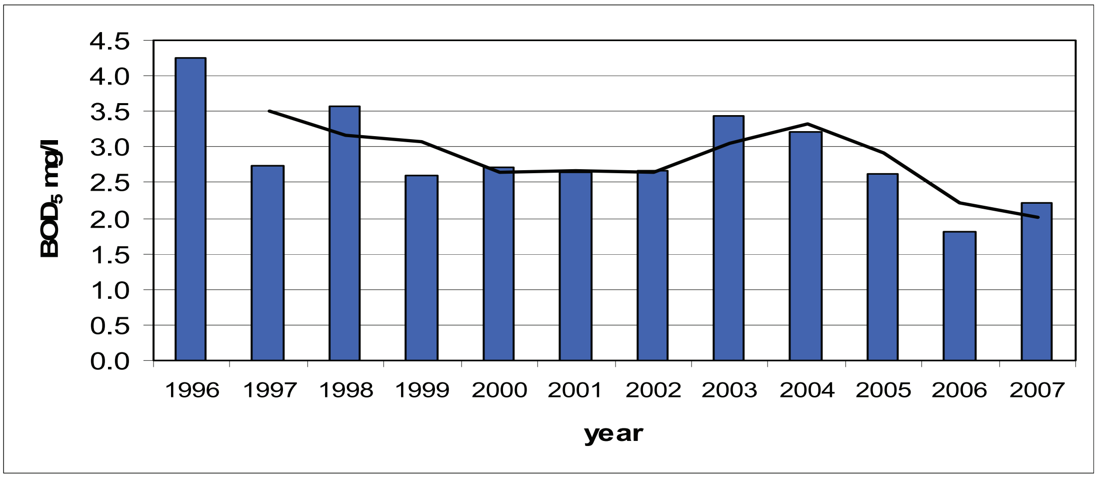


Figure 4.18: Temporal changes of BOD_5 (c90) in Hercegszanto

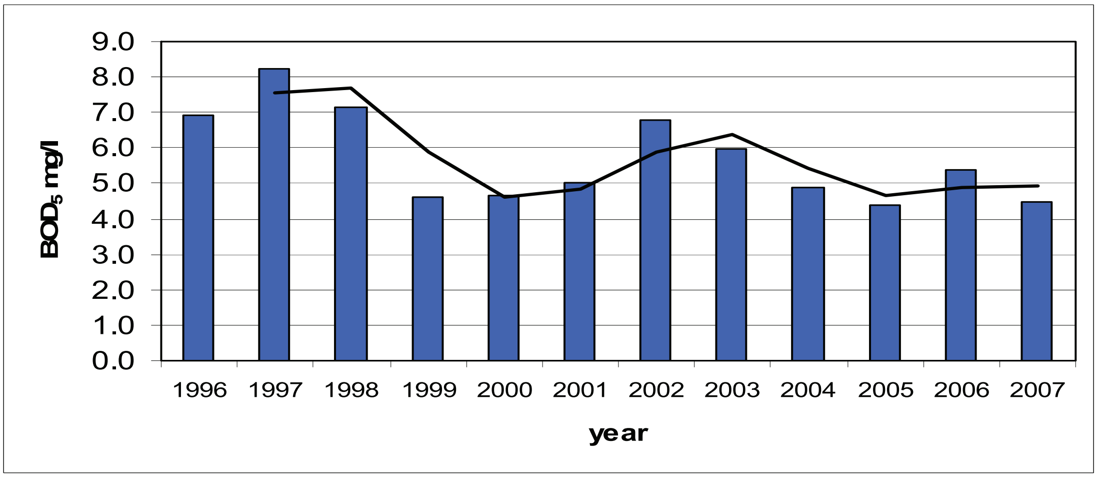


Figure 4.19: Temporal changes of BOD_5 (c90) in Reni

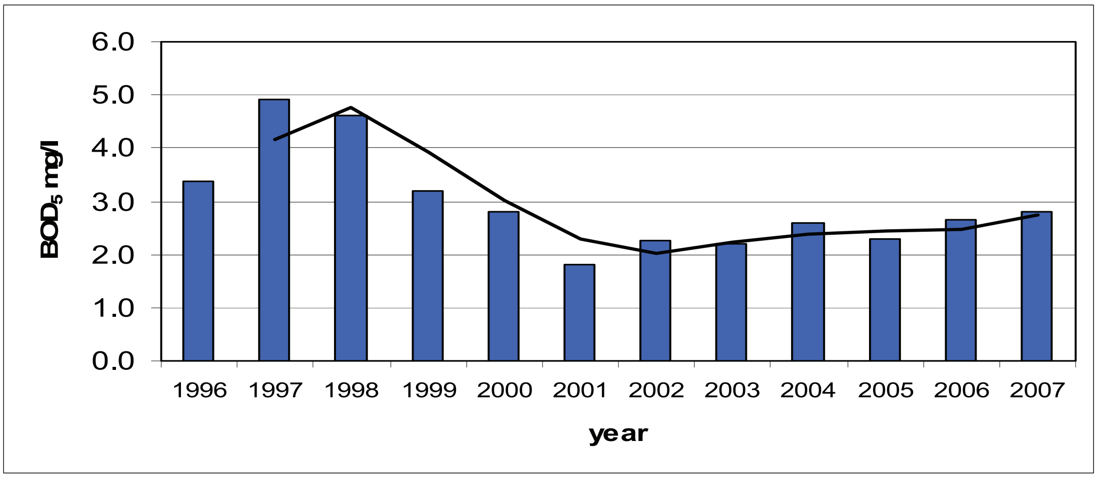


Figure 4.20: Temporal changes of nitrate-nitrogen (c90) in Bratislava

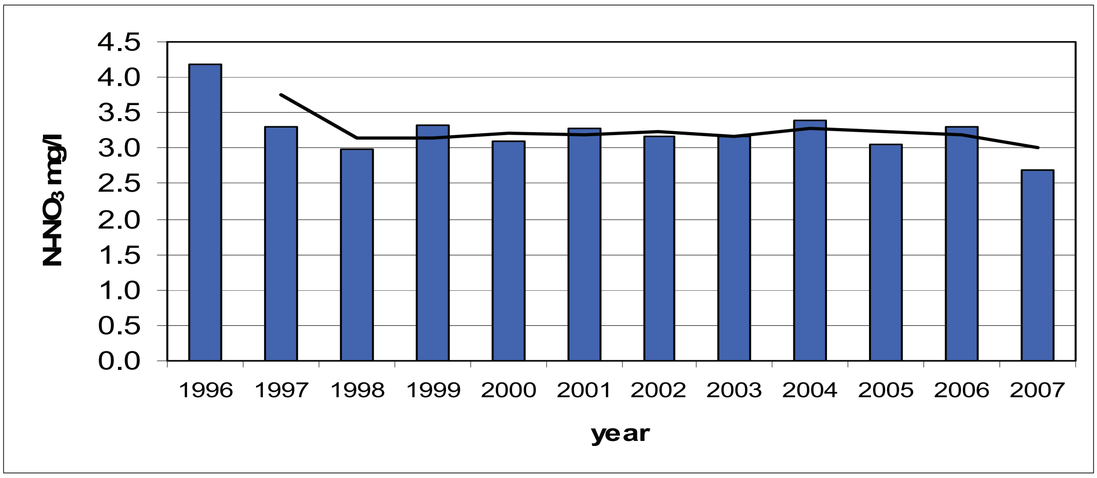


Figure 4.21: Temporal changes of nitrate-nitrogen (c90) in Hercegszanto

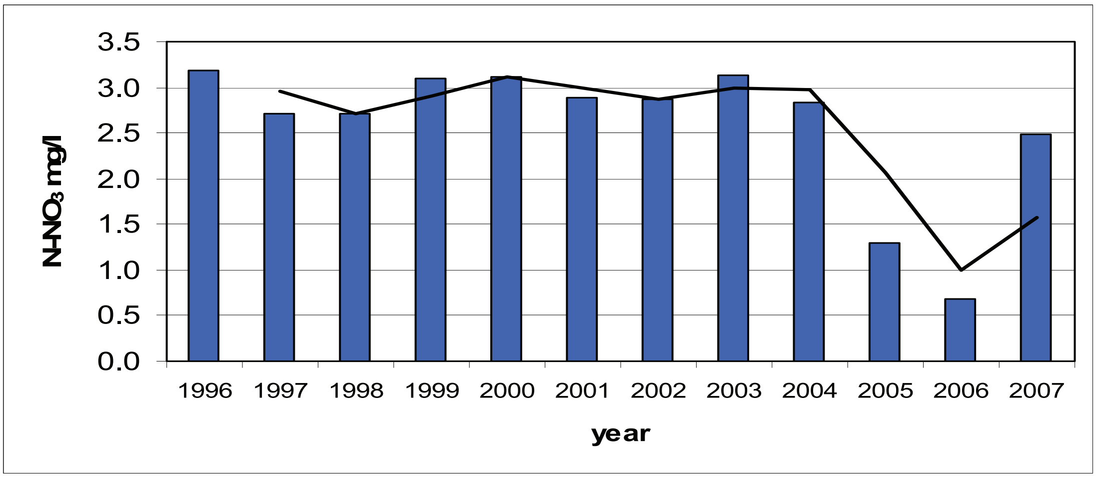


Figure 4.22: Temporal changes of nitrate-nitrogen (c90) in Reni

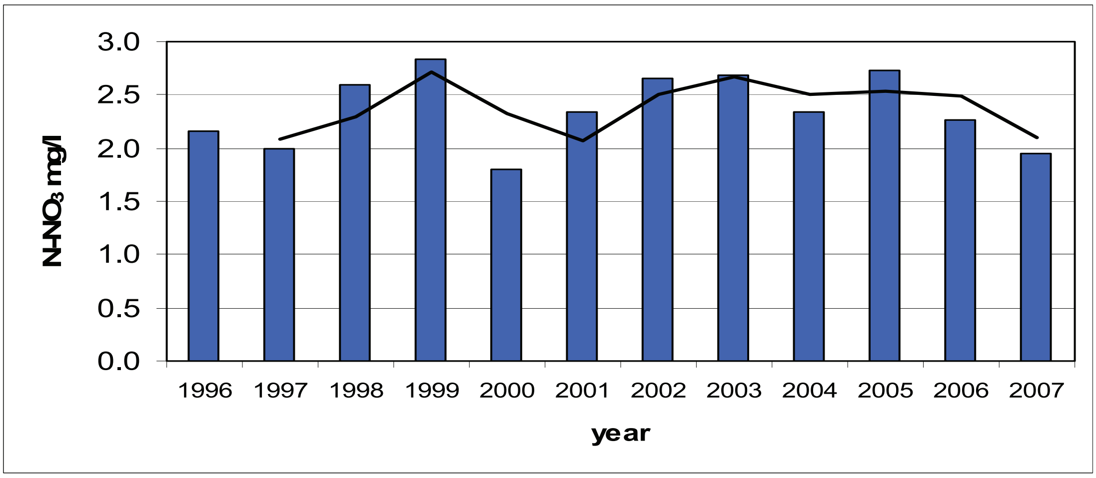


Figure 4.23: Temporal changes of total phosphorus (c90) in Bratislava

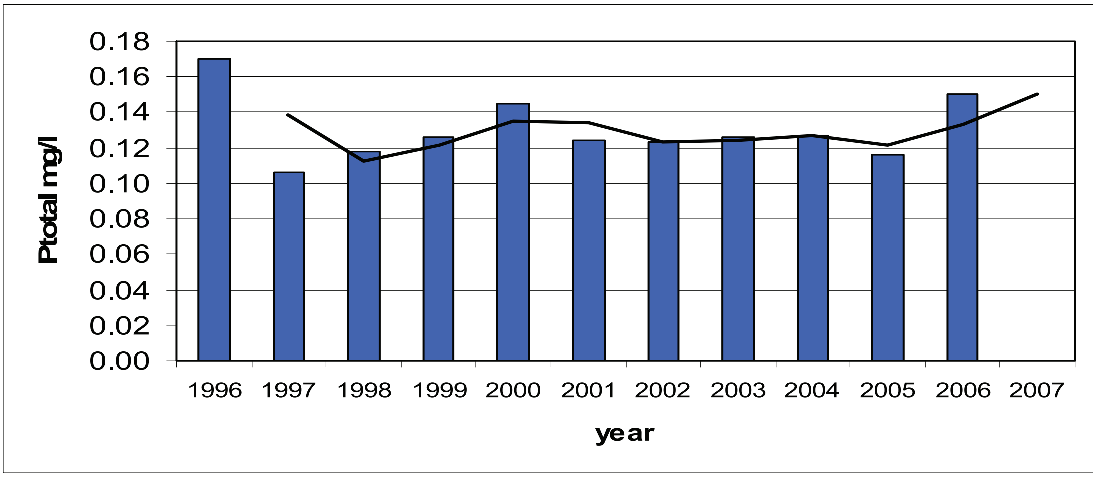


Figure 4.24: Temporal changes of total phosphorus (c90) in Hercegszanto

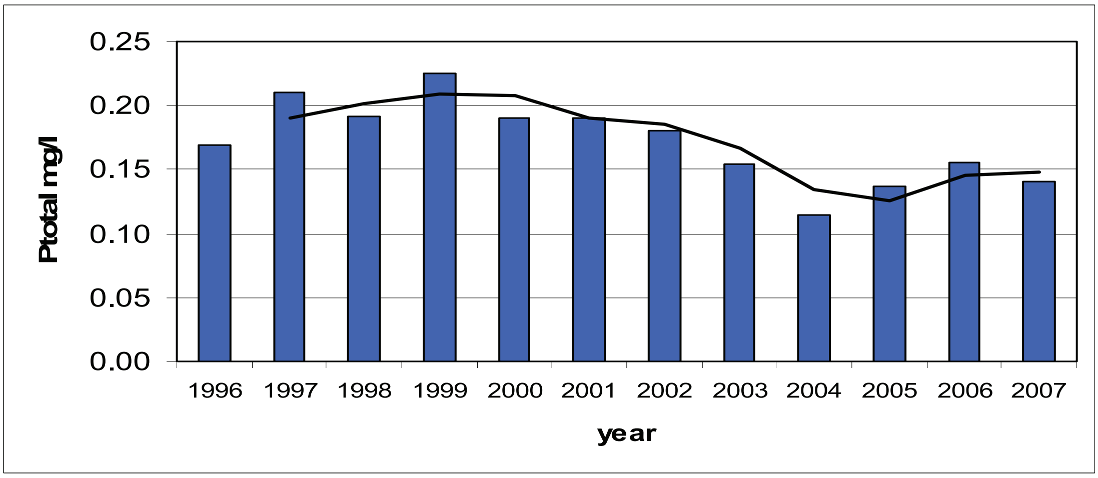


Figure 4.25: Temporal changes of total phosphorus (c90) in Reni

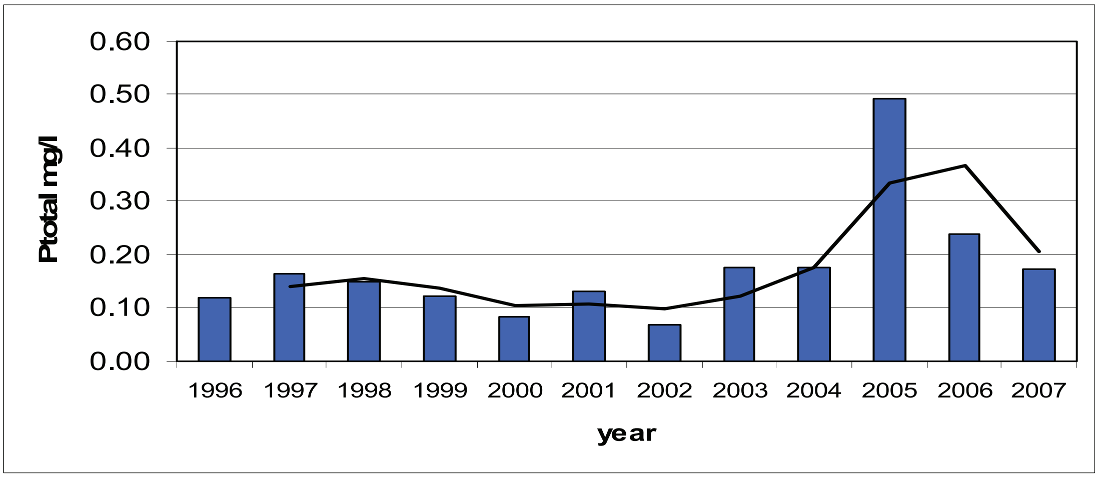


Figure 4.26: The percentile (90, 10) of N-NH$_4$ concentration along the Danube river in 2007.

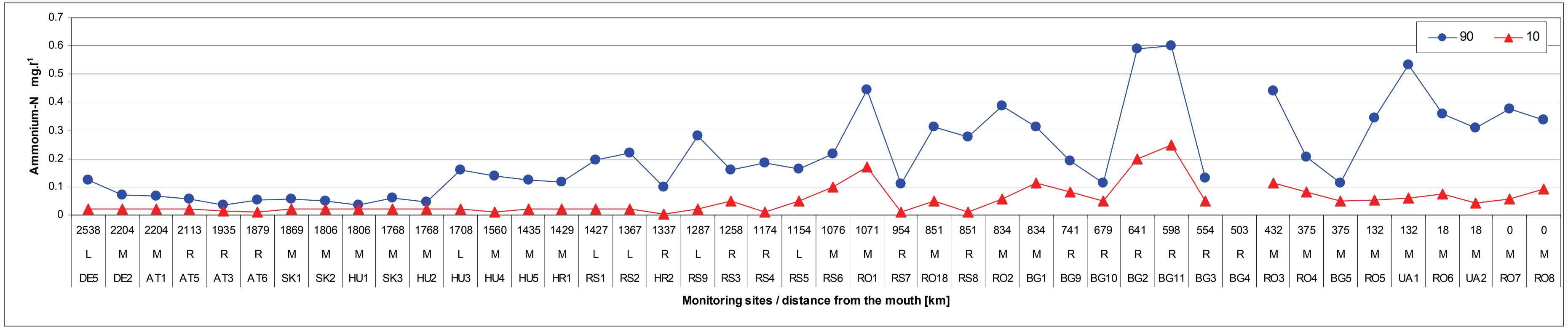


Figure 4.27: The percentile (90, 10) of N-NH$_4$ concentration in the tributaries in 2007.

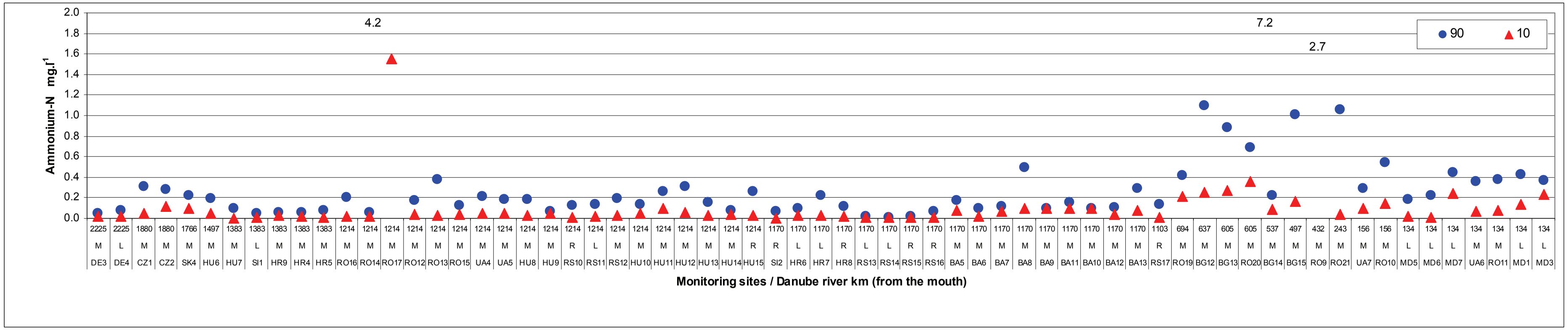


Figure 4.28: The percentile (90, 10) of P-PO_4 concentration along the Danube river in 2007.

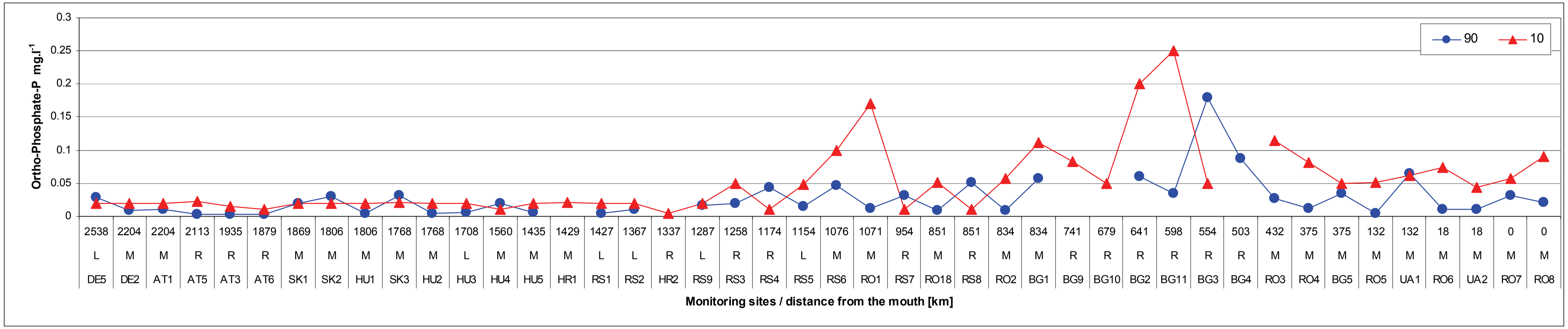


Figure 4.29: The percentile (90, 10) of P-PO_4 concentration in the tributaries in 2007.

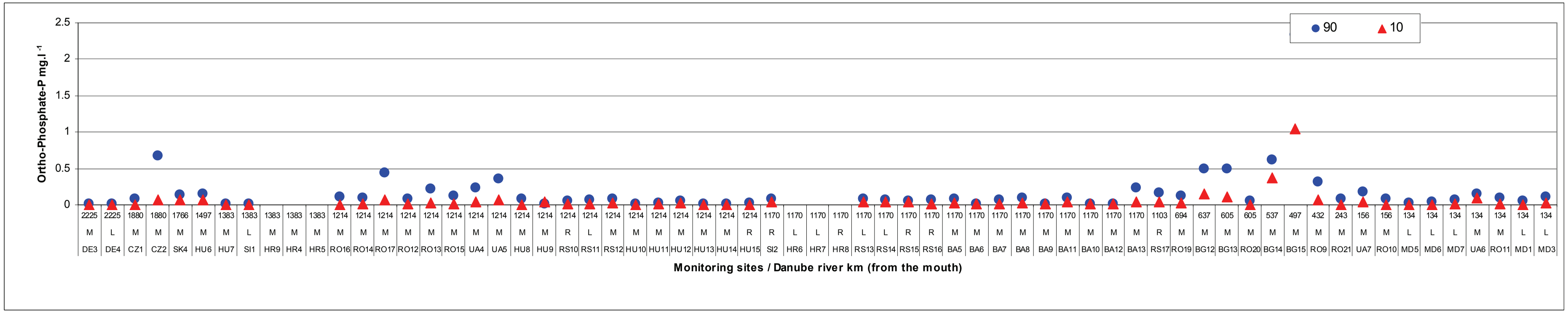


Figure 4.30: The percentile (90, 10) of COD_{cr} concentration along the Danube river in 2007.

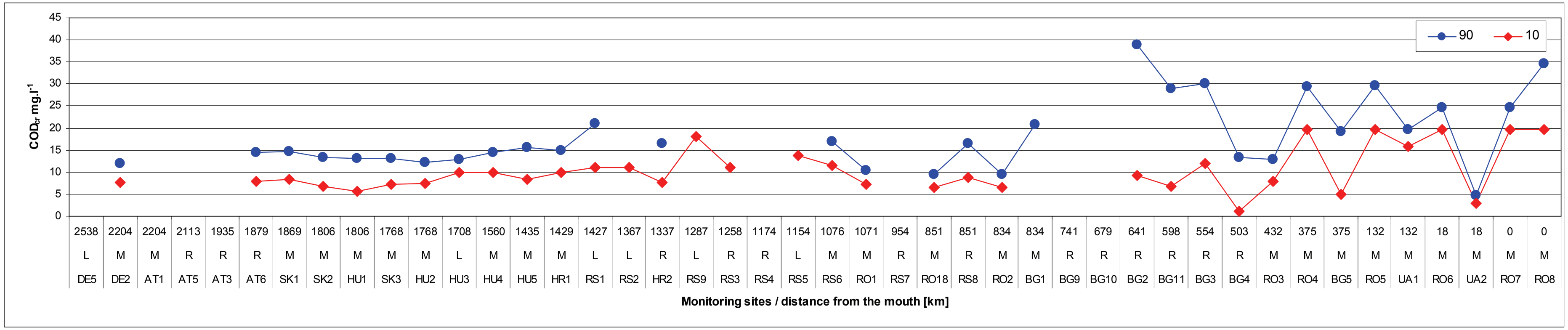


Figure 4.31: The percentile (90, 10) of COD_{cr} concentration in the tributaries in 2007.

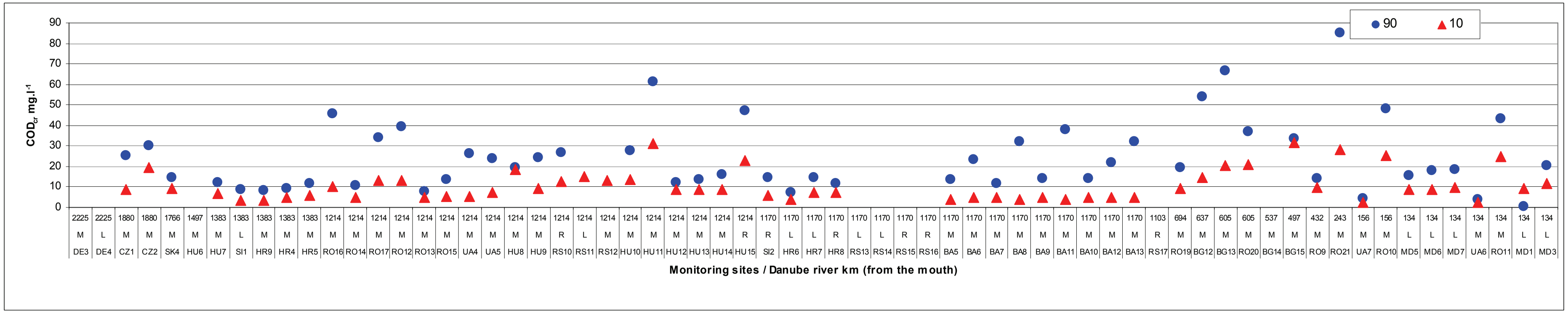


Figure 4.32: The percentile (90, 10) of BOD_5 concentration along the Danube river in 2007.

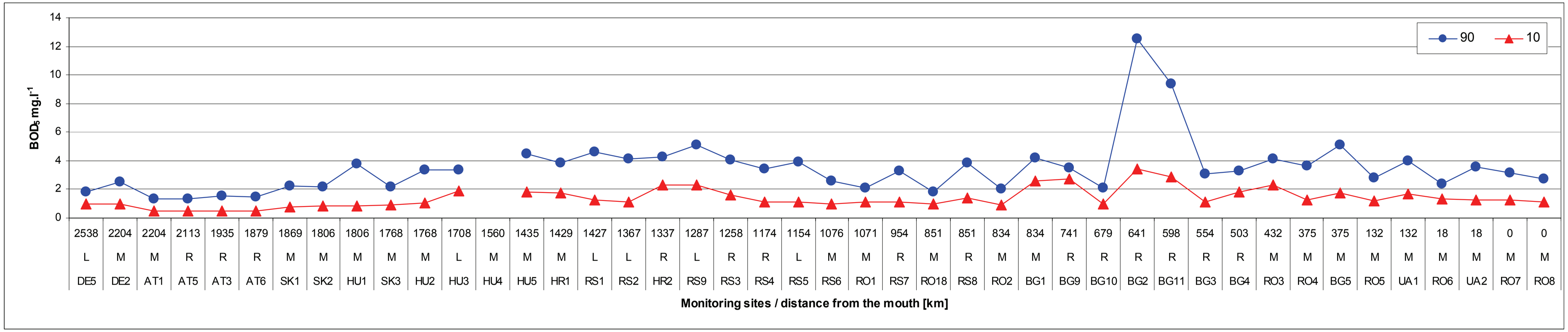


Figure 4.33: The percentile (90, 10) of BOD_5 concentration in the tributaries in 2007.

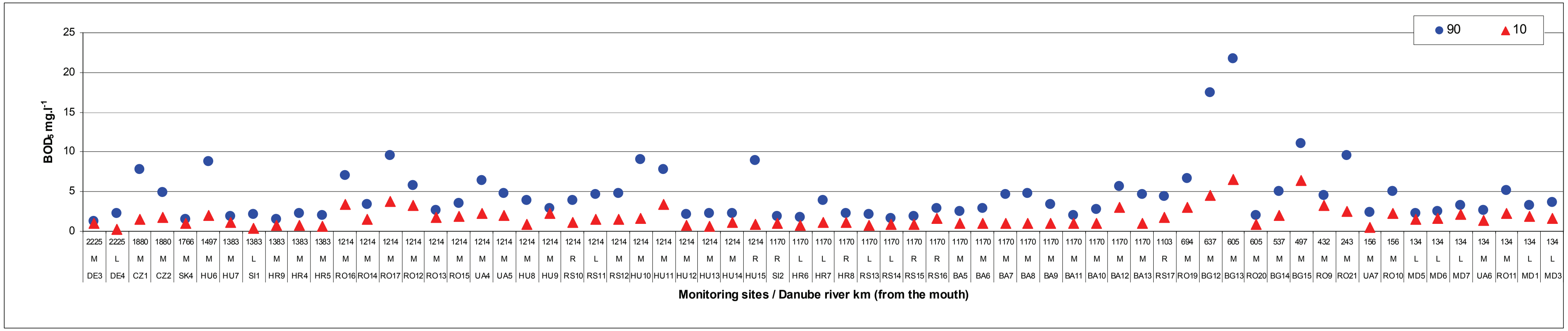


Figure 4.34: The maximum of Macrozoobenthos- saprobic index along the Danube river in 2007.

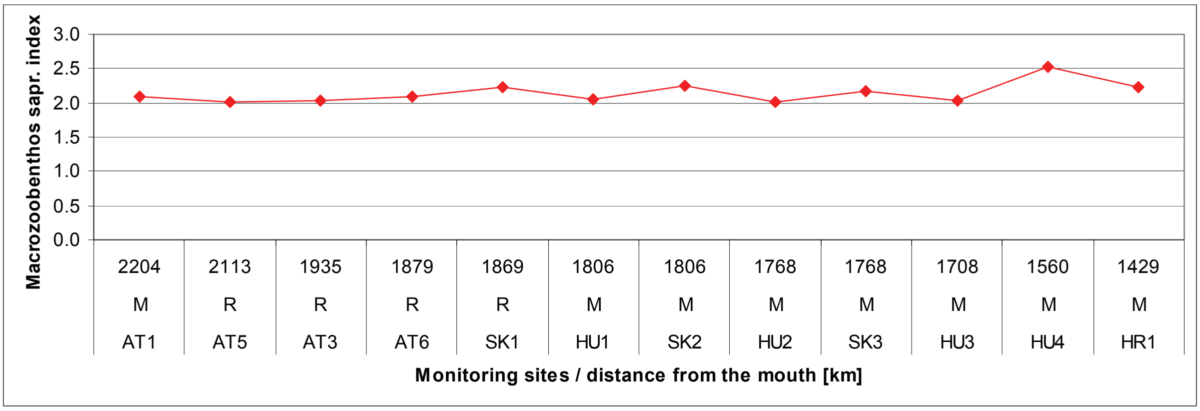
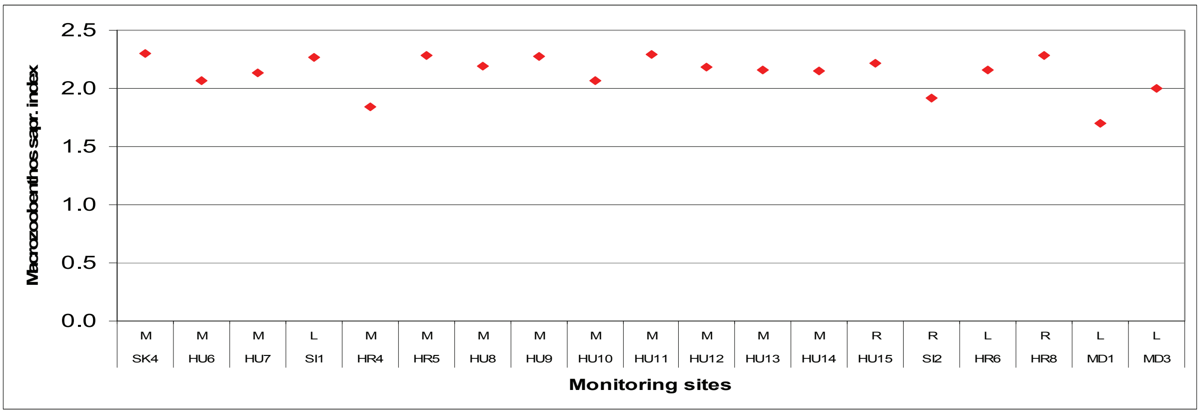
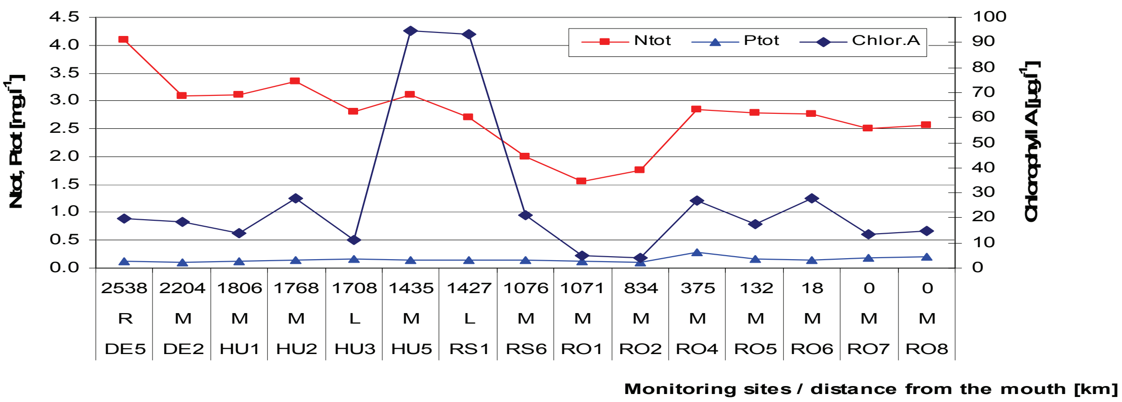


Figure 4.35: The maximum of Macrozoobenthos- saprobic index in the tributaries in 2007



The maximum of macrozoobenthos- saprobic index in Danube river and tributaries. is presented in the Figures 4.34 and 4.35. The macrozoobenthos was measured during the year 2007 in 12 monitoring points located in the Danube river and in 20 monitoring points in tributaries. The maximal concentration was observed in HU4 Dunafoldvar. The highest macrozoobenthos- saprobic index was found in Vah (SK4).

Figure 4.36: The percentile (90) of total nitrogen, phosphorus and chlorophyll-A concentration along the Danube river in 2007.



The concentration of nutrients and chlorophyll A are presented in Figure 4.36. The maximal concentration of chlorophyll A was observed in the middle part of Danube river, there were also high values of total nitrogen (HU5 and RS1).

Figure 4.37: The percentile (90) of total nitrogen, N-NH$_4$ and N-NO$_3$ concentration along the Sava river in 2007.

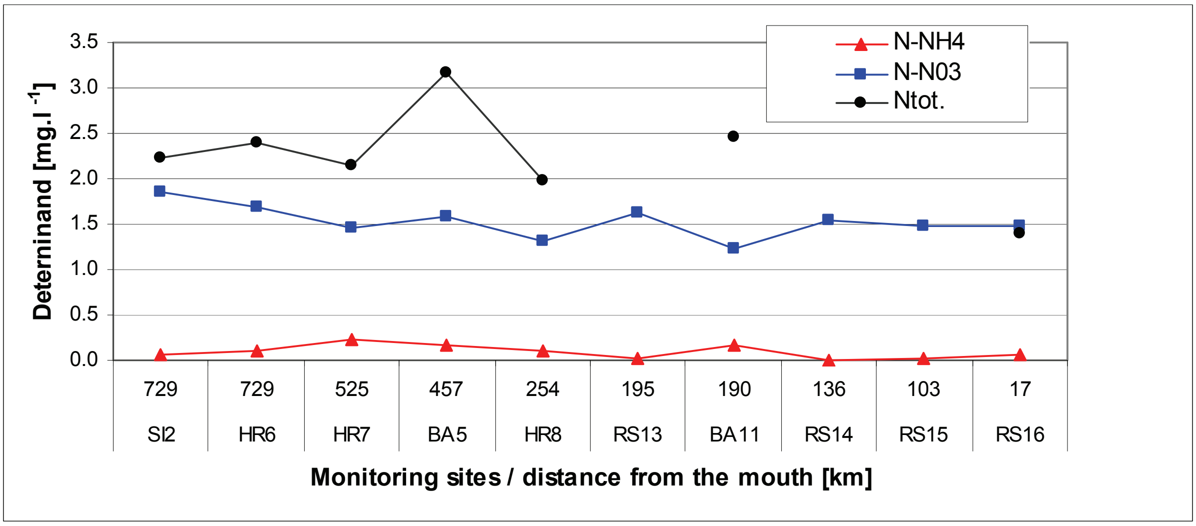
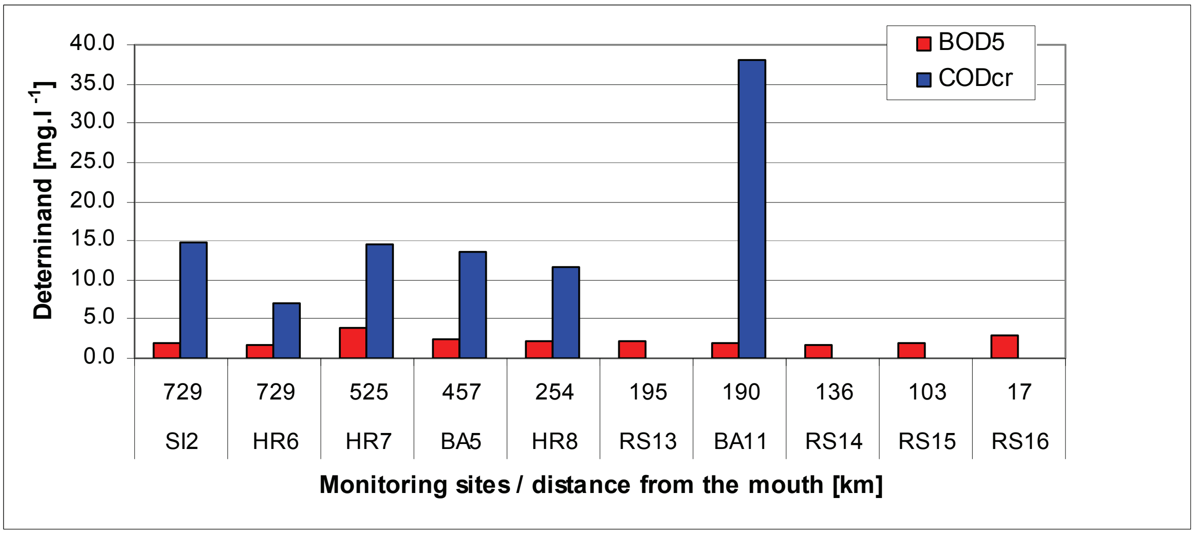


Figure 4.38: The percentile (90) of BOD$_5$ and COD$_{cr}$ concentration along the Sava river in 2007.



The percentiles 90 and of nutrients and CODcr, BOD$_5$ measured in 2007 in Sava and Tisza rivers are presented in the Figures 4.37-4.38. The highest value of N-NH$_4$ in Sava river was found in monitoring point HR7 (rkm 525). The maximal concentration of N-NO$_3$ was observed in SL2 (rkm 729) and the maximum of Ntotal was measured in BA5 (rkm 457, see Figure 4.37). The highest values of BOD$_5$ in Sava river was measured in monitoring point HR7 (rkm 525) and the highest COD$_{cr}$ value was measured in monitoring point BA11 (rkm 190, see Figure 4.38).

Figure 4.39: The percentile (90) of total nitrogen, N-NH_4 and N-NO_3 concentration along the Tisza river in 2007.

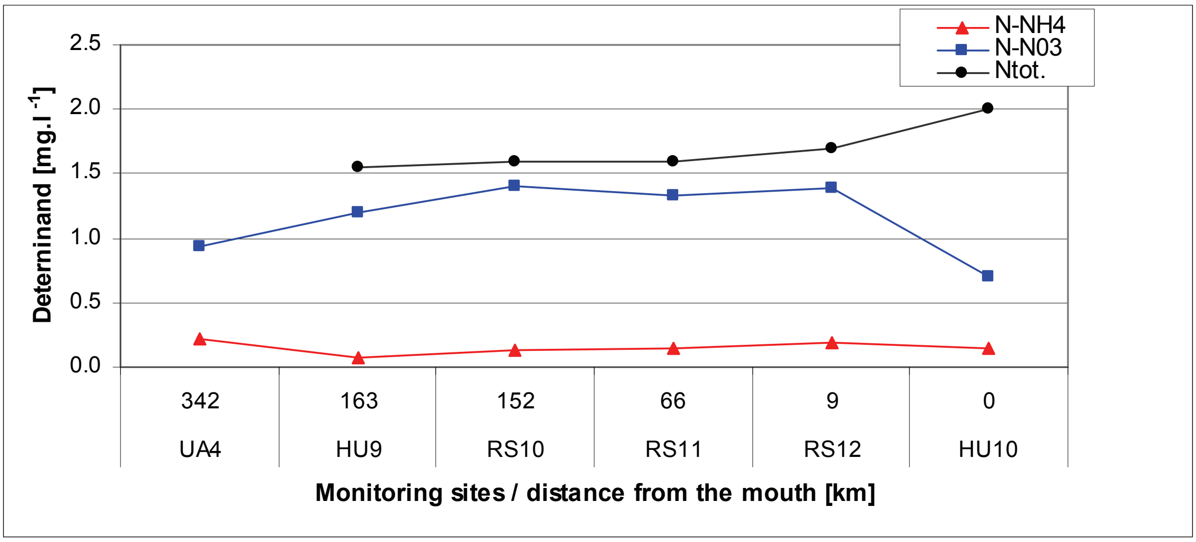
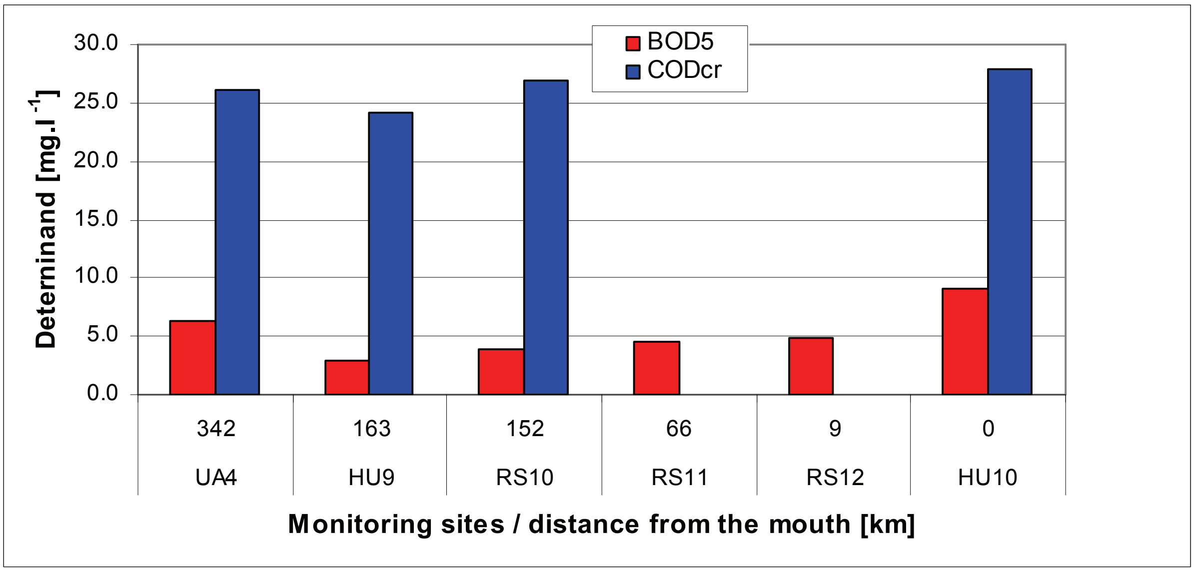


Figure 4.40: The percentile (90) of BOD_5 and COD_{cr} concentration along the Tisza river in 2007.



The maximal value of N-NH_4 in Tisza river was measured in monitoring points UA4 and maximal value N-NO_3 in RS12 was observed (rkm 342 and 9, see Figure 4.39). The highest value of Ntotal was measured in HU10 (in the mouth). The highest values of BOD_5 and COD_{cr} in Tisza river was found in monitoring point HU10 (rkm 0, see Figure 4.40).

5. Load Assessment

5.1. Introduction

The 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. This is why the load assessment programme in the Danube River Basin started in 2000. For the calculation of loads, a commonly agreed standard operational procedure is used.

5.2. Description of load assessment procedure

The 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 a voluntary basis - chlorides; based on the agreement with the Black Sea Commission, silicates are measured at the Romanian load assessment sites since 2004;*
- *The minimum sampling frequency at sampling sites selected for load calculation is set at 24 per year;*
- *The 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 for which valid flow data is available (see Table 5).*

Table 5 shows TNMN monitoring locations selected for the load assessment program. It also provides information about hydrological stations collecting flow data for load assessment. Altogether 21 monitoring locations from nine countries are included in the list. Two locations – Danube-Jochenstein and Sava-Jesenice – have been included by two neighboring countries, therefore the actual number of locations is 19, with ten locations on the Danube River itself and nine locations on the tributaries.

5.3. Monitoring Data in 2007

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 2007 there were seven measurements for load assessment available from Ukraine; thisenabled a rough calculation of loads. These are shown in tables 7 and 9. Flow data are missing from one 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. 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 determinands, leading to differences in results. Regarding particular determinands, there is still a lack of data on dissolved phosphorus as it was measured in six locations only. At Reni the silicate load was calculated to respond to the agreements with the Black Sea Commission.

Table 4: 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	DE2	Jochenstein	2204	Achleiten	2223
Germany	Inn	DE3	Kirchdorf	195	Oberaudorf	211
Germany	Inn/Salzach	DE4	Laufen	47	Laufen	47
Austria	Danube	AT1	Jochenstein	2204	Aschach	2163
Austria	Danube	AT6	Hainburg	1879	Hainburg (Danube) Angern (March)	1884 32
Czech Republic	Morava	CZ1	Lanzhot	79	Lanzhot	79
Czech Republic	Morava/Dyje	CZ2	Pohansko	17	Breclav-Ladná	32,3
Slovak Republic	Danube	SK1	Bratislava	1869	Bratislava	1869
Hungary	Danube	HU3	Szob	1708	Nagymaros	1695
Hungary	Danube	HU5	Hercegszántó	1435	Mohács	1447
Hungary	Tisza	HU9	Tiszasziget	163	Szeged	174
Croatia	Danube	HR2	Borovo	1337	Borovo	1337
Croatia	Sava	HR6	Jesenice	729	Jesenice	729
Croatia	Sava	HR7	Una Jesenovac	525	Una Jesenovac	525
Croatia	Sava	HR8	Zupanja	254	Zupanja	254
Slovenia	Drava	SI1	Ormoz	300	Borl HE Formin Pesnica-Zamusani	325 311 10.1(to the Drava)
Slovenia	Sava	SI2	Jesenice	729	Catez Sotla -Rakovec	737 8.1 (to the Sava)
Romania	Danube	RO2	Pristol-Novo Selo	834	Gruia	858
Romania	Danube	RO4	Chiciu-Silistra	375	Chiciu	379
Romania	Danube	RO5	Reni	132	Isaccea	101
Ukraine	Danube	UA2	Vylkove	18		

5.4. Calculation Procedure

Regarding several sampling sites in the profile, the average concentration at a site is calculated for each sampling day. In case of values "below the limit of detection", the value of the limit of detection is used in the further calculation. The average monthly concentrations are calculated according to the formula:

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

where C_m average monthly concentrations

C_i concentrations in the sampling days of each month

Q_i discharges in the sampling days of each month

The monthly load is calculated by using the formula:

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

where L_m monthly load

Q_m average monthly discharge

- *If discharges are available only for the sampling days, then Q_m is calculated from those discharges.*
- *For months without measured values, the average of the products $C_m.Q_m$ in the months with sampling days is used.*

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

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

Table 5: Number of measurements in TNMN locations selected for assessment of pollution load in 2007

Country Code	River	Location	Location in profile	River Km	Number of measausrements in 2007								
					Q	SS	N_{inorg}	$P\text{-}PO_4$	P_{total}	BOD_5	Cl	P_{diss}	SiO_2
DE2	Danube	Jochenstein	M	2204	365	26	14	37	37	26	26	25	0
DE3	Inn	Kirchdorf	M	195	365	26	26	26	26	26	26	14	0
DE4	Inn/Salzach	Laufen	L	47	365	24	24	24	24	24	24	24	0
AT1	Danube	Jochenstein	M	2204	365	12	12	38	37	12	12	25	0
AT6	Danube	Hainburg	R	1879	365	25	25	25	25	25	25	25	0
CZ1	Morava	Lanzhot	M	79	365	12	12	12	12	12	12	0	0
CZ2	Morava/Dyje	Pohansko	M	17	365	12	12	12	12	12	12	0	0
SK1	Danube	Bratislava	M	1869	365	25	25	25	0	25	12	25	25
HU3	Danube	Szob	L	1708	365	22	23	23	23	23	23	0	0
			M	1708	365	0	0	0	0	0	0	0	0
			R	1708		0	0	0	0	0	0	0	0
HU5	Danube	Hercegszántó	M	1435	365	17	24	24	24	24	17	0	0
HU9	Tisza	Tiszasziget	L	163		18	19	19	18	12	12	0	5
			M	163	365	18	18	18	19	11	10	0	4
			R	163		18	18	18	19	11	11	0	4
HR2	Danube	Borovo	R	1337	0	26	26	0	26	26	0	0	0
HR6	Sava	Jesenice/D	L	729	365	25	25	0	25	24	12	0	0
HR7	Sava	us Una Jesenovac	L	525	365	25	25	0	25	24	12	0	0
HR8	Sava	ds Zupanja	R	254	365	25	25	0	25	24	12	0	0
SI1	Drava	Ormoz	L	300	365	26	26	26	26	14	14	0	0
SI0	Sava	Jesenice	R	729	365	26	26	26	26	14	14	0	0
RO2	Danube	Pristol-Novo Selo	L	834		24	24	25	25	19	19	0	22
			M	834	365	23	23	24	24	18	18	0	21
			R	834		23	23	24	24	18	17	0	21
RO4	Danube	Chiciu-Silistra	L	375		26	26	26	26	24	18	0	26
			M	375	365	26	26	26	26	24	18	0	26
			R	375		26	26	26	26	24	18	0	26
RO5	Danube	Reni	L	132		26	26	26	26	26	21	0	26
			M	132	365	27	27	25	27	27	22	0	26
			R	132		27	27	27	27	27	22	0	26
UA2	Danube	Vylkove	M	18	365	12	12	12	12	12	12	0	12

5.5. 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 for monitoring locations on tributaries. The 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 2007
c_{mean}	arithmetical mean of the concentrations in the year 2007
Annual Load	annual load of given determinand in the year 2007

Table 10 shows loads of other determinands (nitrogen forms and heavy metals) at the profile Reni, which are monitored since 2005 based on the agreement with the Black Sea Commission.

The mean annual discharge was lower in 2007 than in 2006. There are no significant differences in discharges measured in the Danube river and in tributaries during these two years.

A higher annual load of suspended solids was observed only in Tisza and Inn rivers in comparison with the year 2006. The rest of the annual load values were lower and similar as in 2006.

The spatial pattern of the annual load along the Danube river is similar to the previous year. In the case of suspended solids, inorganic nitrogen, P-total and chlorides, the highest load is observed in the lower part of the Danube river, reaching a maximum at monitoring location Danube-Reni (RO5). The maximum ortho-phosphate, total phosphorus and BOD_5 loads were found at the location Danube-Chiciu-Silistra (RO4).

In the case of tributaries, the highest load of suspended solids, nutrients and chlorides are coming from the Tisza river. The maximum BOD_5 amount is coming from the Sava river HR8 and maximum of inorganic nitrogen reached in Sava river HR7.

Table 6: Mean annual concentrations in monitoring locations selected for load assessment on Danube River in 2007

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	Silicates
					$(m^3.s^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$
DE2 +AT1	M	Danube	Jochenstein	2204	1287	12.286	1.978	0.032	0.073	1.631	16.992	0.043	
AT5	R	Danube	Hainburg	1879	1922	20.120	1.923	0.011	0.058	1.148	15.413	0.037	
SK1	M	Danube	Bratislava	1869	1916	32.360	1.975	0.039		1.336	16.625	0.049	5.576
HU3	L	Danube	Szob	1708	2136	14.364	1.947	0.063	0.126	2.777	20.309		
HU5	M	Danube	Hercegszántó	1435	2182	21.294	1.868	0.018	0.122	3.108	20.376		
HR2	R	Danube	Borovo	1337		31.962	1.935		0.125	3.338			
RO2	LMR	Danube	Pristol-Novo Selo	834	4512	28.133	1.257	0.033	0.066	1.396	26.839		5.943
RO4	LMR	Danube	Chiciu-Silistra	375	5195	26.974	1.672	0.073	0.145	2.728	35.387		6.901
RO5	LMR	Danube	Reni	132	5626	36.049	1.624	0.043	0.095	1.897	36.009		6.466
UA2	M	Danube	Vylkove	18	2850	89.025	1.551	0.055	0.101	2.590	33.108		2.191

Table 7: Mean annual concentrations in monitoring locations selected for load assessment on tributaries in 2007

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
					$(m^3.s^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$
DE3	M	Inn	Kirchdorf	195	272	39.654	0.631	0.007	0.079	1.085	6.038	0.029
DE4	L	Inn/Salzach	Laufen	47	234	14.958	0.693	0.009	0.035	1.517	8.625	0.011
CZ1	M	Morava	Lanzhot	79	52	30.333	2.435	0.053	0.136	3.467	25.375	
CZ2	L	Morava/Dyje	Pohansko	17.00	32	18.250	2.652	0.313	0.363	2.792	46.733	
HU9	LMR	Tisza	Tiszasziget	163	722	73.704	0.841	0.011	0.171	1.844	41.458	
SI1	L	Drava	Ormoz	300	204	8.806	1.573	0.058	0.108	1.436	7.989	
SI2	R	Sava	Jesenice	729	250	7.345	1.097	0.008	0.032	1.586	6.209	
HR6	L	Sava	Jesenice	729	203	7.087	1.516		0.114	0.114	7.660	
HR7	L	Sava	us. Una Jasenovac	525	560	19.292	1.304		0.179	2.175	8.580	
HR8	R	Sava	ds. Zupanja	254	833	18.232	1.037		0.119	1.808	15.883	

Table 8: Annual load in selected monitoring locations on Danube River

Station Code	Profile	River Name	Location	River km	Annual Load in 2007							
					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)
DE2 +AT1	M	Danube	Jochenstein	2204	0.590	77.291	1.292	3.077	63.053	0.912	2.301	
AT5	R	Danube	Hainburg	1879	1.871	114.510	0.716	3.804	68.933	0.891	2.257	
SK1	M	Danube	Bratislava	1869	2.380	118.524	2.329		75.635	0.982	3.033	0.348
HU3	L	Danube	Szob	1708	1.080	139.219	4.402	8.463	176.092	1.354		
HU5	M	Danube	Hercegszántó	1435	1.382	129.651	1.286	9.057	207.400	1.389		
HR2	R	Danube	Borovo	1337								
RO2	LMR	Danube	Pristol-Novo Selo	834	3.741	164.559	4.765	9.220	181.814	3.556		0.781
RO4	LMR	Danube	Chiciu-Silistra	375	4.801	279.702	12.861	24.017	442.071	5.042		1.174
RO5	LMR	Danube	Reni	132	6.953	343.421	9.163	18.468	402.701	7.256		1.430
UA2	M	Danube	Vylkove	18	3.158	75.859	2.963	5.168	140.629	1.586		0.116

Table 9: Annual load in selected monitoring locations on tributaries

Station Code	Profile	River Name	Location	River km	Annual Load in 2007						
					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)
DE3	M	Inn	Kirchdorf	195	0.519	4.935	0.056	0.748	9.131	0.040	0.185
DE4	L	Inn/Salzach	Laufen	47	0.236	4.785	0.059	0.337	11.009	0.057	0.072
CZ1	M	Morava	Lanzhot	79	0.041	4.771	0.080	0.200	4.560	0.037	
CZ2	L	Morava/Dyje	Pohansko	17	0.017	3.573	0.219	0.274	2.840	0.045	
HU9	LMR	Tisza	Tiszasziget	163	2.698	22.979	0.251	4.824	36.765	0.813	
SI1	L	Drava	Ormoz	300	0.070	8.101	0.062	0.279	11.293	0.044	
SI2	R	Sava	Jesenice	729	0.064	10.354	0.357	0.681	8.771	0.049	
HR6	L	Sava	Jesenice	729	0.055	9.890		0.732	6.759	0.046	
HR7	L	Sava	us. Una Jasenovac	525	0.406	24.437		2.783	31.120	0.138	
HR8	R	Sava	ds. Zupanja	254	0.595	30.341		3.170	47.902	0.303	

Table 10: Additional annual load data at Reni for reporting to the Black Sea Commission

Country Code	River	Location	Location in profile	River km	Number of measurements in 2007												
					Q	N-NH_4	N-NO_2	N-NO_3	N_{total}	Cu	$Cu_{diss.}$	Pb	$Pb_{diss.}$	Cd	$Cd_{diss.}$	Hg	$Hg_{diss.}$
RO5	Danube	Reni	LMR	132	365	27	27	27	27	19	20	15	16	19	20	19	20
Country Code	River	Location	Location in profile	River km	c_{mean}												
					Q_a	N-NH_4	N-NO_2	N-NO_3	N_{total}	Cu	$Cu_{diss.}$	Pb	$Pb_{diss.}$	Cd	$Cd_{diss.}$	Hg	$Hg_{diss.}$
					($m^3.s^{-1}$)	($mg.l^{-1}$)	($mg.l^{-1}$)	($mg.l^{-1}$)	($mg.l^{-1}$)	($\mu g.l^{-1}$)	($\mu g.l^{-1}$)	($\mu g.l^{-1}$)	($\mu g.l^{-1}$)	($\mu g.l^{-1}$)	($\mu g.l^{-1}$)	($\mu g.l^{-1}$)	($\mu g.l^{-1}$)
RO5	Danube	Reni	LMR	132	5626	0.176	0.040	1.407	2.052	4.229	2.603	2.069	1.267	0.806	0.465	0.085	0.059
Country Code	River	Location	Location in profile	River km	Annual Load in 2007												
						N-NH_4	N-NO_2	N-NO_3	N_{total}	Cu	$Cu_{diss.}$	Pb	$Pb_{diss.}$	Cd	$Cd_{diss.}$	Hg	$Hg_{diss.}$
						($x10^3$tonns)	($x10^3$tonns)	($x10^3$tonns)	($x10^3$tonns)	(tonns)	(tonns)	(tonns)	(tonns)	(tonns)	(tonns)	(tonns)	(tonns)
RO5	Danube	Reni	LMR	132		39.601	8.328	296.450	434.583	705.933	446.429	385.946	243.731	174.475	71.981	16.819	10.974

Figure 5.5.1: Annual load of suspended solids at monitoring locations along the Danube River.

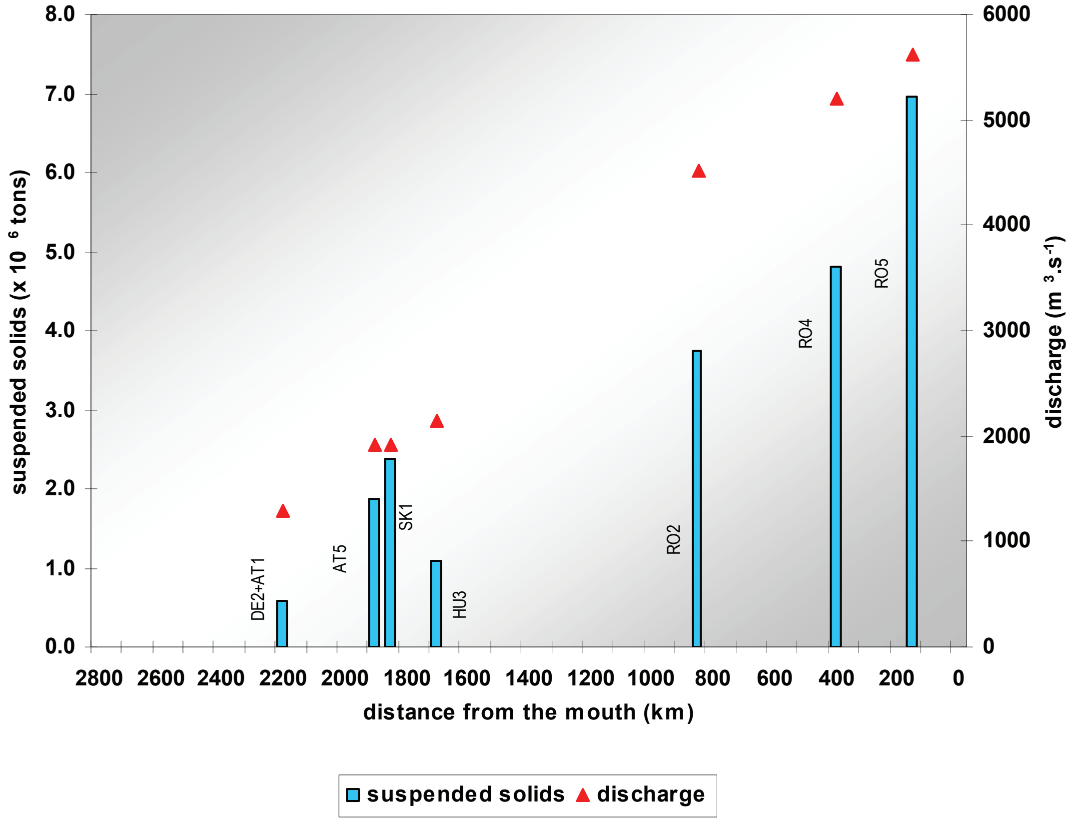


Figure 5.5.2: Annual load of suspended solids at monitoring locations on tributaries.

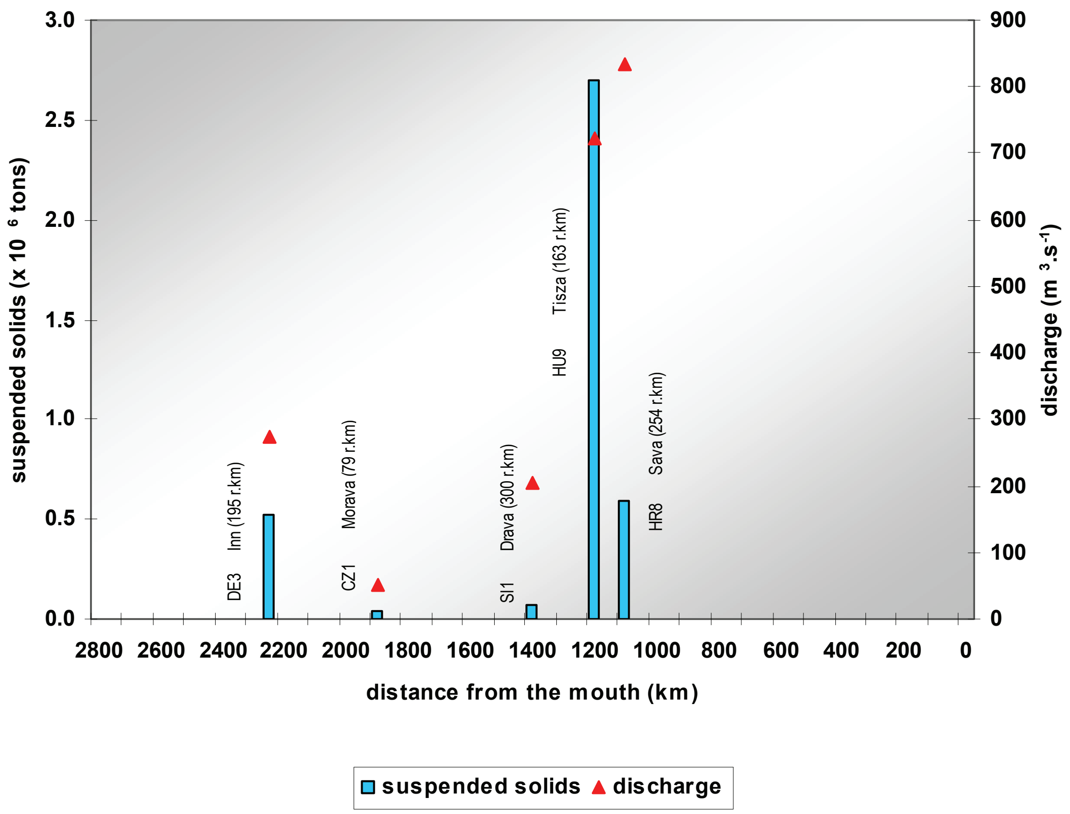


Figure 5.5.3: Annual loads of inorganic nitrogen at monitoring locations along the Danube River.

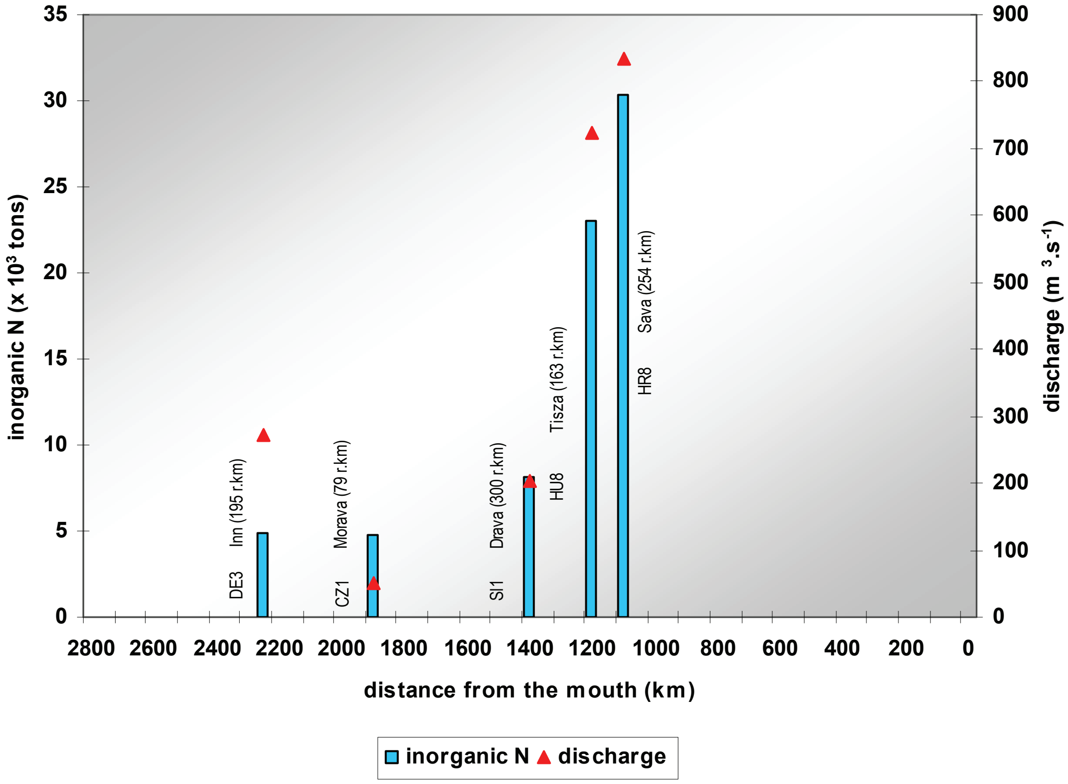


Figure 5.5.4: Annual loads of inorganic nitrogen at monitoring locations on tributaries.

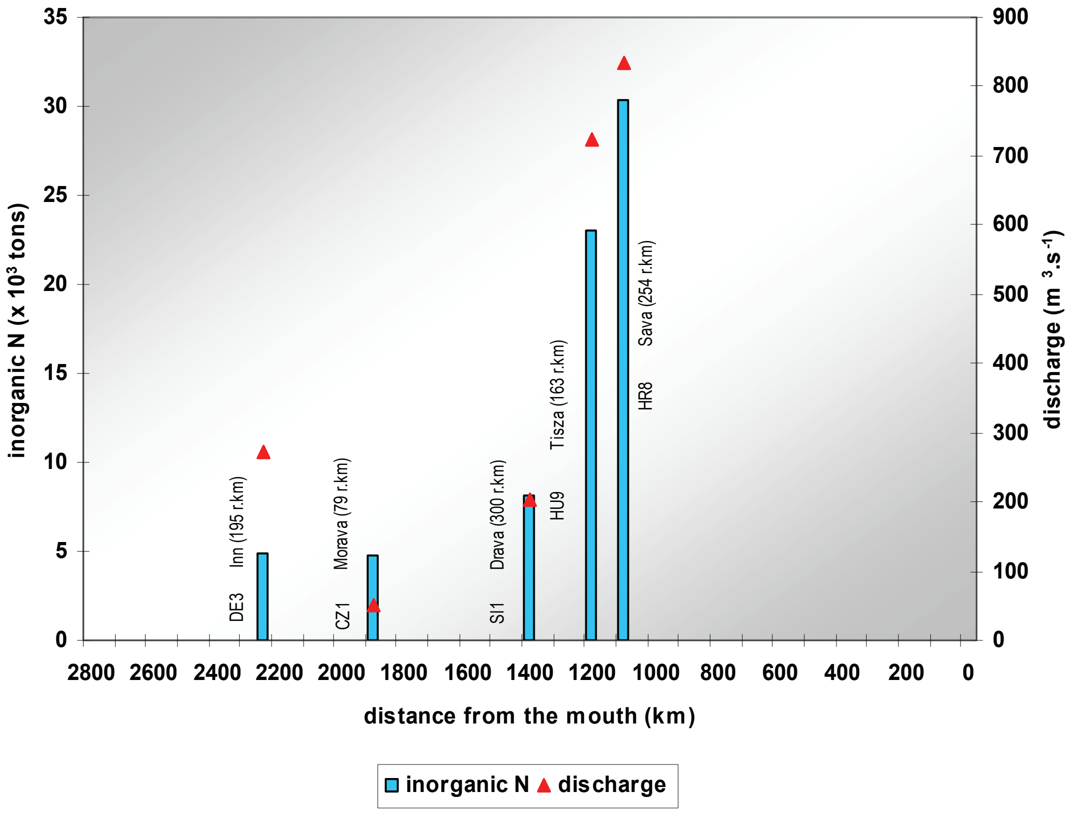


Figure 5.5.5: Annual loads of ortho-phosphate-P at monitoring locations along the Danube River.

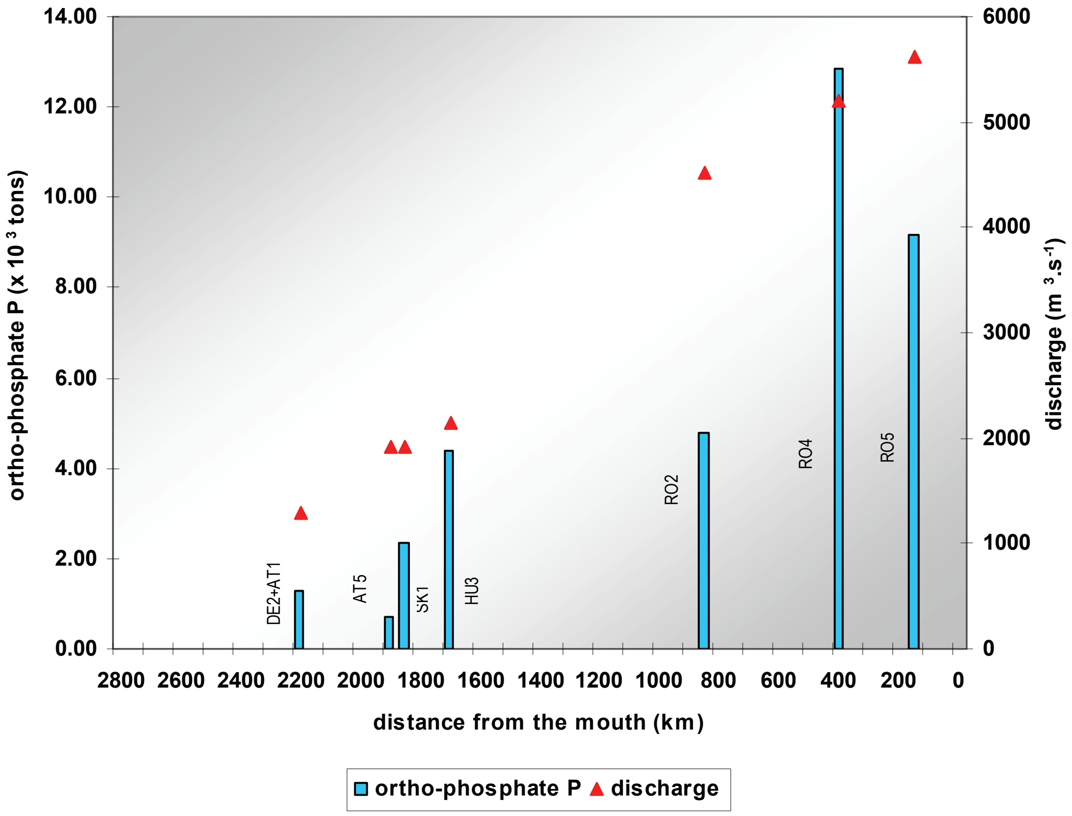
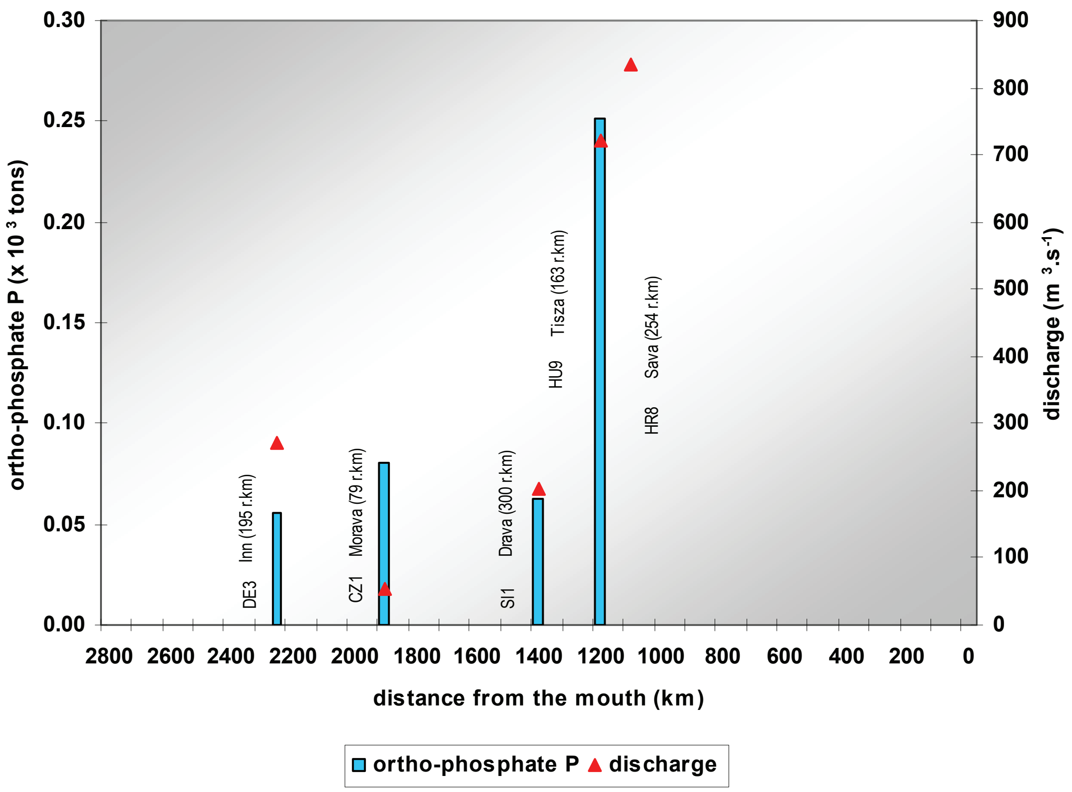


Figure 5.5.6: Annual loads of ortho-phosphate-P at monitoring locations on tributaries.



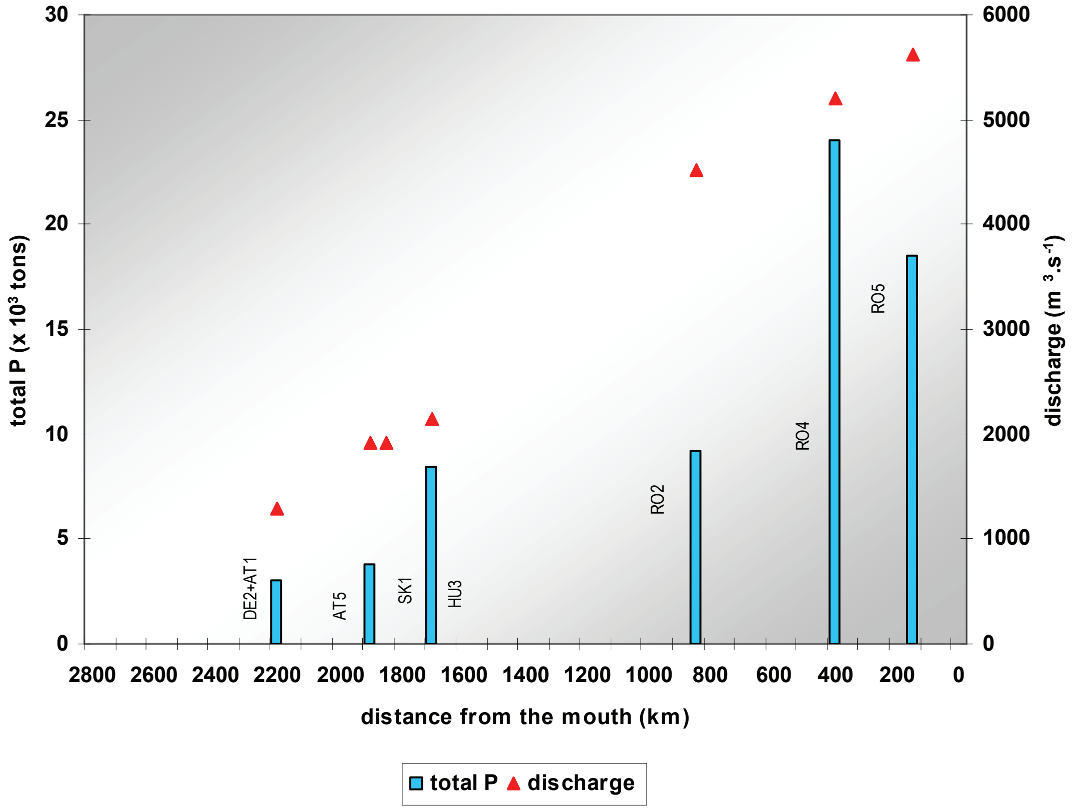


Figure 5.5.7: Annual loads of total phosphorus at monitoring locations along the Danube River.

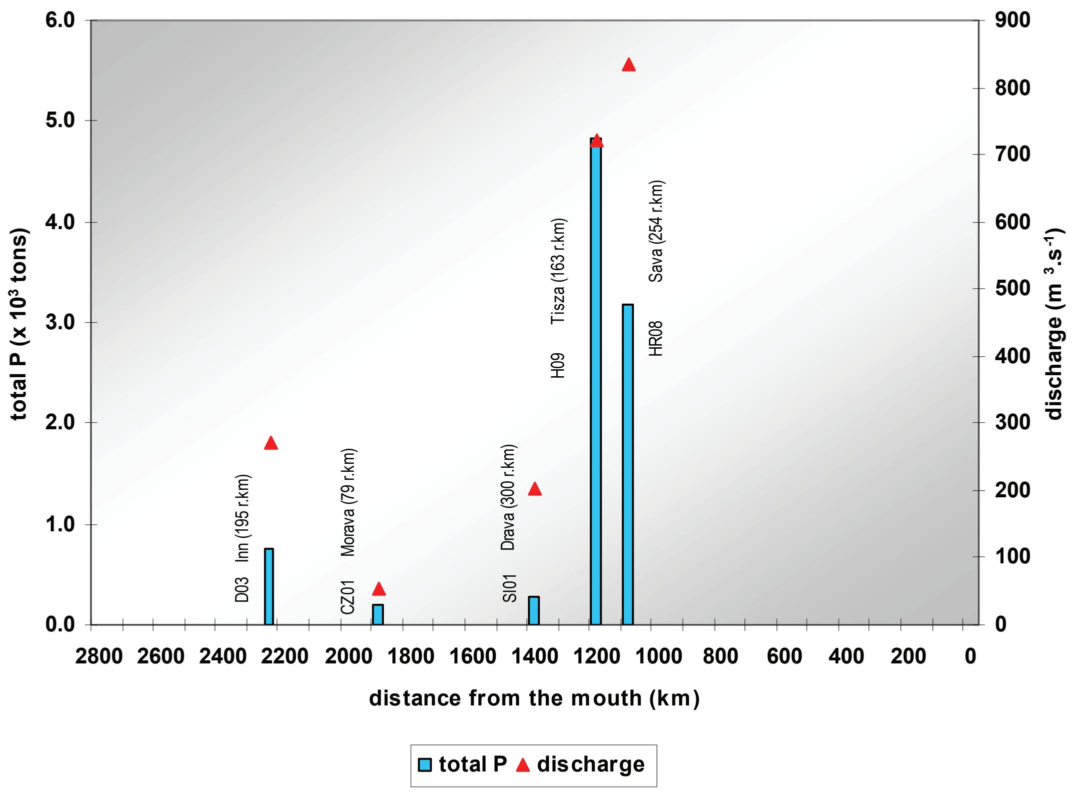


Figure 5.5.8: Annual loads of total phosphorus at monitoring locations on tributaries.

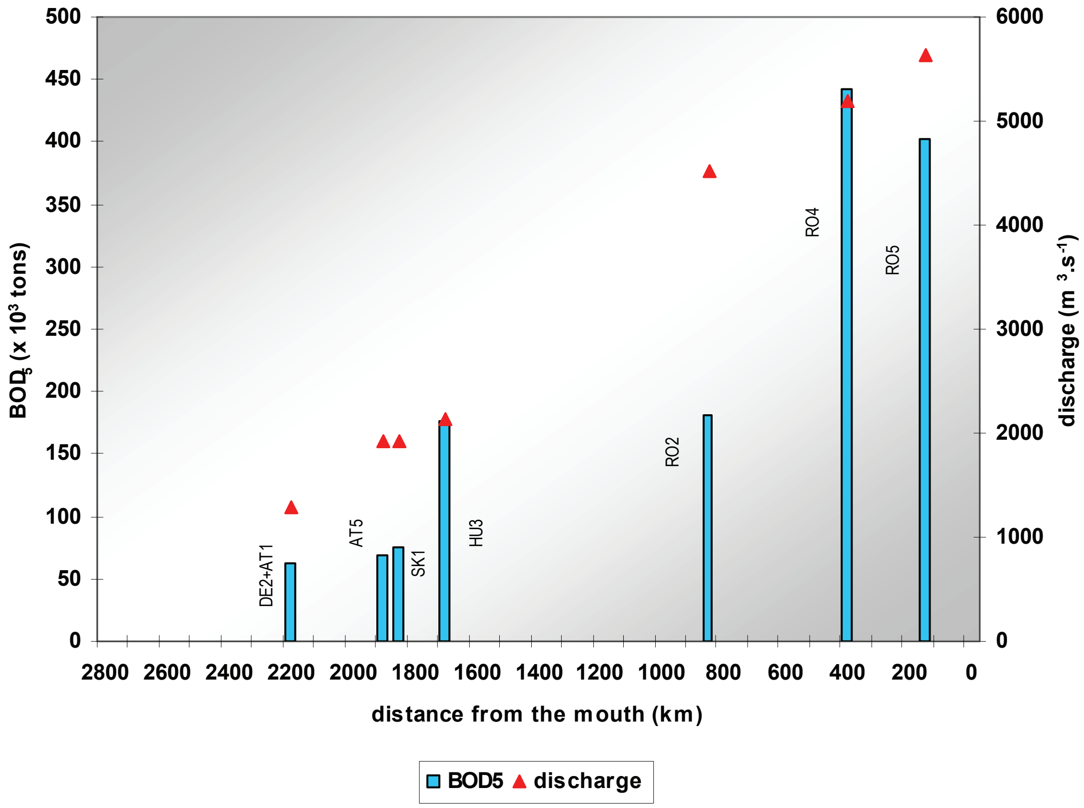


Figure 5.5.9: Annual loads of BOD_5 at monitoring locations along the Danube River.

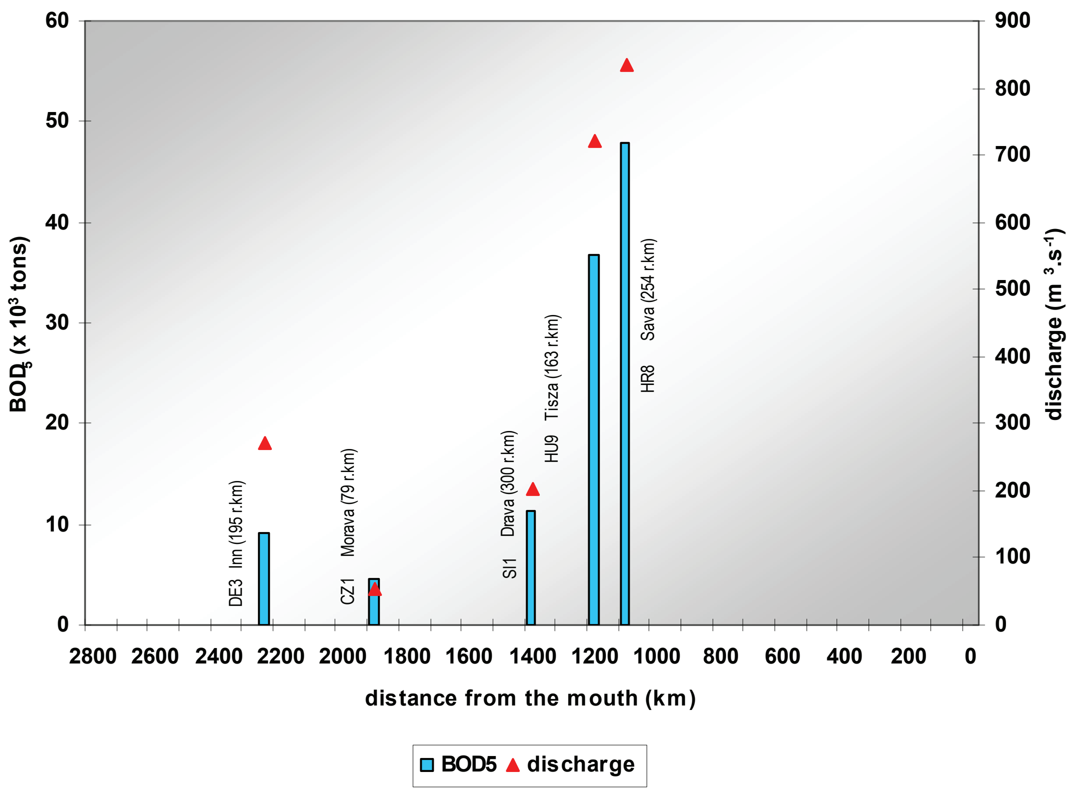


Figure 5.5.10: Annual loads of BOD_5 at monitoring locations on tributaries.

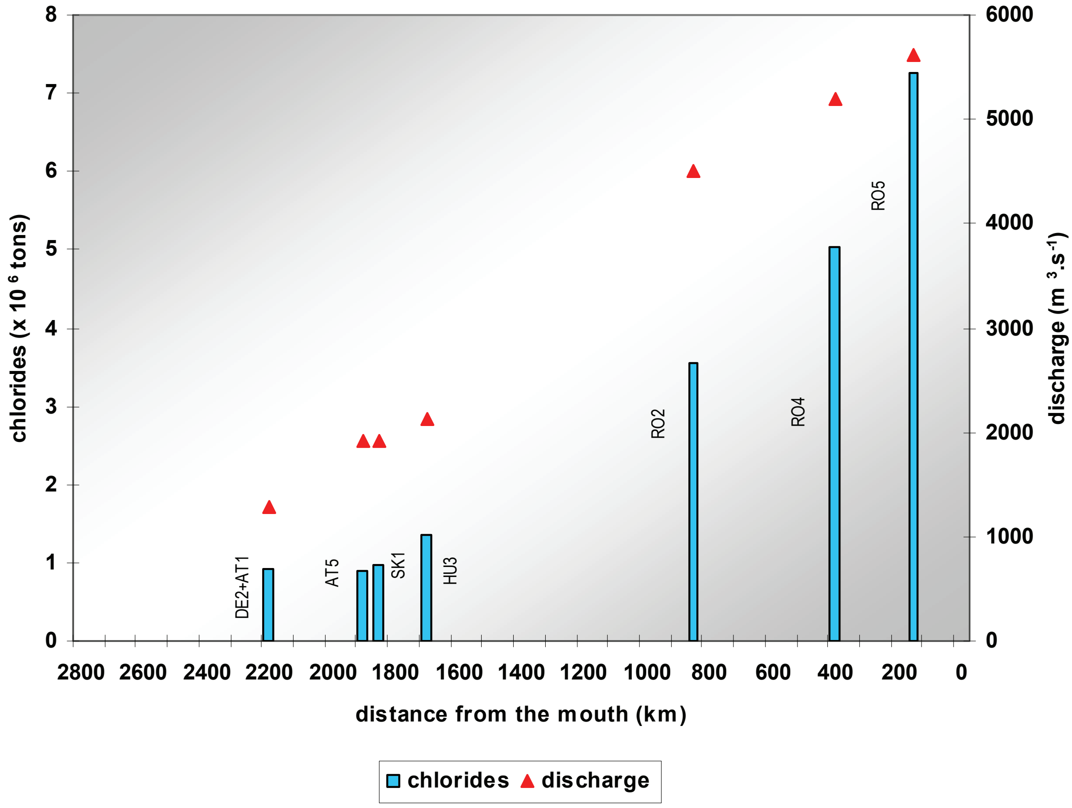


Figure 5.5.11: Annual loads of chlorides at monitoring locations along the Danube River.

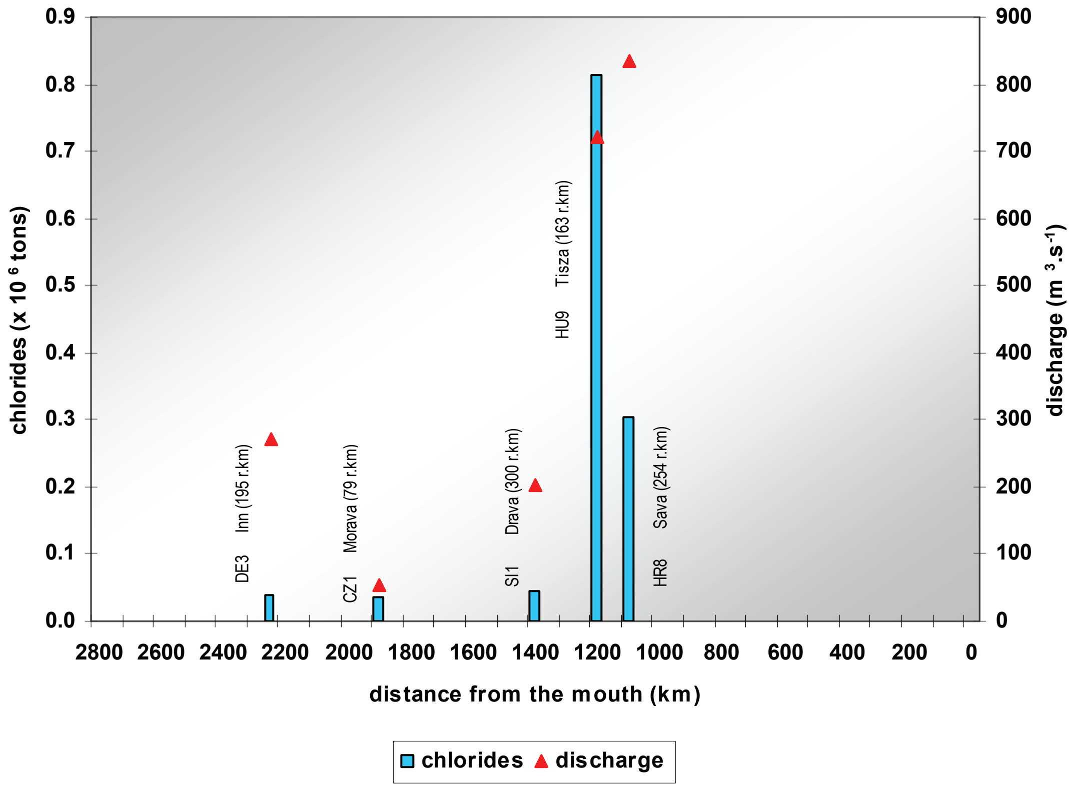


Figure 5.5.12: Annual loads of chlorides at monitoring locations on tributaries.

6. Groundwater monitoring

6.1. GW bodies of basin-wide importance

According to the Article 2 of the EU Water Framework Directive (2000/60/EC) 'Groundwater' means all water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil.

The analysis and review of the groundwater bodies in the Danube River Basin as required under Article 5 and Annex II of the WFD was performed in 2004 and it identified 11 GW-bodies or groups of GW-bodies of basin-wide importance, which are shown in Map (Figure 5.6.1).

GW-bodies of basin-wide importance were defined as follows:

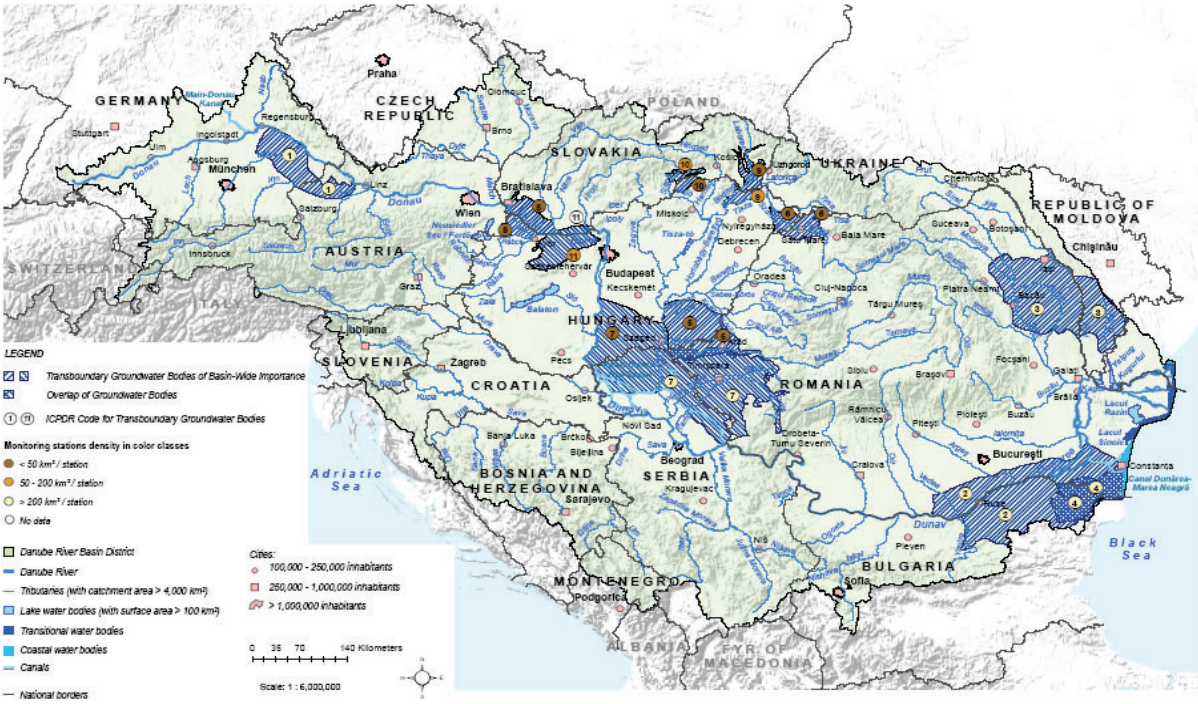
- important due to the size of the groundwater body which means an area larger than 4000 km²

or

- important due to various criteria e.g. socio-economic importance, uses, impacts, pressures interaction with aquatic eco-system. The criteria need to be agreed bilaterally.

This means that the other groundwater bodies even those with an area larger than 4000 km², which are fully situated within one country of the DRB are dealt with at the national level. A link between the content of the DRBMP and the national plans is given by the national codes of the groundwater bodies.

Figure 6.2: Transboundary GW-bodies of basin-wide importance and their transnational monitoring network



6.2. Reporting on groundwater quality

According to the WFD groundwater is an integral part of the river basin management district and therefore monitoring of groundwater of basin-wide importance was introduced into the TNMN in the Danube River Basin. The detailed description of the current status in development of the groundwater monitoring network in the Danube River Basin District is given in the TNMN Groundwater monitoring report (Part II of the Summary Report to EU on monitoring programs in the Danube River Basin District designed under Article 8).

For groundwater monitoring under TNMN a six-year reporting cycle is foreseen, which is in line with the WFD reporting requirements. Information on status of the groundwater bodies of basin-wide importance will be regularly provided in the DRBM Plans. This will sufficiently allow for making any relevant statement on significant changes of groundwater status for these GW-bodies.

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

Deutschland //// Österreich //// Česká republika //// Slovensko //// Magyarország //// Slovenija //// Hrvatska //// Bosna i Hercegovina //// Србија //// Crna Gora //// România //// България //// Moldova //// Україна

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