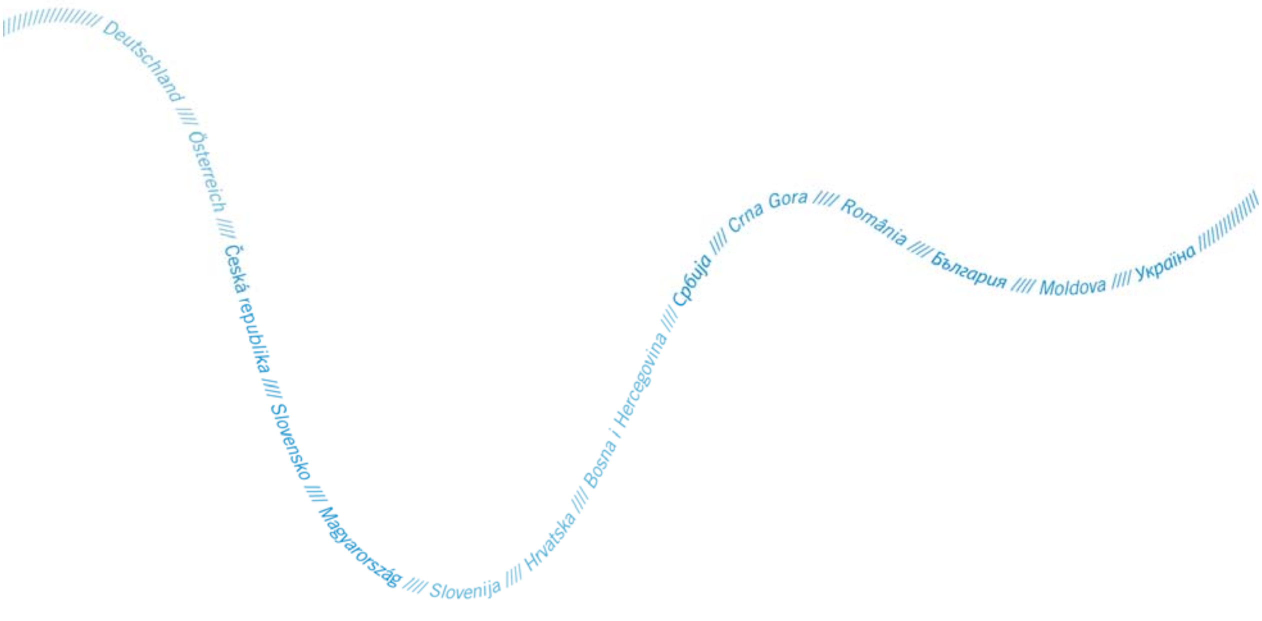
Water Quality in the Danube River Basin - 2009

TNMN – Yearbook 2009



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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 evaluated data for 2009

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 boundaries 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	Medveďov	M	17.652	47.794	1 806	108	132 168
13	SK	L1960	SK4	/Váh	Komárno	M	18.142	47.761	1	106	19 661
14	SK	L1871	SK5	Danube	Szob	M	18.964	47.787	1 707	100	183 350
15	HU	L1470	HU1	Danube	Medvedov	M	17.652	47.792	1 806	108	131 605
16	HU	L1475	HU2	Danube	Komarom	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/Kettõs-Körös/Fekete-Körös	Sarkad	M	21.255	46.414	16	85	4302
28	HU		HU14	/Tisza/Hármas-Körös/Kettõs-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	15.692	45.861	729	135	10 878
32	HR	L1315	HR1	Danube	Batina	MR	16.938	46.241	1 429	86	210 250

No.	Country code	DEFF Code	New TNMN code	River	Name of site	Locations	x- coord.	y-coord.	River-km	Altitude	Catch-ment
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
35	HR	L1240	HR4	/Drava	Botovo	MR	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	LR	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	LMR	16.953	45.251	254	85	62 890
40	HR		HR10	/Sava	Drenje	L	15.690	45.862	728.8	135	10 878
41	RS	L2350	RS1	Danube	Bezdan	L	18.854	45.864	1 427	83	210 250
42	RS	L2360	RS2	Danube	Bogojevo	L	19.084	45.529	1 367	80	251 253
43	RS	L2370	RS3	Danube	Novi Sad	R	19.842	45.225	1 258	75	254 085
44	RS	L2380	RS4	Danube	Zemun	R	20.417	44.849	1 174	71	412 762
45	RS	L2390	RS5	Danube	Pancevo	L	20.594	44.856	1 155	70	525 009
46	RS	L2400	RS6	Danube	Banatska Palanka	M	21.345	44.826	1 077	69	568 648
47	RS	L2410	RS7	Danube	Tekija	R	22.424	44.700	955	0	574 307
48	RS	L2420	RS8	Danube	Radujevac	R	22.686	44.263	851	32	577 085
49	RS	L2430	RS9	Danube	Backa Palanka	L	19.386	45.234	1 287	0	253 737
50	RS	L2440	RS10	/Tisza (Tisa)	Martonos	R	20.087	46.114	152	76	140 130
51	RS	L2450	RS11	/Tisza (Tisa)	Novi Becej	L	20.140	45.586	66	74	145 415
52	RS	L2460	RS12	/Tisza (Tisa)	Titel	M	20.320	45.205	9	73	157 147
53	RS	L2470	RS13	/Sava	Jamena	L	20.320	45.205	195	78	64 073
54	RS	L2480	RS14	/Sava	Sremska Mitrovica	L	19.608	44.966	136	75	87 996
55	RS	L2490	RS15	/Sava	Sabac	R	19.704	44.770	104	74	89 490
56	RS	L2500	RS16	/Sava	Ostruznica	R	20.317	44.732	17	0	37 320
57	RS	L2510	RS17	/Velika Morava	Ljubicevski Most	R	21.138	44.585	35	75	37 320
58	BA		BA5	/Sava	Gradiska	M	17.255	45.141	457	86	39 150
59	BA		BA6	/Sava/Una	Kozarska Dubica	M	16.849	45.200	16	94	9 130
60	BA		BA7	/Sava/Vrbas	Razboj	M	17.458	45.050	12	100	6 023
61	BA		BA8	/Sava/Bosna	Modrica	M	18.313	44.961	24	114	10 500
62	BA		BA9	/Sava/Drina	Foca	M	18.833	43.344	234	442	3 884
63	BA		BA10	/Sava/Drina	Badovinci	M	19.344	44.779	16	90	19 226
64	BA		BA11	/Sava	Raca	M	19.335	44.891	190	80	64 125
65	BA		BA12	/Sava/Una	Novi Grad	M	16.295	44.988	70	137	4 573
66	BA		BA13	/Sava/Bosna	Usora	M	18.074	44.664	78	148	7 313
67	BG	L0730	BG1	Danube	Novo Selo harbour	LMR	22.785	44.165	834	35	580 100
68	BG		BG9	Danube	Lom	R	23.270	43.835	741	24	588 860
69	BG		BG10	Danube	Orjahovo	R	23.997	43.729	679	22	607 260
70	BG	L0780	BG2	Danube	Bajkal	R	24.400	43.711	641	20	608 820
71	BG		BG11	Danube	Nikopol	R	25.927	43.701	598	21	648 620
72	BG	L0810	BG3	Danube	Svishtov	R	25.345	43.623	554	16	650 340
73	BG	L0820	BG4	Danube	Upstream Russe	R	25.907	43.793	503	12	669 900
74	BG	L0850	BG5	Danube	Silistra	LMR	27.268	44.125	375	7	698 600
75	BG		BG12	/Iskar	mouth	M	24.461	43.706	4	27	8 646
76	BG		BG13	/Vit	Guljantzi	M	24.728	43.644	7	29	3 225
77	BG		BG14	/Jantra	mouth	M	25.579	43.603	4	25	7 869
78	BG		BG15	/Russenski Lom	mouth	M	25.936	43.813	1	17	2 974
79	RO	L0020	RO1	Danube	Bazias	LMR	21.384	44.816	1 071	70	570 896
80	RO		RO18	Danube	Gruia/Radujevac	LMR	22.684	44.270	851	32	577 085
81	RO	L0090	RO2	Danube	Pristol/Novo Selo	LMR	22.676	44.214	834	31	580 100
82	RO	L0240	RO3	Danube	Dunare - upstream Arges (Oltenita)	LMR	26.619	44.056	432	16	676 150
83	RO	L0280	RO4	Danube	Chiciu/Silistra	LMR	27.268	44.128	375	13	698 600
84	RO	L0430	RO5	Danube	Reni	LMR	28.232	45.463	132	4	805 700
85	RO	L0450	RO6	Danube	Vilkova-Chilia arm/Kilia arm	LMR	29.553	45.406	18	1	817 000
86	RO	L0480	RO7	Danube	Sulina - Sulina arm	LMR	29.530	45.183	0	1	817 000
87	RO	L0490	RO8	Danube	Sf. Gheorghe-Ghorghe arm	LMR	29.609	44.885	0	1	817 000
88	RO	L0250	RO9	/Arges	Conf. Danube (Clatesti)	M	26.599	44.145	0	14	12 550
89	RO	L0380	RO10	/Siret	Conf. Danube (Sendreni)	M	27.933	45.406	0	4	42 890
90	RO	L0420	RO11	/Prut	Conf. Danube (Giurgiulesti)	M	28.203	45.469	0	5	27 480
91	RO		RO12	/Tisza/Somes	Dara (frontiera)	M	22.720	47.815	3	118	15 780
92	RO		RO13	/Tisza/Hármas-Körös/Sebes-Körös/Crisul Repede	Cheresig	M	21.692	47.030	3	116	2 413

No.	Country code	DEFF Code	New TNMN code	River	Name of site	Locations	x- coord.	y-coord.	River-km	Altitude	Catch-ment
93	RO		RO14	/Tisza/Hármas-Körös/Kettõs-Körös/Crisul Negru	Zerind	M	21.517	46.627	13	86.4	3 750
94	RO		RO15	/Tisza/Hármas-Körös/Kettõs-Körös/Crisul Alb	Varsand	M	21.339	46.626	0.2	88.9	4 240
95	RO		RO16	/Tisza/Mures	Nadlac	M	20.727	46.145	21	85.6	27 818
96	RO		RO17	/Tisza/Bega	Otelec	M	20.847	45.620	7	46	2 632
97	RO		RO19	/Jiu	Zaval	M	23.845	43.842	9	30.9	10 046
98	RO		RO20	/Olt	Islaz	M	24.797	43.744	3	32	24 050
99	RO		RO21	/Ialomita	Downstream Tandarei	M	27.665	44.635	24	8.5	10 309
100	MD	L2230	MD1	/Prut	Lipcani	L	26.483	48.152	658	100	8 750
101	MD	L2270	MD3	/Prut	Conf. Danube-Giurgiulesti	LMR	28.124	45.285	0	5	27 480
102	MD		MD5	/Prut	Costesti Reservoir	L	27.145	47.513	557	91	11 800
103	MD		MD6	/Prut	Braniste	L	27.145	47.475	546	63	12 000
104	MD		MD7	/Prut	Valea Mare	L	27.515	47.075	387	55	15 200
105	UA	L0630	UA1	Danube	Reni	M	28.241	45.463	132	4	805 700
106	UA	L0690	UA2	Danube	Vylkove	M	29.246	45.436	18	1	817 000
107	UA		UA4	/Tisza	Chop	M	22.184	48.416	342	92	33000
108	UA		UA5	/Tisza/Bodrog/Latoritsa	Strazh	M	22.212	48.454	144	97	4418
109	UA		UA6	/Prut	Tarasivtsi	M	26.336	48.183	262	122	9836
110	UA		UA7	/Siret	Porubne	M	26.030	47.981	100	303	2070
111	UA		UA8	/Uzh	Storozhnica	R	22.200	48.617	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

Figure 2.2.1: The Danube Stationmap TNMN

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

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	

	Surveillance Monitoring 2	
	Water	**Water**
	concentrations	**load assessment**
Parameter		
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	
COD_{Cr} (5)	anually / 12 x per year	
COD_{Mn} (5)	anually / 12 x per year	
Dissolved Silica		anually / 26 x per year
BOD_5	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)

In 2009 the AQC programme for the Danube River Basin was organized by the VITUKI Environmental and Water Management Research Institute Non-profit Ltd., Budapest, Hungary (QualcoDanube AQC programme).

Following the dynamic expansion in participation during the last two years, no new laboratory was added to the 2009 AQC programme. However, the number of laboratories reporting results increased for most of the parameters, which in turn increases the reliability of the evaluation as well.

The AQC programme has been significantly revised: sample types were reduced to surface water only, 6 new measurands were added to the determinand list, and performance assessment was based on z-scores instead of the previous percentage bias thresholds.

In accordance with previous years, general parameters were measured with little problem in 2009 too; performance even improved in case of certain parameters in comparison with previous years' data. The same holds true for nutrients and metals, which are also traditionally among the successful determinations. In case of organic indicator parameters the improved agreement of results experienced in 2008 remained in 2009 as well.

Similarly to previous years, the most problematic parameter group was organic micropollutants. alachlor, simazine and endosulfan were measured for the first time in the AQC programme. Endosulfan proved to be the most difficult to analyse, with by far the highest dispersion of results among all pesticides. Though redistribution was necessary for all parameters, dispersion of results lessened compared to the previous year.

In conclusion, the 2009 AQC Scheme continued integration of the new laboratories into the Danube Basin quality control network and provided valuable experience for the participants.

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

139 sites at 108 TNMN monitoring stations were monitored in the Danube River Basin in 2009 (some monitoring stations contain two or three sampling sites - left, middle and/or right side of the river). The data was collected from 71 sampling sites at 42 stations on the Danube river and from 68 sampling sites at 66 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 2009
Mean	arithmetical mean of the measurements done in the year 2009
Max	maximum value of the measurements done in the year 2009
C50	50 percentile of the measurements done in the year 2009
C90	90 percentile of the measurements done in the year 2009

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

- *If "less than the quantification limit" values were present in the dataset for a given determinand, then the ½ value of the limit of quantification 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 statistic value "C90" 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 "C90" value is represented by a maximum value from a data set (a minimum value for dissolved oxygen and lower limit of pH value).*

In year 2009 the analytical data method was according to Directive 2009/90/EC using the limit of quantification (LOQ). In such case if the measured values were less than the limit of quantification, ½ LOQ was used for statistic processing of data.

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 2009. 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. In this table there are minimal and maximal values for all determinands for all Danube and tributary stations and minimal and maximal values for all determinands calculated from mean (average) values from all Danube or tributaries.

* 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 2009

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	71/41	0.0	28.8	10.3	17.1	68/66	0.0	29.5	7.8	22.5
Suspended Solids	mg/l	69/39	2.0	284	9	94	66/64	<1	4457	3	490
Dissolved Oxygen	mg/l	71/41	4.9	16.9	7.5	11.4	68/66	1.8	17.6	5.1	11.7
BOD$_5$	mg/l	68/40	<0.35	7.1	1.0	3.8	67/65	0.4	23.8	0.7	14.4
COD$_{Mn}$	mg/l	63/35	0.6	7.5	1.9	5.1	42/40	< 0.5	25.0	1.8	13.8
COD$_{Cr}$	mg/l	61/31	5.1	31.9	5.3	23.6	56/56	<2.5	105.6	4.2	58.1
TOC	mg/l	32/24	1.3	10.9	2.4	5.2	22/22	0.5	17.3	1.5	7.4
DOC	mg/l	20/14	0.9	7.2	2.3	4.4	10/8	<0.01	20.3	1.2	11.9
pH		70/40	7.1	8.7	7.7	8.4	66/64	6.5	9.9	7.6	8.3
Alkalinity	mmol/l	70/40	1.2	4.9	1.6	4.5	51/49	0.8	47.2	1.2	7.4
Ammonium-N	mg/l	71/41	<0.005	2.10	0.03	0.46	68/66	0.004	4.14	0.03	2.91
Nitrite-N	mg/l	71/41	<0.0024	0.118	0.012	0.033	68/66	<0.00005	1.13	0.01	0.84
Nitrate-N	mg/l	71/41	0.05	4.38	0.69	3.06	68/66	<0.05	7.86	<0.05	3.93
Total Nitrogen	mg/l	41/25	0.8	7.0	1.6	3.4	40/40	<0.25	10.5	0.7	6.2
Organic Nitrogen	mg/l	29/21	0.09	5.92	0.33	1.91	33/31	<0.05	7.48	0.05	2.00
Ortho-Phosphate-P	mg/l	69/39	<0.00115	0.650	0.021	0.273	58/56	<0.0015	0.597	0.004	0.369
Total Phosphorus	mg/l	64/39	0.018	0.923	0.051	0.361	58/56	0.007	3.740	0.012	2.520
Total Phosphorus - Dissolved	mg/l	13/9	0.008	0.150	0.031	0.089	17/17	<0.0025	0.332	0.009	0.149
Chlorophyll-a	µg/l	44/28	<1	122.00	1.52	33.83	41/39	< 0.045	296	< 0.045	95.8
Conductivity @ 20°C	µS/cm	68/39	248	660	351	508	63/61	<1	1120	51	982
Calcium	mg/l	70/40	1.0	99.0	31.9	84.6	60/58	4.0	109.7	28.9	83.3
Sulphates	mg/l	68/40	10.0	115.0	18.8	68.8	46/44	<5	163.2	11.0	119.9
Magnesium	mg/l	67/39	7.0	80.3	10.0	34.5	60/58	2.4	77.7	3.1	66.1
Potassium	mg/l	62/36	0.7	30.0	1.9	4.5	27/25	<0.6	15.6	1.0	7.8
Sodium	mg/l	62/36	6.00	49.62	10.68	23.06	30/28	1.80	87.90	5.10	50.10
Manganese	mg/l	45/24	<0.001	51.00	0.01	19.48	21/19	< 0.001	49.34	0.01	4.15
Iron	mg/l	46/24	<0.005	3.66	0.0529	1.03	25/25	<0.005	7.47	0.03	2.29
Chlorides	mg/l	71/41	6.1	68.0	15.3	33.2	67/65	0.2	192.7	2.4	137.20
Silicates (SiO2)	mg/l	5/3	1.2	8.7	3.6	5.8	4/2	1.4	11.0	5.2	7.8
Macrozoobenthos- saprobic index		15/14	1.91	2.56	1.91	2.36	20/19	1.91	2.61	1.91	2.39
Macrozoobenthos - no.of taxa		5/3	30	13	13	25	1/1	23	23	23	23
Macrozoobenthos-number of families		12/10	23	6	8	20	20/19	6	30	6	30

Table 3: Concentration ranges and mean annual concentrations of selected determinands in the Danube River and its tributaries in 2009 (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	55/31	0.32	292.1	2.1883	39.6	55/53	<0.5	885.6	1.6969	82.7
Copper - Dissolved	µg/l	55/31	<0.5	47	1.15	15.5	55/53	0.27	71.49	0.53	16.5
Chromium - Dissolved	µg/l	55/30	<0.1	19	0.1	3.0	48/46	0.07	27	0.1	5.3
Lead - Dissolved	µg/l	51/31	0.04	15	0.1558	4.3	55/53	0.014	14	0.05	6.0
Cadmium - Dissolved	µg/l	51/31	<0.005	2.2	0.01	0.5	55/53	0.004	2.93	0.01	0.8
Mercury - Dissolved	µg/l	51/31	<0.0003	0.44	0.0022	0.2	40/38	<0.0003	2.8	0.0018	0.4
Nickel - Dissolved	µg/l	51/31	<0.25	43.27	0.52	7.2	55/53	0.1	49.85	0.26	8.3
Arsenic - Dissolved	µg/l	46/28	<0.25	15.3	0.45	2.6	44/42	0.23	8.2	0.37	4.2
Aluminium - Dissolved	µg/l	4/2	<4	430	18.5833	94.8	14/12	3.9	148	3.4033	55.6
Zinc *	µg/l	42/20	<0.5	950.7	2.75	110.5	33/33	<0.01	915.02	0.0099	226.3
Copper	µg/l	42/20	<0.5	111	2.12	20.01	34/34	<0.5	138.07	0.50	29.40
Chromium - total	µg/l	42/20	<0.5	32.76	0.66	10.00	27/27	<0.1	30.55	0.42	18.27
Lead	µg/l	40/18	<0.25	26.77	0.63	8.43	33/33	<0.15	46.11	0.15	18.64
Cadmium	µg/l	39/18	<0.05	6.4	0.050	2.7	31/31	<0.025	6.7	<0.025	2.3
Mercury	µg/l	30/12	0.03	1.1	0.050	0.4	21/21	<0.015	1.1	0.015	0.4
Nickel	µg/l	40/18	<0.5	52.2	0.8	9.8	30/30	<0.01	68.1	0.025	14.1
Arsenic	µg/l	26/12	<0.25	4.7	0.9	2.8	23/23	<0.05	7.0	0.5	4.0
Aluminium	µg/l	6/4	10	980	18	314	9/9	14	7330	55	2217
Phenol index	mg/l	33/23	<0.0005	0.020	0.001	0.006	33/31	<0.0004	0.280	<0.0004	0.095
Anionic active surfactants	mg/l	53/29	0.003	0.150	0.006	0.128	46/44	<0.005	4.500	0.009	2.658
AOX	µg/l	16/8	2.6	44.2	6.6	16.1	10/8	<2.5	78.2	12.6	46.2
Petroleum hydrocarbons	mg/l	54/30	<0.0029	1.370	0.005	0.377	44/42	<0.01	31.100	0.005	5.013
PAH (sum of 6)	µg/l	0/0					2/2	0.002	0.109	0.015	0.035
PCB (sum of 7)	µg/l	9/5	<0.005	<0.005	<0.005	<0.005	4/4	<0.005	<0.005	<0.005	<0.005
Lindane	µg/l	33/25	<0.00025	<0.025	<0.0003	<0.025	27/35	<0.00025	0.01	<0.00025	0.01
pp´DDT	µg/l	64/24	<0.00025	<0.025	<0.0003	<0.025	32/30	<0.00025	<0.025	<0.0003	<0.025
Atrazine	µg/l	32/24	<0.001	0.025	0.001	0.025	36/34	<0.001	1.120	0.001	0.220
Chloroform	µg/l	13/10	<0.025	6.500	0.10	2.888	13/13	<0.0015	0.500	<0.0015	0.500
Carbon tetrachloride	µg/l	11/8	<0.025	0.200	0.03	0.200	6/6	<0.05	0.500	0.05	0.500
Trichloroethylene	µg/l	12/9	<0.0005	0.100	0.001	0.055	8/8	<0.0005	0.500	<0.0005	0.500
Tetrachloroethylene	µg/l	15/10	<0.0025	0.50	0.003	0.27	14/14	<0.0025	<0.5	<0.0025	<0.5

4. Profiles and trend assessment of selected determinands

The 90 percentiles (C90) of selected determinands (dissolved oxygen, BOD_5, COD_{Cr}, $N\text{-}NH_4$, $N\text{-}NO_3$, $P\text{-}PO_4$, Ptotal and Cd) measured in last ten years are displayed in the Figures 4.1-4.16. Due to the 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. In 2008 the site HR6 rkm 729 was replaced by HR10 rkm 728.8. In 2009 the site SK3 was replaced by SK5, this monitoring point is also shown in graphs as Hungarian point HU3. For trend graphs SK3 and HU3 was used because for SK5 is only one year of monitoring data is available.
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 4.17-4.33).

As regards general spatial distribution of key water quality parameters along the Danube River in 2009 the highest concentrations of biodegradable organic matter were observed in the middle and lower parts of the river. The concentration of nutrients and cadmium reached their highest concentration values in the lower part of the Danube. The highest pollution by the biodegradable organic matter in 2009 was measured in Russenski Lom, Jantra, Arges, Siret and Prut.

The highest values of dissolved oxygen were observed in the upper part of the Danube, in the lower Danube the dissolved oxygen levels decreased (Figure 4.1). The lowest value was detected at the monitoring point BG2. In the tributaries Russenski Lom, Arges, Jantra and Prut low values of dissolved oxygen were measured in 2009.

Taking into account the entire period of TNMN operation, 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 also at some stations of the lower Danube (BG2, BG4, RO5, RO6, RO7, RO8 see Figure 4.3). The BOD levels at the monitoring points SK1, HU5, RO5 were decreased in 2009 (Figure 4.17-4.19). The BOD levels in the tributaries Dyje, Inn, Sava, Arges, Siret had a decreasing tendency (Figure 4.14).

Decreasing concentration of ammonium-N was recorded in most of the Danube River. During the last ten years of TNMN operation, concentrations of ammonium were decreasing in the upper Danube tributaries (Inn, Salzach, Morava, Dyje) as well as in the Sava, Siret, Tisza and Prut rivers (see Figure 4.8).

The level of nitrate-N concentrations is rather stable during recent years. A decrease was observed at several stations along the Danube (e.g., BG4, RO3, RO5-RO8, see Figure 4.9). At several monitoring sites nitrate-N concentrations increased in 2009 (HU5 and RO5)

(Figure 4.20-4.22). The nitrate-N has a decreasing tendency in the tributaries Dyje, Vah, Tisza/Sajo, Sio, Sava, Arges, Prut and Siret (Figure 4.10).

In the last decade a decreasing tendency of ortho-phosphate-P concentrations is mostly seen in the upper part of the Danube, but in the last year concentration a decrease was observed also at several stations at the lower Danube (BG2, RO5, RO6, RO7, RO8, Figure 4.11). Decreasing tendency of ortho-phosphate-P was observed in the tributaries Dyje, Vah, Prut, Arges and Siret (Figure 4.12).

P-total concentrations declined in the last decade in the upper and middle Danube (Figure 4.13) as well as in the tributaries Dyje, Morava, Inn, Sio, Tisza, Arges and Sava (see Figure 4.14). On the other hand in 2009 the P-total concentration increased in tributaries Russenski Lom and Jantra.

The trends of COD in Danube river was rather stable over the last ten years, the highest concentrations were detected in the lower part of the Danube River. The highest COD concentrations in 2009 were observed in tributaries Russenski Lom, Jantra, Siret and Prut.

At the stations SK1 Bratislava, HU5 Hercegszanto and RO5 Reni P-total concentration had decreasing trend.

The 90 and 10 percentiles of selected determinands (N-NH_4, P-PO_4, CODcr, BOD_5) measured in 2009 are displayed in the Figures 4.26-4.33. These images indicate the margins of a usual annual concentration range for a given parameter at a particular site. Low concentrations of N-NH_4 were observed in the upper Danube (Figure 4.26), the highest concentration was detected in BG2. In tributaries the highest N-NH_4 values were observed in Arges and Bega (Figure 4.27). The highest values of percentiles of P-PO_4 were observed in the Bulgarian and Romanian part of the Danube (Figure 4.28) and in the tributaries Sio, Bega, Dyje, and Prut (Figure 4.29). The maximal values of COD_{cr} percentiles were found in the lower Danube and in tributaries Ialomita, Olt, Russenski Lom, Sio and Tisza (Figure 4.30 and Figure 4.31). The highest values of BOD_5 percentiles were found in the lower Danube and in HU1 and HU2 sites (Figure 4.32). In tributaries the highest BOD_5 percentile values were observed in the Russenski Lom, Jantra, Ialomita, Bega, Mures, Iskar and Tisza(Figure 4.33).

The annual differences between C90 and C10 have an insignificant variation 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 apparent differences between C90 and C10 were observed for BOD_5 along the whole Danube. For COD_{cr}, N-NH_4 and P-PO_4 significant differences between C90 and C10 were observed only in the middle and lower Danube.

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

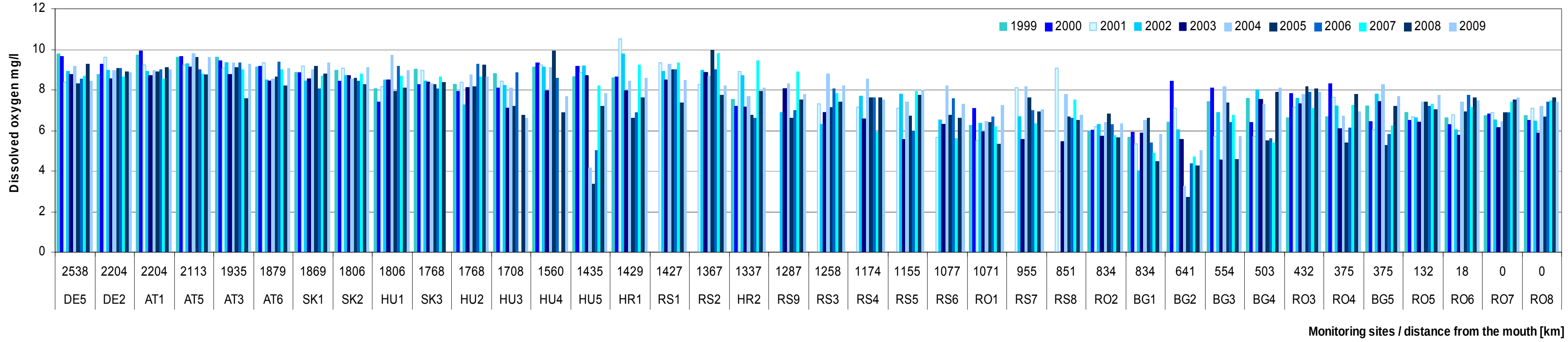


Figure 4.2.: Temporal changes of dissolved oxygen (c10) in tributaries.

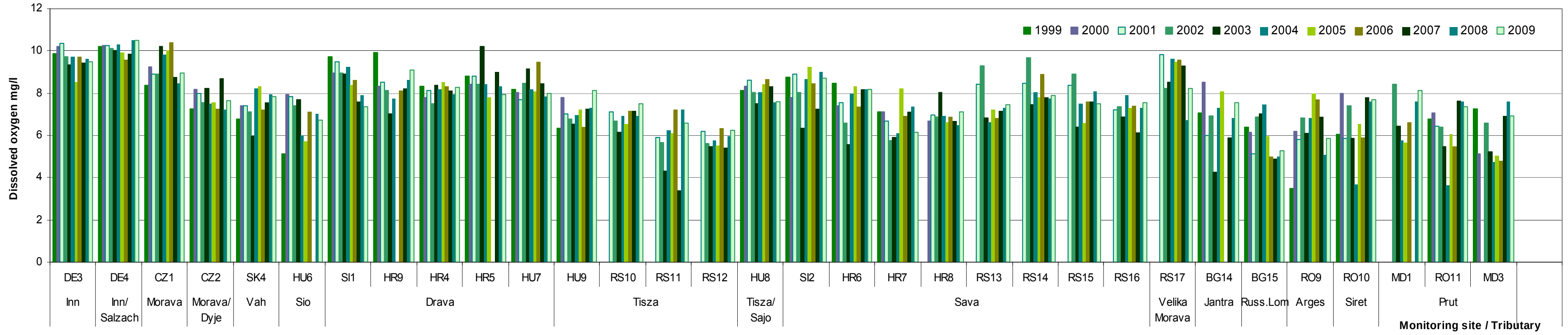


Figure 4.3.: Temporal changes of BOD$_5$ (c90) in the Danube river.

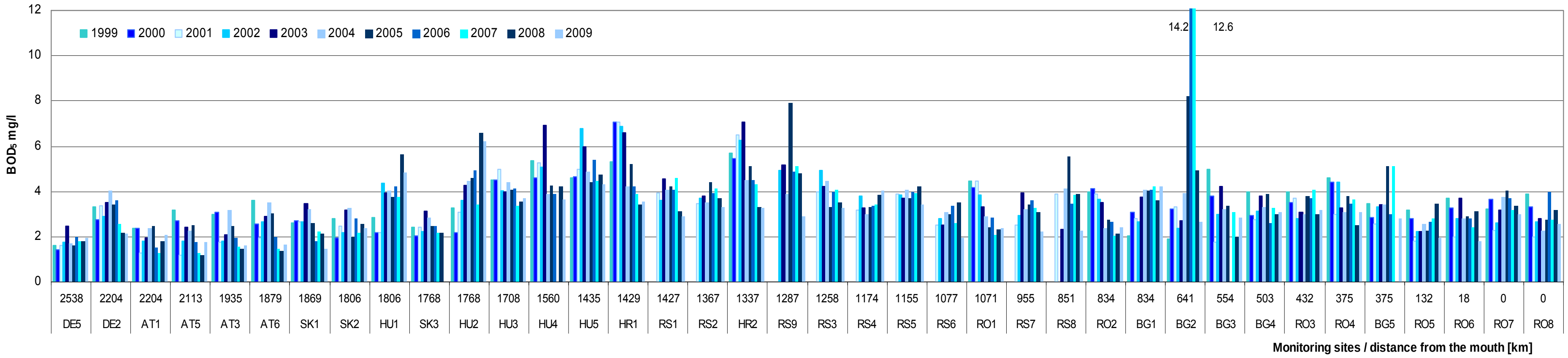


Figure 4.4.: Temporal changes of BOD$_5$ (c90) in tributaries.

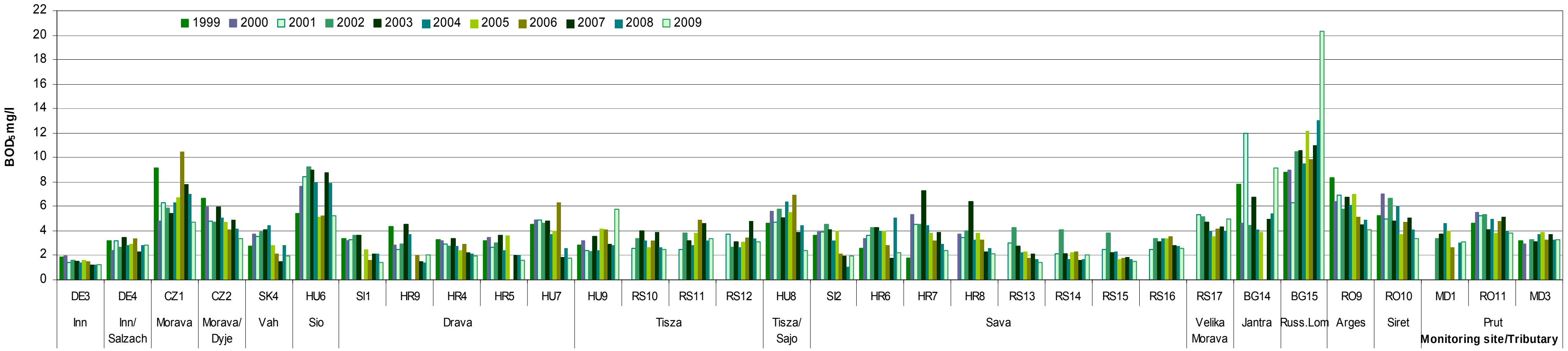


Figure 4.5.: Temporal changes of COD_{Cr} (c90) in the Danube river.

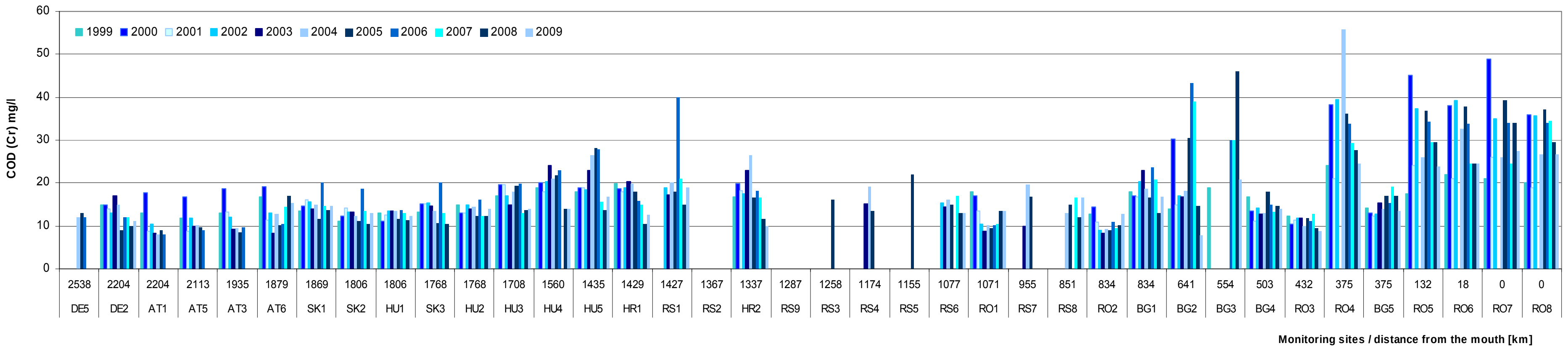


Figure 4.6.: Temporal changes of COD_{Cr} (c90) in tributaries.

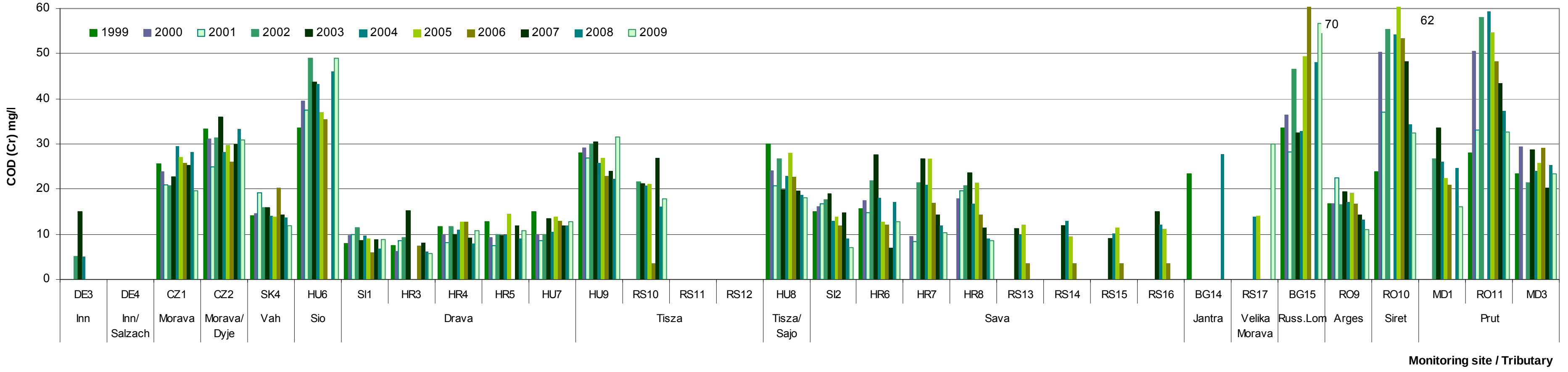


Figure 4.7.: Temporal changes of ammonium-nitrogen (c90) in the Danube river.

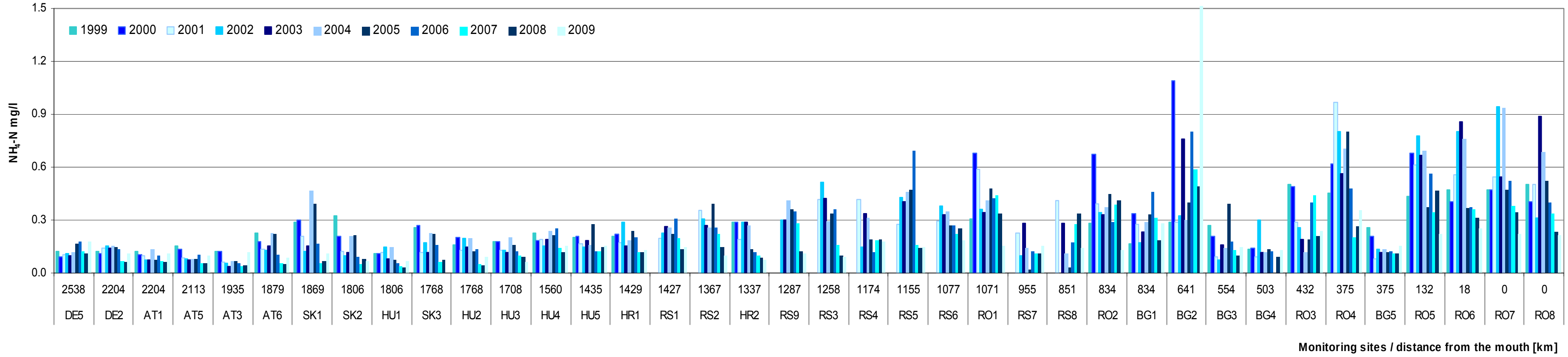


Figure 4.8.: Temporal changes of ammonium-nitrogen (c90) in tributaries.

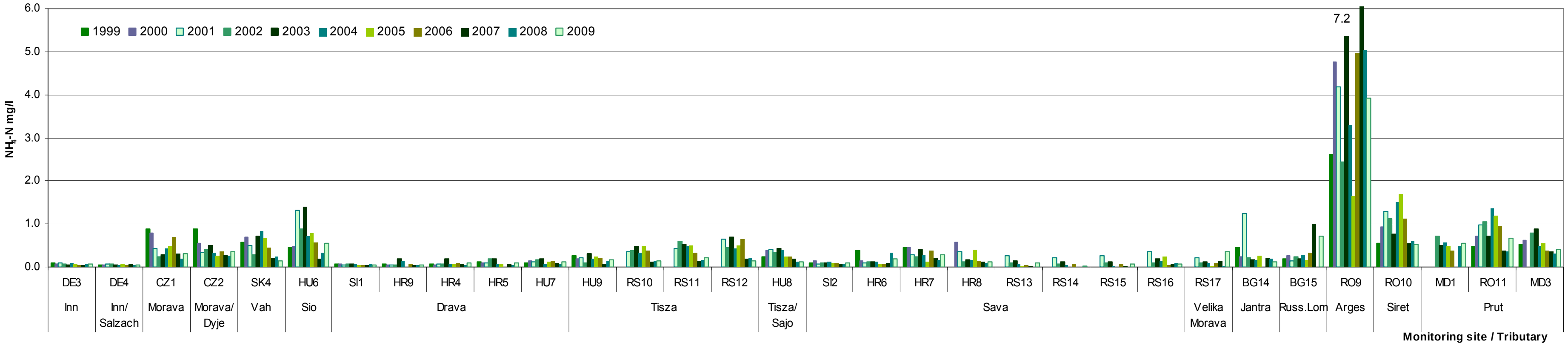


Figure 4.9.: Temporal changes of nitrate-nitrogen (c90) in the Danube river.

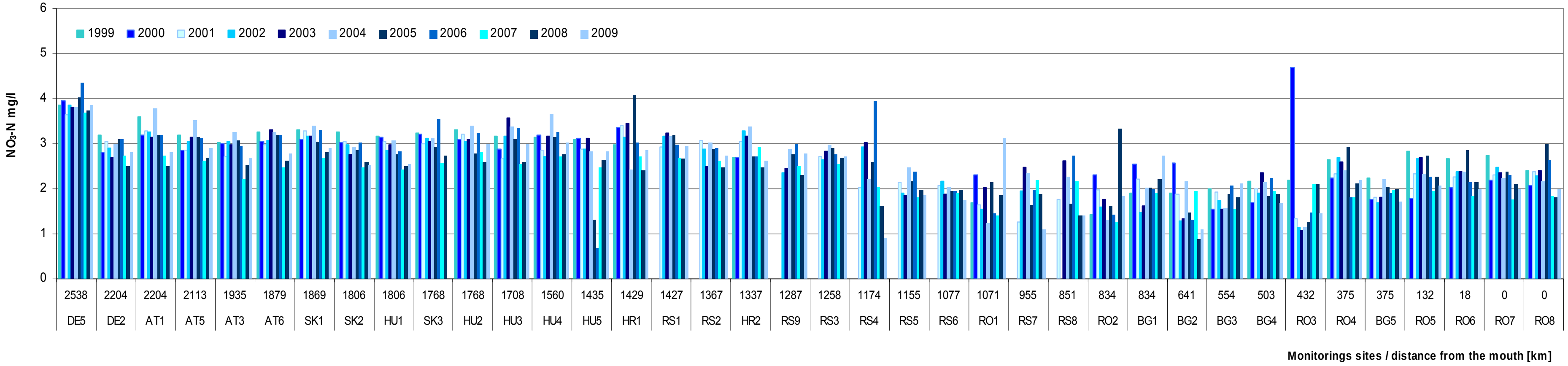


Figure 4.10.: Temporal changes of nitrate-nitrogen (c90) in tributaries.

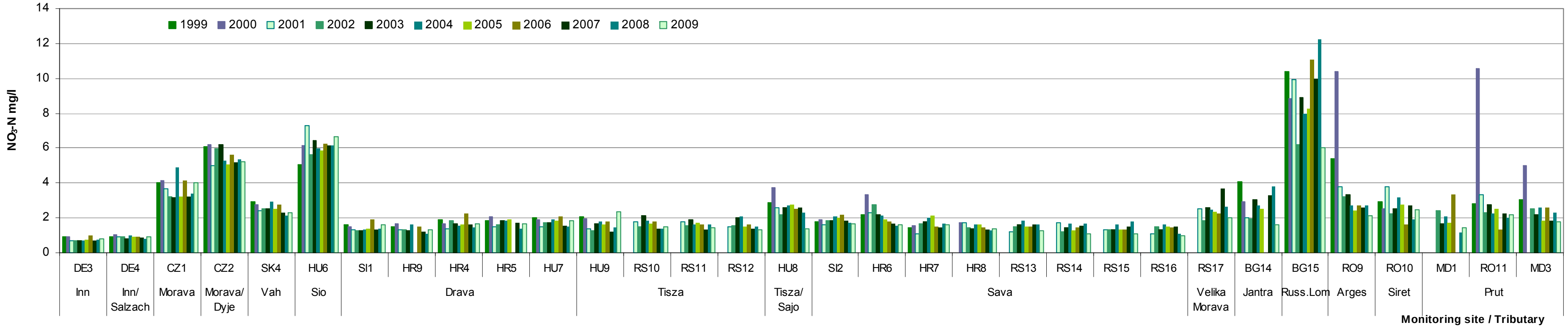


Figure 4.11: Temporal changes of ortho-phosphate-phosphorus (c90) in the Danube river.

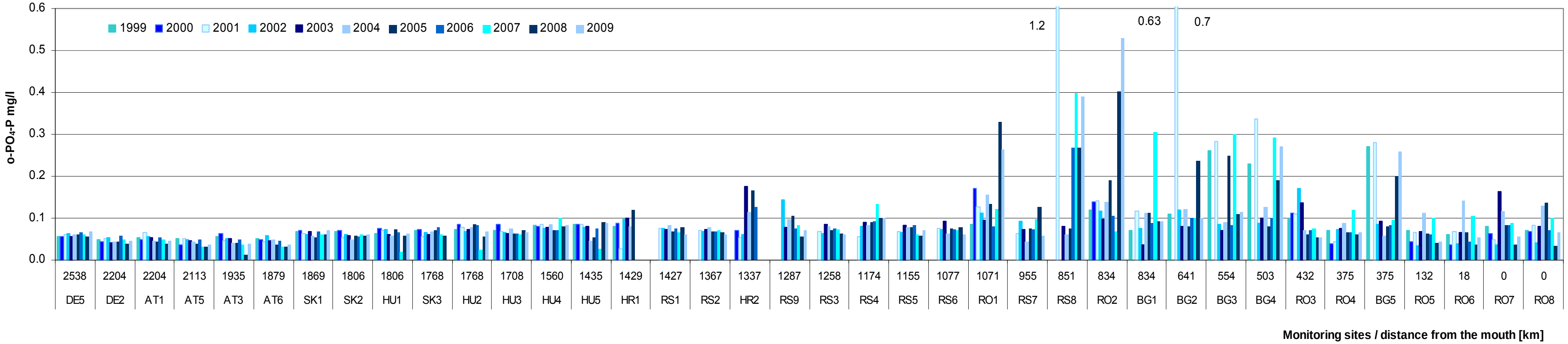


Figure 4.12: Temporal changes of ortho-phosphate-phosphorus (c90) in tributaries

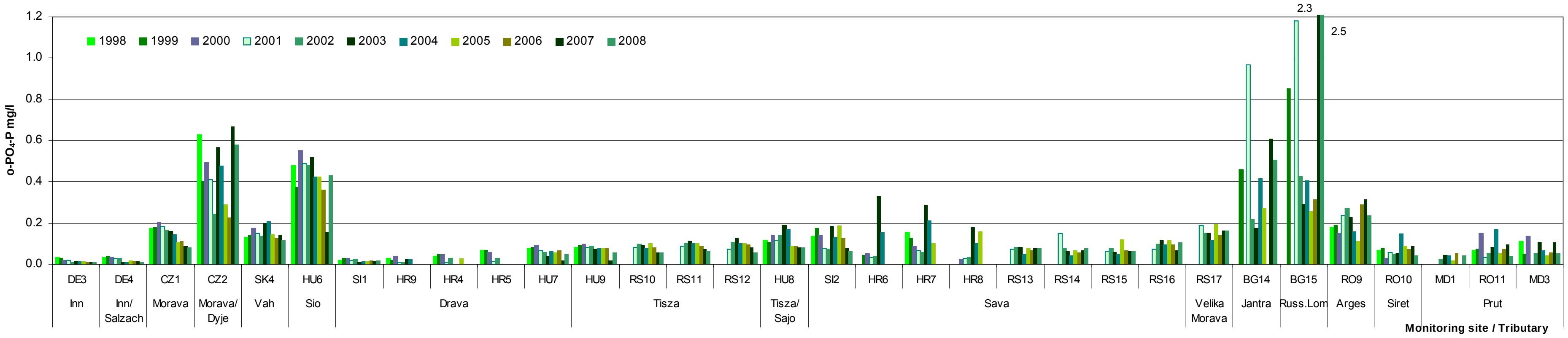


Figure 4.13: Temporal changes of total phosphorus (c90) in the Danube river.

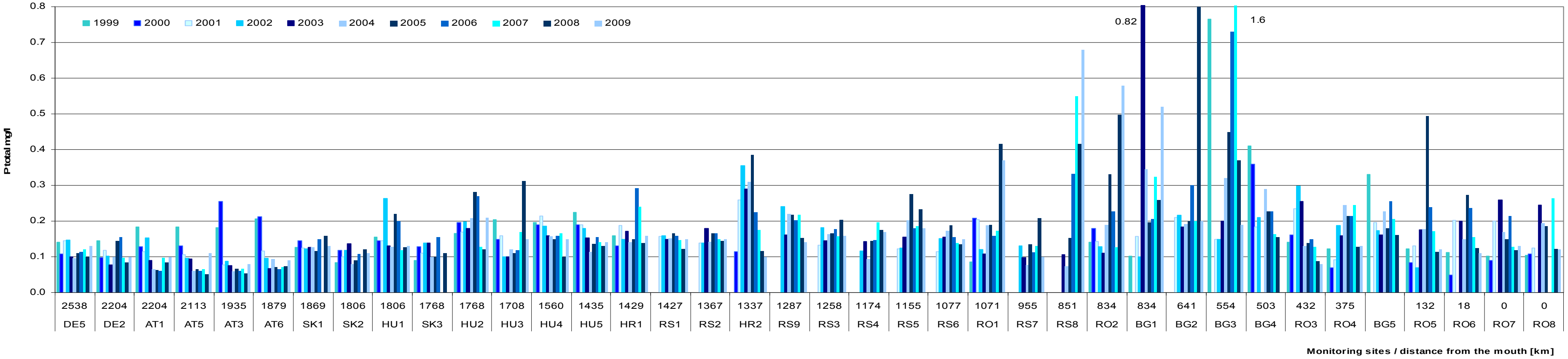


Figure 4.14: Temporal changes of total phosphorus (c90) in tributaries.

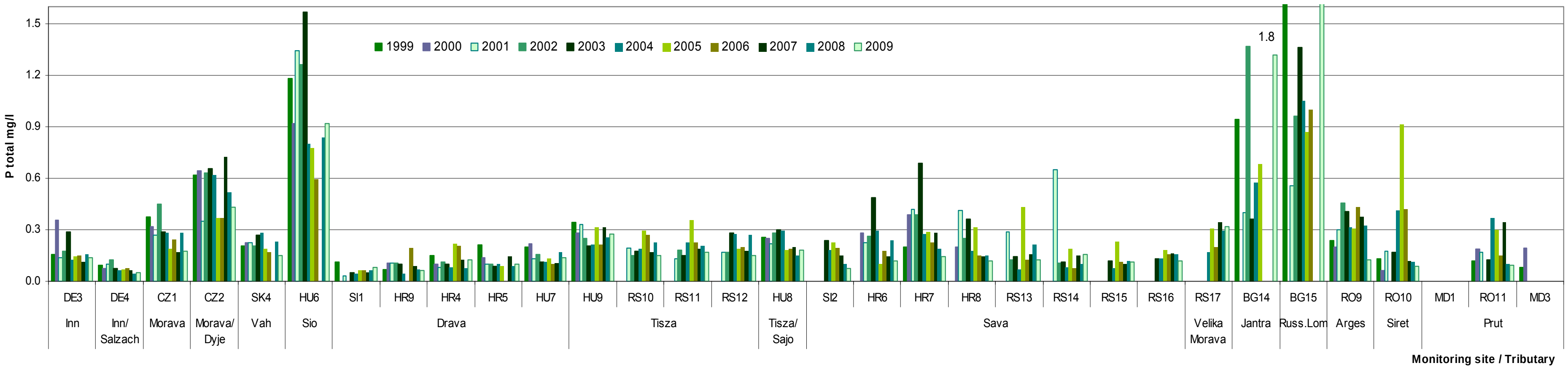


Figure 4.15: Temporal changes of cadmium (c90) in the Danube river.

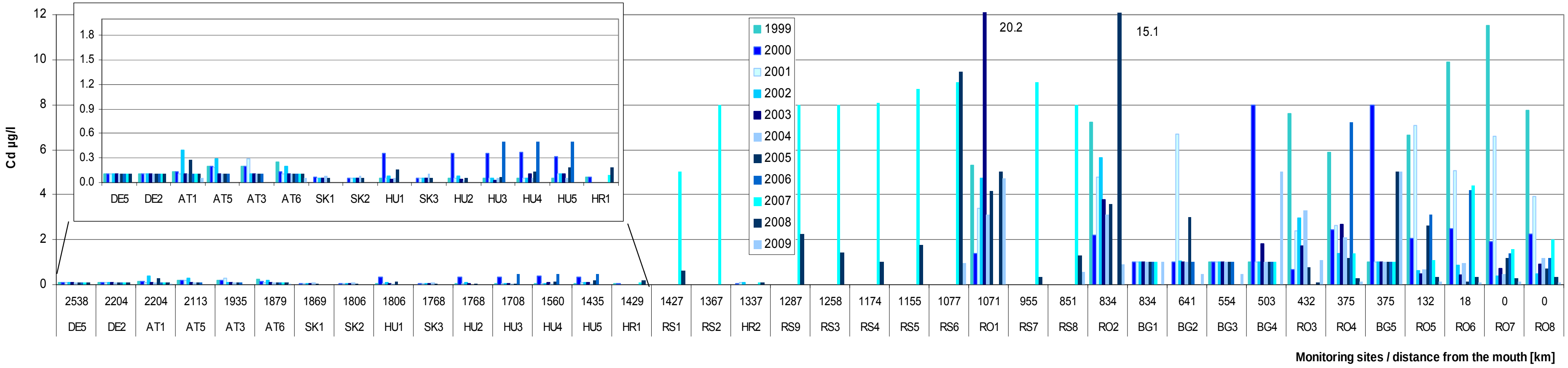


Figure 4.16: Temporal changes of cadmium (c90) in tributaries.

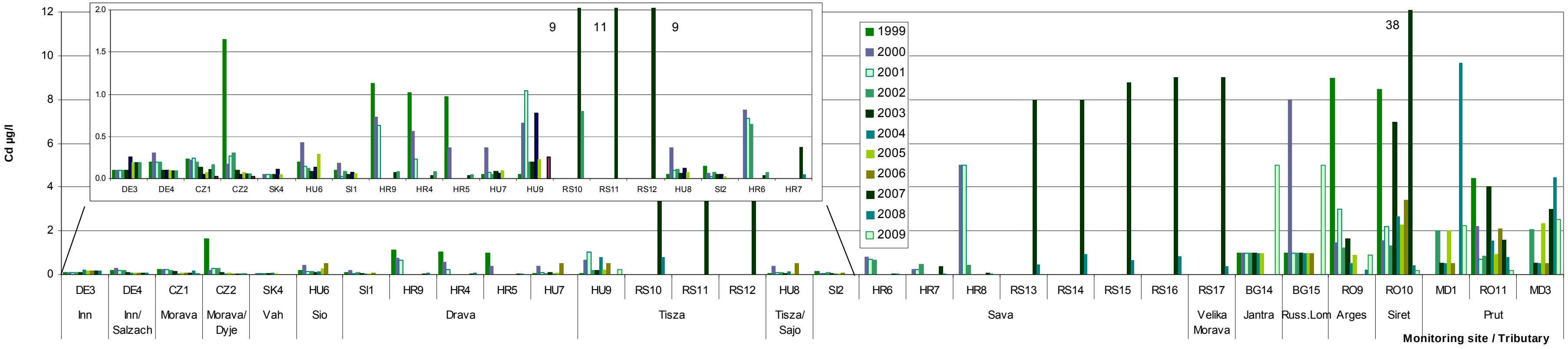


Figure 4.17: Temporal changes of BOD$_5$ (c90) in Bratislava

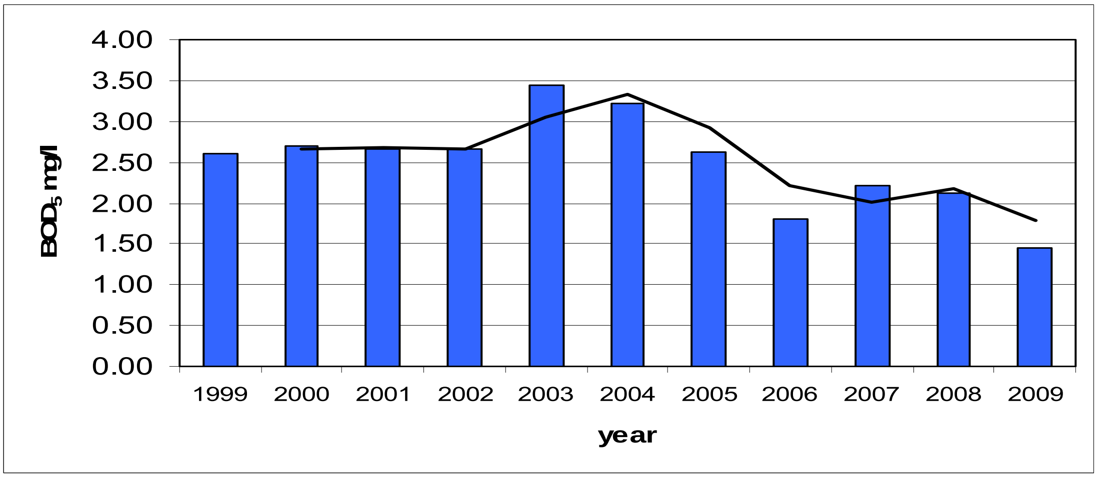


Figure 4.18: Temporal changes of BOD$_5$ (c90) in Hercegszanto

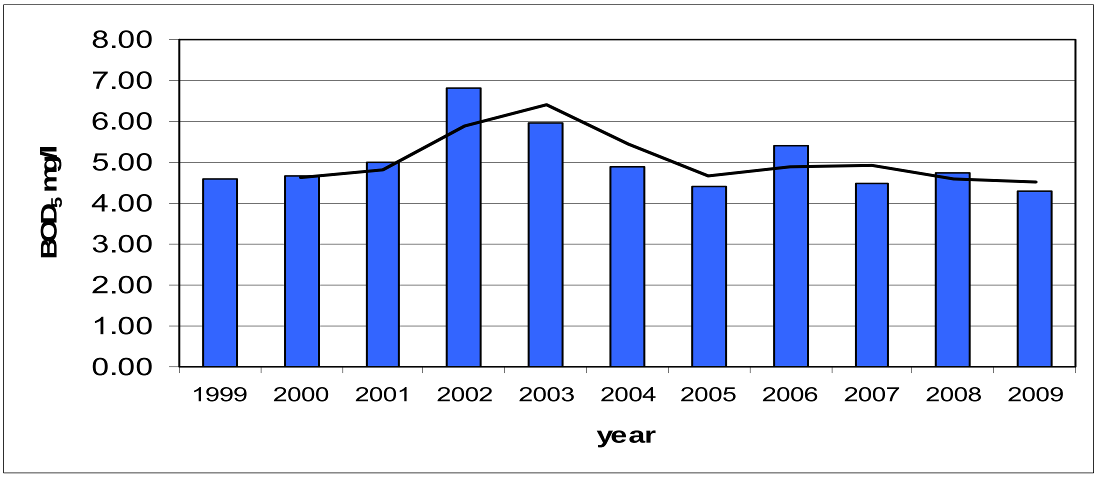


Figure 4.19: Temporal changes of BOD$_5$ (c90) in Reni

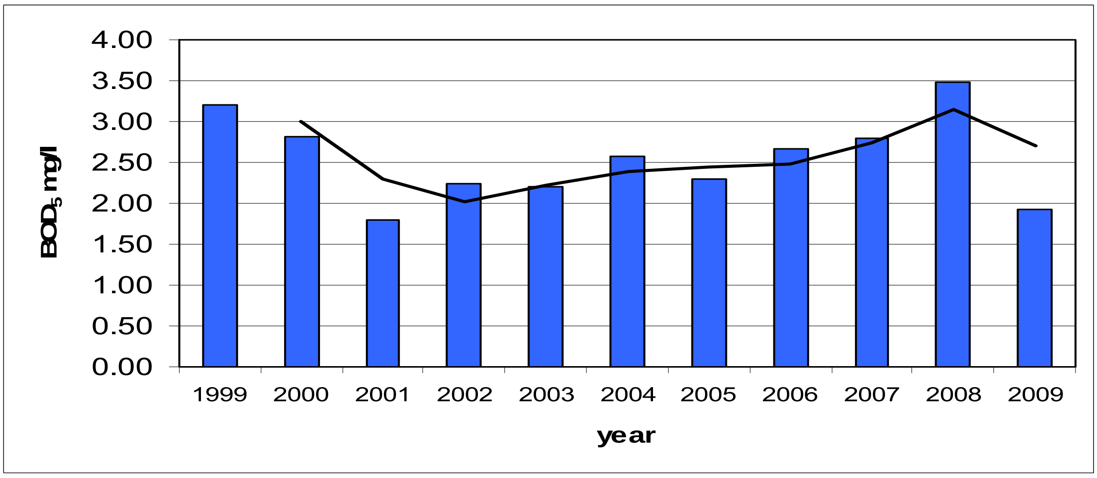


Figure 4.20: Temporal changes of nitrate-nitrogen (c90) in Bratislava

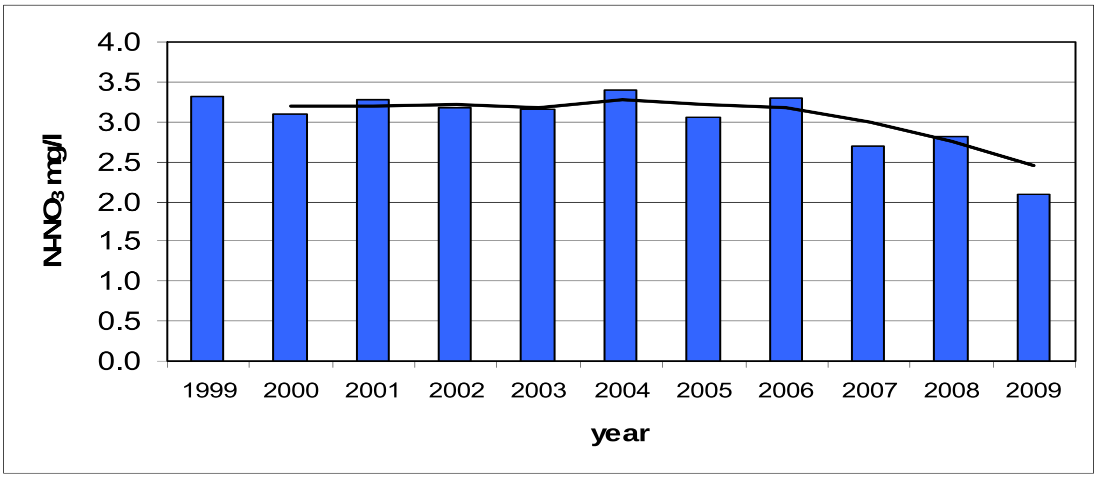


Figure 4.21: Temporal changes of nitrate-nitrogen (c90) in Hercegszanto

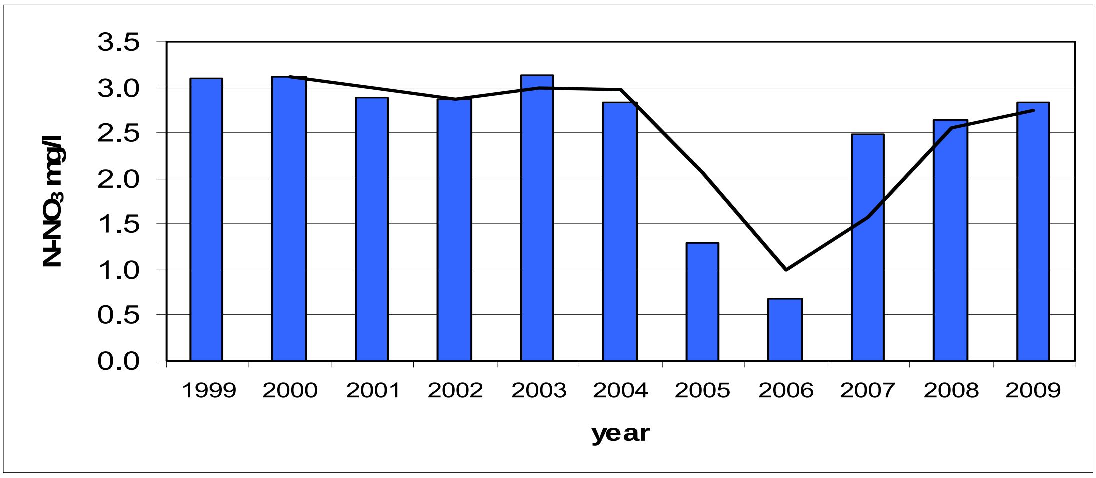


Figure 4.22: Temporal changes of nitrate-nitrogen (c90) in Reni

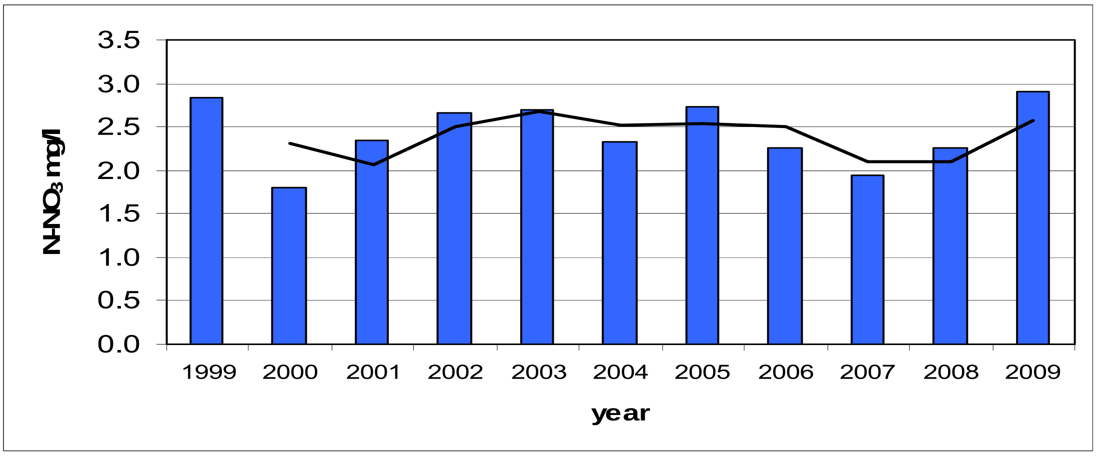


Figure 4.23: Temporal changes of total phosphorus (c90) in Bratislava

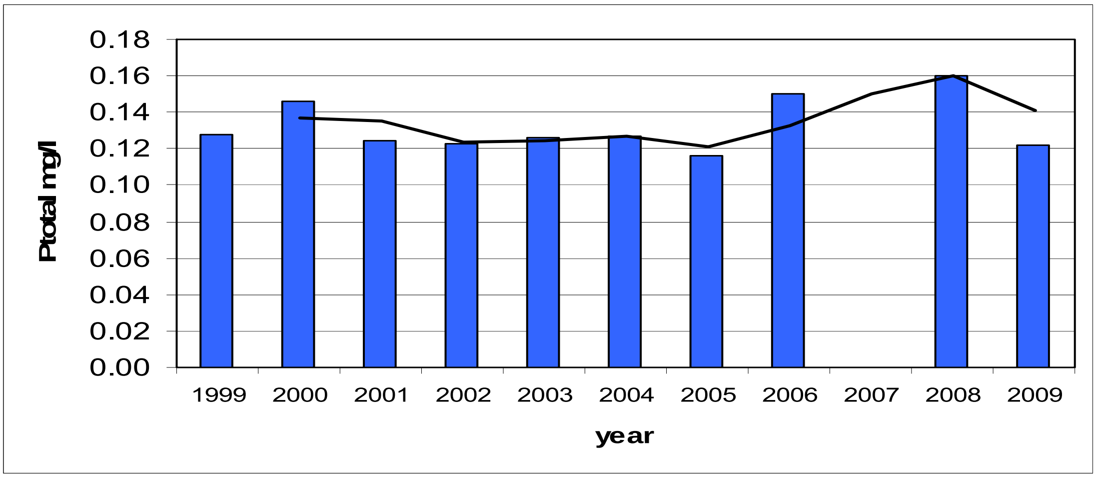


Figure 4.24: Temporal changes of total phosphorus (c90) in Hercegszanto

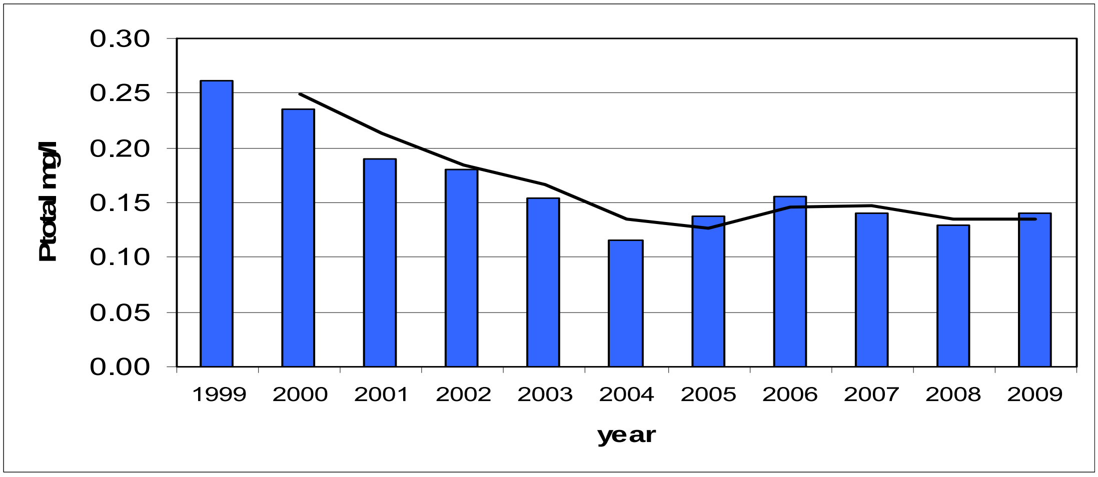


Figure 4.25: Temporal changes of total phosphorus (c90) in Reni

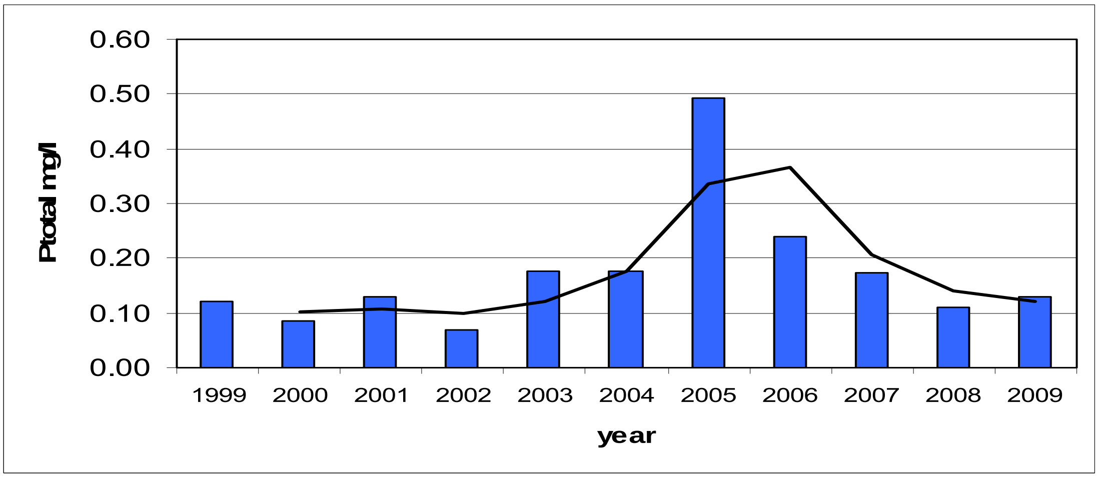


Figure 4.26: The percentile (90, 10) of N-NH$_4$ concentration along the Danube river in 2009.

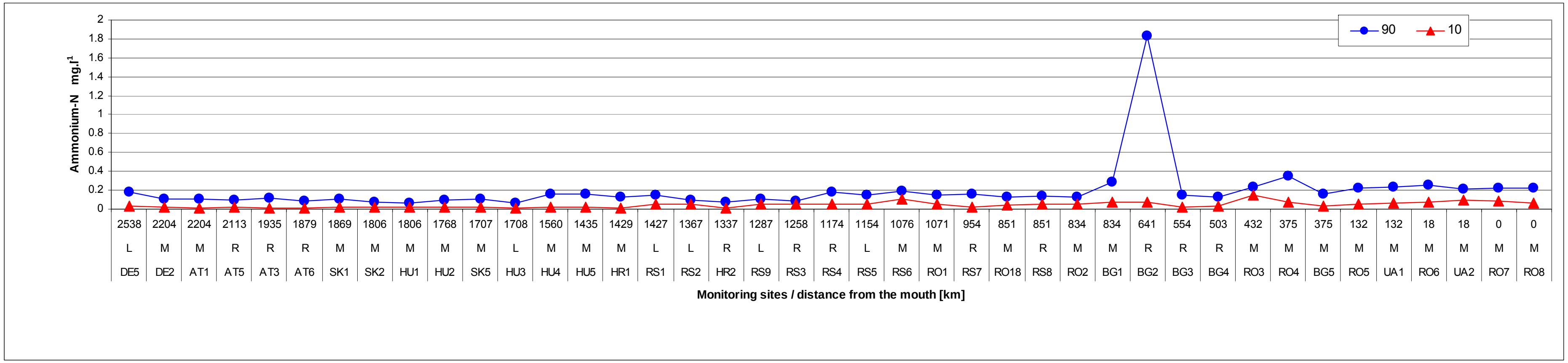


Figure 4.27: The percentile (90, 10) of N-NH$_4$ concentration in the tributaries in 2009.

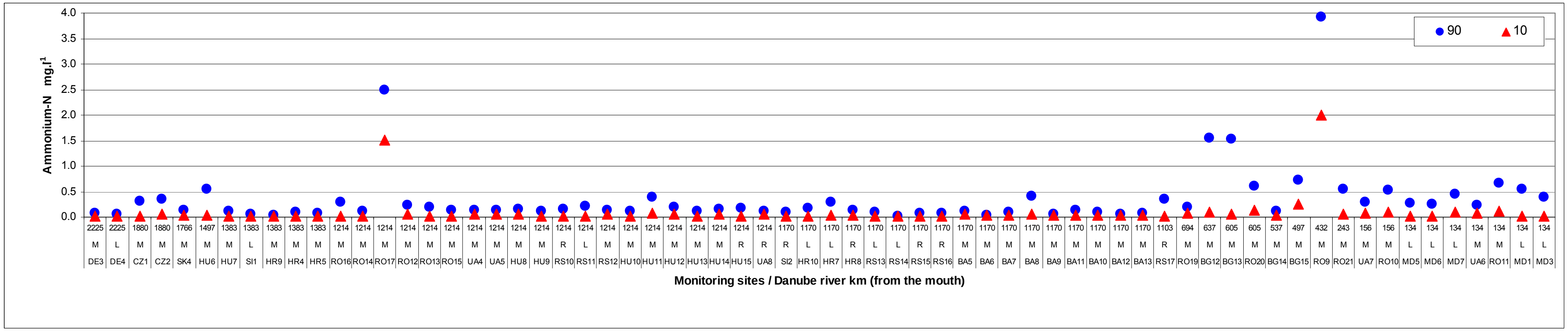


Figure 4.28: The percentile (90, 10) of P-PO_4 concentration along the Danube river in 2009.

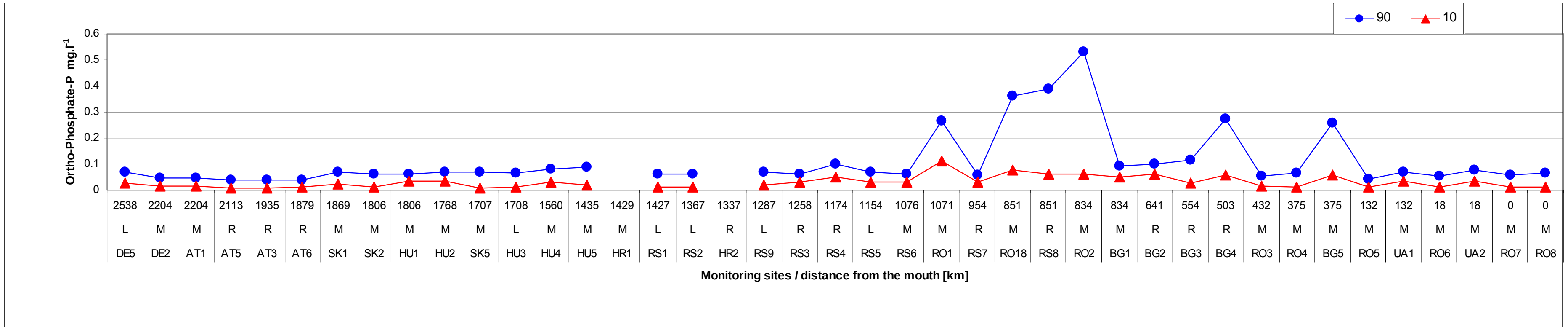


Figure 4.29: The percentile (90, 10) of P-PO_4 concentration in the tributaries in 2009.

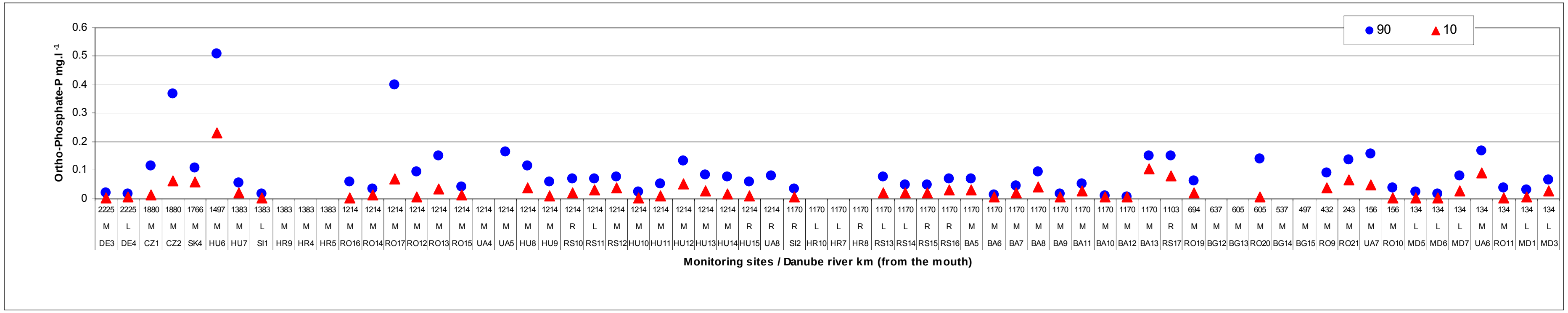


Figure 4.30: The percentile (90, 10) of COD_{cr} concentration along the Danube river in 2009.

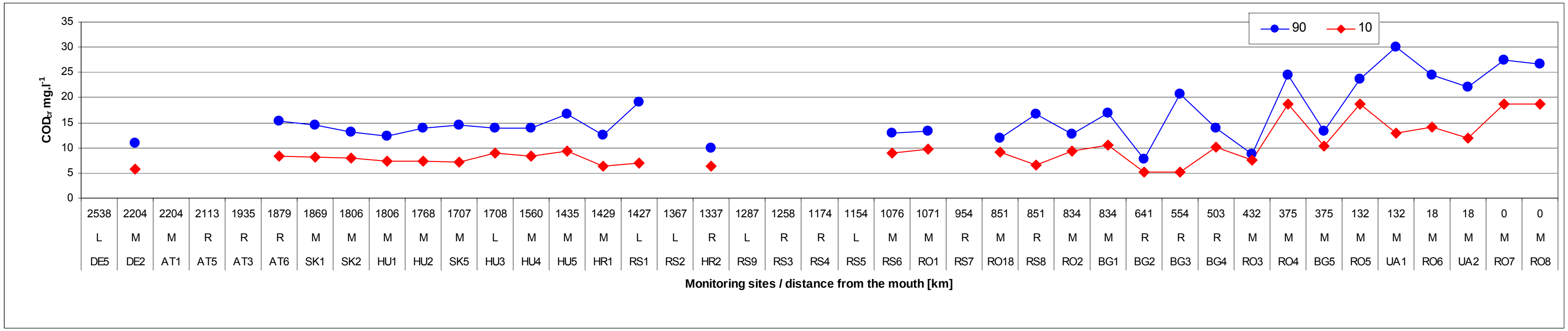


Figure 4.31: The percentile (90, 10) of COD_{cr} concentration in the tributaries in 2009.

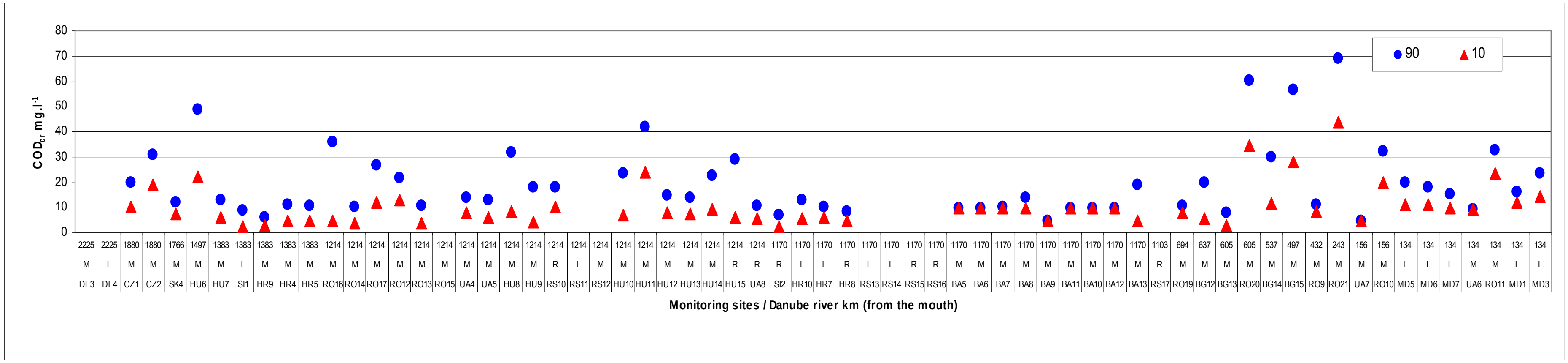


Figure 4.32: The percentile (90, 10) of BOD$_5$ concentration along the Danube river in 2009.

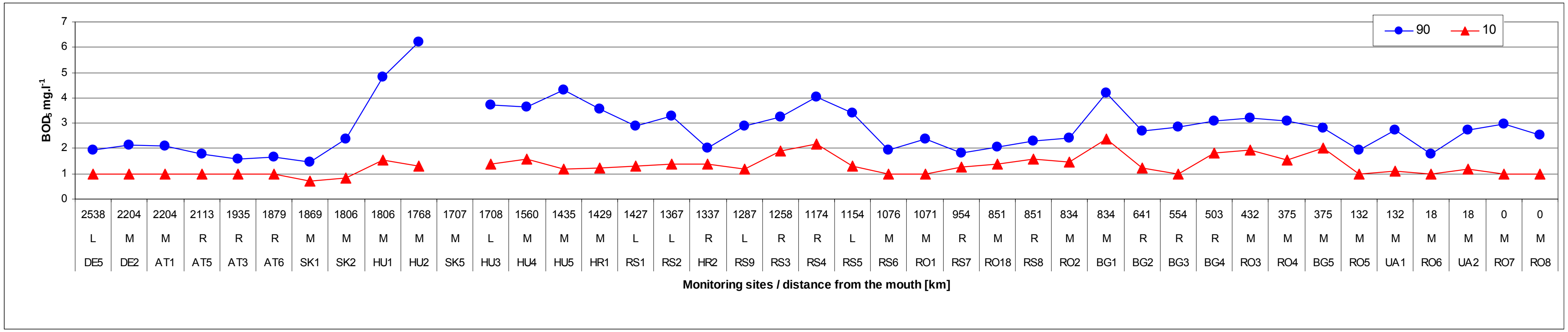


Figure 4.33: The percentile (90, 10) of BOD$_5$ concentration in the tributaries in 2009.

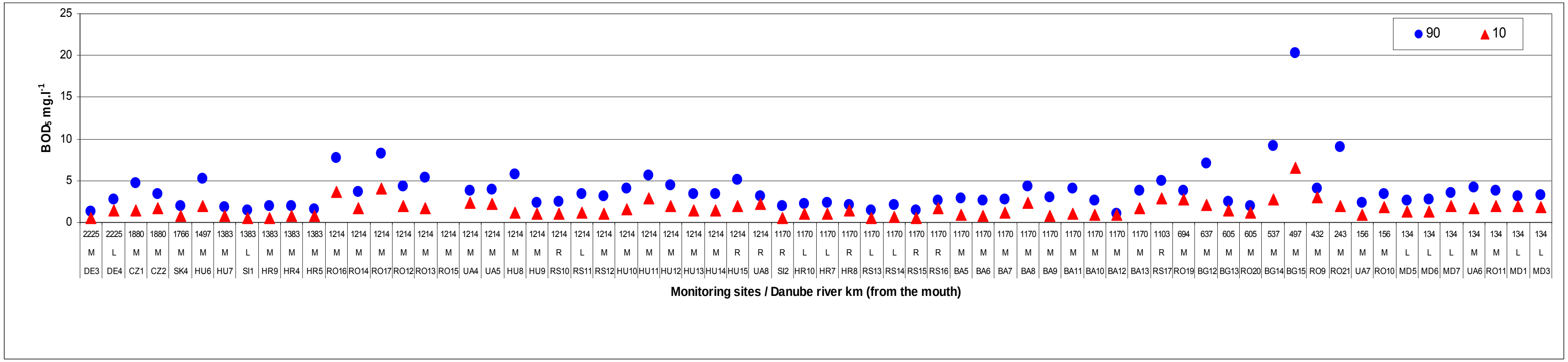


Figure 4.34: The maximum of Macrozoobenthos- saprobic index along the Danube river in 2009.

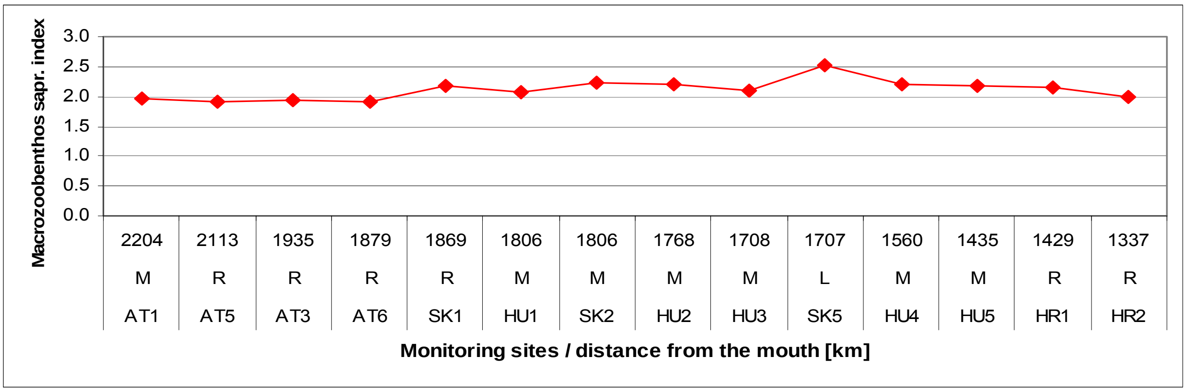
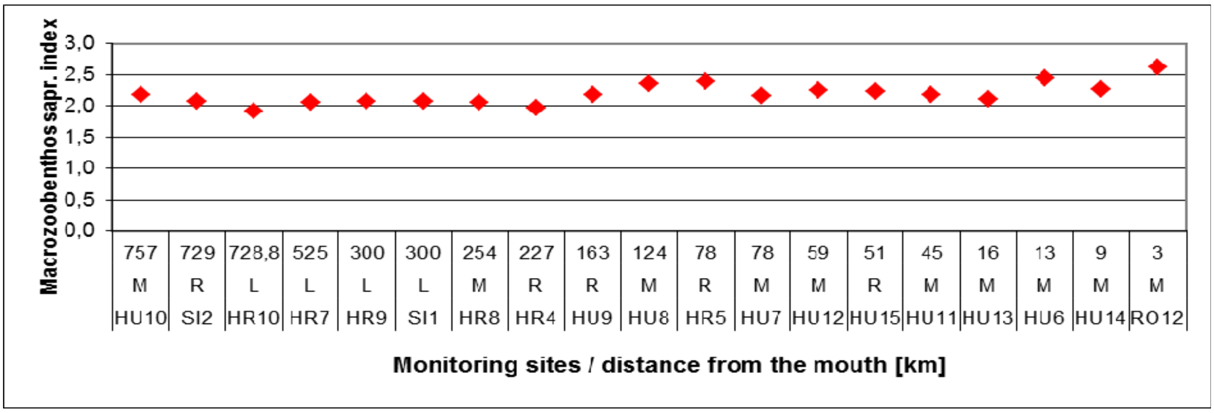
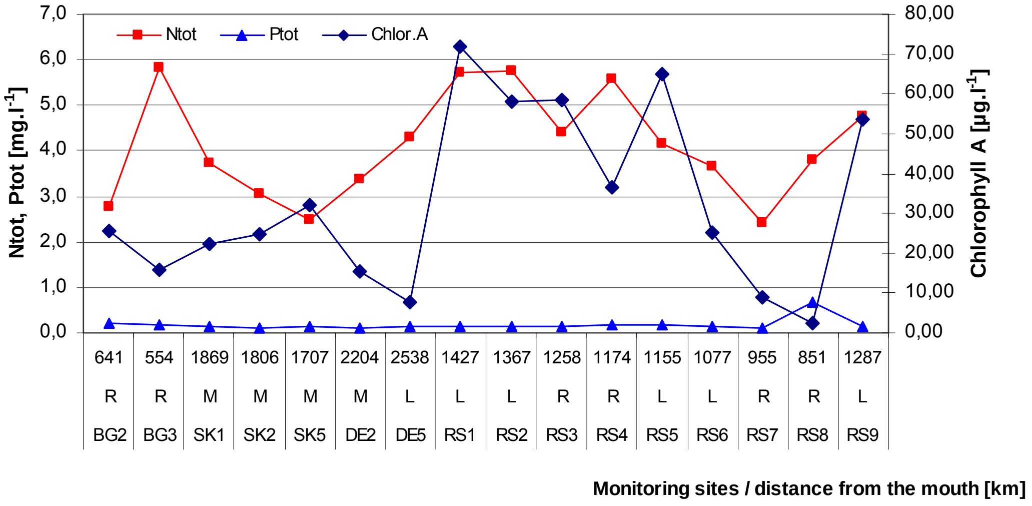


Figure 4.35: The maximum of Macrozoobenthos- saprobic index in the tributaries in 2009



The maximum values of saprobic index for macrozoobenthos in the Danube River and its tributaries are presented in the Figures 4.34 and 4.35. The data of macrozoobenthos was delivered during the year 2009 for 16 monitoring points located in the Danube river and for 19 monitoring points in tributaries. The absolute maximum value of saprobic index has been calculated for SK5 Szob and for the tributary Tisza (RO12).

Figure 4.36: The percentile (90) of total nitrogen, phosphorus and chlorophyll-A concentration along the Danube river in 2009.



The concentrations of nutrients and chlorophyll A are presented in Figure 4.36 (only those monitoring points are shown for which all three determinands were measured). The maximum concentration of chlorophyll A was observed in the lower part of Danube River correlating with the high value of total nitrogen (RS1).

Figure 4.37: The percentile (90) of $N_{tot.}$, N-NH_4 and N-NO_3 concentration along the Sava river in 2009.

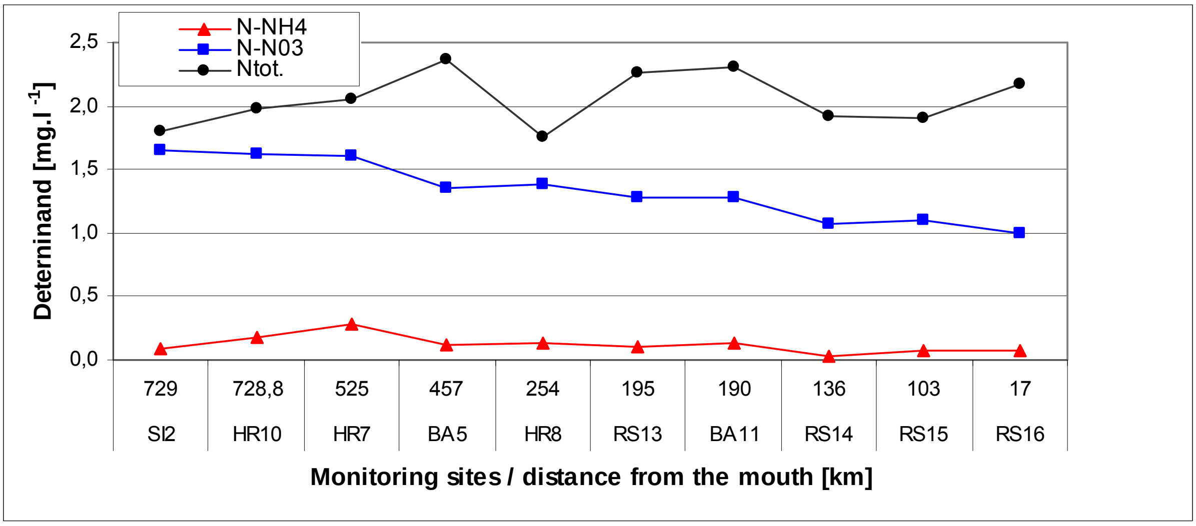
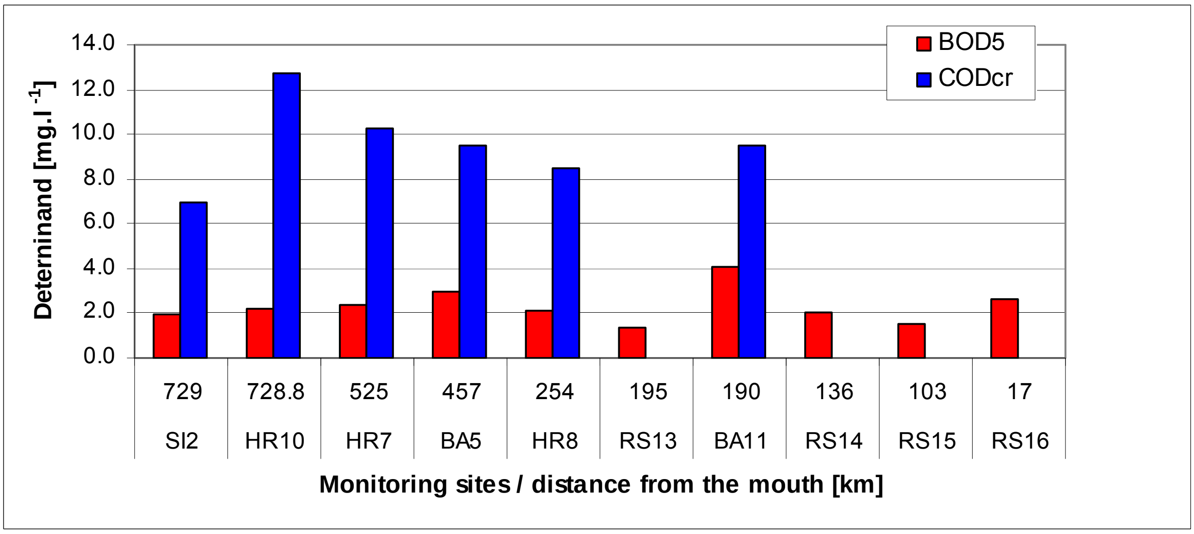


Figure 4.38: The percentile (90) of BOD_5 and COD_{cr} concentration along the Sava river in 2009.



The 90-percentiles for nutrients and for COD_{Cr}, BOD_5 measured in 2009 in the Sava and Tisza rivers are presented in the Figures 4.37-4.38. The highest value of N-NH_4 in the Sava River was found in the monitoring point HR7 (rkm 525). The maximum concentration of N-NO_3 was observed in SI2 (rkm 729) and the maximum of Ntotal was measured in BA5 (rkm 457, Figure 4.37). The highest values of BOD_5 in Sava river were measured at the monitoring point BA11 rkm 190 while the highest COD_{cr} value was measured at the monitoring point HR10 (rkm 728.8), 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 2009.

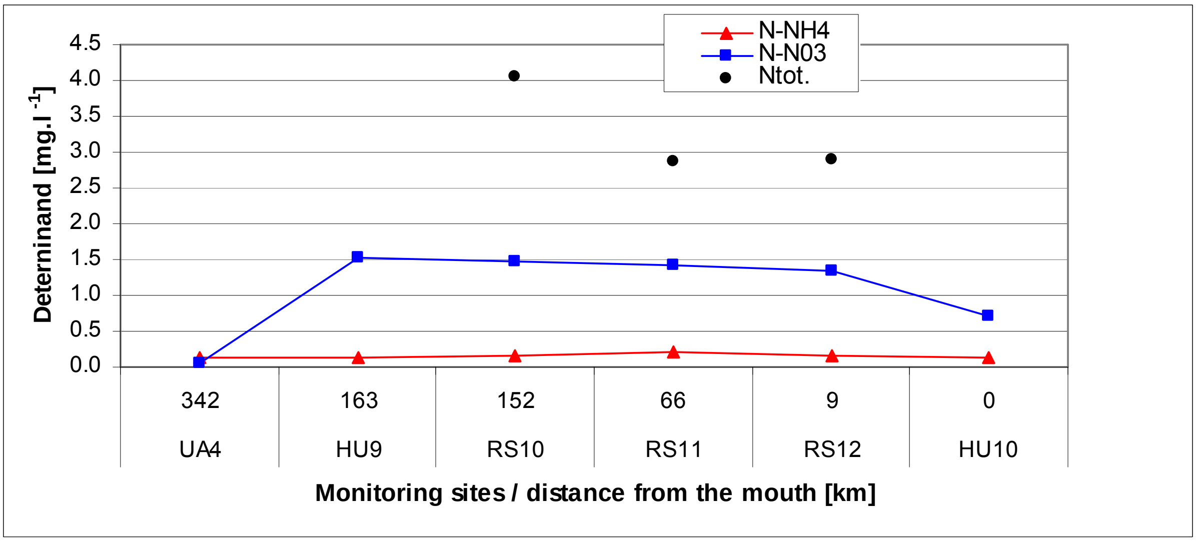
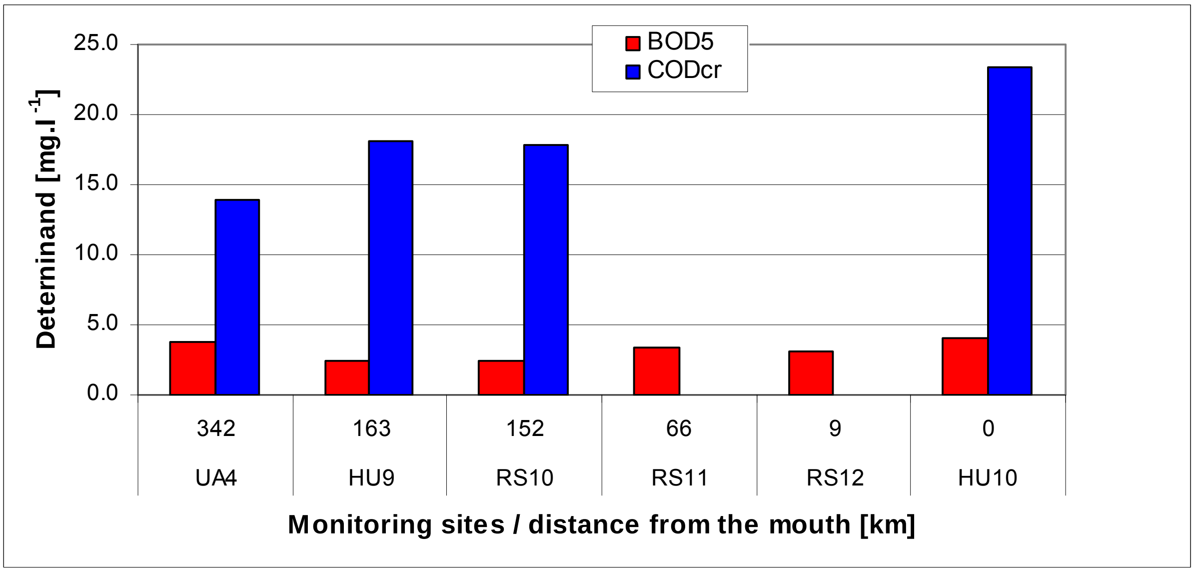


Figure 4.40: The percentile (90) of BOD_5 and COD_{cr} concentration along the Tisza river in 2009.



4.1. Phytobenthos

Cyanophytes and algae are important primary producers using for bio-indicating long-term changes in aquatic ecosystems, especially related to eutrophication. Phytobenthos is considered to be a suitable parameter to determine the impact of nutrient pollution in running waters, because the organisms are generally sessile and therefore represent the status of realized nutrients at the sampled stretch.

As a part of Trans National Monitoring Network of the Danube river basin the phytobenthos (benthic diatoms) has been monitored as an optional parameter in the year 2009. A frequency of once or three times a year for investigation of benthic diatoms was used in some of Danube River Basin countries as Romania, Slovenia and Slovakia. Slovakia and Romania use IPS index for assessment of the ecological status while Slovenia use different indices (Trophic index and Saprobic index). Therefore, for the TNMN Yearbook 2009, only Slovak and Romanian data were used.

IPS (the Specific Pollution Sensitivity Index) is the most used metric, which was developed in France as a national assessment index for detection of total water pollution. Indicator taxa are divided into 5 classes according their sensitivity to pollution and into 3 classes according indicative weight. The applicability of the index in many different European regions is great advantage, when judged through WFD, because the same metric used in more countries facilitates the intercalibration of national assessment methods. For this purpose, the IPS was successfully used as intercalibration metric of diatoms within intercalibration exercise of Central Baltic and Eastern Continental Geographical Intercalibration Groups as well as of Cross Geographical Intercalibration Group for large rivers.

Data on monitoring of phytobenthos of the TNMN in the year 2009 are shown in table 4 and in figure 4.41.

Table 4: IPS values of selected TNMN sampling sites in the year 2009

Country code/River/Site	Date	IPS
SK1- Danube - Bratislava (right bank)	3.6.2009	16.10
SK2 – Danube - Medvedov (left/right bank)	3.6/6.10.2009	13.95
SK4 - Vah - Komarno (right bank)	2.6/5.10.2009	12.40
SK5 – Danube – Szob (left/right bank)	4.6/7.10.2009	11.92
RO3 - Danube- upstream Arges (Oltenita)	13.7/28.9/27.4.2009	12.00
RO5 – Danube - Reni	21.5/14.7.2009	12.30
RO6 – Danube - Vilkova	21.5/14.7.2009	12.20
RO7 – Danube - Sulina arm (left/right bank)	21.5/7.8.2009	12.90
RO8 – Danube - Sf Gheorghe arm (left/right bank)	21.5/7.8.2009	14.20
RO9 – Arges - Up Danube conf (left/right bank)	27.4/13.7/28.9.2009	15.10
RO10 – Siret - Up Danube conf	22.5/3.8.2009	10.50
RO11 – Prut - Up Danube conf	22.5/3.8.2009	13.50
RO12 - Somes - Dara	15.4.2009	14.50
RO13 – Crisul Repede - Cheresig	18.3.2009	12.40
RO14 – Crisul Negru - Zerind	17.3.2009	13.00
RO15 – Crisul Alb - Varsand	17.3.2009	14.30
RO16 – Mures - Nadlac	19.5/18.8/14.10.2009	12.40
RO19 - Jiu - Up Danube conf	4.5/9.7/17.9.2009	14.20

There are 8 sampling stations on the Danube (green bars in the Fig.4.41) and 10 tributaries (Vah, Arges, Prut, Siret, Somes, Crisul Repede, Crisul Negru, Crisul Alb, Mures, Jiu – grey bars in the Fig. 4.41).

The values ranged in the Danube from 11.92 up to 16.10 and in the tributaries from 10.5 up to 15.10. Referring to the scale of IPS index (0-20) the stations show the upper classes (1st - 2nd) of the sensitivity to the pollution.

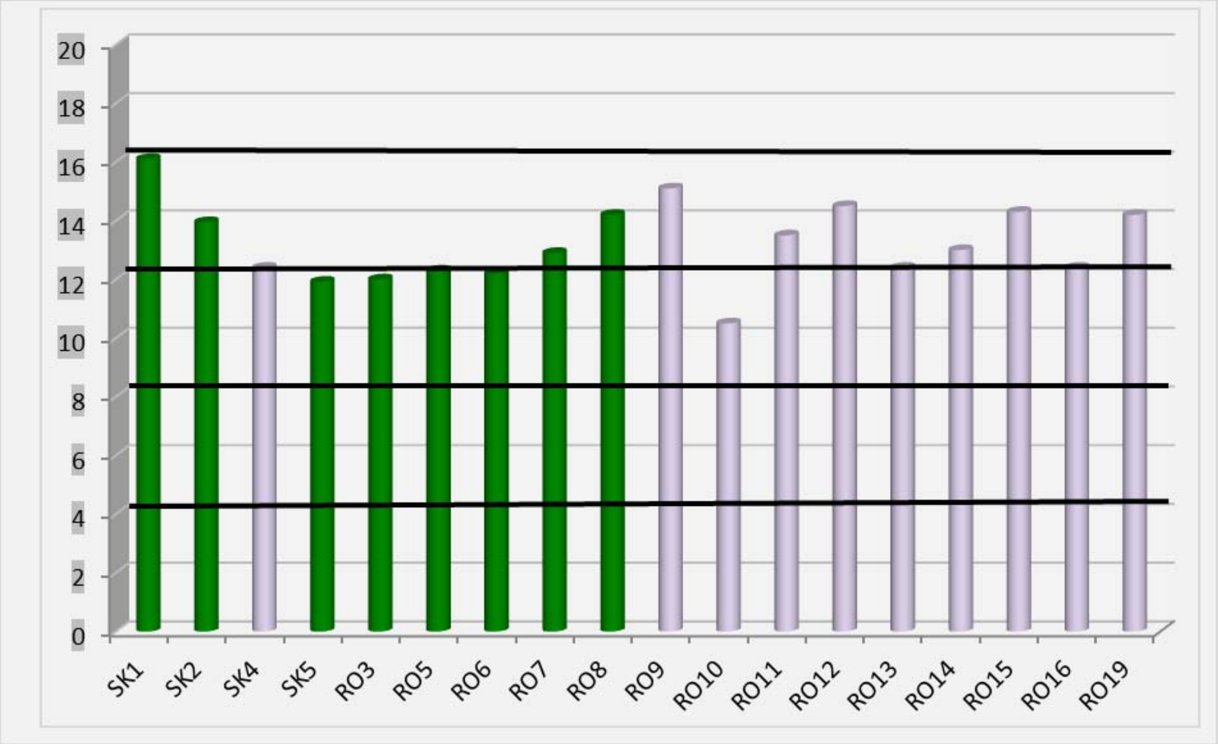


Figure 4.41: IPS values of selected TNMN sampling sites in the year 2009.

5. Load Assssment

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 20, with ten locations on the Danube River itself and ten locations on the tributaries.

5.3. Monitoring Data in 2009

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 2009 there were 12 measurements for load assessment available from Ukraine. Data are shown in tables 7 and 9. Flow data are missing from one Croatian monitoring location. In most of the locations, the number of samples was higher than 20, lower frequency was the case only for chlorides. A frequency of 12 times per year was applied only in Morava and 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 in 2009 one site performed samplings at the location Drenje (left side of the river Sava) located under the influence of the estuary Sotla. Therefore the results at the location Sava Drenje do not show the load of the Sava River in the border profile.

Regarding particular determinands, there is still a lack of data on dissolved phosphorus as it was measured in six locations only. At nine monitoring points the silicate load was calculated. This calculation of the silicate load is to respond to the agreements with the Black Sea Commission.

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

Country	River	Water quality monitoring location			Hydrological station	
		Country Code	Location	Distance from mouth (Km)	Location	Distance from mouth (Km)
Germany	Danube	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	HR10	Drenje	728.8	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:

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

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

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 6: Number of measurements in TNMN locations selected for assessment of pollution load in 2009

Country Code	River	Location	Location in profile	River Km	Number of meausrements in 2009								
					Q	SS	N_{inorg}	P-PO_4	P_{total}	BOD_5	Cl	P_{diss}	SiO_2
DE2	Danube	Jochenstein	M	2204	365	26	38	38	38	21	26	38	0
DE3	Inn	Kirchdorf	M	195	365	25	22	26	26	26	25	22	0
DE4	Inn/Salzach	Laufen	L	47	365	25	22	26	26	26	26	26	0
AT1	Danube	Jochenstein	M	2204	365	12	38	38	38	12	12	38	0
AT6	Danube	Hainburg	R	1879	365	24	24	24	24	24	24	24	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	24	24	24	12	24	12	24	24
HU3	Danube	Szob	L	1708	365	24	24	24	24	24	24	0	0
			M	1708	365	21	21	21	21	21	21	0	0
			R	1708		24	24	24	24	24	24	0	0
HU5	Danube	Hercegszántó	M	1435	365	0	24	24	24	24	21	0	24
HU9	Tisza	Tiszasziget	L	163		26	26	26	26	12	12	0	26
			M	163	365	24	24	25	24	11	11	0	24
			R	163		25	25	26	25	11	11	0	25
HR2	Danube	Borovo	R	1337	0	13	13	0	13	13	13	0	13
HR10	Sava	Drenje	L	729	0	13	13	0	13	13	13	0	13
HR7	Sava	us Una Jesenovac	L	525	0	13	13	0	13	13	13	0	13
HR8	Sava	ds Zupanja	ML	254	0	11	11	0	11	11	11	0	11
SI1	Drava	Ormoz	L	300	365	26	26	26	26	26	12	0	0
SI0	Sava	Jesenice	R	729	365	26	26	26	26	26	12	0	0
RO2	Danube	Pristol-Novo Selo	L	834		22	24	24	24	12	12	0	0
			M	834	365	20	22	22	22	10	10	0	0
			R	834		20	22	22	22	10	10	0	0
RO4	Danube	Chiciu-Silistra	L	375		26	26	26	26	21	17	0	0
			M	375	365	26	26	26	26	21	17	0	0
			R	375		26	26	26	26	21	17	0	0
RO5	Danube	Reni	L	132		27	27	27	27	24	26	0	0
			M	132	365	27	27	27	27	24	26	0	0
			R	132		27	27	27	27	23	26	0	0
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 2009
c_{mean}	arithmetical mean of the concentrations in the year 2009
Annual Load	annual load of given determinand in the year 2009

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 similar as in 2008, the discharge in Reni was a little bit higher than that in 2008. There are no significant differences in discharges measured in the Danube River and in its tributaries during last two years.

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, BOD_5 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 and total phosphorus and loads were found at the location Pristol-Novo Selo (RO2).

In the case of tributaries, the highest load of suspended solids, nutrients BOD_5 and chlorides are coming from the Tisza river.

Table 7: Mean annual concentrations in monitoring locations selected for load assessment on Danube River in 2009

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	1433	14.224	1.925	0.032	0.068	1.418	17.982	0.042	
AT6	R	Danube	Hainburg	1879	2206	25.458	1.937	0.022	0.060	1.017	17.550	0.033	
SK1	M	Danube	Bratislava	1869	2186	38.654	2.024	0.046	0.103	1.000	17.558	0.062	5.487
HU3	L	Danube	Szob	1708	2441	22.347	1.945	0.050	0.108	3.034	21.596		
HU5	M	Danube	Hercegszántó	1435	2607		1.872	0.052	0.112	2.829	21.838		3.550
HR2	R	Danube	Borovo	1337		16.877	1.683		0.090	2.285	17.228		4.428
RO2	LMR	Danube	Pristol-Novo Selo	834	5412	33.985	1.685	0.230	0.292	1.864	60.193		
RO4	LMR	Danube	Chiciu-Silistra	375	5990	21.828	1.945	0.030	0.098	2.163	18.658		
RO5	LMR	Danube	Reni	132	6492	42.259	1.746	0.023	0.070	1.319	28.324		
UA2	M	Danube	Vylkove	18	3329	93.892	1.271	0.052	0.092	1.864	33.225		2.452

Table 8: Mean annual concentrations in monitoring locations selected for load assessment on tributaries in 2009

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
					$(m^3.s^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$	$(mg.l^{-1})$
DE3	M	Inn	Kirchdorf	195	303	56.960	0.616	0.010	0.084	0.677	6.424	0.017	
DE4	L	Inn/Salzach	Laufen	47	285	15.200	0.749	0.011	0.030	2.038	9.696	0.016	
CZ1	M	Morava	Lanzhot	79	57	17.333	2.526	0.061	0.122	2.717	32.100		
CZ2	L	Morava/Dyje	Pohansko	17.00	32	16.833	3.026	0.181	0.243	2.758	45.208		
HU8	LMR	Tisza	Tiszasziget	163	666	38.404	0.998	0.036	0.127	1.819	39.500		7.726
SI1	L	Drava	Ormoz	300	381	16.588	1.182	0.009	0.054	1.021	6.358		
SI2	R	Sava	Jesenice	729	286	8.000	1.432	0.016	0.053	0.831	6.604		
HR10	L	Sava	Drenje	729	269	13.269	1.341		0.103	1.554	10.180		5.572
HR7	L	Sava	us. Una Jasenovac	525	682	16.338	1.430		0.108	1.631	8.055		3.618
HR8	ML	Sava	ds. Zupanja	254	992	10.964	1.192		0.096	1.809	14.501		3.989

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

Station Code	Profile	River Name	Location	River km	Annual Load in 2009							
					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	0.87	82.43	1.34	3.13	63.66	1.02	2.39	
AT6	R	Danube	Hainburg	1879	2.49	129.05	1.52	4.44	66.01	1.10	2.28	
SK1	M	Danube	Bratislava	1869	3.61	139.15	3.15	7.52	69.66	1.13	4.34	0.38
HU3	LMR	Danube	Szob	1708	1.91	150.38	3.87	8.71	248.47	1.64		
HU5	LMR	Danube	Hercegszántó	1435		153.11	4.03	9.07	219.92	1.78		0.29
HR2	R	Danube	Borovo	1337								
RO2	LMR	Danube	Pristol-Novo Selo	834	5.04	253.43	31.34	39.55	286.36	2.81		
RO4	LMR	Danube	Chiciu-Silistra	375	4.55	384.27	5.09	17.47	322.45	4.93		
RO5	LMR	Danube	Reni	132	8.17	376.82	4.77	14.33	289.32	5.26		
UA2	M	Danube	Vylkove	18	10.04	133.72	5.33	9.76	208.66	3.49		0.26

Table 10: Annual load in selected monitoring locations on tributaries

Station Code	Profile	River Name	Location	River km	Annual Load in 2009							
					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)
DE3	M	Inn	Kirchdorf	195	0.91	5.15	0.07	1.14	6.25	0.04	0.15	
DE4	L	Inn/Salzach	Laufen	47	0.20	5.76	0.08	0.31	17.10	0.06	0.14	
CZ1	M	Morava	Lanzhot	79	0.04	5.81	0.10	0.23	4.07	0.05		
CZ2	L	Morava/Dyje	Pohansko	17	0.03	5.98	0.20	0.29	4.08	0.06		
HU9	LMR	Tisza	Tiszasziget	163	1.16	25.37	0.88	3.13	40.94	0.75		0.18
SI1	L	Drava	Ormoz	300	0.23	13.66	0.14	0.71	12.07	0.07		
SI2	R	Sava	Jesenice	729	0.07	12.88	0.13	0.47	7.08	0.06		
HR10	L	Sava	Drenje	728.8	0.13	11.94		0.88	13.62	0.09		0.05
HR7	L	Sava	us. Una Jasenovac	525	0.34	30.41		2.29	36.36	0.18		0.08
HR8	ML	Sava	ds. Zupanja	254	0.34	30.72		2.57	45.13	0.34		0.11

Table 11: 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 2009												
					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	27	27	27	27	27	27	27	27

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	6492.493	0.155	0.030	1.561	2.103	2.863	2.138	1.740	1.334	0.469	0.424	0.069	0.049

Country Code	River	Location	Location in profile	River km	Annual Load in 2009												
						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		31.76	6.74	340.91	453.37	582.45	430.36	356.06	268.70	24.68	21.33	14.99	10.84

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

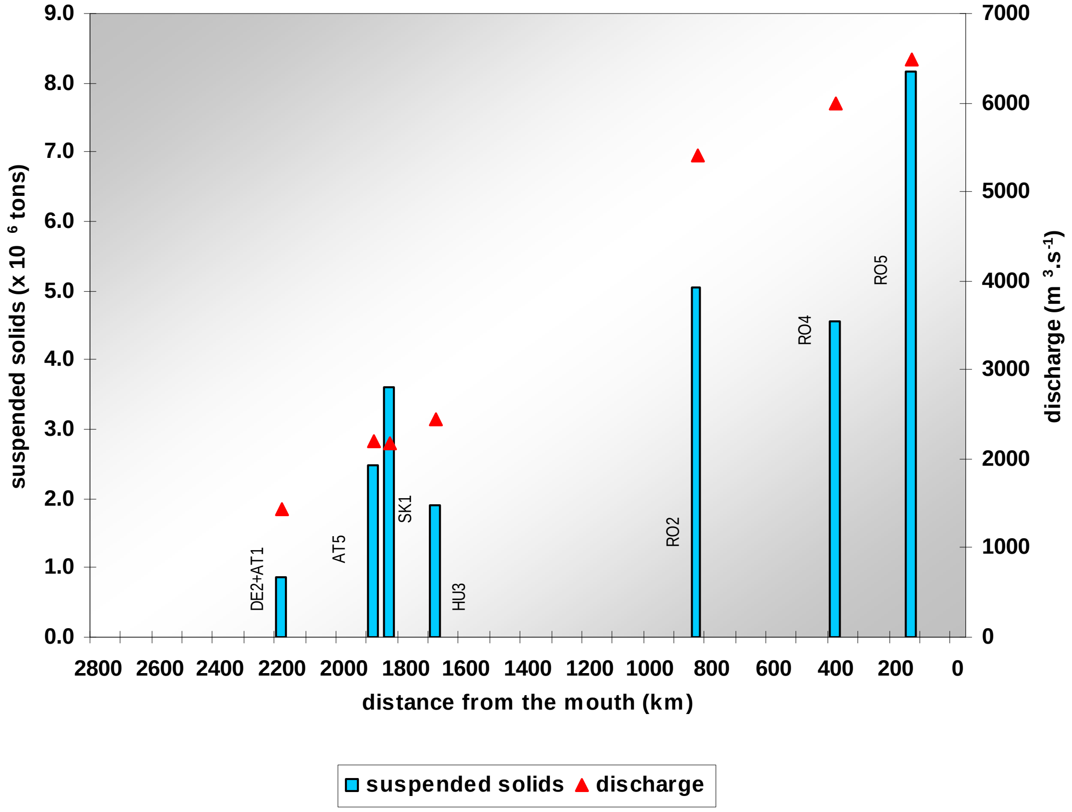


Figure 5.5.2: Annual load of suspended solids at monitoring locations on tributaries.

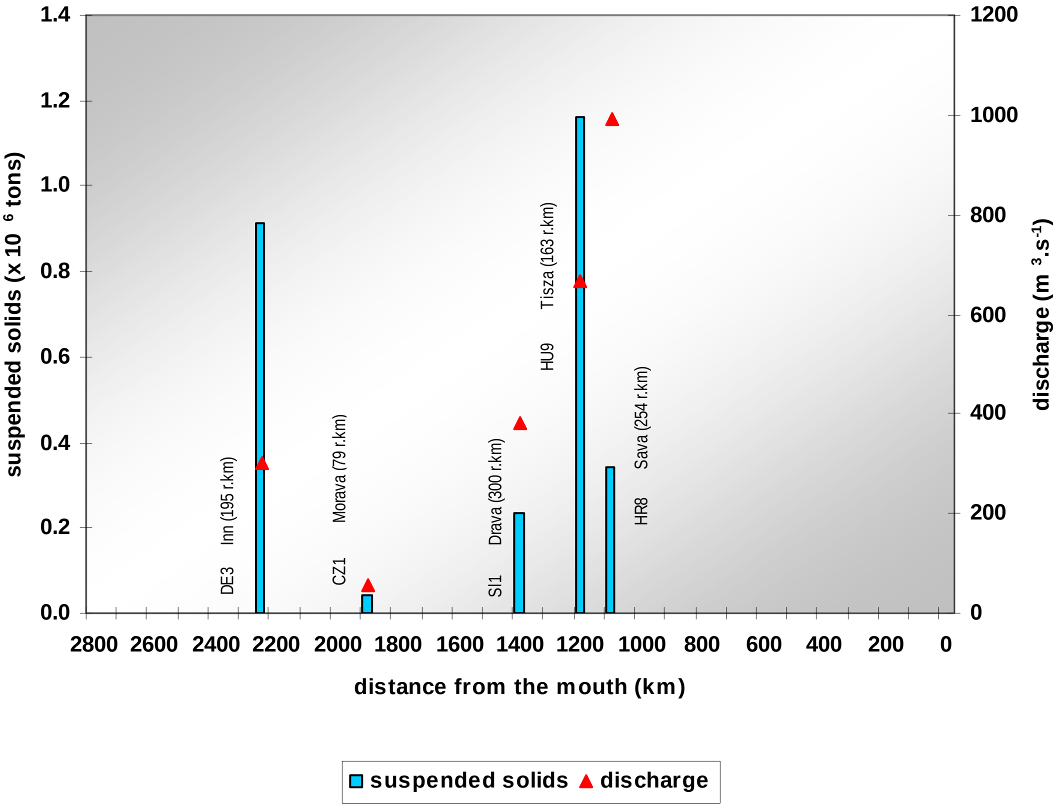


Figure 5.5.3: Annual loads of inorganic nitrogen at monitoring locations along the Danube River.

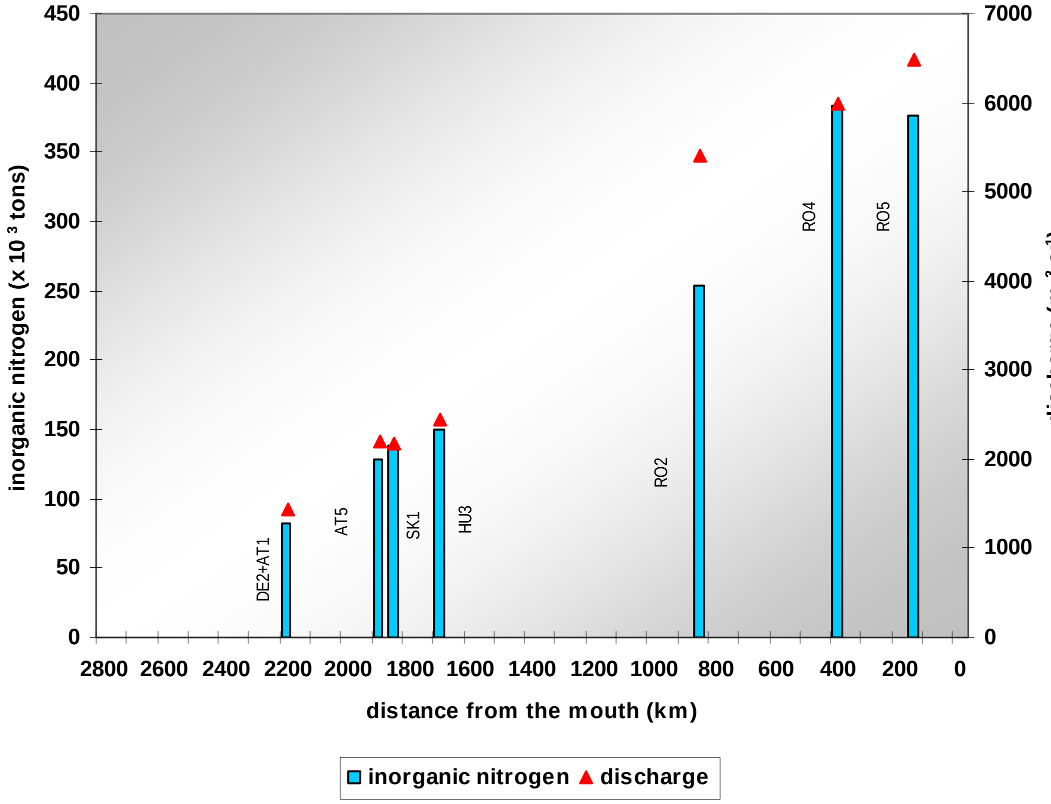


Figure 5.5.4: Annual loads of inorganic nitrogen at monitoring locations on tributaries.

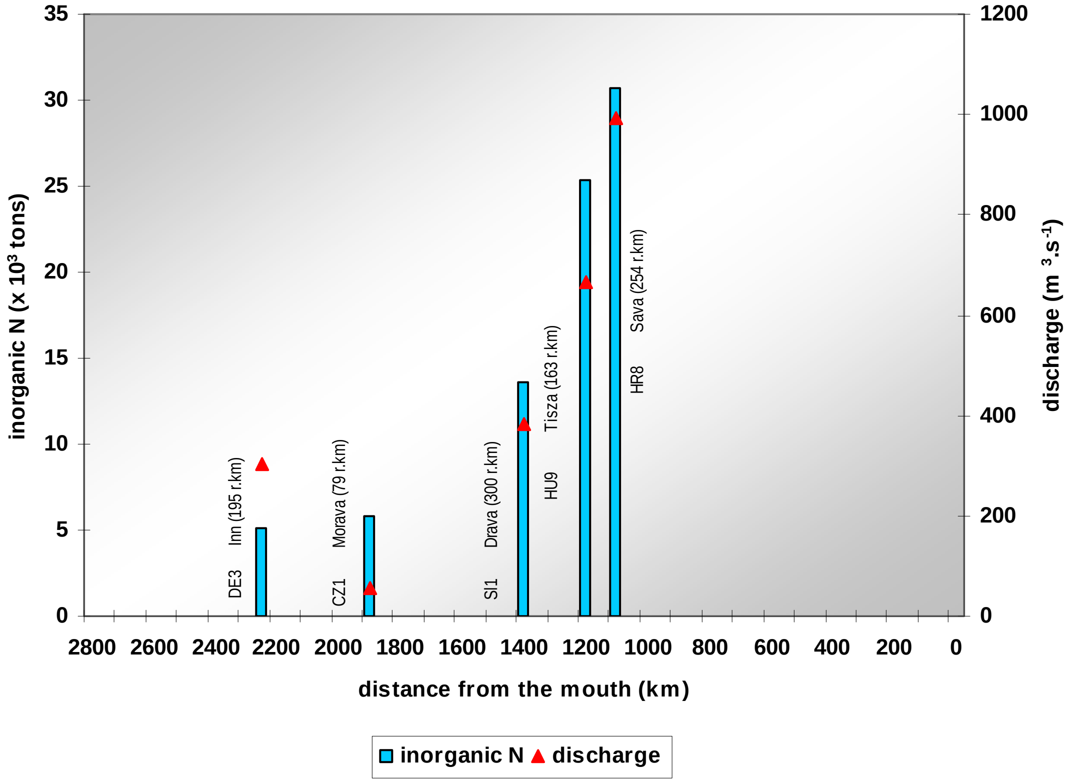


Figure 5.5.5: Annual loads of ortho-phosphate-P at monitoring locations along the Danube River.

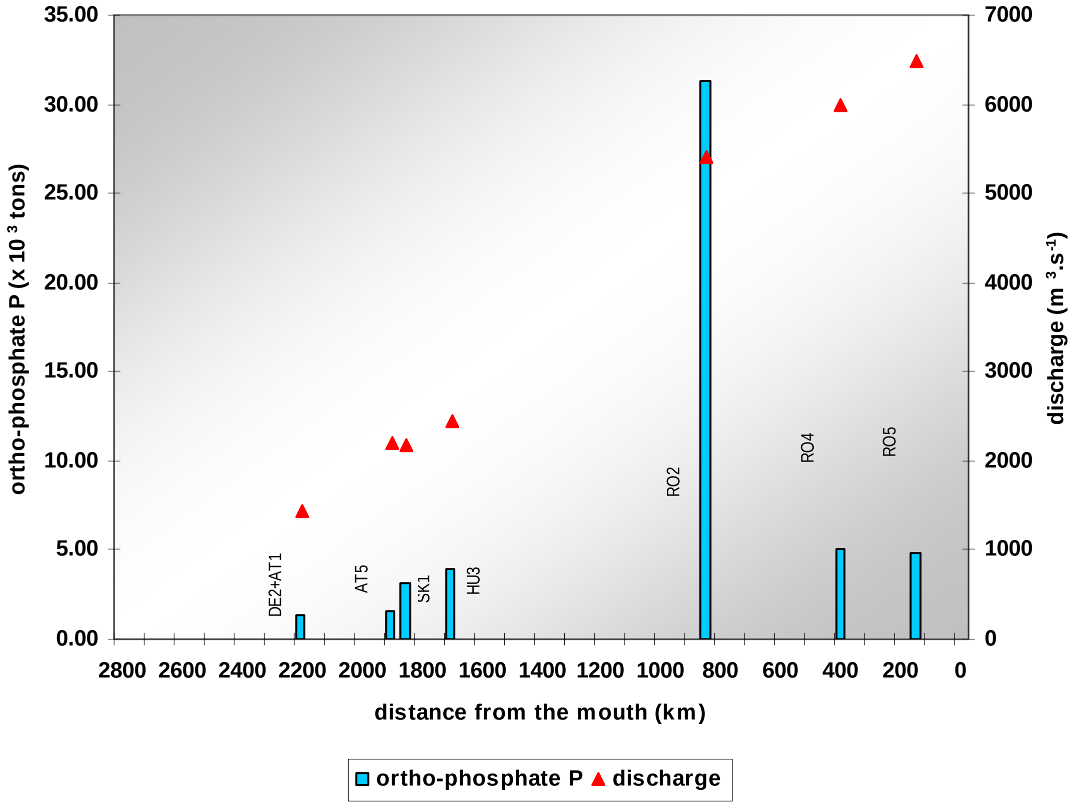


Figure 5.5.6: Annual loads of ortho-phosphate-P at monitoring locations on tributaries.

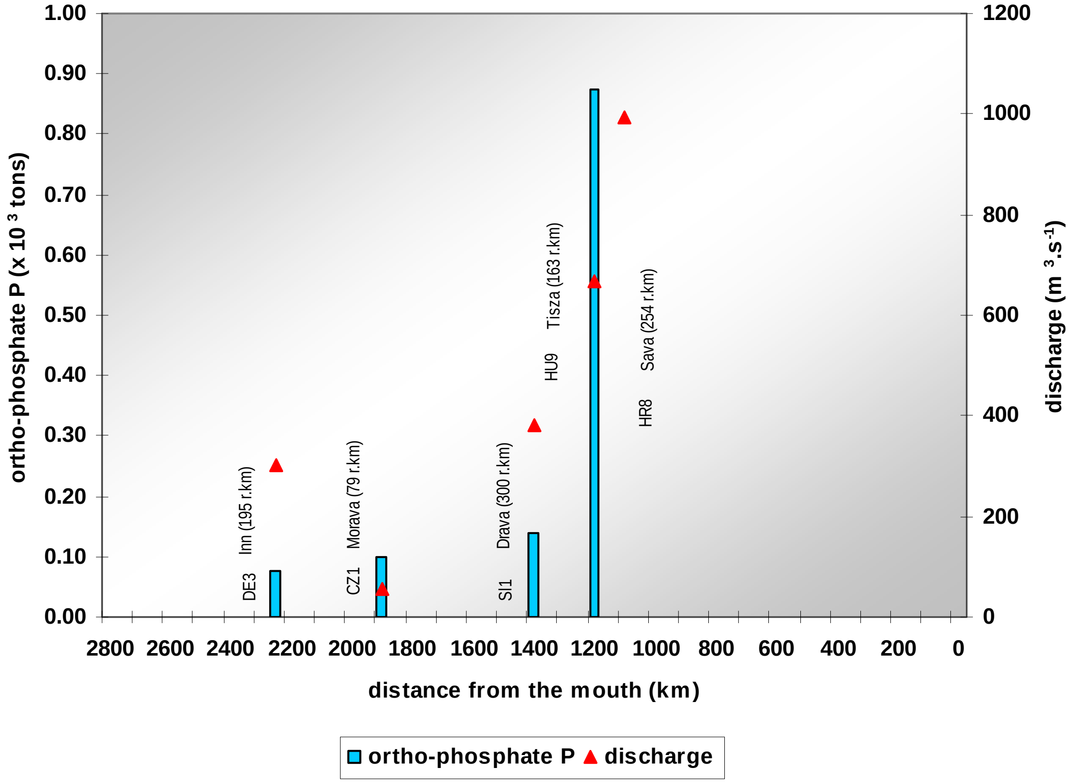


Figure 5.5.7: Annual loads of total phosphorus at monitoring locations along the Danube River.

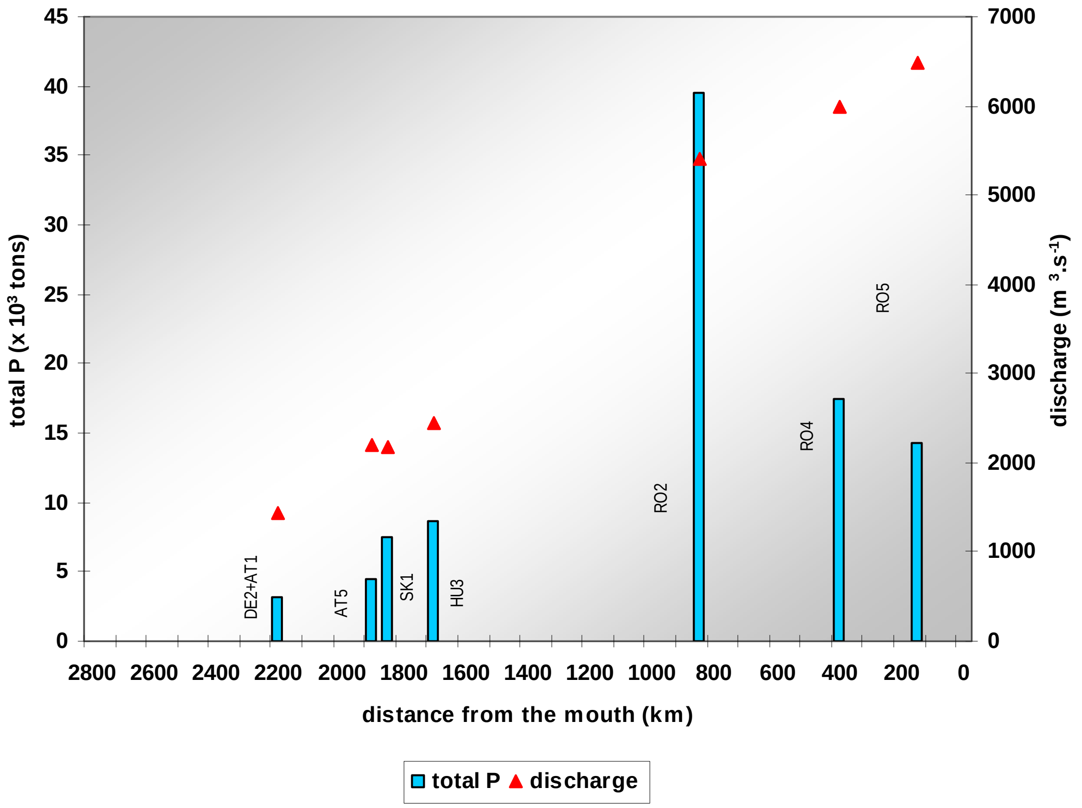


Figure 5.5.8: Annual loads of total phosphorus at monitoring locations on tributaries.

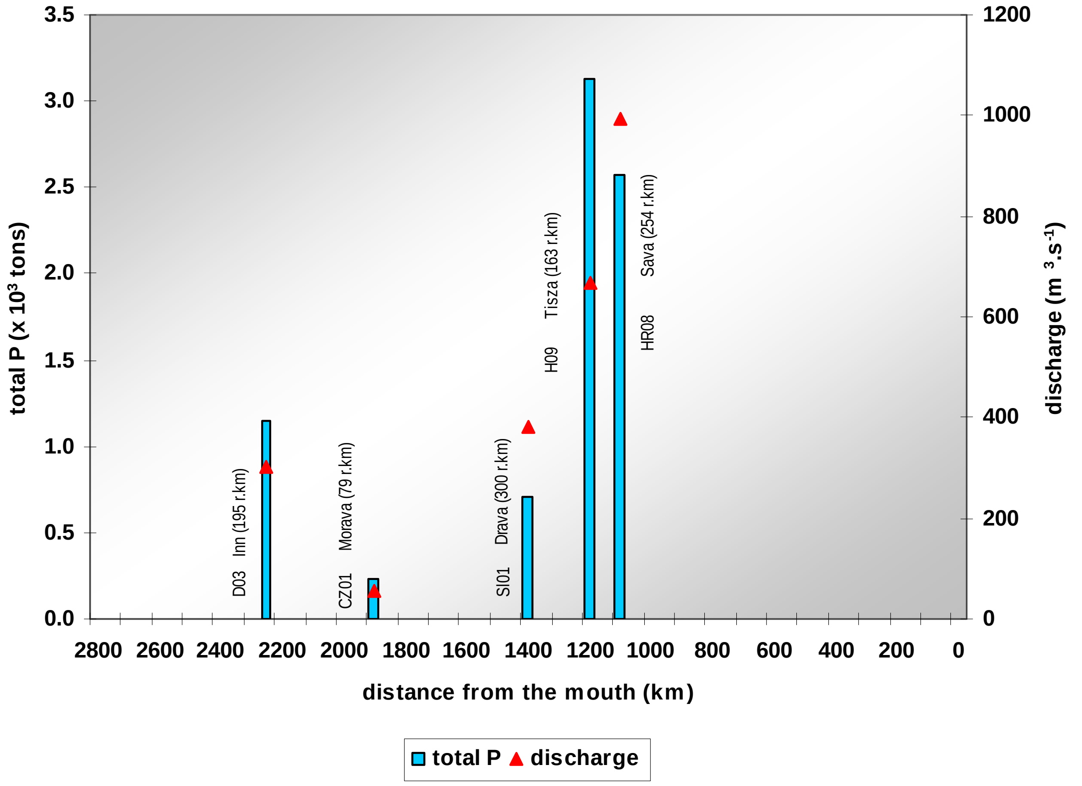


Figure 5.5.9: Annual loads of BOD_5 at monitoring locations along the Danube River.

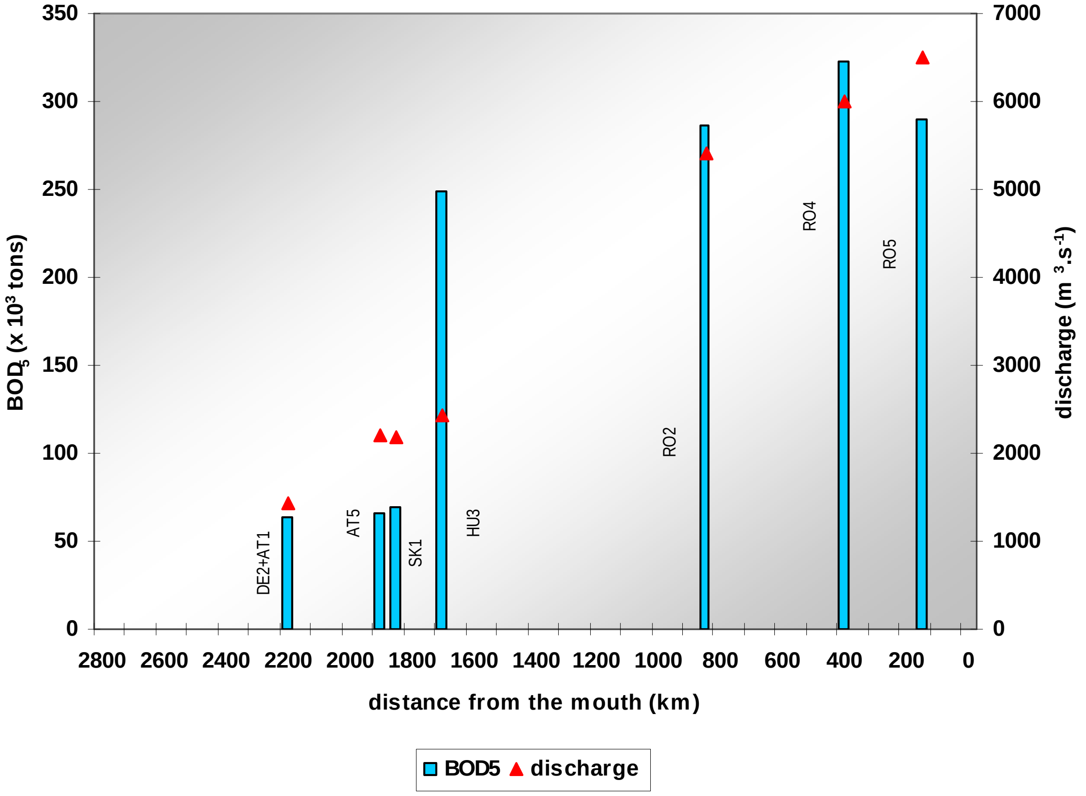


Figure 5.5.10: Annual loads of BOD_5 at monitoring locations on tributaries.

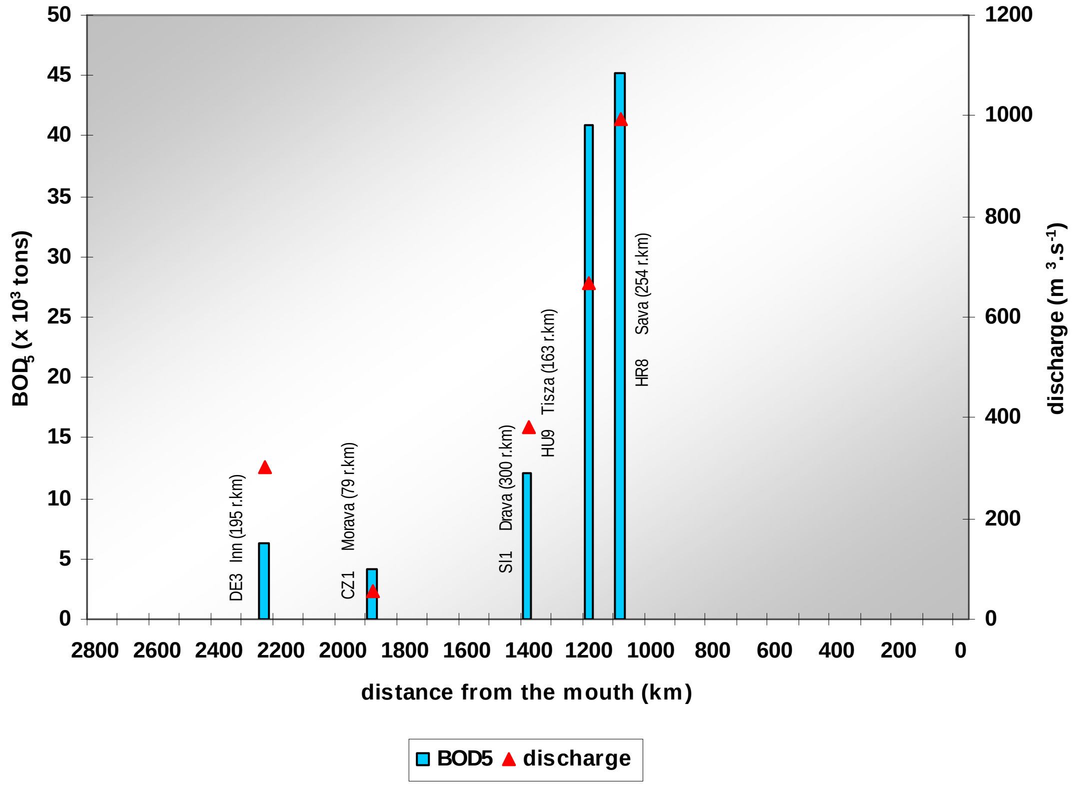


Figure 8.5.11: Annual loads of chlorides at monitoring locations along the Danube River.

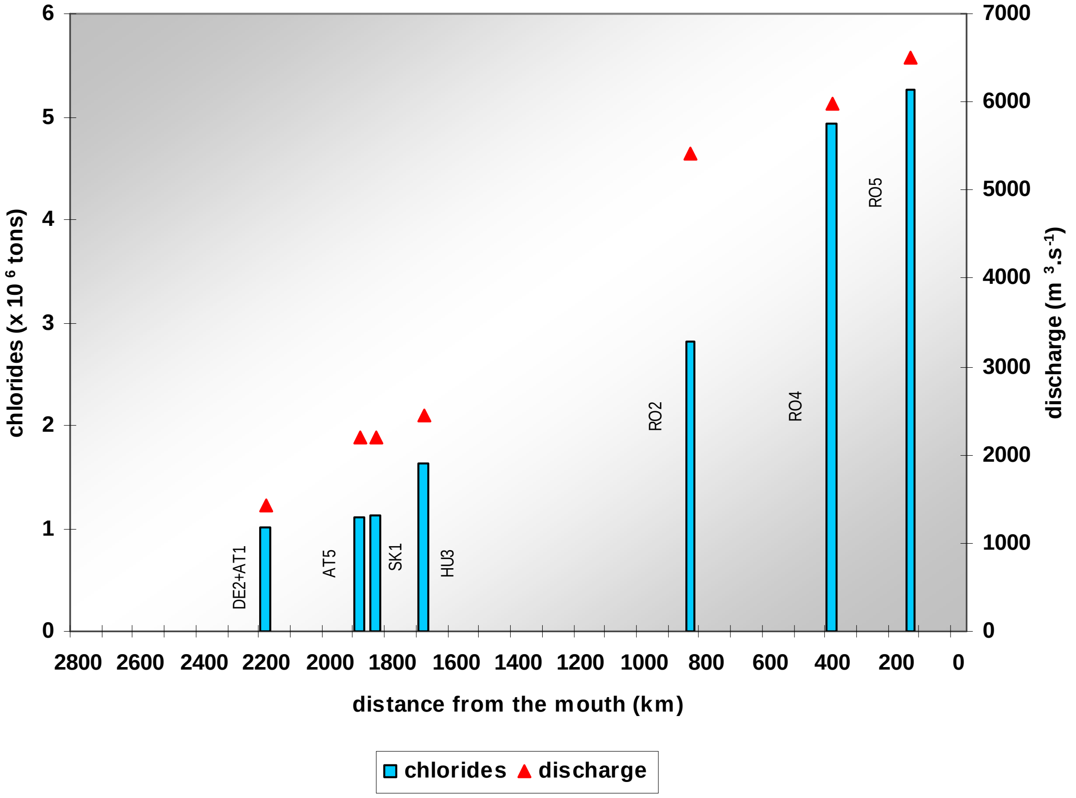
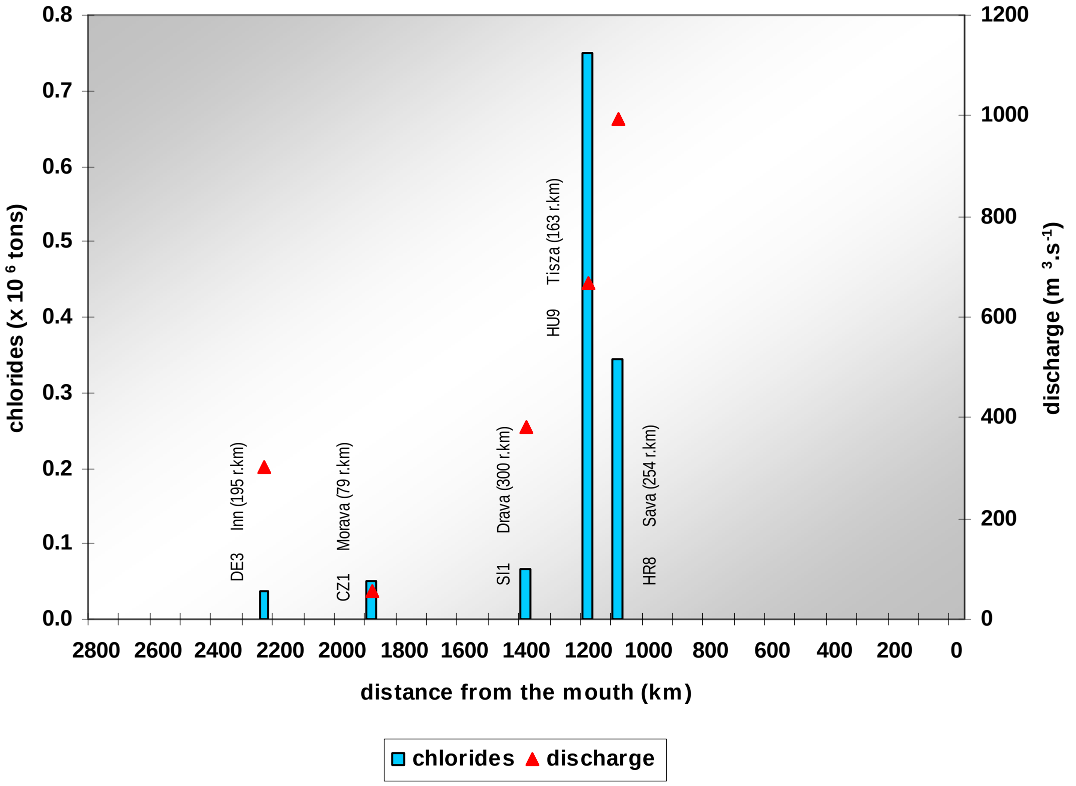


Figure 5.5.12: Annual loads of chlorides at monitoring locations on tributaries.



6. Groundwater status and chemical monitoring results

6.1. Groundwater bodies of basin-wide importance

According to the Water Framework Directive (WFD, Article 2) ‘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 (ICPDR GW-body).

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

- transboundary; and
- 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 other groundwater bodies even those with an area larger than 4000 km², which are fully situated within one country of the Danube River Basin (DRB) are dealt with at the national level.

6.2. Groundwater status assessment

The groundwater chemical and quantitative status was assessed by EU Member States the first time within the preparation of the first River Basin Management Plans which were due under Article 13 of the WFD in 2009.

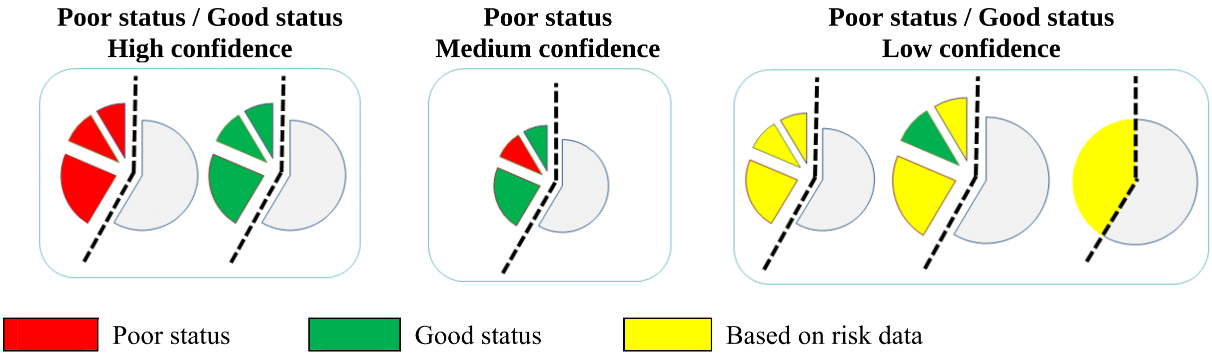
According to the stratified approach of 3 level reports which supplement each other (Part A – Roof Report, Part B – National level and/or Sub-basin level, Part C – National level, provision to EC on request), the content of the DRBM Plan 2009 is focusing on the ICPDR GW-bodies only and give relevant summary information on the status of these GW-bodies, on the description of the methodologies applied for the assessment of status, on the related impacts on these GW-bodies, on the significant pressures causing poor status and on the measures implemented in order to reach good status by 2015. Detailed information is to be found in the Part B (national level) reports. A link between the content of the Danube River Basin Management Plan (DRBMP) and the national plans is established by the national codes of the groundwater bodies.

The Groundwater Task Group (GW TG) acts as a platform for facilitation and promotion of transnational coordination and harmonisation of the implementation of EU legislation by the ICPDR Contracting Parties. It is not the aim of the GW TG to duplicate any assessments carried out by the Contracting Parties at the national level but to compile the available results as far as they are relevant on a Danube basin-wide scale. Following the subsidiarity principle of the implementation of EU legislation, Member States can apply their own, national criteria and approaches (e.g. for the risk assessment, status assessment, establishment of groundwater threshold values, etc), which may lead to different results available for the national parts of the ICPDR GW-bodies. Criteria have been therefore developed for the uniform presentation of status results at the basin-wide level, taking into account the status assessment at the level of national GW-bodies.

As decided by the GW TG, the result of the status assessment is illustrated for the whole national part of an ICPDR GW-body. If a national part of an ICPDR GW-body consists of several individual national-level GW-bodies then the poor status of only one national-level GW-body is decisive for characterizing the whole national part of an ICPDR GW-body in poor status.

To indicate the (in)homogeneity of the status within a national part of an ICPDR GW-body the concept of confidence in status assessment was introduced (illustrated in Figure 6.1). High confidence expresses that all national-level GW-bodies forming a national part of an ICPDR GW-body show the same status (either all good or all poor). Medium confidence is assigned when national-level GW-bodies show different status results within one national part of an ICPDR GW-body. Low confidence indicates that the status assessment is based on risk assessment data.

Figure 6.1: Concept of confidence in the groundwater status assessment



The level of confidence is color coded together with the groundwater status and illustrated in the maps on groundwater quantitative (Figure 6.2) and chemical status (Figure 6.3).

6.3. Groundwater quantitative status

As reported in the DRBM Plan 2009, good quantitative status was assigned to 19 (out of 23) national parts of ICPDR GW-bodies. In the meantime for one additional national part (MD-3, not classified in the plan) good quantitative status was reported. Two national parts of an ICPDR GW-body are of poor quantitative status and for one (RS-7) there is no status information available and in this case the information based on risk assessment was included - the risk assessment showed risk for RS-7.

In 9 out of 11 ICPDR GW-bodies all national parts are of good quantitative status. In ICPDR GW-body GWB-7, one national part shows poor quantitative status (HU-7), one shows risk (RS-7) and one is of good quantitative status (RO-7). In GWB-11 poor quantitative status was observed in one national part (HU-11).

The poor quantitative status is caused by various reasons. In two national parts (RS-7 and HU-11) the groundwater abstractions are exceeding the available groundwater resources; in one case (HU-7) poor quantitative status is caused by significant damage to groundwater dependent terrestrial ecosystems and in one case (HU-11) by damage to associated surface waters (springs). For the national part RS-7, over-abstraction lowers the groundwater tables and increases pumping costs for users and it poses threats to an intrusion of deep mineralized waters.

The results of the quantitative status assessment (considering the confidence in the assessment) reflect the information status of September 2011 and they are illustrated in Figure 6.2. The summary overview (Table 12) gives details on the achievement of the good quantitative status objectives which had to be considered within the status assessment according to the WFD.

Figure 6.2: ICPDR GW-bodies – Quantitative status of groundwater

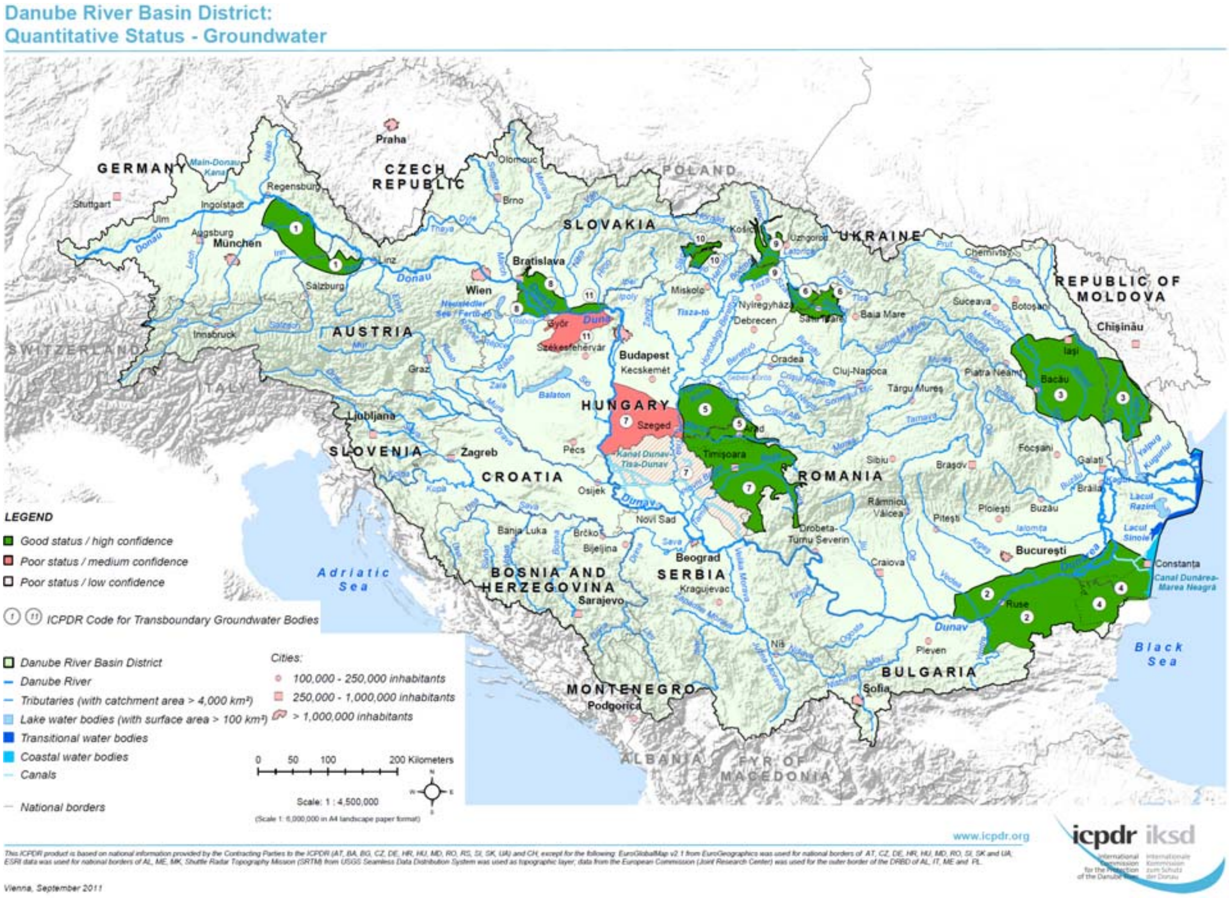


Table12: ICPDR GW-bodies – Groundwater quantitative status and achievement of good status objectives

CODE	NAME of ICPDR GW-body	national part	ref. year	"at risk"	Status	if at risk or in poor status:	Exceedance of available GW resource	Failed achievement of Article 4 objectives for associated surface waters	Significant damage to GW dependent terrestrial ecosystem	Uses affected	Intrusions detected or likely to happen due to alterations of flow directions resulting from level changes
				yes / possibly / no	good / poor / unknown		Yes / No / Unknown	Yes / No / Unknown	Yes / No / Unknown	Yes / No / Unknown If yes, which?	Yes / No / Unknown
GWB-1	Deep Groundwater Body – Thermal Water	DE-1	2009	-	good		no	no	no	no	no
		AT-1	2009	-	good		no	no	no	no	no
GWB-2	Upper Jurassic – Lower Cretaceous GWB	BG-2	2009	-	good		no	no	no	no	no
		RO-2	2009	-	good		no	no	no	no	no
GWB-3	Middle Sarmatian - Pontian GWB	RO-3	2009	-	good		no	no	no	no	no
		MD-3	2009	-	good		no	no	no	no	no
GWB-4	Sarmatian GWB	RO-4	2009	-	good		no	no	no	no	no
		BG-4	2009	-	good		no	no	no	no	no
GWB-5	Mures / Maros	RO-5	2009	-	good		no	no	no	no	no
		HU-5	2009	-	good		no	no	no	no	no
GWB-6	Somes / Szamos	RO-6	2009	-	good		no	no	no	no	no
		HU-6	2009	-	good		no	no	no	no	no
GWB-7	Upper Pannonian – Lower Pleistocene / Vojvodina / Duna-Tisza köze deli r.	RO-7	2009	-	good		no	no	no	no	no
		RS-7	2009	yes	unknown		yes	no	no	yes, DRW	unknown
		HU-7	2009	-	poor		no	no	yes	no	no
GWB-8	Podunajska Basin, Zitny Ostrov / Szigetköz, Hanság-Rábca	SK-8	2009	-	good		no	no	no	no	no
		HU-8	2009	-	good		no	no	no	no	no
GWB-9	Bodrog	SK-9	2009	-	good		no	no	no	no	no
		HU-9	2009	-	good		no	no	no	no	no
GWB-10	Slovensky kras / Aggtelek-hgs.	SK-10	2009	-	good		no	no	no	no	no
		HU-10	2009	-	good		no	no	no	no	no
GWB-11	Komarnanska Vysoka Kryha / Dunántúli-khgs. északi r.	SK-11	2009	-	good		no	no	no	no	no
		HU-11	2009	-	poor		yes	yes	no	no	no

Note: DRW…drinking water

6.4. Groundwater chemical status

As reported in the DRBM Plan 2009, good chemical status was assigned to 17 (out of 23) national parts of ICPDR GW-bodies. In the meantime for one additional national part (MD-3, not classified in the plan) good chemical status was reported. Four national parts of an ICPDR GW-body are of poor chemical status and for one national part (RS-7) there is no status information available and in this case the information based on risk assessment was included. The risk assessment showed no risk for RS-7.

In 8 out of 11 ICPDR GW-bodies all national parts are of good chemical status. In two ICPDR GW-bodies (GWB-7 and GWB-8), poor chemical status was observed in one national part (HU-7 and HU-8). In GWB-5 both national parts (RO-5 and HU-5) were identified to be in poor chemical status. All these national parts of ICPDR GW-bodies which are in poor status consist of aggregations of superposed national GWBs where the shallow GWBs are in poor status and the deep (medium deep) GWBs, which are used for drinking water abstraction, are in good status.

Considering the general status assessment of the GWBs as a whole, nitrates were the cause of the poor chemical status classification in all case. In addition, at HU-7 the WFD Article 4 objectives for associated surface waters could not be achieved for nitrates and increasing trends for nitrates and ammonium already exceeded the starting points of trend reversal. For RO-5 the objectives of WFD Article 7 regarding the drinking water protected areas (avoid deterioration of water quality to reduce the level of purification treatment) could not be met for nitrates as well.

The results of the chemical status assessment (considering the confidence in the assessment) reflect the information status of September 2011 and they are illustrated in Figure 6.3. The summary overview (Table 13) gives details on the achievement of the single groundwater quality objectives which had to be considered within the chemical status assessment according to the WFD.

Figure 6.3: ICPDR GW-bodies – Chemical status of groundwater

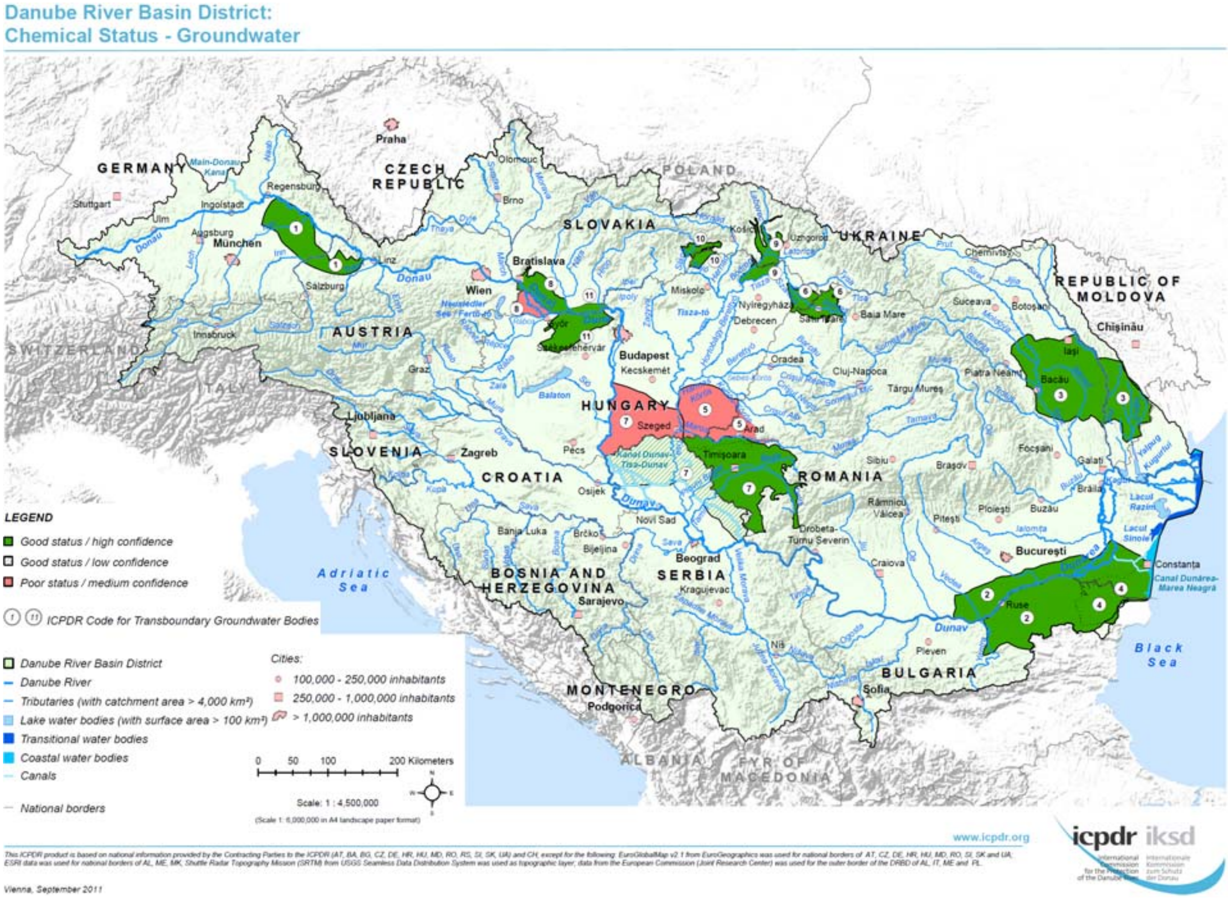


Table 13: ICPDR GW-bodies – Groundwater chemical status and achievement of good status objectives

CODE	**NAME of ICPDR GW-body**	**national part**	**ref. year**	**"at risk"**	**Status**	**if at risk or in poor status:**	for which parameters	Failured general assessment of GWB as a whole	Saline or other intrusions	Failured achievement of Article 4 objectives for associated surface waters	Significant damage to GW dependent terrestrial ecosystem	Art 7 drinking water protected area affected	increasing trend exceeding starting points of trend reversal
				yes / possibly / no	good / poor / unknown		parameter	Yes / No / Unknown (parameter)	Yes / No / Unknown (parameter)	Yes / No / Unknown (parameter)	Yes / No / Unknown (parameter)	Yes / No / Unknown (parameter)	Yes / No / Unknown (parameter)
GWB-1	Deep Groundwater Body – Thermal Water	DE-1	2009	-	good		-	no	no	no	no	no	no
		AT-1	2009	-	good		-	no	no	no	no	no	no
GWB-2	Upper Jurassic – Lower Cretaceous GWB	BG-2	2009	-	good		-	no	no	no	no	no	no
		RO-2	2009	-	good		-	no	no	no	no	no	no
GWB-3	Middle Sarmatian - Pontian GWB	RO-3	2009	-	good		-	no	no	no	no	no	no
		MD-3	2009	-	good		-	no	no	no	no	no	no
GWB-4	Sarmatian GWB	RO-4	2009	-	good		-	no	no	no	no	no	no
		BG-4	2009	-	good		-	no	no	no	no	no	no
GWB-5	Mures / Maros	RO-5	2009	-	poor		nitrates	yes	no	no	no	yes	unknown*
		HU-5	2009	-	poor		nitrates	yes	no	no	no	no	no
GWB-6	Somes / Szamos	RO-6	2009	-	good		-	no	no	no	no	no	no
		HU-6	2009	-	good		-	no	no	no	no	no	no
GWB-7	Upper Pannonian – Lower Pleistocene / Vojvodina / Duna-Tisza köze deli r.	RO-7	2009	-	good		-	no	no	no	no	no	no
		RS-7	2009	no	unknown		-	no	no	no	no	no	no
		HU-7	2009	-	poor		nitrates, ammonium	yes nitrates	no	yes nitrates	no	no	yes, nitrates, ammonium
GWB-8	Podunajska Basin, Zitny Ostrov / Szigetköz, Hanság-	SK-8	2009	-	good		-	no	no	no	no	no	no
		HU-8	2009	-	poor		nitrates	yes	no	no	no	no	no
GWB-9	Bodrog	SK-9	2009	-	good		-	no	no	no	no	no	no
		HU-9	2009	-	good		-	no	no	no	no	no	no
GWB-10	Slovensky kras / Aggtelek-hgs.	SK-10	2009	-	good		-	no	no	no	no	no	no
		HU-10	2009	-	good		-	no	no	no	no	no	no
GWB-11	Komarnanska Vysoka Kryha / Dunántúli-khgs. északi r.	SK-11	2009	-	good		-	no	no	no	no	no	no
		HU-11	2009	-	good		-	no	no	no	no	no	no

* Trend assessment is still ongoing

6.5. Reporting on groundwater quality within the TNMN

The transnational groundwater management activities in the Danube River Basin District (DRBD) were initiated in 2002 and were triggered by the implementation of the WFD. Monitoring of the 11 transboundary GWBs of basin-wide importance has been integrated into the TNMN of the ICPDR. For groundwater monitoring under the TNMN (GW TNMN) a 6-year reporting cycle has been set, which is in line with reporting requirements under the WFD and which will sufficiently allow for making any relevant statement on significant changes of groundwater status for these GW-bodies.

This year, groundwater quality data have been collected the first time and it is only possible to present the current situation. From the next data collection onwards (in six years) also the temporal development will be considered and presented.

The core set of parameters which were agreed to be reported are: electrical conductivity, nitrates, ammonium, all parameters posing risk or causing poor status and all parameters which are characterizing groundwater chemistry. As it can be seen in Table 13, nitrates and ammonium are causing poor chemical status in the year 2009.

For each national part of an ICPDR GW-body the following aggregated data (statistical key values) are requested for a defined reference year: minimum value, mean value, standard deviation, maximum value and the 10-, 25-, 50-, 75- and 90-percentiles. The assessment is based on annual arithmetic mean values (for the reference year) for each monitoring point. The number of sampling sites and the groundwater threshold values complement the data collection.

6.6. Groundwater chemical monitoring results

All countries sharing ICPDR GW-bodies provided groundwater quality data, except Moldova (MD-3). For SK-11 no data were provided as there is no monitoring network established yet. In addition to the 23 national parts of ICPDR GW-bodies, Hungary decided to distinguish the data assessment for HU-5, HU-6, HU-7, HU-8 and HU-9 between a shallow and a deeper part due to the striking differences in groundwater chemistry. Therefore, the following assessment considers data for 28 national parts of ICPDR GW-bodies. For this data collection, the reference year of the data is in general 2009 except for Hungary where data refer to 2007. In the case of Hungary, the results of the chemical status assessment (as presented in chapter 6.4) can differ from the chemical monitoring results presented in this chapter due to a differing data basis of the WFD assessment and of TNMN Groundwater.

The most commonly reported parameters were the core parameters electrical conductivity, nitrates and ammonium. Five countries also provided data on chloride and sulphate for in total 8 national parts of ICPDR GW-bodies. 63 more parameters were reported but for very few GW-bodies which does not allow for basin-wide comparable presentation. These data will be considered in six years when analyzing temporal developments and significant changes.

To give a broader picture on the current situation by the distribution of the measured data the data are presented in a Box-and-Whisker-Plot.

6.6.1. Nitrates in groundwater

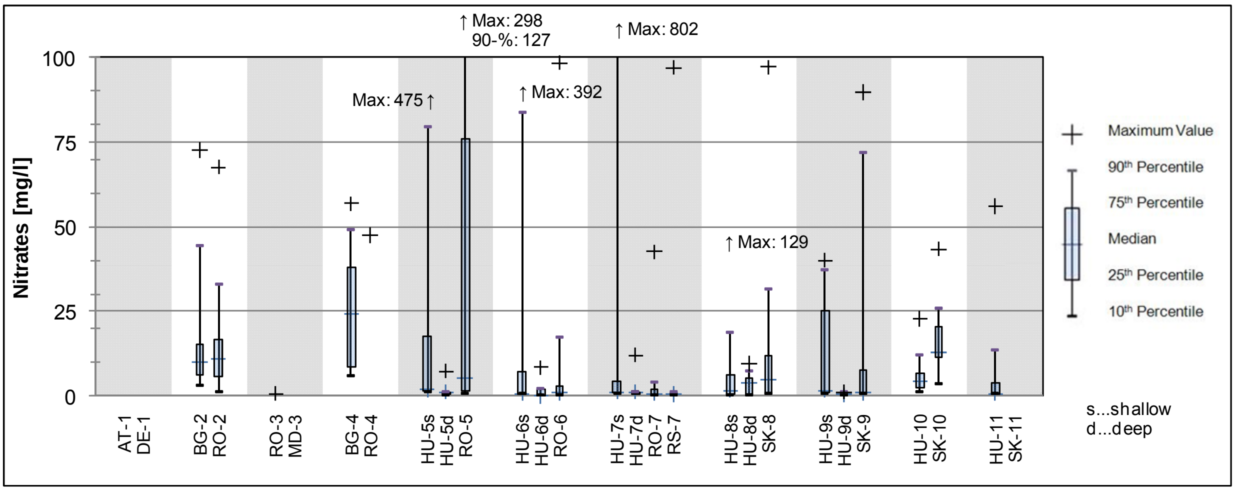
Nitrate in groundwater is a main indicator for pollution by agricultural fertilizers and urban waste water. The EU Groundwater Directive established a groundwater quality standard of 50 gm/l to be considered within the groundwater chemical status assessment. If this standard could still lead to a failure of achieving the WFD objectives, more stringent threshold values have to be established by the EU Member States.

Hungary and Romania reported groundwater threshold values (TVs) for nitrates of 50 mg/l, Bulgaria established 38.8 mg/l and Serbia has not yet established TVs for groundwater but reported the national drinking water standard of 50 mg/l.

Figure 6.4 illustrates the distribution of nitrates in groundwater. There are no data available for MD-3 and SK-11 (no monitoring) and for the ICPDR GW-body GWB-1 (AT-1 and DE-1) where nitrate is not relevant as this deep thermal groundwater body is free of oxygen and therefore free of nitrates. The distribution of measured nitrate concentrations shows that within each ICPDR GW-body the concentration ranges in the single national parts are quite similar.

The majority of the measured nitrate concentrations are far below 50 mg/l. The reported arithmetic mean values are between 0.4 and 44 mg/l and the highest reported median value is about 24 mg/l. Only in 5 of 24 different national parts of ICPDR GW-bodies (where data are available) the 90-percentile exceeds 50 mg/l. In 13 of the 24 national parts, the maximum values exceed 50 mg/l with the highest nitrate concentration of 802 mg/l in HU-7 (shallow porous GWB).

Figure 6.4: ICPDR GW-bodies – Nitrate concentrations in groundwater



6.6.2. Ammonium in groundwater

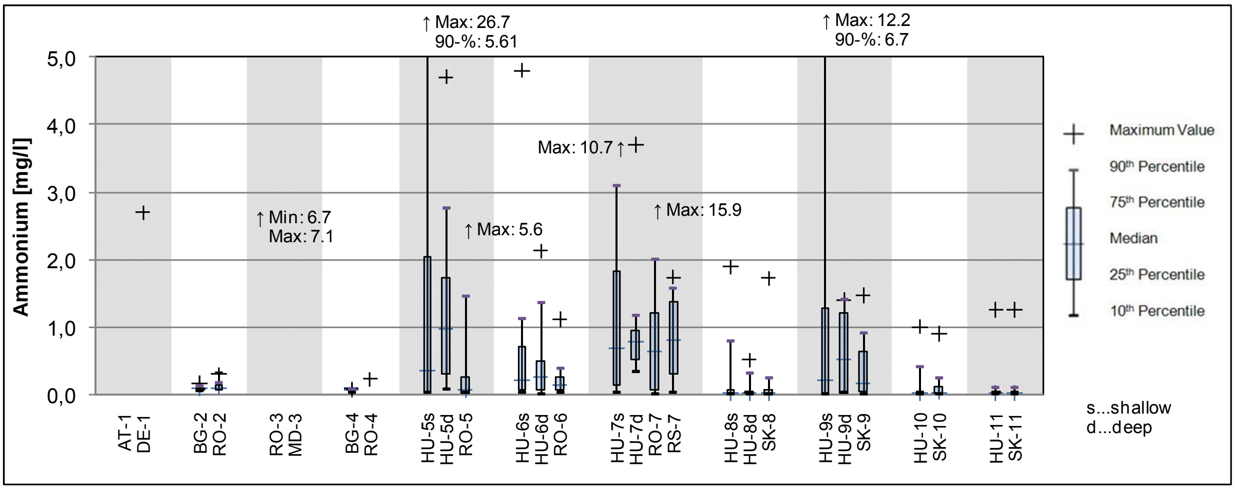
Ammonium in groundwater is a good indicator of pollution by agricultural fertilizers, waste water and leachates from landfills. Naturally occurring ammonium concentrations in groundwater are generally around 0.1 mg/l and caused by bacteriological processes in the soil. The parametric value of the EU Drinking Water Directive (98/83/EC, DWD) is established at 0.5 mg/l.

Five countries reported groundwater TVs. Slovakia reported TVs in a range of 0.26 to 0.295 mg/l, Hungary reported a range of 0.5 and 5 mg/l, Romania reported a range of 0.5 to 6.9 mg/l, Bulgaria established 0.38 mg/l and Serbia reported a national drinking water standard of 0.1 mg/l.

Figure 6.5 illustrates the distribution of ammonium in groundwater. There are no data available for MD-3 and SK-11 (no monitoring). In AT-1 ammonium is not monitored as it is not relevant for the status assessment of this deep thermal groundwater body. Also for ammonium the distributions of concentrations in the single national parts of an ICPDR GW-body are very similar.

The majority of the measured ammonium concentrations are below 1 mg/l. The reported arithmetic mean values are between 0.05 and 6.9 mg/l and the median values range between 0.01 and close to 1 mg/l where nearly half of the reported median values are below 0.1 mg/l. In 11 different national parts of ICPDR GW-bodies the 90-percentile exceeds 1 mg/l. In 5 of the 25 national parts, the maximum values exceed 5 mg/l with the highest ammonium concentration of 26.7 mg/l in HU-3.

Figure 6.5: ICPDR GW-bodies – Ammonium concentrations in groundwater



6.6.3. Electrical conductivity of groundwater

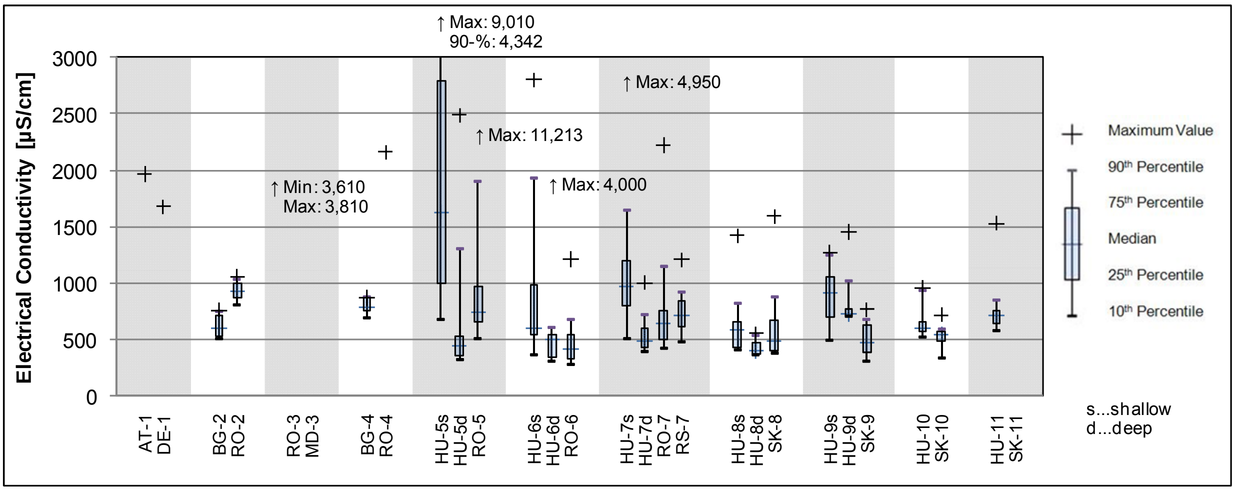
Electrical conductivity is an indicator of the degree of mineralization of groundwater which is determined by natural geological conditions and anthropogenic pollution. It is an indirect measure of salinity and often used as a general indicator for characterizing groundwater chemistry. The parametric value of the EU Drinking Water Directive (98/83/EC, DWD) is established at 2,500 µS/cm.

Hungary and Romania reported groundwater TVs of 2,500 µS/cm and Serbia reported a national drinking water standard of 896 µS/cm (the originally reported TV of 1,000 µS/cm at 25°C was re-calculated to 20°C) and Bulgaria established 1,481 µS/cm (1,653µS/cm re-calculated to 20°).

Figure 6.6 illustrates the distribution of electrical conductivity of groundwater at 20°C. Data which referred to the reference temperature of 25°C were re-calculated to 20°C in order to guarantee overall comparability of the data. There are no data available for MD-3 and SK-11 (no monitoring).

The reported arithmetic mean values of electrical conductivity are in a range of 417–3,710 µS/cm and the median values between nearly 400–1,630 µS/cm where half of the reported median values are below 600 µS/cm. Only in 4 of 22 different national parts of ICPDR GW-bodies, where respective percentile data were available, the 90-percentile exceeds 1,300 µS/cm. In 3 of the 26 national parts, the maximum values exceed 4,000 µS/cm with the highest electrical conductivity of 11,213 µS/cm in RO-5.

Figure 6.6: ICPDR GW-bodies – Electrical conductivity of groundwater



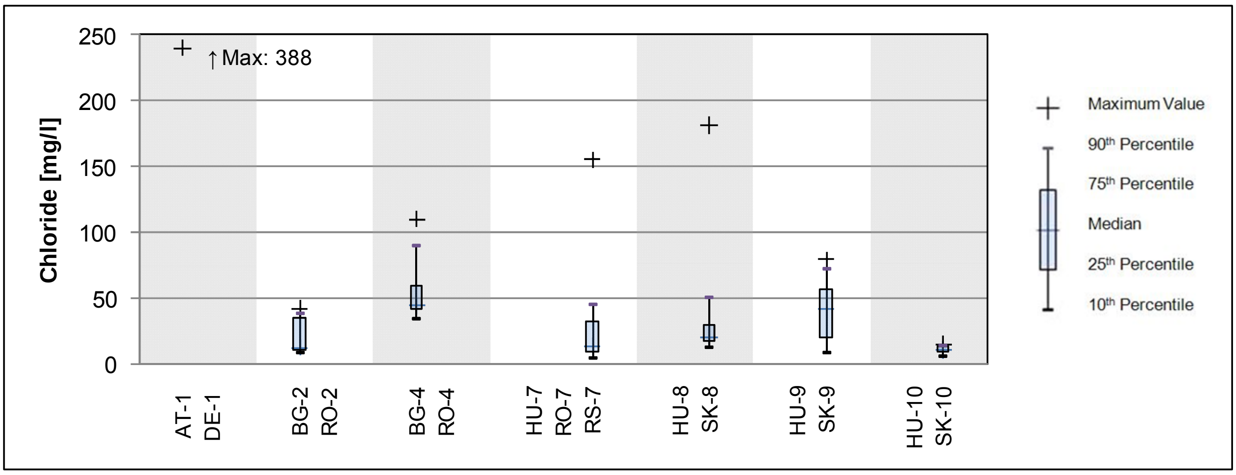
6.6.4. Chloride

Chloride concentrations in groundwater range from 10–40 mg/l and originate naturally from weathering and leaching of sedimentary rocks and the dissolution of salt deposits. Other sources are saltwater intrusion, leachates from landfills, sewage, Cl-containing fertilizers and de-icing of roads. Chloride concentrations hardly change with physico-chemical and biochemical processes and remain very stable in the groundwater. The EU Drinking Water Directive (98/83/EC) lays down a parametric value of 250 mg/l.

Slovakia reported TVs in a range from 56.75 to 72.35 mg/l, Bulgaria established 191.56 mg/l and Serbia reported a national drinking water standard of 200 mg/l.

Figure 6.7 compares the chloride concentrations for the 8 national parts of GW-bodies where data were provided. Most of the values are found below 100 mg/l. The highest salinisation (up to 388 mg/l) was due for the deep thermal ICPDR GW-body GWB-1 because salty water has a higher specific gravity and therefore accumulates in deeper layers where groundwater movement is restricted.

Figure 6.7: ICPDR GW-bodies – Chloride in groundwater



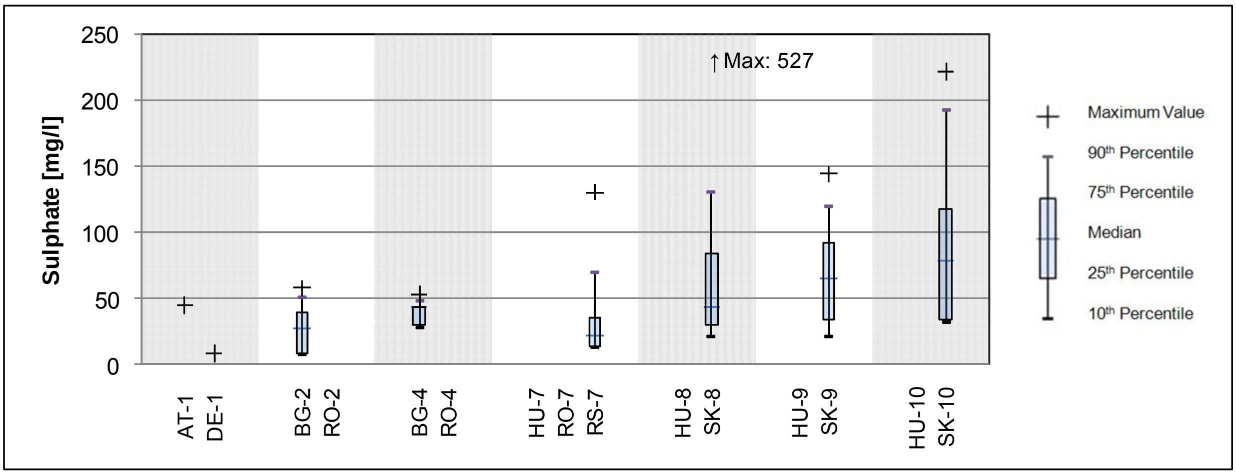
6.6.5. Sulphate

Natural origin of most sulfate compounds in groundwater is the oxidation of pyrite (ferrous sulphide) which is widely present in sedimentary rocks. Natural concentrations in groundwater range between 10 and 30 mg/l. Higher sulphate concentrations can be caused by anthropogenic inputs like leachates from landfills, industrial effluents, fertilizers and emissions from traffic (input via rain). The EU Drinking Water Directive (98/83/EC) lays down a parametric value of 250 mg/l.

Slovakia reported TVs in a range from 157.6 to 167.55 mg/l, Bulgaria established 194.27 mg/l and Serbia reported a national drinking water standard of 250 mg/l.

Figure 6.8 compares the sulphate concentrations for the 8 national parts of GW-bodies where data were provided. Most of the data are below 100 mg/l.

Figure 6.8: ICPDR GW-bodies – Sulphate in groundwater



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
DRB	Danube River Basin
DRBMP	Danube River Basin Management Plan
GW	Groundwater
BOD_5	Biochemical oxygen demand (5 days)
COD_{Mn}	Chemical oxygen demand (Potassium permanganate)
COD_{Cr}	Chemical oxygen demand (Potassium dichromate)
TOC	Total organic carbon
DOC	Dissolved organic carbon
AOX	Adsorbable organic halogens
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyls

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