Water Quality in the Danube River Basin - 2014

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International Commission for the Protection of the Danube River

Internationale Kommission zum Schutz der Donau

TNMN – Yearbook 2014

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1. Introduction

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 2014.

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.

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

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.

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.	TNMN code	River	Name of site	Locations	x- coord	y-coord	River-km	Altitude	Catchment Area [km^2]
1	DE2	Danube	Jochenstein	M	13.703	48.520	2 204	290	77 086
2	DE5	Danube	Dillingen	L	10.499	48.568	2 538	420	11 315
3	DE3	/Inn	Kirchdorf	M	12.126	47.782	195	452	9 905
4	DE4	/Inn/Salzach	Laufen	L	12.933	47.940	47	390	6 113
5	AT1	Danube	Jochenstein	M	13.703	48.521	2 204	290	77 086
6	AT5	Danube	Enghagen	R	14.512	48.240	2 113	241	84 869
7	AT3	Danube	Wien-Nussdorf	R	16.371	48.262	1 935	159	101 700
8	AT6	Danube	Hainburg	R	16.993	48.164	1 879	136	130 759
9	CZ1	/Morava	Lanzhot	M	16.989	48.687	79	150	9 725
10	CZ2	/Morava/Dyje	Pohansko	M	16.885	48.723	17	155	12 540
11	SK1	Danube	Bratislava	LMR	17.107	48.138	1 869	128	131 329
12	SK2	Danube	Medveďov	M	17.652	47.794	1 806	108	132 168
13	SK4	/Váh	Komárno	M	18.142	47.761	1.5	106	19 661
14	SK5	Danube	Szob	LMR	18.890	47.805	1 707	100	183 350
15	SK6	/Morava	Devín	M	16.976	48.188	1	145	26 575
16	SK7	/Hron	Kamenica	M	18.723	47.826	1.7	114	5 417
17	SK8	/Ipeľ	Salka	M	18.763	47.886	12	110	5 060
18	HU1	Danube	Medvedov	M	17.652	47.792	1 806	108	131 605
19	HU2	Danube	Komarom	LMR	18.121	47.751	1 768	101	150 820
20	HU3	Danube	Szob	LMR	18.860	47.811	1 708	100	183 350
21	HU4	Danube	Dunafoldvar	LMR	18.934	46.811	1 560	89	188 700
22	HU5	Danube	Hercegszanto	LMR	18.814	45.909	1 435	79	211 503
23	HU6	/Sio	Szekszard-Palank	M	18.720	46.380	13	85	14 693
24	HU7	/Drava	Dravaszabolcs	M	18.200	45.784	78	92	35 764
25	HU8	/Tisza/Sajo	Sajopuspoki	M	20.340	48.283	124	148	3 224
26	HU9	/Tisza	Tiszasziget	LMR	20.105	46.186	163	74	138 498
27	HU10	/Tisza	Tiszabecs	M	22.831	48.104	757	114	9707
28	HU11	/Tisza/Szamos	Csenger	M	22.693	47.841	45	113	15283
29	HU12	/Tisza/Hármas-Körös/ Sebes-Körös	Korosszakal	M	21.657	47.020	59	92	2489
30	HU13	/Tisza/Hármas-Körös / Kettõs-Körös/Fekete-Körös	Sarkad	M	21.431	46.694	16	85	4302
31	HU14	/Tisza/Hármas- Körös /Kettõs-Körös/Fehér-Körös	Gyulavari	M	21.336	46.629	9	85	4251
32	HU15	/Tisza/Maros	Nagylak	R	20.703	46.161	51	80	30149
33	SI1	/Drava	Ormož most	LM	16.155	46.403	300	192	15 356
34	SI2	/Sava	Jesenice na Dolenjskem	R	15.692	45.861	729	135	10 878
35	HR1	Danube	Batina	MR	18.829	45.875	1 429	86	210 250
36	HR2	Danube	Borovo	R	18.967	45.381	1 337	89	243 147
37	HR9	/Drava	Ormoz	LM	16.155	46.403	300	192	15356
38	HR4	/Drava	Botovo	MR	16.938	46.241	227	123	31 038
39	HR5	/Drava	Donji Miholjac	MR	18.201	45.783	78	92	37 142
40	HR6	/Sava	Jesenice	LR	15.692	45.861	729	135	10 834
41	HR7	/Sava	Upstream Una Jasenovac	L	16.915	45.269	525	87	30 953
42	HR8	/Sava	Zupanja	LMR	18.696	45.040	254	85	62 890
43	RS1	Danube	Bezdan	L	18.860	45.854	1 426	83	210 250
44	RS2	Danube	Bogojevo	L	19.079	45.530	1 367	80	251 593

No.	TNMN code	River	Name of site	Locations	x- coord	y-coord	River-km	Altitude	Catchment Area [km^2]
45	RS3	Danube	Novi Sad	R	19.855	45.255	1 255	74	254 085
46	RS4	Danube	Zemun	R	20.412	44.849	1 173	71	412 762
47	RS5	Danube	Pancevo	L	20.637	44.854	1 155	71	525 009
48	RS6	Danube	Banatska Palanka	M	21.339	44.826	1 077	70	568 648
49	RS7	Danube	Tekija	R	22.419	44.700	954	68	574 307
50	RS8	Danube	Radujevac	R	22.680	44.263	851	32	577 085
51	RS9	Danube	Backa Palanka	L	19.382	45.234	1 299	77	253 737
52	RS10	/Tisza (Tisa)	Martonos	R	20.081	46.114	152	76	140 130
53	RS11	/Tisza (Tisa)	Novi Becej	L	20.135	45.586	65	75	145 415
54	RS12	/Tisza (Tisa)	Titel	M	20.312	45.198	9	73	157 174
55	RS13	/Sava	Jamena	L	19.084	44.878	205	77	64 073
56	RS14	/Sava	Sremska Mitrovica	L	19.602	44.967	139	75	87 996
57	RS15	/Sava	Sabac	R	19.699	44.770	106	74	89 490
58	RS16	/Sava	Ostruznica	R	20.312	44.732	17	72	95 430
59	RS17	/Velika Morava	Ljubicevski Most	R	21.132	44.586	22	71	37 320
60	BA5	/Sava	Gradiska	M	17.255	45.141	457	86	39 150
61	BA6	/Sava/Una	Kozarska Dubica	M	16.836	45.188	16	94	9 130
62	BA7	/Sava/Vrbas	Razboj	M	17.458	45.050	12	100	6 023
63	BA8	/Sava/Bosna	Modrica	M	18.313	44.961	24	114	10 500
64	BA9	/Sava/Drina	Foca	M	18.833	43.344	234	442	3 884
65	BA10	/Sava/Drina	Badovinci	M	19.344	44.779	16	90	19 226
66	BA11	/Sava	Raca	M	19.335	44.891	190	80	64 125
67	BA12	/Sava/Una	Novi Grad	M	16.295	44.988	70	137	4 573
68	BA13	/Sava/Bosna	Usora	M	18.074	44.664	78	148	7 313
69	BG1	Danube	Novo Selo harbour	LMR	22.785	44.165	834	35	580 100
70	BG9	Danube	Lom	R	23.270	43.846	741	24	588 860
71	BG10	Danube	Orjahovo	R	23.963	43.741	679	22	607 260
72	BG2	Danube	Bajkal	R	24.400	43.711	641	20	608 820
73	BG11	Danube	Nikopol	R	24.891	43.706	598	21	648 620
74	BG3	Danube	Svishtov	R	25.345	43.623	554	16	650 340
75	BG4	Danube	Upstream Russe	R	25.907	43.793	503	12	669 900
76	BG5	Danube	Silistra	LMR	27.268	44.125	375	7	698 600
77	BG12	/Iskar	mouth	M	24.456	43.706	4	27	8 646
78	BG13	/Vit	Guljantzi	M	24.728	43.644	7	29	3 225
79	BG14	/Jantra	mouth	M	25.579	43.609	4	25	7 869
80	BG15	/Russenski Lom	mouth	M	25.936	43.813	1	17	2 974
81	RO1	Danube	Bazias	LMR	21.384	44.816	1 071	70	570 896
82	RO18	Danube	Gruia/Radujevac	LMR	22.684	44.270	851	32	577 085
83	RO2	Danube	Pristol/Novo Selo	LMR	22.676	44.214	834	31	580 100
84	RO3	Danube	Dunare - upstream Arges (Oltenita)	LMR	26.619	44.056	432	16	676 150
85	RO4	Danube	Chiciu/Silistra	LMR	27.268	44.128	375	13	698 600
86	RO5	Danube	Reni	LMR	28.232	45.463	132	4	805 700
87	RO6	Danube	Vilkova-Chilia arm/Kilia arm	LMR	29.553	45.406	18	1	817 000
88	RO7	Danube	Sulina - Sulina arm	LMR	29.530	45.183	0	1	817 000
89	RO8	Danube	Sf. Gheorghe-Ghorghe arm	LMR	29.609	44.885	0	1	817 000
90	RO9	/Arges	Conf. Danube (Clatesti)	M	26.599	44.145	0	14	12 550
91	RO10	/Siret	Conf. Danube (Sendreni)	M	28.009	45.415	0	4	42 890
92	RO11	/Prut	Conf. Danube (Giurgiulesti)	M	28.203	45.469	0	5	27 480
93	RO12	/Tisza/Somes	Dara (frontiera)	M	22.720	47.815	3	118	15 780
94	RO13	/Tisza/Hármas-Körös/Sebes-Körös/Crisul Repede	Cheresig	M	21.692	47.030	3	116	2 413

No.	TNMN code	River	Name of site	Locat ions	x- coord	y-coord	River-km	Altitude	Catchment Area [km²]
95	RO14	/Tisza/Hármas-Körös/Kettõs-Körös/Crisul Negru	Zerind	M	21.517	46.627	13	86.4	3 750
96	RO15	/Tisza/Hármas-Körös/Kettõs-Körös/Crisul Alb	Varsand	M	21.339	46.626	0.2	88.9	4 240
97	RO16	/Tisza/Mures	Nadlac	M	20.727	46.145	21	85.6	27 818
98	RO17	/Tisza/Bega	Otelec	M	20.847	45.620	7	46	2 632
99	RO19	/Jiu	Zaval	M	23.845	43.842	9	30.9	10 046
100	RO20	/Olt	Islaz	M	24.797	43.744	3	32	24 050
101	RO21	/Ialomita	Downstream Tandarei	M	27.665	44.635	24	8.5	10 309
102	MD1	/Prut	Lipcani	L	26.483	48.152	658	100	8 750
103	MD3	/Prut	Conf. Danube-Giurgiulesti	LMR	28.124	45.285	0	5	27 480
104	MD5	/Prut	Costesti Reservoir	L	27.145	47.513	557	91	11 800
105	MD6	/Prut	Braniste	L	27.145	47.475	546	63	12 000
106	MD7	/Prut	Valea Mare	L	27.515	47.075	387	55	15 200
107	UA1	Danube	Reni	M	28.288	45.437	132	4	805 700
108	UA2	Danube	Vylkove	M	29.592	45.394	18	1	817 000
109	UA4	/Tisza	Chop	M	22.184	48.416	342	92	33000
110	UA5	/Tisza/Bodrog/Latoritsa	Strazh	M	22.212	48.454	144	96	4418
111	UA6	/Prut	Tarasivtsi	M	26.336	48.183	262	122	9836
112	UA7	/Siret	Porubne	M	26.030	47.981	100	303	2070
113	UA8	/Uzh	Storozhnica	R	22.200	48.617	106	112	1582
114	ME1	/Lim	Dobrakovo	L	19.773	43.121	112	609	2875
115	ME2	/Cehotina	Gradac	L	19.154	43.396	55.5	55	809.8

Distance:	The distance in km from the mouth of the mentioned river	Sampling location in profile:
Altitude:	The mean surface water level in meters above sea level	L: Left bank
Catchment:	The area in square km, from which water drains through the station	M: Middle of river
ds.	Downstream of	R: Right bank
us.	Upstream of	
Conf.	Confluence tributary/main river	
/	Indicates tributary to a river in front of the slash. No name in front of the slash means Danube	

Figure 2.2.1: The Danube Station map TNMN

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

Quality elements

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)

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 II	
	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	

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

	Surveillance Monitoring II	
	Water	Water
	concentrations	load assessment
Parameter		
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

Analytical Quality Control (AQC)

Parameters covered and samples distributed in the 2014 QUALCODanube programme were as follows:

- real surface water samples for nutrient analysis: preserved natural surface water, spiked if necessary and adequately homogenised. Sample codes were SW-N-1 and SW-N-2. 500 cm^3 plastic bottles were provided for $NH4^+$, NO_3^-, organic N, total N, PO_4^{3-} and total P analysis. Measurement results were asked to be reported as mg N/dm^3 and mg P/dm^3, respectively.

- real surface water samples for heavy metal analysis: preserved natural surface water, spiked and adequately homogenised. Due to error which went undiscovered until postage, the first batch of samples contained parameters at concentrations a magnitude higher than intended. Thus a second batch of samples was produced and sent to participants for analysis under sample codes NEW SW-M-1 and NEW SW-M-2. 250 cm^3 plastic bottles were provided for Cd, Ni and Pb analysis. Measurement results were asked to be reported as $\mu g/dm^3$.

- spike solutions together with matrix water for NO_2^- and Hg analysis: due to stability concerns during transport, it was decided that participants should compose the proficiency testing samples themselves in situ by mixing prescribed amounts of the spike solutions (synthetic concentrates) of the measurands with the matrix water provided (real surface water, filtered and stabilized by boiling) according to instructions. Spike solutions were put in 20 cm^3 plastic containers with sample codes SW-N/M-1 and SW-N/M-2, whereas matrix water was provided in 500 cm^3 plastic bottles labelled "Blank surface water for NO_2^-" and "Blank surface water for Hg" (2 bottles per each parameter). Measurement results were asked to be reported as mg N/dm^3 and µg/dm^3, respectively.

Evaluation was performed according to ISO 13528:2005 and ISO/IEC 17043:20103. Reported results were first inspected for obviously erroneous results or blunders, which were excluded from the dataset in accordance with section B.2.5. of ISO/IEC 17043:2010. Then the assigned value of the parameter [Ẋ], the standard uncertainty of the assigned value [u(x)] and the standard deviation for proficiency assessment (SDPA) was determined. Finally, performance statistics was calculated including z-scores, z'- scores and En numbers (section 7.4. and 7.6. of ISO 13528:2005) and assessment was given based on the performance statistics.

Assigned value was determined as a consensus value from all participants. For this end, robust average of all laboratories was calculated according to algorithm "A" (for details see Annex C of ISO 13528:2005). The same algorithm was used to calculate the standard uncertainty of the assigned value, i.e. the robust average of all laboratories. Assigned values were tested against analytical measurements by WESSLING Hungary Ltd. The standard deviation for proficiency assessment was chosen as a fit-for-purpose value, pre-set as percentage of the assigned value. Regulatory requirements, previous experience with the proficiency testing scheme, and expert judgement were taken into consideration when defining SDPA. Robust standard deviations calculated from the current datasets (using algorithm "A") were given special emphasis.

Number of participants increased from 32 to 37 compared to 2013.

The 2014 proficiency testing scheme was performed with good results overall: evaluation could be performed for all parameters, number and ratio of unsatisfactory results remained low. Phosphorus measurements were highly successful, none of the results were unsatisfactory for phosphate and total P. Organic nitrogen, which debuted in the scheme in 2013, was measured by few participants (14), but agreement among results improved from previous year. However, this parameter still exhibited the highest uncertainty of the assigned value compared to the standard deviation of proficiency assessment. In case of nitrite, some participants reported markedly low values for the sample. A possible explanation may be the usage of high purity laboratory water for dilution of the spike sample instead of the matrix water provided, which, being real surface water, contained naturally occurring nitrite in non-negligible amount. A positive feature was to see that the majority of participants reported their expanded uncertainties together with measurement results, allowing for calculation of En numbers, thus assessment of the validity of the underlying uncertainty estimation.

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

143 sites at 110 TNMN monitoring stations were monitored in the Danube River Basin in 2014 (some monitoring stations contain two or three sampling sites - left, middle and/or right side of the river). The data was collected from 69 sampling sites at 39 stations on the Danube River and from 74 sampling sites at 71 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 2014
Mean	arithmetical mean of the measurements done in the year 2014
Max	maximum value of the measurements done in the year 2014
C50	50 percentile of the measurements done in the year 2014
C90	90 percentile of the measurements done in the year 2014

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).*

The 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 2014. 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 the table there are minimal, maximal values for all determinands calculated from all Danube or tributaries station and minimal and maximal values for all determinands calculated from mean (average) values from all Danube or tributaries.

Table 3: Concentration ranges and mean annual concentrations of selected determinands in the Danube River and its tributaries in 2014

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	69/39	0.3	29.5	10.7	17.1	73/71	< 0.005	34.0	8.6	17.0
Suspended Solids	mg/l	69/39	< 1	505	8	84	73/71	< 1	2468	5	668
Dissolved Oxygen	mg/l	69/39	3.9	14.2	6.8	11.0	73/71	3.2	14.9	6.8	13.6
BOD_5	mg/l	69/39	< 0.25	21.0	1.1	4.6	68/66	< 0.25	74.7	0.7	10.2
COD_{Mn}	mg/l	63/33	1.2	38.6	2.1	9.6	46/46	1.0	40.5	2.0	10.9
COD_{Cr}	mg/l	63/33	< 1.00	57.0	6.1	36.6	71/69	< 2.00	431.1	< 2.50	83.7
TOC	mg/l	42/24	1.2	15.7	1.9	5.9	26/24	0.7	15.2	1.4	11.3
DOC	mg/l	6/6	1.3	5.9	1.9	2.6	4/4	0.5	7.4	0.9	6.2
pH		65/37	6.5	9.5	7.6	8.3	71/69	6.5	9.4	7.3	8.4
Alkalinity	mmol/l	67/37	0.3	4.9	1.6	3.6	63/61	0.9	8.4	1.2	6.9
Ammonium-N	mg/l	69/39	< 0.002	0.43	0.01	0.17	73/71	< 0.002	6.55	0.01	1.40
Nitrite-N	mg/l	69/39	< 0.0005	0.151	0.008	0.035	73/71	< 0.0005	0.24	0.0037	0.0739
Nitrate-N	mg/l	69/39	0.09	3.80	0.73	2.82	73/71	0.017	7.02	0.353	6.22
Total Nitrogen	mg/l	61/31	< 0.500	3.9	1.4	2.6	57/57	0.14	16.4	0.5	7.9
Organic Nitrogen	mg/l	31/21	< 0.025	2.48	0.03	0.85	28/26	0.009	2.89	0.12	1.54
Ortho-Phosphate-P	mg/l	66/38	< 0.0025	0.270	0.022	0.094	73/71	< 0.0015	0.545	0.006	0.241
Total Phosphorus	mg/l	67/37	0.015	0.492	0.046	0.172	67/67	< 0.0015	1.200	< 0.02	0.573
Total Phosphorus - Dissolved	mg/l	39/17	0.01	0.180	0.037	0.111	17/17	0.007	0.442	0.012	0.216
Chlorophyll-a	µg/l	54/26	< 0.0015	81.00	1.07	21.84	43/41	< 0.0015	209.70	< 0.0015	58.86
Conductivity 20°C	µS/cm	67/37	31	845	38	526	67/67	4.96	1567	24	1148
Calcium	mg/l	68/38	29.6	101.0	39.5	83.9	71/69	12.06	145.2	26.02	91.34
Sulphates	mg/l	59/31	11.4	75.0	18.5	50.8	51/49	5.68	195.0	9.34	128.55
Magnesium	mg/l	68/38	4.4	30.7	10.6	20.6	71/69	< 0.25	68	3.72	56.91
Potassium	mg/l	45/23	1.0	5.0	1.5	3.5	39/37	< 0.03	76.0	0.99	15.76
Sodium	mg/l	45/23	3.40	30.00	10.37	21.40	39/37	1.7	80.2	4.08	55.28
Manganese	mg/l	16/12	0.001	0.16	< 0.0025	0.05	18/18	< 0.0005	0.63	< 0.0005	0.171
Iron	mg/l	16/12	< 0.005	5.95	< 0.005	0.692	25/25	< 0.001	2.91	< 0.001	0.667
Chlorides	mg/l	68/38	7.7	79.0	14.2	32.2	73/71	0.15	251.9	1.64	168.56
Silicates (SiO2)	mg/l	13/7	1.3	8.4	2.9	8.4	12/10	0.7	26.1	1.7417	20.4
Silicates(SiO2), dissolved	mg/l	14/10	< 0.200	19	2.8	8.7	20/20	0.36	16.2	1.642	12.514
Macrozoobenthos- saprobic index		22/14	1.89	28.82	1.89	2.82	22/22	1.78	3.09	1.87	2.96

Table 3: Concentration ranges and mean annual concentrations of selected determinands in the Danube River and its tributaries in 2014 (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	66/36	< 0.150	1329.00	1.64	119.51	72/70	< 0.150	148.10	< 0.500	54.13
Copper - Dissolved	µg/l	64/34	< 0.100	151.00	1.00	21.33	69/67	< 0.100	29.00	< 0.500	9.86
Chromium - Dissolved	µg/l	68/38	< 0.03	12.69	< 0.03	6.17	63/61	< 0.03	52.00	< 0.03	7.70
Lead - Dissolved	µg/l	66/36	< 0.025	13	< 0.040	2.18	63/61	< 0.004	65.00	< 0.040	10.02
Cadmium - Dissolved	µg/l	66/36	< 0.003	0.44	< 0.007	0.16	63/61	< 0.003	1.17	< 0.007	0.54
Mercury - Dissolved	µg/l	66/36	< 0.001	0.28	< 0.0025	0.09	58/56	< 0.0010	0.24	0.002	< 0.15
Nickel - Dissolved	µg/l	66/36	< 0.025	39.30	< 0.025	21.13	64/62	< 0.025	31.20	< 0.025	9.57
Arsenic - Dissolved	µg/l	64/34	< 0.015	5.90	< 0.500	2.66	52/50	< 0.015	8.18	0.32	5.60
Aluminium - Dissolved	µg/l	16/10	< 0.25	133.00	2.65	21.57	20/18	< 0.25	215.00	< 1.50	50.02
Zinc	µg/l	31/21	< 0.50	249.00	< 2.50	104.13	27/27	< 0.15	140.00	< 2.50	73.00
Copper	µg/l	30/20	< 0.500	52.30	1.17	20.93	28/28	< 0.100	42.60	0.81	16.24
Chromium - total	µg/l	29/19	< 0.1000	18.00	0.37	3.67	21/21	< 0.1000	39.10	0.38	8.89
Lead	µg/l	38/22	< 0.0500	34.10	0.43	4.18	35/35	< 0.0500	57.20	< 0.5	11.16
Cadmium	µg/l	38/22	< 0.00250	0.63	0.03	0.20	33/33	< 0.00250	5.28	0.03	1.63
Mercury	µg/l	32/20	< 0.0075	0.50	< 0.0075	0.16	34/34	< 0.0075	0.50	< 0.0075	0.20
Nickel	µg/l	38/22	< 0.250	51.40	< 0.500	27.45	33/33	< 0.100	150.00	< 0.5	18.06
Arsenic	µg/l	30/20	< 0.050	5.00	0.64	2.29	23/23	< 0.050	27.80	0.82	5.58
Aluminium	µg/l	4/4	36.00	3700.00	138.53	410.15	8/8	2.5	1210.00	21.21	302.13
Phenol index	mg/l	46/20	< 0.0010	0.03	< 0.0015	0.0071	39/39	< 0.0004	0.03	< 0.0004	0.0093
Anionic active surfactants	mg/l	51/23	< 0.0045	0.64	< 0.0045	0.34	40/38	< 0.0045	0.50	< 0.0045	0.45
AOX	µg/l	25/11	2	39.40	< 5.0000	25.83	9/9	< 5.0000	55.20	7.60	36.66
Petroleum hydrocarbons	mg/l	39/17	< 0.01	0.53	0.01	0.24	33/33	< 0.003	0.62	< 0.003	0.30
Lindane	µg/l	56/30	< 0.0005	0.01	< 0.0005	0.0054	56/54	< 0.0005	< 0.025	< 0.0005	< 0.025
pp´DDT	µg/l	57/29	< 0.0005	< 0.025	< 0.0005	< 0.025	56/54	< 0.0005	< 0.025	< 0.0005	< 0.025
Atrazine	µg/l	58/30	< 0.0005	< 0.09	< 0.005	< 0.09	44/42	< 0.0005	< 0.09	< 0.0025	< 0.09
Chloroform	µg/l	22/12	< 0.005	2	0.009	0.484	26/26	< 0.005	< 5.0	0.006	< 5.0
Carbon tetrachloride	µg/l	19/11	< 0.005	0.4	< 0.005	0.217	22/22	< 0.005	0.4	< 0.005	< 0.25
Trichloroethylene	µg/l	10/6	< 0.005	< 0.250	0.01	< 0.250	19/19	< 0.005	< 10.0	< 0.005	< 10.0
Tetrachloroethylene	µg/l	13/7	< 0.005	< 0.250	< 0.025	< 0.250	19/19	< 0.005	< 5.0	< 0.005	< 5.0

4. Profiles and trend assessment of selected determinands

The 90 percentiles (C90) of selected determinands (dissolved oxygen, BOD_5, COD_{Cr}, N-NH_4, N-NO_3, P-PO_4, Ptotal and Cd) measured in last ten years are displayed in the Figures 4.1-4.16. Due to revision of the TNMN in 2006 following monitoring points on the Danube were replaced: AT2 rkm 2120 to AT5 rkm 2113, AT4 rkm 1874 to AT6 rkm 1879, DE1 rkm 2581 to DE5 rkm 2538. Among tributaries the site HR3 rkm 288 was replaced by HR9 rkm 300 BG8 rkm 54 to BG14 rkm 4 and BG8 rkm 13 to BG15 rkm 1. In 2009 SK3 was replaced with SK5, this monitoring point is also illustrated in graphs as the Hungarian point HU3. For trend graphs data from SK5 and HU3 was used.

To indicate the long-term trends in the upper, middle and lower Danube a more detailed analysis for selected parameters (BOD_5, N-NO_3, P_{total}) is provided for the sites SK1 Bratislava, HU5 Hercegszanto and RO5 Reni (Figures 4.17-4.25).

As regards a general spatial distribution of key water quality parameters along the Danube River in 2014 the highest concentrations of biodegradable organic matter were observed in the lower parts of the river. The concentration of nutrients and cadmium also reached their highest concentration values in the lower part of the Danube.

The highest pollution by the biodegradable organic matter in 2014 was measured in Sio, Morava, Arges.

The highest values of dissolved oxygen were observed in the upper part of the Danube, in the lower Danube dissolved oxygen levels decreased (Figure 4.1). The lowest DO value was observed at the monitoring point BG2. Low values of dissolved oxygen were in 2014 measured in the tributaries Arges, Sio and Tisza.

From the longer-term perspective positive changes in water quality can be seen at several TNMN stations. Decreasing tendencies of biodegradable organic matter were observed in the upper Danube. BOD levels at monitoring sites SK1, HU5 and RO5 have also a decreasing trend (Figures 4.17-4.19). In 2014 BOD increased at the monitoring site BG2 (see Figure 4.3).

A decreasing tendency of BOD levels in the tributaries Inn, Russenski Lom and Tisza were observed (Figure 4.4). In 2014 concentration of BOD increased in Dyje, Morava and Sio.

The trends of COD_{Cr} in the Danube River was rather stable during last ten years, the highest concentrations were observed in the lower part of Danube River. The highest COD_{Cr} concentrations in 2014 were observed in the tributaries Arges, Siret, Russenski Lom.

The decreasing or stable level of concentration of ammonium-N was recorded in the whole Danube River. In 2014 concentration of ammonium-N decreased substantially in the Danube at BG2. During the last ten years of TNMN operation, concentration of ammonium was decreasing in the Morava, Dyje, Vah, Sava and Tisza rivers (see Figure 4.8).

The level of nitrate-N concentrations is rather stable during recent years. A decrease was observed at several stations on the lower Danube (RO3, RO5, RO6, BG2, BG5 see Figure 4.9).

In the last decade a decreasing tendency of ortho-phosphate-P concentrations is mostly seen in the upper part of the Danube, and partly also in its lower part (BG1, BG3, RO4, RO7 Figure 4.11). A significant decrease of ortho-phosphate-P was observed in the tributaries Jantra, Russenski Lom and Arges (Figure 4.12). A slight increase of ortho-phosphate-P can be observed in the tributaries Dyje, Morava and Vah.

P-total concentration has a general decreasing tendency during the last decade in the Danube (Figure 4.13). At SK1 Bratislava and HU5 Hercegszanto concentration of P-total decreased in 2014, but a slight increase was observed at RO5 Reni (Figures 4.23-4.25).

The 90 and 10 percentiles of selected determinands ($N\text{-}NH_4$, $P\text{-}PO_4$, COD_{Cr}, BOD_5) measured in 2014 are displayed in the Figures 4.26-4.33. Pictures indicate the margins of a usual annual concentration range for a given parameter and site. In graphs for tributaries there are rkm of the Danube, where tributary discharge to the Danube River.

Low concentrations of $N\text{-}NH_4$ were observed in the upper part of Danube (Figure 4.26), the highest concentration was detected at RS4. In tributaries the highest values were observed in the Arges and Ialomita (Figure 4.27).

The highest values of percentiles of $P\text{-}PO_4$ were observed in the Bulgarian part of the Danube (Figure 4.28). The highest value was observed in the tributary Dyje (Figure 4.29).

The maximum values of COD_{Cr} percentiles were found in the lower Danube (BG2) and in tributaries Ialomita, Arges and Somes (Figure 4.30 and Figure 4.31).

The highest value of BOD_5 was found in the lower part of the Danube at BG2 (Figure 4.32). In the tributaries the highest values were observed in Ialomita and Iskar (Figure 4.33).

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

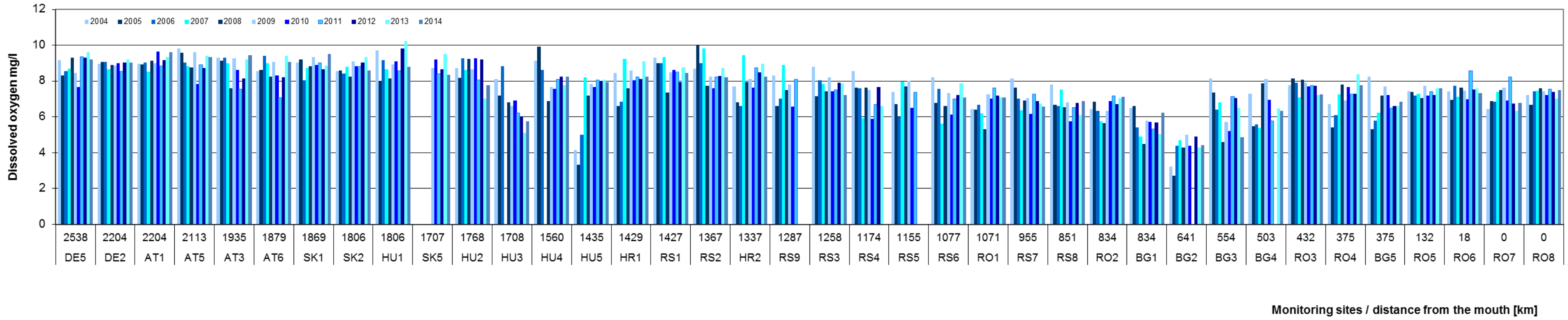


Figure 4.2.: Temporal changes of dissolved oxygen (c10) in tributaries.

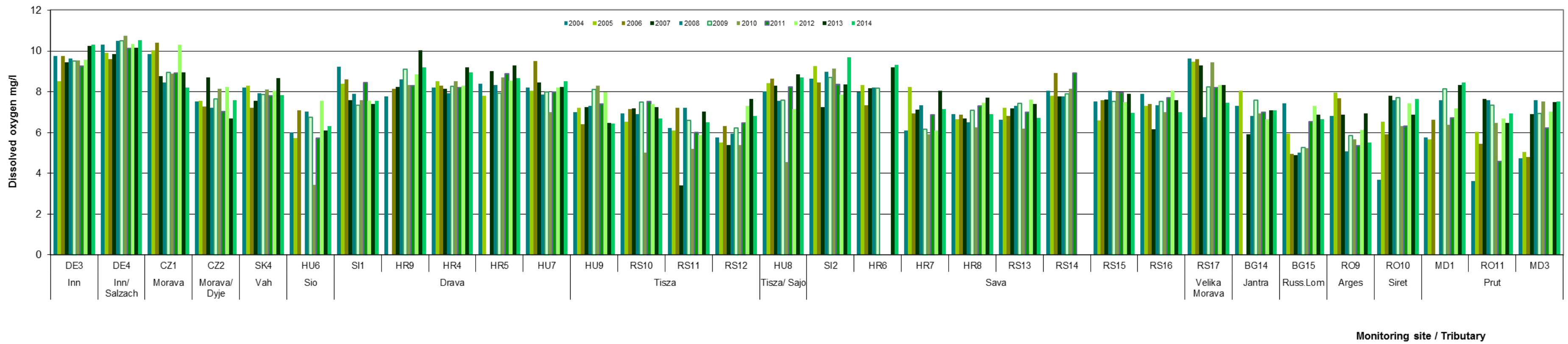


Figure 4.3.: Temporal changes of BOD_5 (c90) in the Danube River.

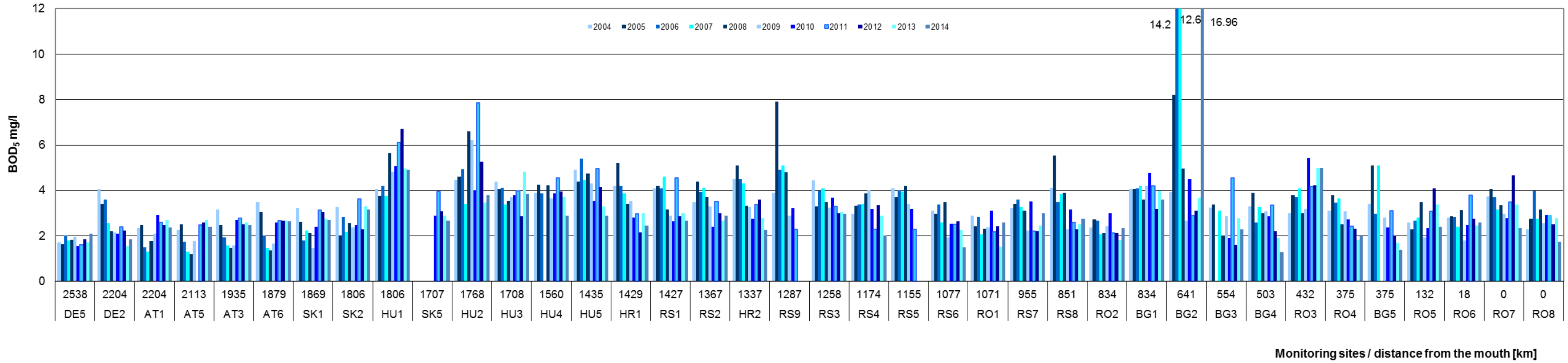


Figure 4.4.: Temporal changes of BOD_5 (c90) in tributaries.

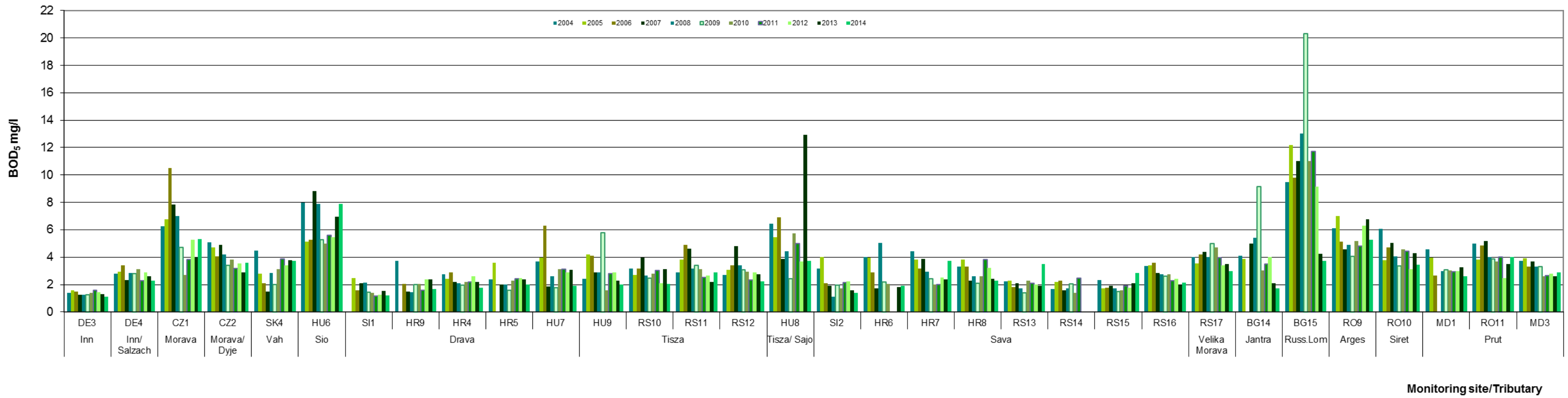


Figure 4.5.: Temporal changes of COD_{Cr} (c90) in the Danube River.

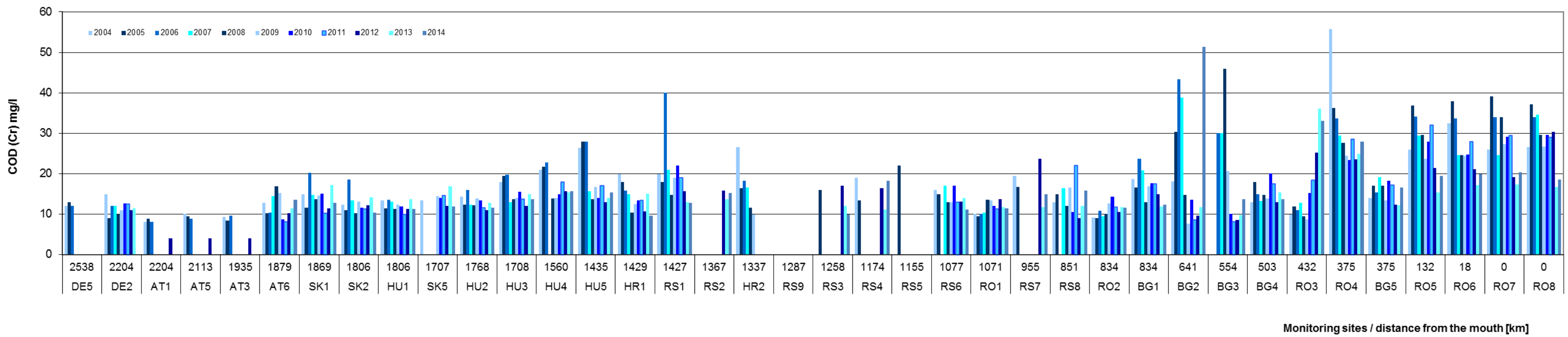


Figure 4.6.: Temporal changes of COD_{Cr} (c90) in tributaries.

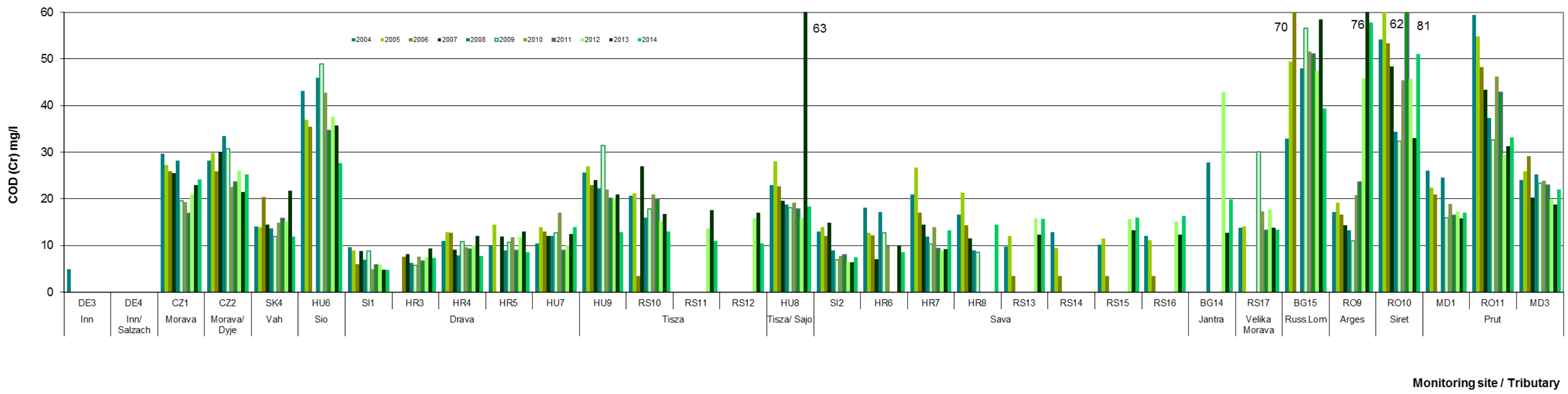


Figure 4.7.: Temporal changes of N-NH$_4$ (c90) in the Danube River.

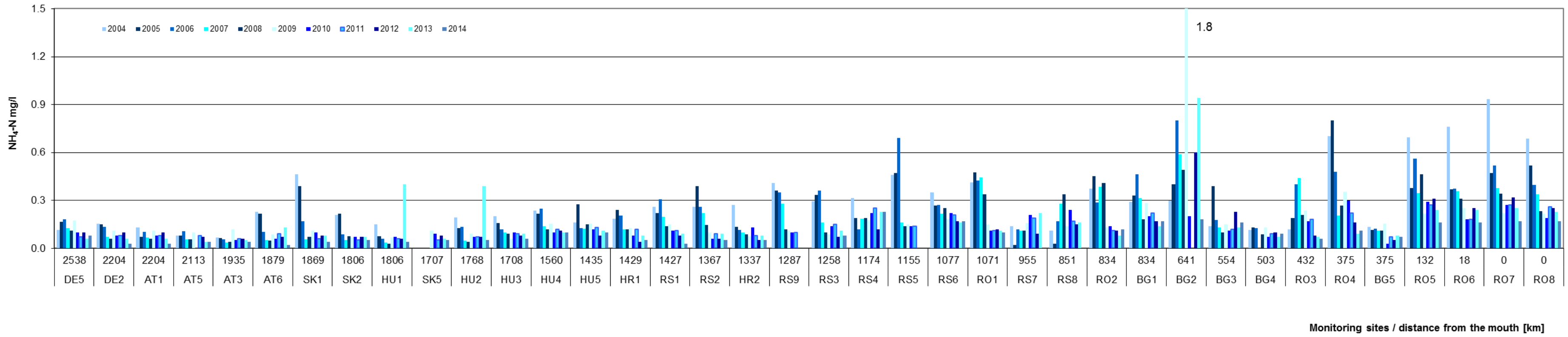


Figure 4.8.: Temporal changes of N-NH$_4$ (c90) in tributaries.

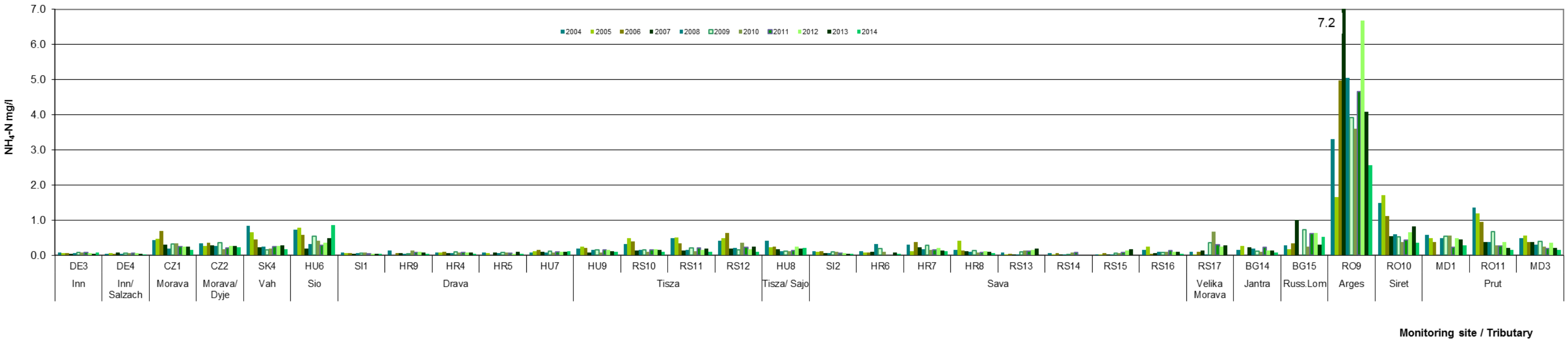


Figure 4.9.: Temporal changes of N-NO_3 (c90) in the Danube River.

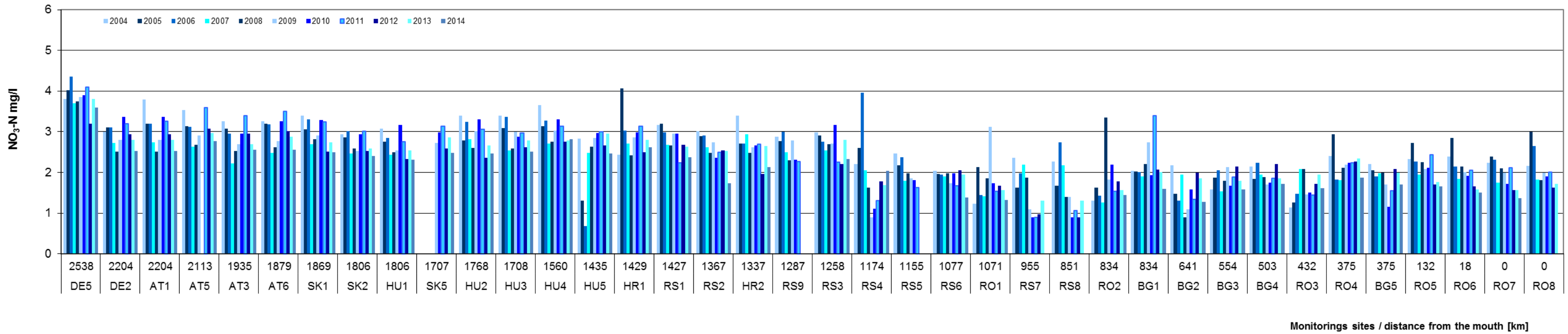


Figure 4.10.: Temporal changes of N-NO_3 (c90) in tributaries.

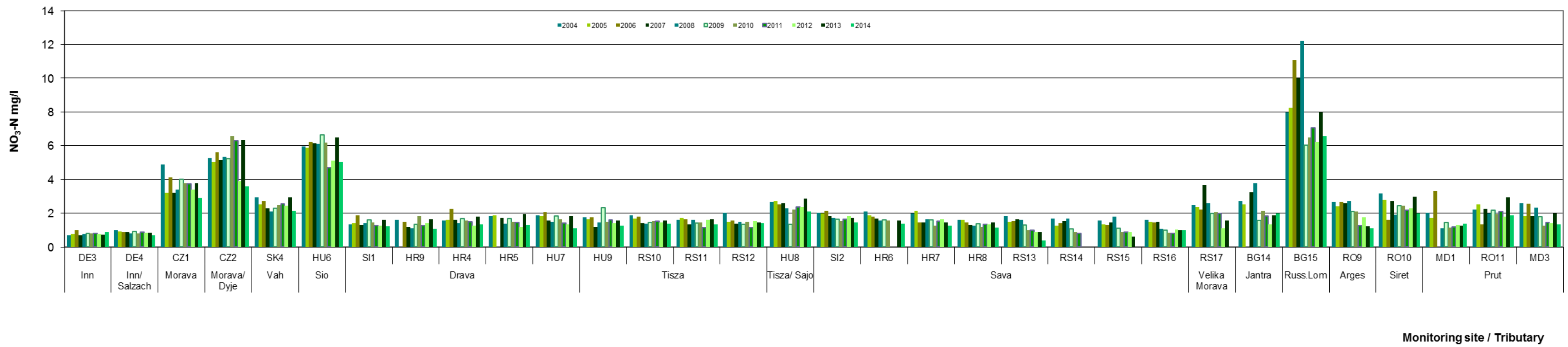


Figure 4.11: Temporal changes of P-PO_4 (c90) in the Danube River.

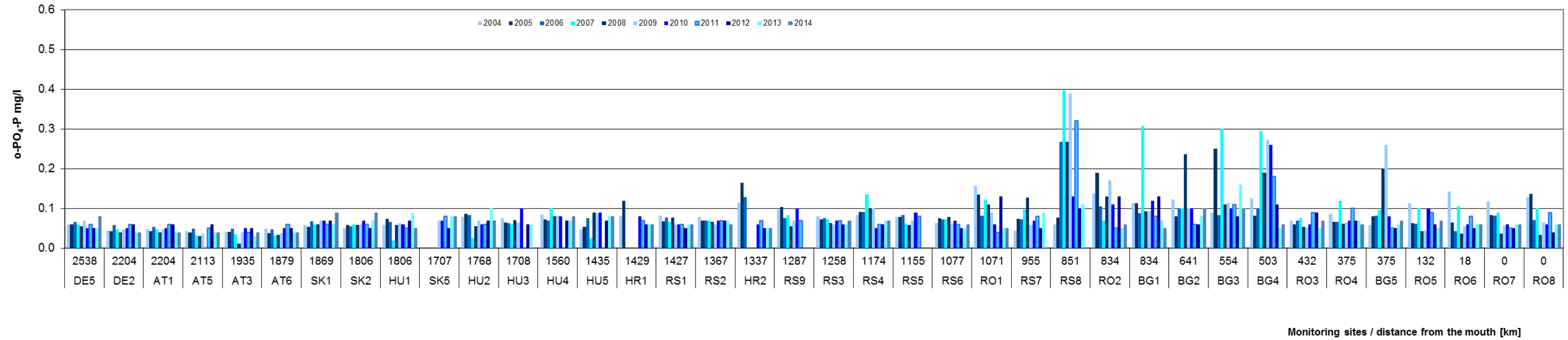


Figure 4.12: Temporal changes of P-PO_4 (c90) in tributaries

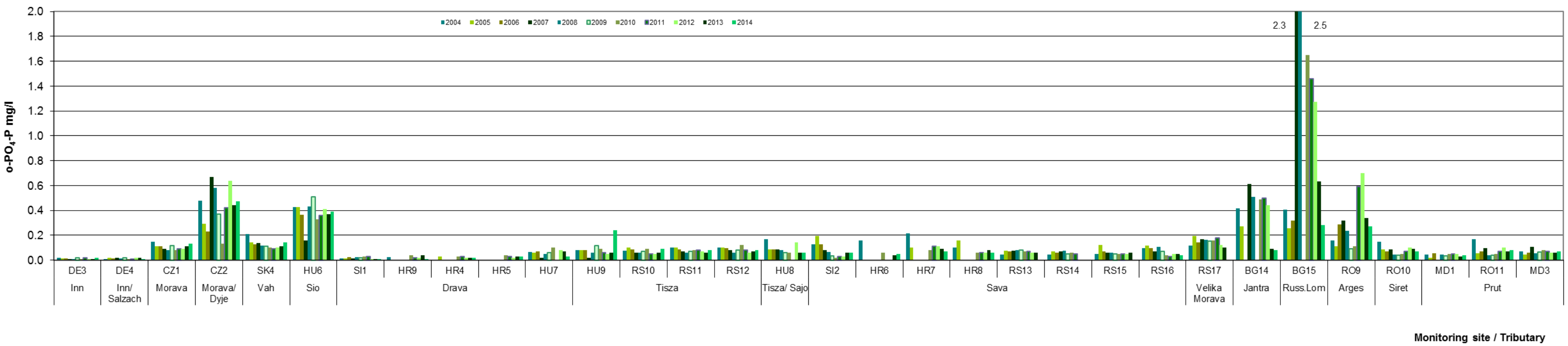


Figure 4.13: Temporal changes of total phosphorus (c90) in the Danube River.

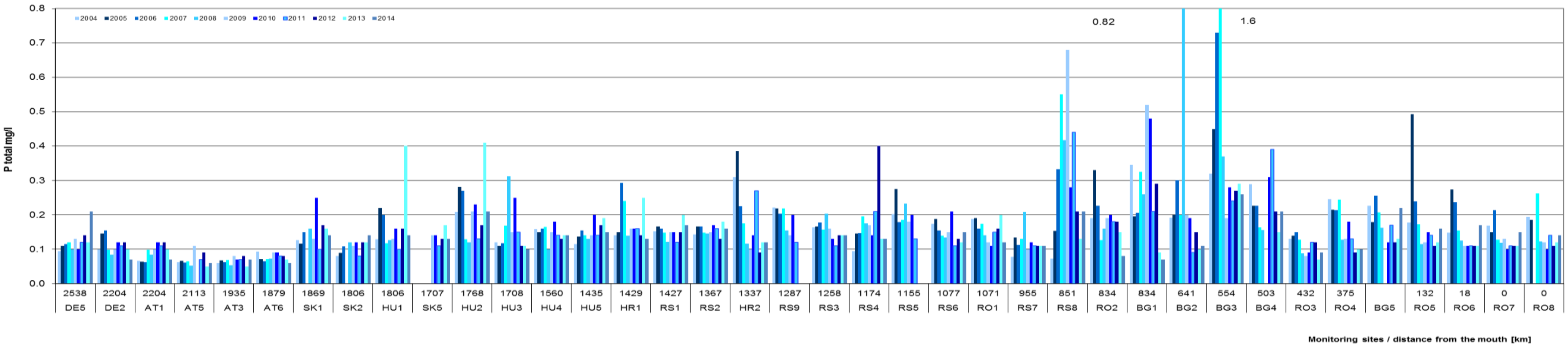


Figure 4.14: Temporal changes of total phosphorus (c90) in tributaries.

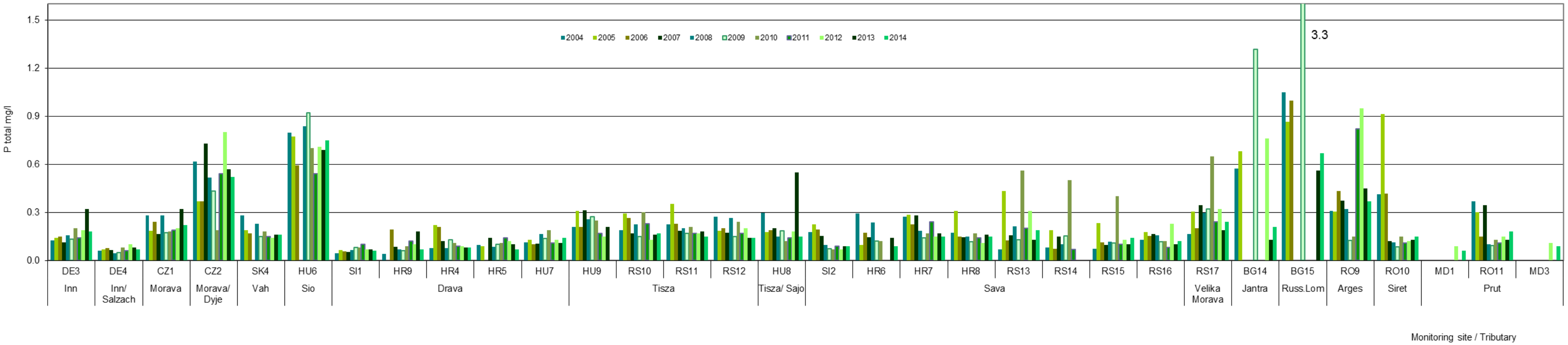


Figure 4.15: Temporal changes of cadmium (c90) in the Danube River.

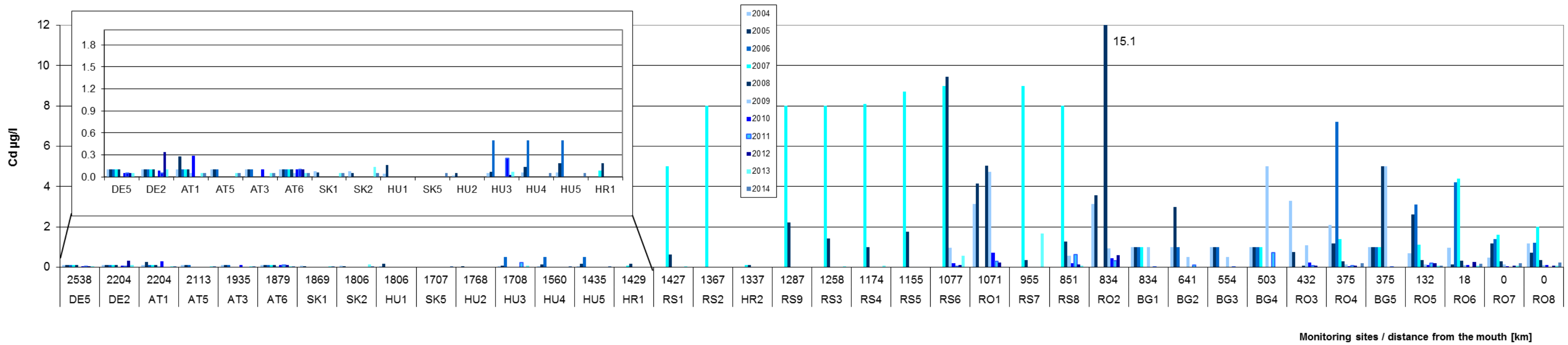


Figure 4.16: Temporal changes of cadmium (c90) in tributaries.

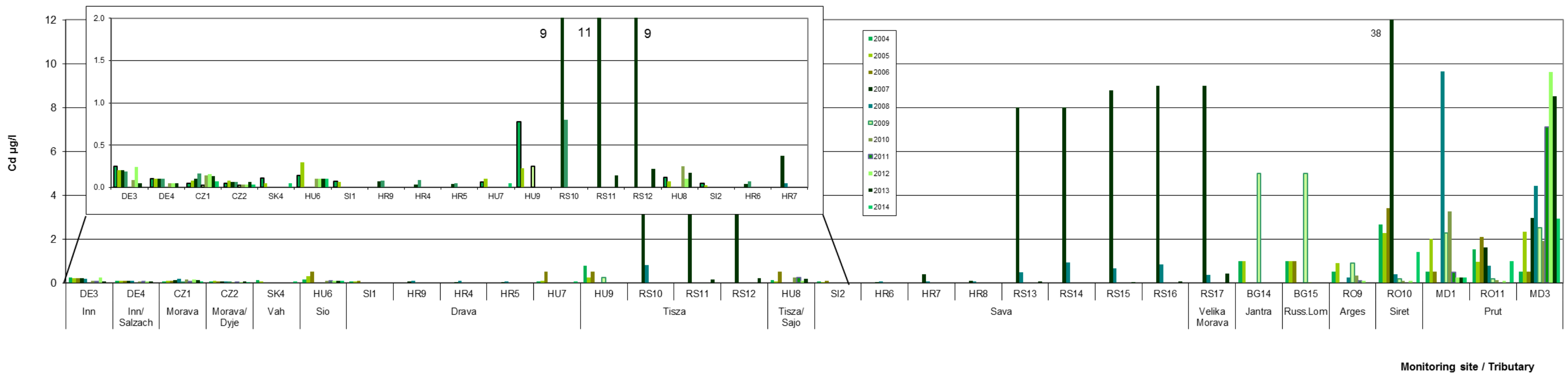


Figure 4.17: Temporal changes of BOD_5 (c90) in Bratislava

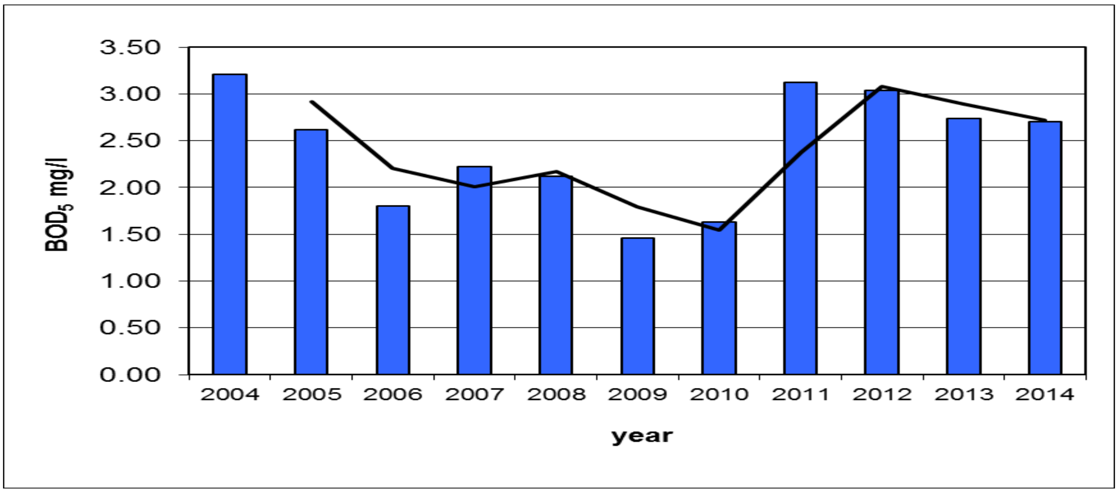


Figure 4.18: Temporal changes of BOD_5 (c90) in Hercegszanto

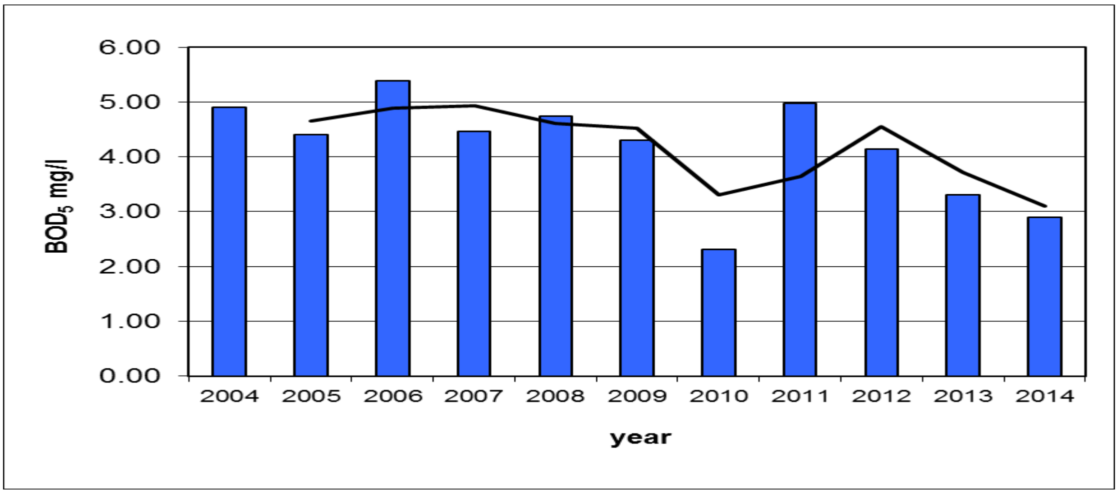


Figure 4.19: Temporal changes of BOD_5 (c90) in Reni

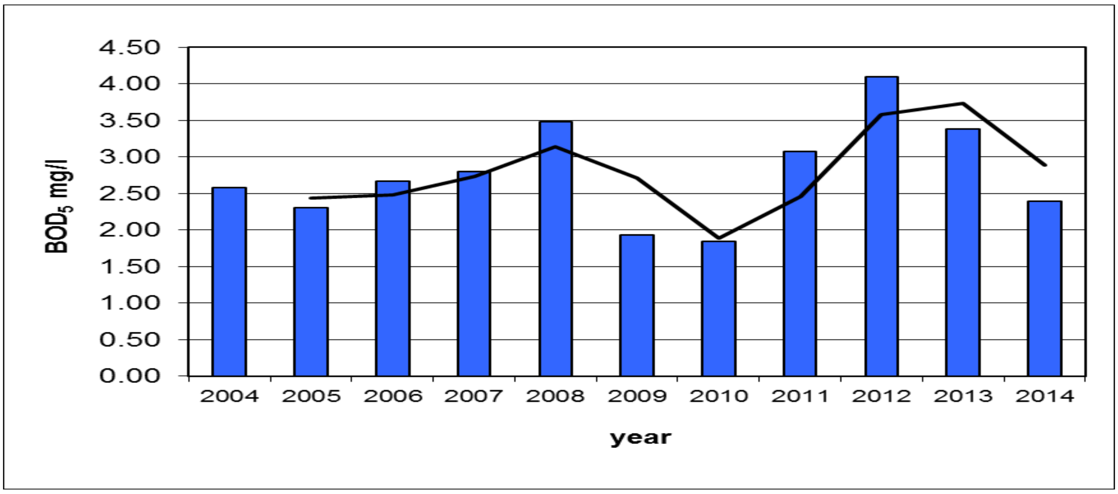


Figure 4.20: Temporal changes of N-NO_3 (c90) in Bratislava

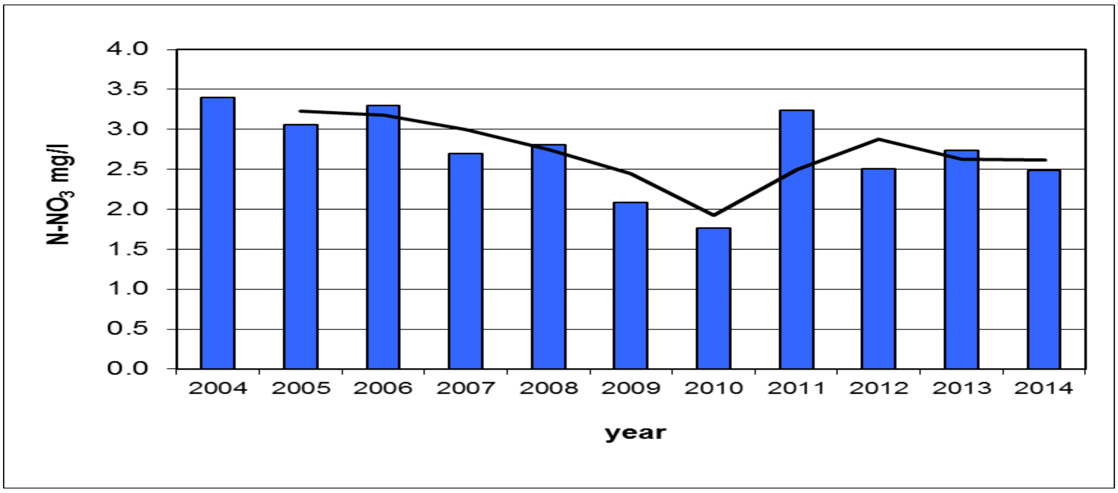


Figure 4.21: Temporal changes of N-NO_3 (c90) in Hercegszanto

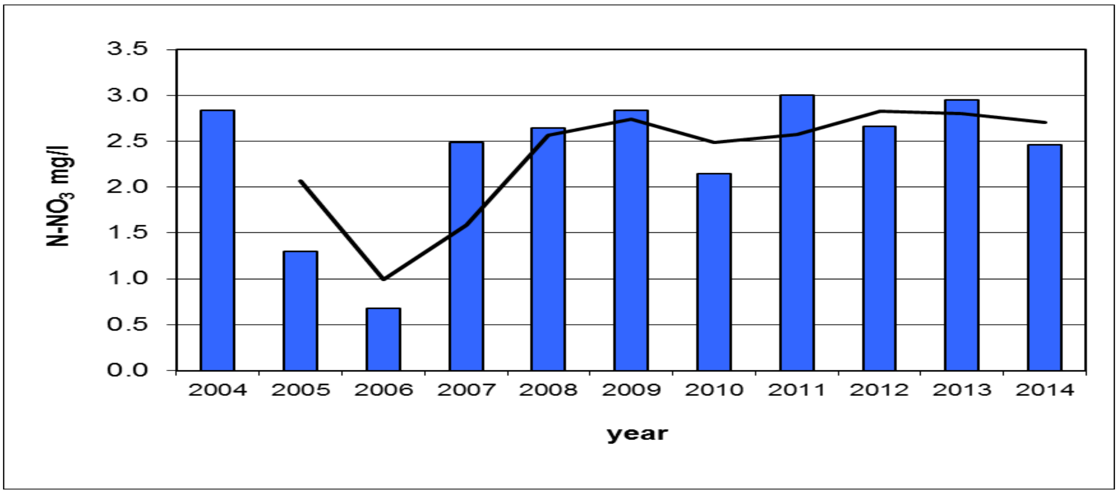


Figure 4.22: Temporal changes of N-NO_3 (c90) in Reni

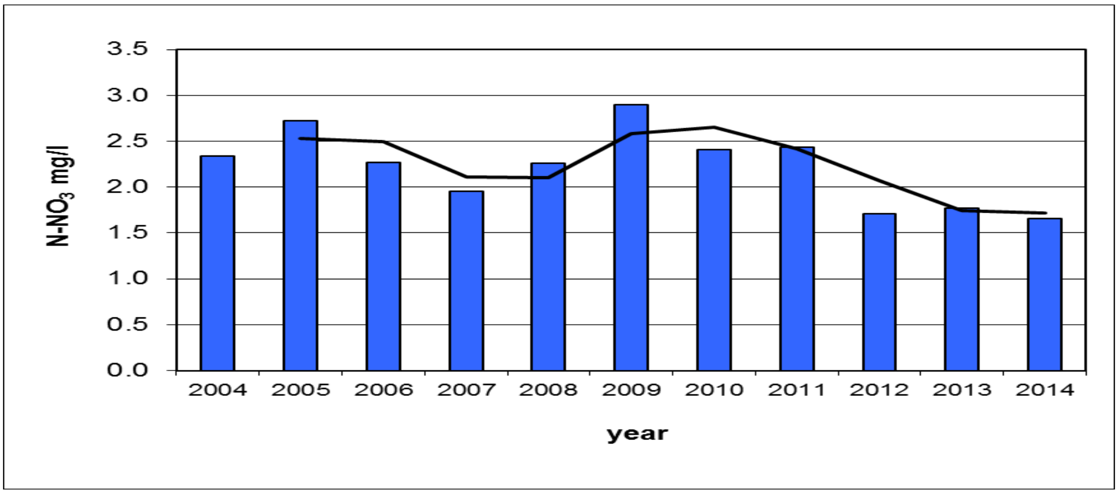


Figure 4.23: Temporal changes of total phosphorus (c90) in Bratislava

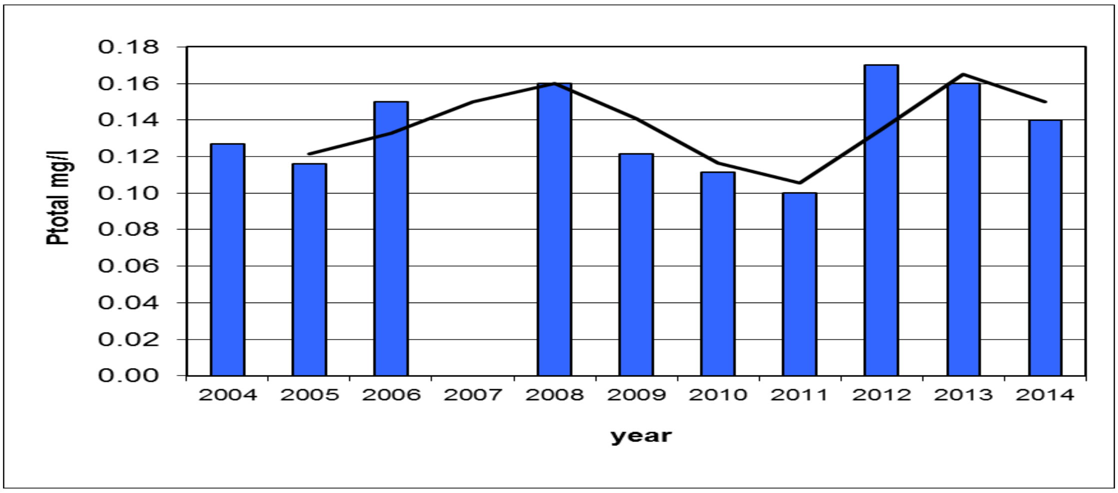


Figure 4.24: Temporal changes of total phosphorus (c90) in Hercegszanto

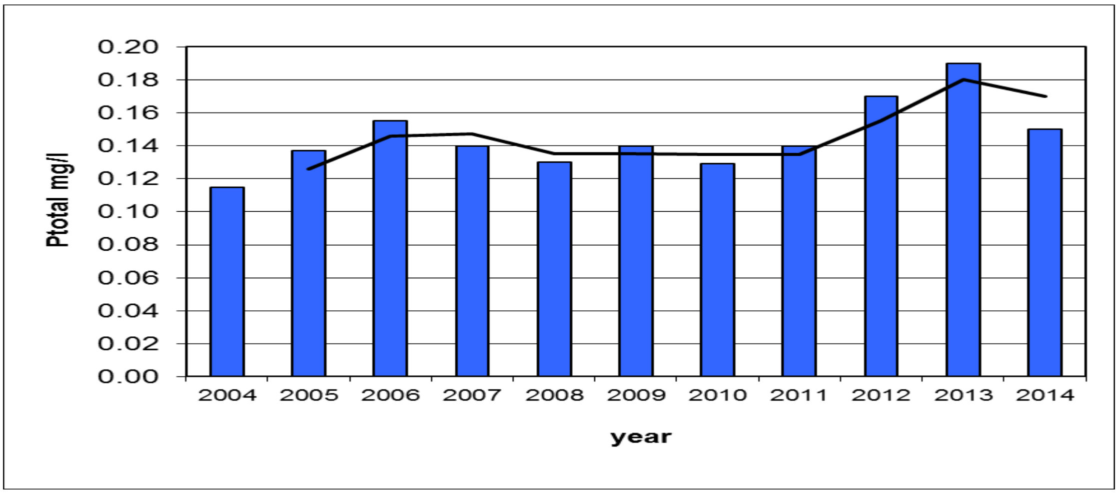


Figure 4.25: Temporal changes of total phosphorus (c90) in Reni

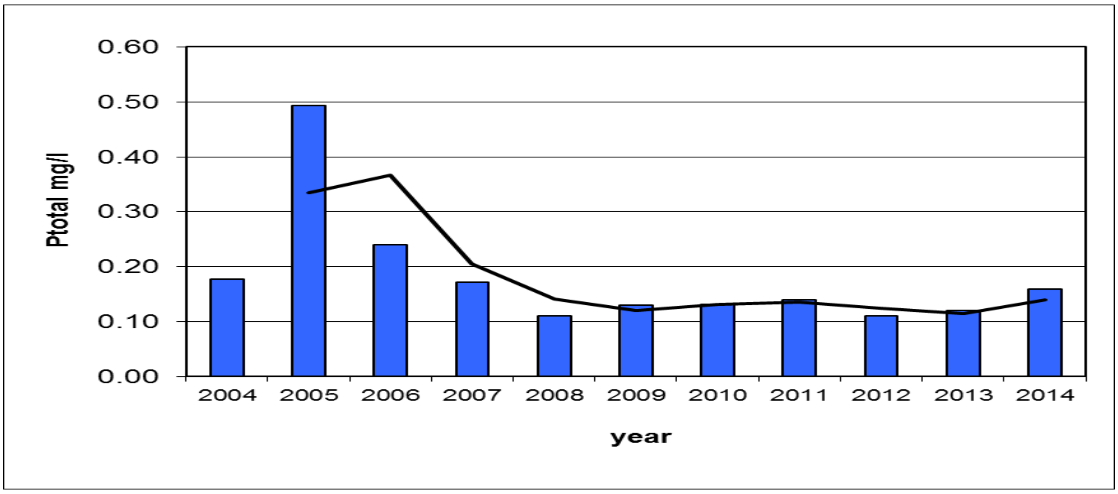


Figure 4.26: The percentile (90, 10) of N-NH_4 concentration along the Danube River in 2014.

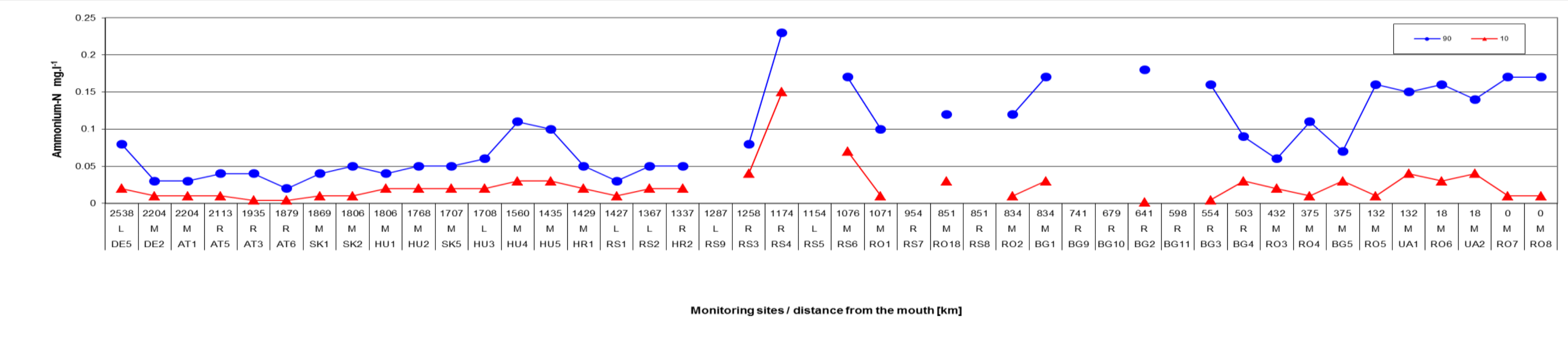


Figure 4.27: The percentile (90, 10) of N-NH_4 concentration in the tributaries in 2014.

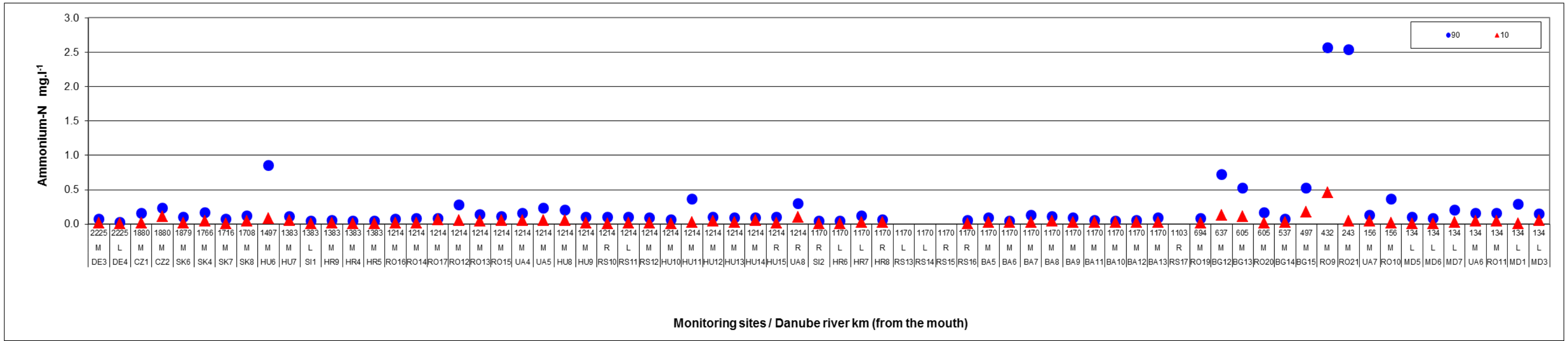


Figure 4.28: The percentile (90, 10) of P-PO_4 concentration along the Danube River in 2014.

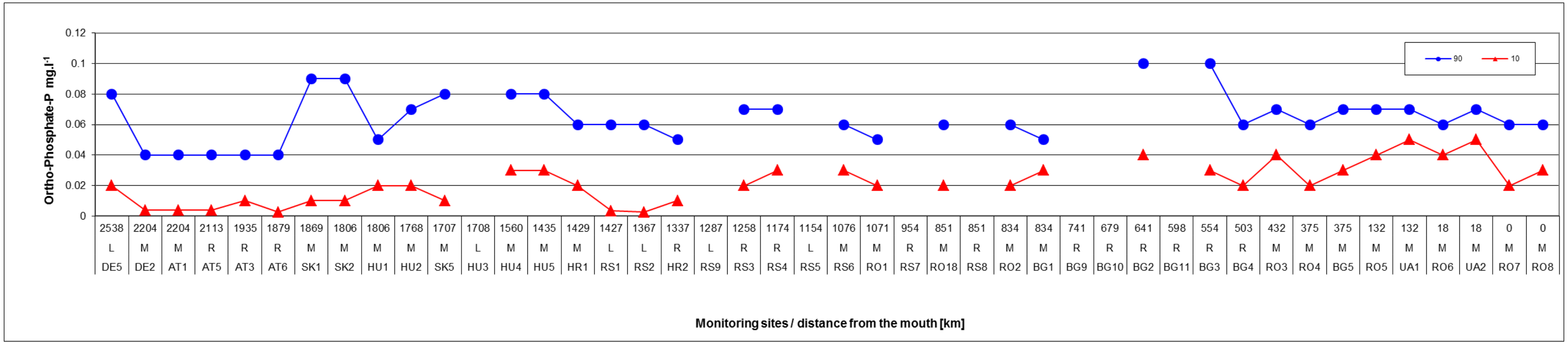


Figure 4.29: The percentile (90, 10) of P-PO_4 concentration in the tributaries in 2014.

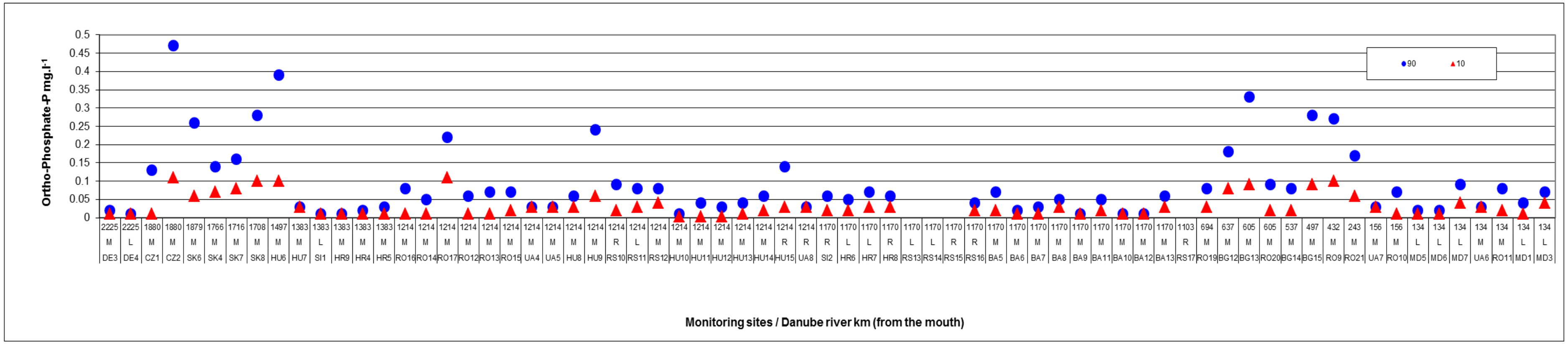


Figure 4.30: The percentile (90, 10) of COD_{Cr} concentration along the Danube River in 2014.

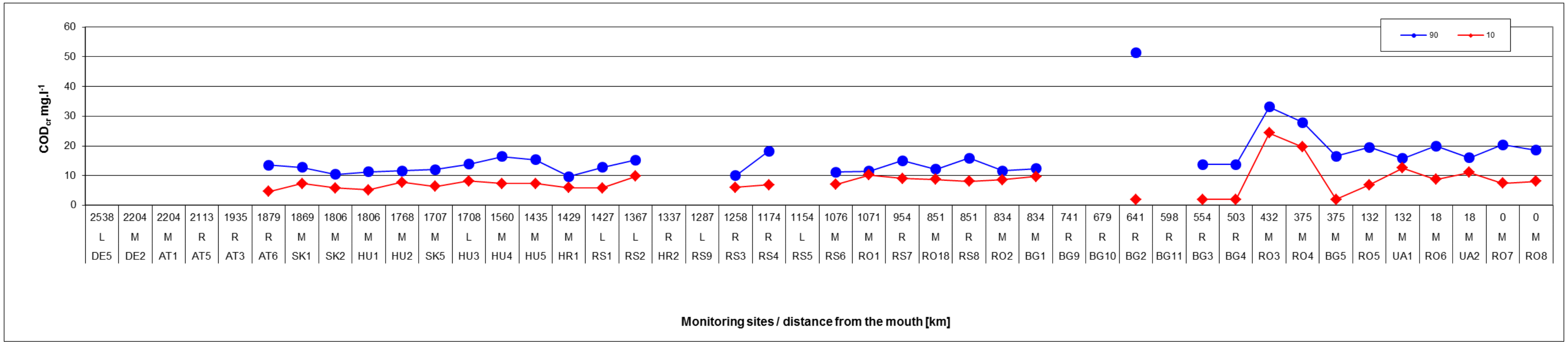


Figure 4.31: The percentile (90, 10) of COD_{Cr} concentration in the tributaries in 2014.

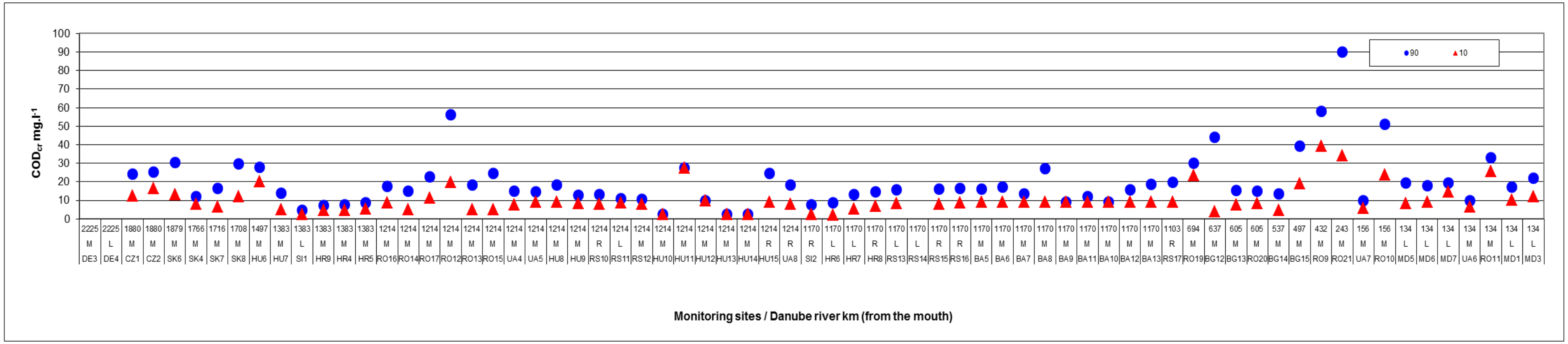


Figure 4.32: The percentile (90, 10) of BOD_5 concentration along the Danube River in 2014.

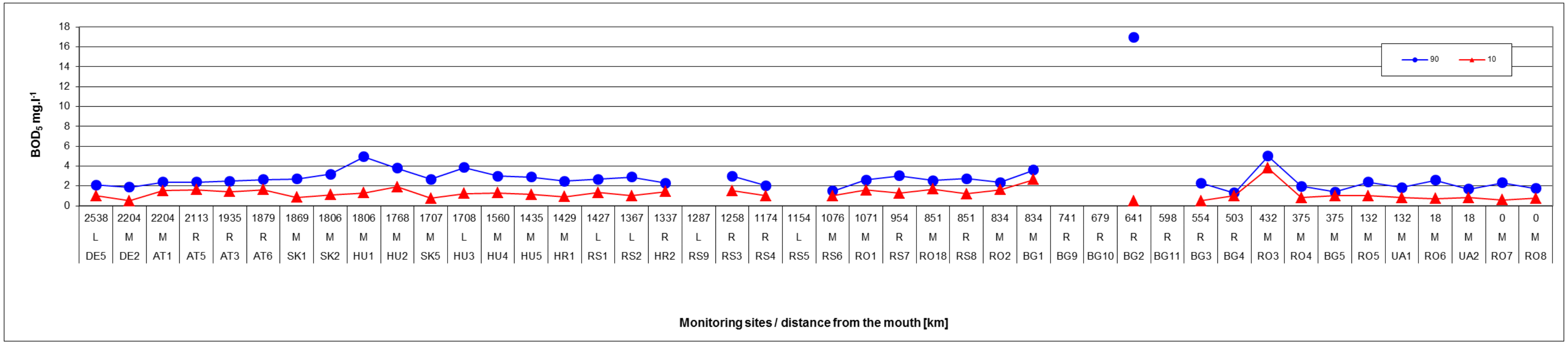


Figure 4.33: The percentile (90, 10) of BOD_5 concentration in the tributaries in 2014.

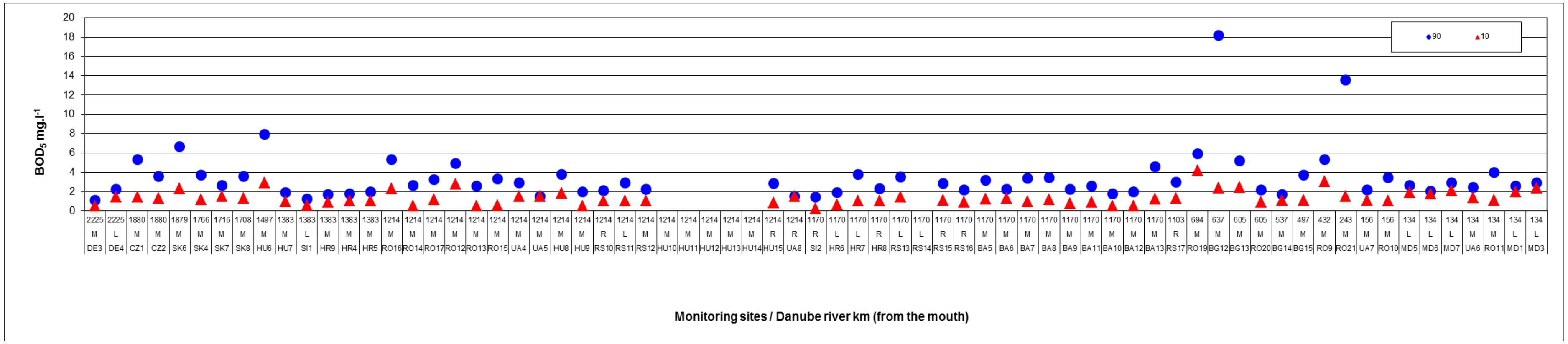


Figure 4.34: The maximum values of macrozoobenthos- saprobic index along the Danube River in 2014.

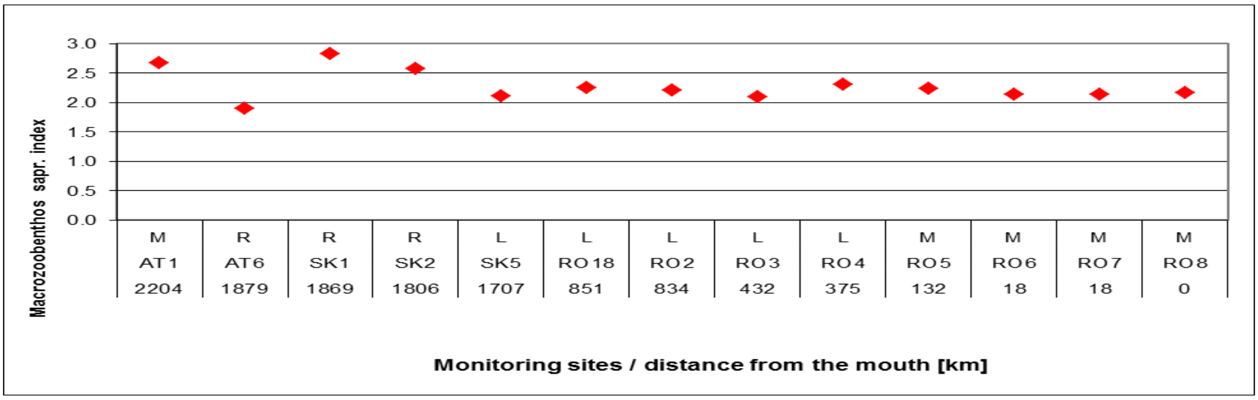
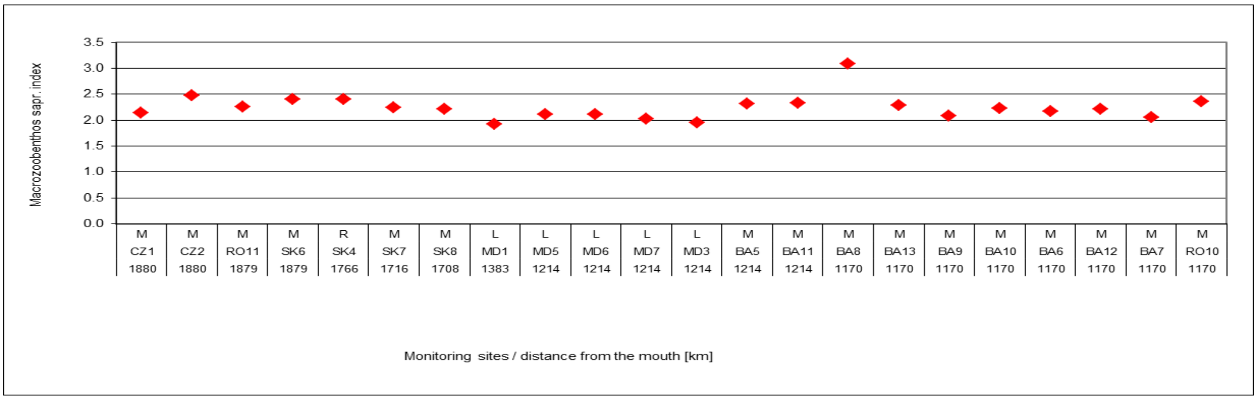
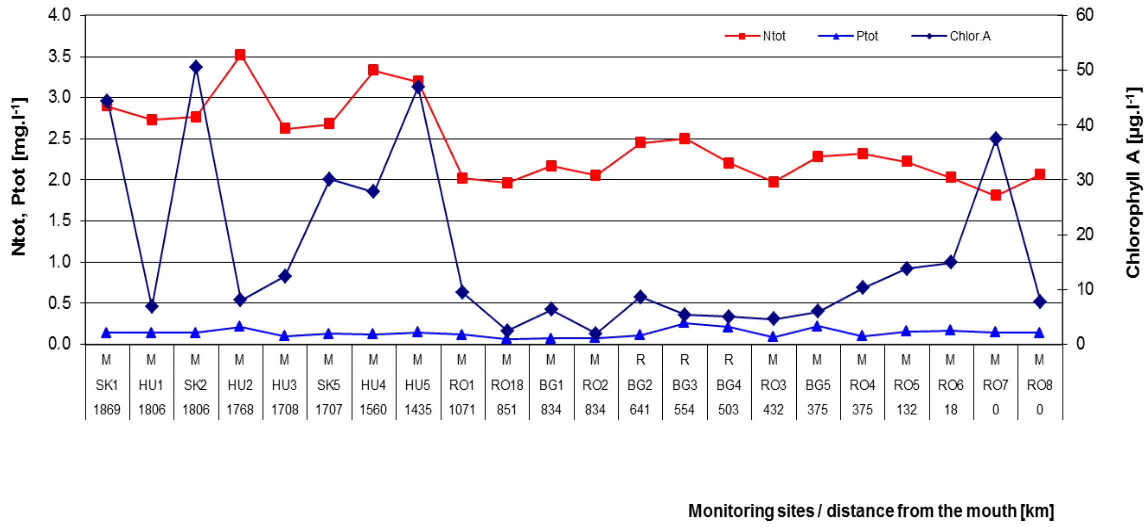


Figure 4.35: The maximum values of macrozoobenthos- saprobic index in the tributaries in 2014.



The maximum values of macrozoobenthos- saprobic index in the Danube River and its tributaries are shown in the Figures 4.34 and 4.35. The macrozoobenthos data were delivered for 14 monitoring sites located in the Danube River and for 22 monitoring sites in the tributaries. The maximal value of saprobic index was determined at SK1 Bratislava. The highest value of macrozoobenthos- saprobic index was found in the tributary Bosna (BA8).

Figure 4.36: The percentile (90) of total nitrogen, phosphorus and chlorophyll *a* concentration along the Danube River in 2014.



The concentration of nutrients and the chlorophyll *a* are presented in the Figure 4.36 (it shows only those monitoring points where all three determinands were measured). The maximum concentration of chlorophyll *a* was observed at SK2. The highest concentration of N_{total} was observed at HU2 and maximal concentration of P_{total} at BG3.

Figure 4.37: The percentile (90) of $N_{tot.}$, N-NH_4 and N-NO_3 concentration along the Sava River in 2014.

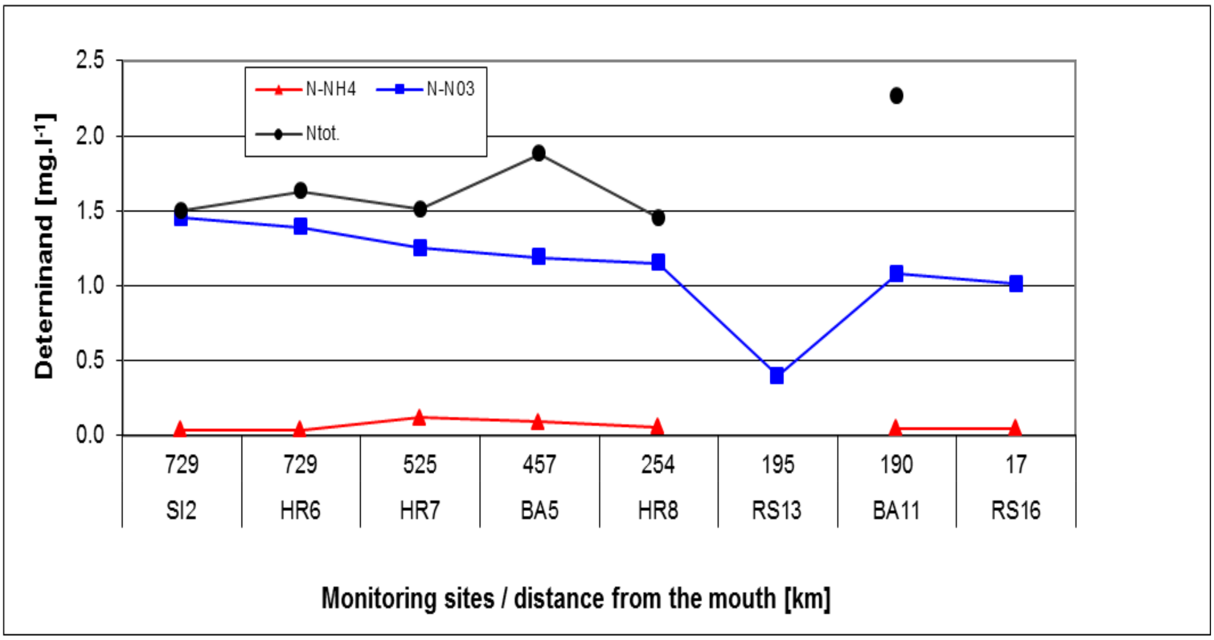
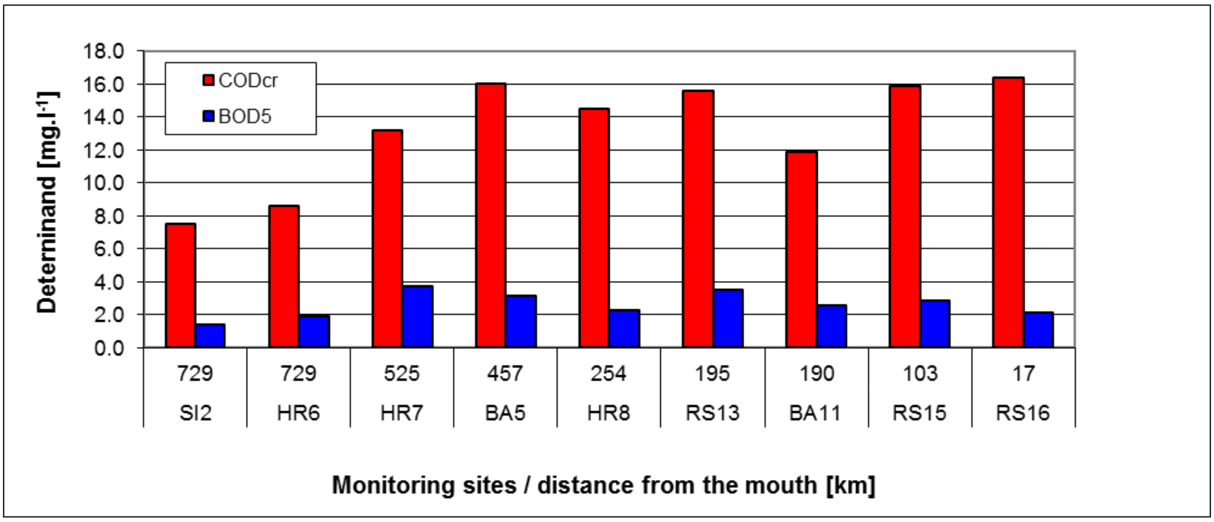


Figure 4.38: The percentile (90) of BOD_5 and COD_{Cr} concentration along the Sava River in 2014.



The percentiles 90 of nutrients COD_{Cr}, BOD_5 measured in 2014 in Sava and Tisza rivers are presented in the Figures 4.37-4.38. The highest value of N-NH_4 in Sava River was found at the monitoring site HR7 (rkm 525). The maximal concentration of N-NO_3 was observed at SI2 (rkm 729, Figure 4.37). The highest value of N_{total} was found at BA11 (rkm 190).

The highest values of BOD_5 in Sava River were measured at HR7 rkm 525 and the highest COD_{Cr} value was measured at RS16 (rkm 17, 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 2014.

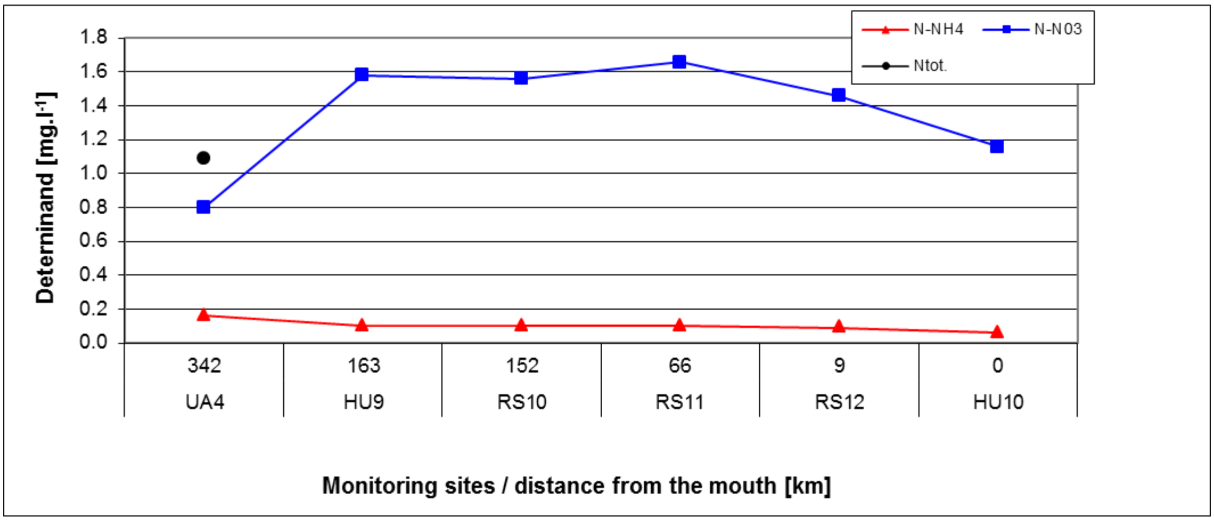
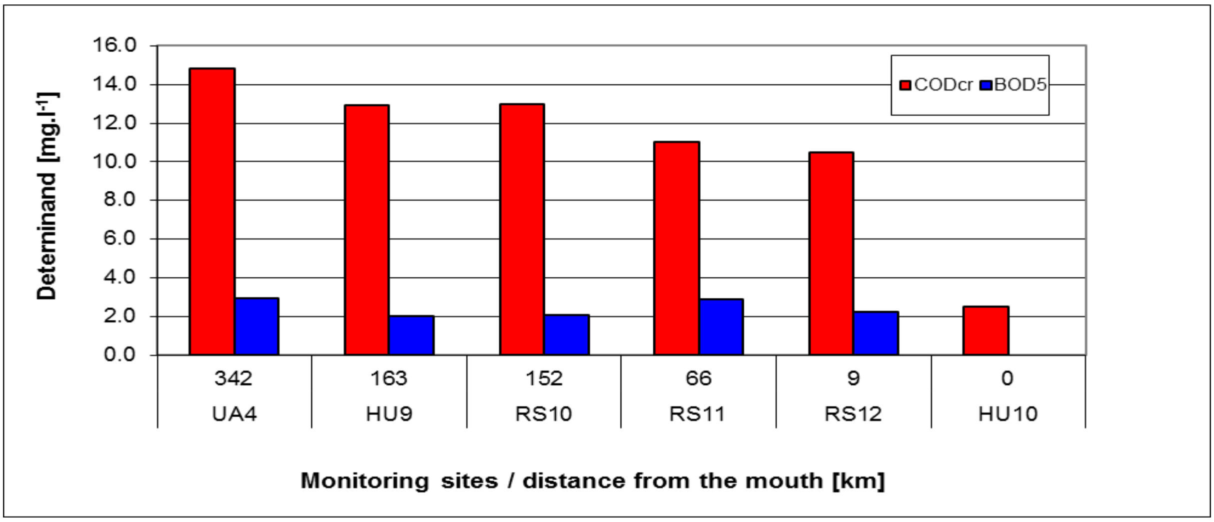


Figure 4.40: The percentile (90) of BOD_5 and COD_{Cr} concentration along the Tisza River in 2014.



The maximal value of N-NH_4 in the Tisza River was measured at UA4 rkm 342 (see Figure 4.39). The highest value of N-NO_3 was measured at RS11 rkm 66. In 2014 N_{total} was measured only at UA4.

The highest value of COD_{Cr} and BOD_5 in the Tisza River was found at UA4 (rkm 342, Figure 4.40).

5. Load Assssment

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.

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 27 monitoring locations from nine countries are included in the list. One location – Danube-Jochenstein have been included by two neighbouring countries, therefore the actual number of locations is 26, with ten locations on the Danube River itself and 16 locations on the tributaries. Rivers Prut and Siret were added in the year 2010.

The second location that could potentially be processed by using combined data from two countries is Sava-Jesenice.

Monitoring Data in 2014

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 most of the locations, the number of samples was higher than 20, lower frequency was for chlorides. A frequency of 10-12 times per year was applied only for Czech and Croatian monitoring stations. In 2010 load calculation for Slovak monitoring sites on tributaries Morava, Hron, Ipeľ was added, for these sites the frequency of monitoring was also 12.

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.

Regarding particular determinands, there is still a lack of data on dissolved phosphorus as it was measured at 13 locations only. At 10 monitoring points the silicate or dissolved 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
Slovak Republic	Váh	SK4	Komárno		Sum of: Maly Dunaj -Trstice Vah- Sala Nitra -Nove Zamky	22,5 58,8 12,3
Slovak Republic	Morava	SK6	Devín		Zahorska Ves	32,5
Slovak Republic	Hron	SK7	Kamenica		Kanenin	10,9
Slovak Republic	Ipeľ	SK8	Salka		Salka	12,2
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	Vukovar	1337
Croatia	Sava	HR06	Jesenice	729	Jesenice	729
Croatia	Sava	HR7	Una Jesenovac	525	Una Jesenovac	525
Croatia	Sava	HR8	Zupanja	254	Zupanja	254

Slovenia	Drava	SI1	Ormoz	300	Borl HE Formin Pesnica-Zamusani	325 311 10.1(to the Drava)
Slovenia	Sava	SI2	Jesenice	729	Catez Sotla -Rakovec	737 8.1 (to the Sava)
Romania	Danube	RO2	Pristol-Novo Selo	834	Gruia	858
Romania	Danube	RO4	Chiciu-Silistra	375	Chiciu	379
Romania	Danube	RO5	Reni	132	Isaccea	101
Romania	Siret	RO10	Sendreni	0	Sendreni	0
Romania	Prut	RO11	Giurgiulesti	0	Giurgiulesti	0
Ukraine	Danube	UA2	Vylkove	18		

Calculation Procedure

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

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

where C_m average monthly concentrations

C_i concentrations in the sampling days of each month

Q_i discharges in the sampling days of each month

The monthly load is calculated by using the formula:

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

where L_m monthly load

Q_m average monthly discharge

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

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

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

Table 6: Number of measurements in TNMN locations selected for assessment of pollution load in 2014

Country	River	Location	Location	River	Number of meausrements in 2014								
Code			in profile	Km	Q	SS	N_{inorg}	$P\text{-}PO_4$	P_{total}	BOD_5	Cl	P_{diss}	SiO_2
DE2	Danube	Jochenstein	M	2204	365	13	25	25	25	13	13	12	
DE3	Inn	Kirchdorf	M	195	365	13	13	13	12	13	12		
DE4	Inn/Salzach	Laufen	L	47	365	15	15	15	15	13	14		
AT1	Danube	Jochenstein	M	2204	365	12	25	25	25	12	12	20	
AT6	Danube	Hainburg	R	1879	365	24	24	24	24	24	24	24	
CZ1	Morava	Lanzhot	M	79	365	12	12	12	12	12	12		12
CZ2	Morava/Dyje	Pohansko	M	17	365	12	12	12	12	12	12		12
SK1	Danube	Bratislava	M	1869	365	25	25	25	25	25	12	25	25
SK4	Váh	Komárno	M	1	365	12	12	12	12	12	12	12	10
SK6	Morava	Devín	M	1	365	12	12	12	12	12	12	12	
SK7	Hron	Kamenica	M	2	365	12	12	12	12	12	12	12	10
SK8	Ipoly	Salka	M	12	365	12	12	12	12	12	12	12	10
HU3	Danube	Szob	L	1708		23	23		23	23	23		
			M	1708	365	23	23		23	23	23		
			R	1708		23	23		23	23	23		
HU5	Danube	Hercegszántó	M	1435	365	24	24	24	18	22	24		24
HU9	Tisza	Tiszasziget	L	163		26	26	26	26	12	13		26
			M	163	365	26	26	26	26	12	13		26
			R	163		26	26	26	26	12	13		26
HR2	Danube	Borovo	R	1337	365	12	12	12	12	12			
HR6	Sava	Jesenice	R	729	365	12	12	12	12	12	12		12
HR7	Sava	us Una Jesenovac	L	525	365	12	12	12	12	12	12		12
HR8	Sava	ds Zupanja	ML	254	365	11	11	11	11	11	11		11
SI1	Drava	Ormoz	L	300	362	26	26	26	26	26	12		
SI2	Sava	Jesenice	R	729	365	26	26	26	26	26	12		
RO2	Danube	Pristol-Novo Selo	L	834		25	25	25	25	25	12	25	25
			M	834	365	25	25	25	25	25	12	25	25
			R	834		25	25	25	25	25	12	25	25
RO4	Danube	Chiciu-Silistra	L	375		26	26	26	26	26	12	18	
			M	375		26	26	26	26	26	12	18	
			R	375		26	26	26	26	26	12	18	
RO5	Danube	Reni	L	132		26	26	26	26	25	12	14	26
			M	132	365	26	26	26	26	26	12	14	26
			R	132		26	26	26	26	26	12	14	26
RO10	M	Siret	M	0	365	26	26	26	26	26	13	24	
RO11	M	Prut	M	0	365	26	26	26	26	26	13	24	
UA2	Danube	Vylkove	M	18	365	12	12	6		12	12		12

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 2014
c_{mean}	arithmetical mean of the concentrations in the year 2014
Annual Load	annual load of given determinand in the year 2014

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. Annual loads for Danube and tributaries are in figures 5.5.1 -5.5.12.

Trends for load during last 10 years in the Reni are in figures 5.5.13.-5.5. 18. In general the loads had a decreasing tendency in years 2011 and 2012. Due to the high discharges in 2005 and 2010 higher loads were observed in those years. In 2014 the loads decreased, only for ortho-phosphate, total phosphorus and silicates loads the opposite situation was observed.

The mean annual discharge in whole Danube River in 2014 was lower than that in 2013. A similar situation was observed in the tributaries with the exception of the Morava, Dyje, Ipeľ, Prut and Tisza River which had discharges higher than in 2013.

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, ortho-phosphate, total phosphorus and chlorides, the highest load is observed in the lower part of the Danube River. The maximum load of suspended solids, BOD_5, total phosphorus, ortho-phosphate, chlorides and silicates was observed at Danube-Reni (RO5).

In the case of tributaries, the highest loads of inorganic nitrogen, BOD_5, total phosphorus, chlorides and silicates come from the Sava River. The highest load of the dissolved phosphorus was observed in the Vah River.

Table 7: Mean annual concentrations in monitoring locations selected for load assessment on Danube River in 2014

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	1237	9.53	1.83	0.03	0.06	1.47	17.30	0.04	
AT6	R	Danube	Hainburg	1879	1784	13.81	1.91	0.02	0.05	2.11	16.47	0.04	
SK1	M	Danube	Bratislava	1869	1788	54.54	1.73	0.05	0.10	1.64	16.71	0.06	5.34
HU3	LMR	Danube	Szob	1708	2036	30.39	1.73		0.08	2.75	25.00		
HU5	M	Danube	Hercegszántó	1435	2198	27.21	1.75	0.05	0.10	2.14	21.25		3.85
HR2	R	Danube	Borovo	1337	3067	19.67	1.56	0.03	0.11	2.19			
RO2	LMR	Danube	Pristol-Novo Selo	834	5756	42.43	1.07	0.04	0.06	1.98	15.79	0.05	2.87*
RO4	LMR	Danube	Chiciu-Silistra	375	6901	25.77	1.50	0.04	0.07	1.37	20.14	0.07	
RO5	LMR	Danube	Reni	132	7446	44.44	1.32	0.02	0.12	1.72	20.88	0.08	3.53*
UA2	M	Danube	Vylkove	18	3627	71.30	1.21	0.06		1.25	32.16		2.92

*Silicates (SiO_2) in dissolved form

Table 8: Mean annual concentrations in monitoring locations selected for load assessment on tributaries in 2014

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	307	33.88	0.61	0.01	0.06	0.71	6.46		
DE4	L	Inn/Salzach	Laufen	47	247	21.47	0.55	0.01	0.04	1.74	8.12		
CZ1	M	Morava	Lanzhot	79	42	25.07	2.27	0.08	0.13	2.90	25.68		3.8*
CZ2	L	Morava/Dyje	Pohansko	17.00	31	14.58	2.35	0.24	0.27	2.02	48.24		5.38*
SK4	M	Váh	Komárno	1	80	60.00	2.19	0.15	0.26	3.99	34.87	0.17	8.53
SK6	M	Morava	Devín	1	187	16.88	1.76	0.10	0.14	2.40	16.17	0.11	
SK7	M	Hron	Kamenica	2	52	22.75	1.81	0.11	0.16	1.86	10.97	0.12	14.42
SK8	M	Ipoly	Salka	12	14	145.00	2.29	0.17	0.21	2.47	22.04	0.19	20.44
HU9	LMR	Tisza	Tiszasziget	163	737	19.50	0.96	0.15		1.45	30.21		7.66
SI1	L	Drava	Ormoz	300	427	16.32	0.99	0.01	0.04	0.86	7.66		
SI2	R	Sava	Jesenice	729	418	7.87	1.27	0.04	0.06	0.90	6.13		
HR6	R	Sava	Jesenice	729	421	11.82	1.30	0.03	0.09	1.28	6.85		3.3*
HR7	L	Sava	us. Una Jasenovac	525	1248	19.36	1.04	0.04	0.10	1.70	14.20		4.46*
HR8	ML	Sava	ds. Zupanja	254	1840	25.08	1.04	0.05	0.10	2.23	5.60		4.81*
RO10	M	Siret	Conf. Danube (Sendreni)	0	69	58.37	1.36	0.05	0.10	2.05	58.82	0.08	
RO11	M	Prut	Conf. Danube (Giurgiulesti)	0	247	165.30	1.67	0.03	0.08	1.92	90.02	0.06	

*Silicates (SiO_2) in dissolved form

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

Station Code	Profile	River Name	Location	River km	Annual Load in 2014							
					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	0.45	67.8	1.1	2.01	55.66	0.63	1.62	
AT6	R	Danube	Hainburg	1879	0.92	102.44	1.29	2.66	118.56	0.92	2.14	
SK1	M	Danube	Bratislava	1869	3.72	95.64	3.42	6.11	87.04	0.90	3.67	0.31
HU3	LMR	Danube	Szob	1708	2.34	109.32		5.32	187.79	1.54		
HU5	M	Danube	Hercegszántó	1435	2.20	116.39	3.43	5.57	141.33	1.41		0.26
HR2	R	Danube	Borovo	1337	2.06	146.80	3.47	12.45	228.12			
RO2	LMR	Danube	Pristol-Novo Selo	834	9.03	195.48	7.25	10.75	361.85	2.84	8.80	0.63*
RO4	LMR	Danube	Chiciu-Silistra	375	6.33	327.04	10.02	16.46	304.92	4.29	11.19	
RO5	LMR	Danube	Reni	132	9.98	301.29	12.78	28.09	379.47	4.76	10.66	0.85*
UA2	M	Danube	Vylkove	18	8.95	75.80	3.20		147.85	3.62		0.35

*Silicates (SiO_2) in dissolved form

Table 10: Annual load in selected monitoring locations on tributaries

Station Code	Profile	River Name	Location	River km	Annual Load in 2014							
					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	0.37	5.27	0.11	0.60	6.64	0.05		
DE4	L	Inn/Salzach	Laufen	47	0.16	4.05	0.06	0.32	12.66	0.06		
CZ1	M	Morava	Lanzhot	79	0.03	2.84	0.09	0.17	3.52	0.03		0.005*
CZ2	L	Morava/Dyje	Pohansko	17	0.01	1.86	0.22	0.25	1.82	0.04		0.005*
SK4	M	Váh	Komárno	1	0.10	10.14	0.60	0.83	13.78	0.09	0.65	0.03
SK6	M	Morava	Devín	1	0.15	6.19	0.37	0.62	9.12	0.09	0.42	
SK7	M	Hron	Kamenica	2	0.04	2.97	0.19	0.28	3.04	0.02	0.21	0.02
SK8	M	Ipoly	Salka	12	0.10	1.00	0.08	0.16	1.17	0.02	0.09	0.01
HU9	LMR	Tisza	Tiszasziget	163	0.38	15.96	2.50		24.13	0.48		0.12
SI1	L	Drava	Ormoz	300	0.28	12.97	0.10	0.57	11.26	0.09		
SI2	R	Sava	Jesenice	729	0.12	17.12	0.48	0.76	10.12	0.08		
HR6	R	Sava	Jesenice	729	0.27	17.63	0.39	0.85	15.60	0.09		0.05*
HR7	L	Sava	us. Una Jasenovac	525	1.08	38.61	1.71	3.89	94.50	0.20		0.18*
HR8	ML	Sava	ds. Zupanja	254	0.97	52.17	2.11	5.14	88.12	0.67		0.24*
RO10	M	Siret	Conf. Danube (Sendreni)	0	1.62	13.30	0.31	0.72	15.56	0.54	0.54	
RO11	M	Prut	Conf. Danube (Giurgiulesti)	0	0.19	2.85	0.11	0.24	5.21	0.18	0.18	

*Silicates (SiO_2) in dissolved form

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 2014												
					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	366	26	26	26	26	12	12	12	12	12	12	12	12
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	7446	0.08	0.02	1.22	1.72	8.27	4.22	1.41	0.50	0.09	0.08	0.012	0.008
Country Code	**River**	**Location**	**Location in profile**	**River km**	Annual Load in 2014												
						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		17.78	5.07	278.70	393.56	1978.85	1030.72	332.62	121.54	21.14	17.61	2.90	1.76

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

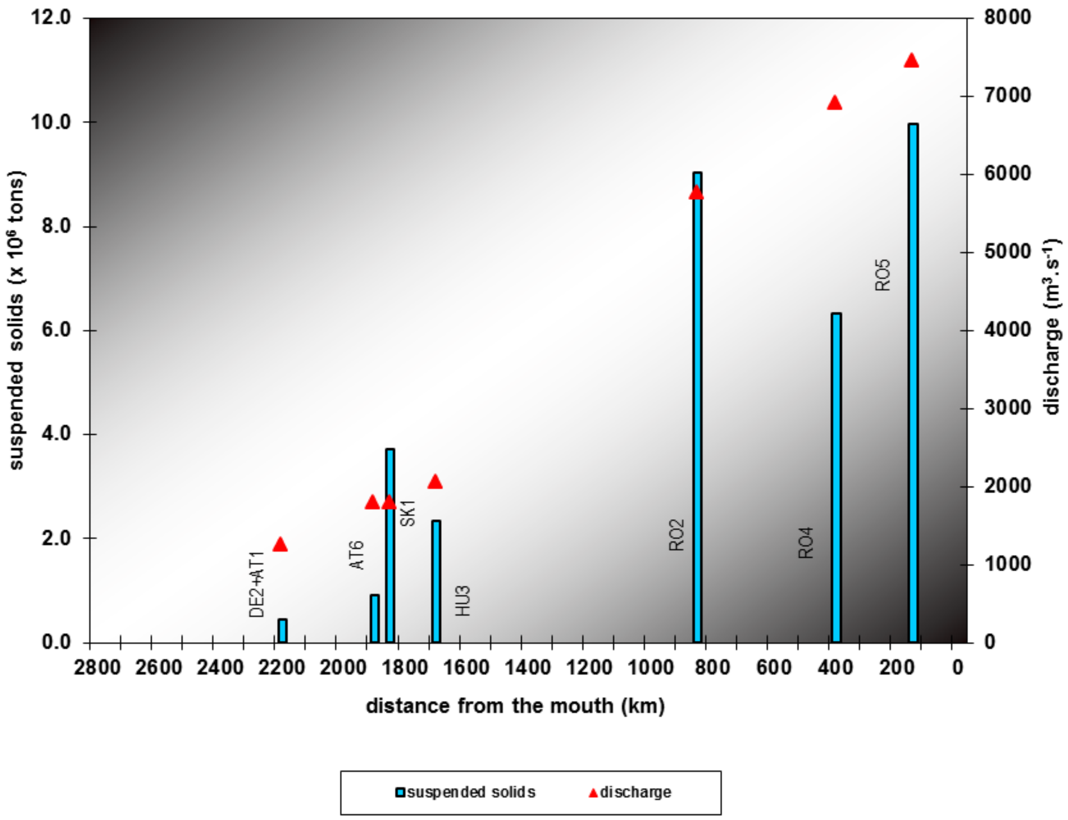


Figure 5.5.2: Annual load of suspended solids at monitoring locations on tributaries.

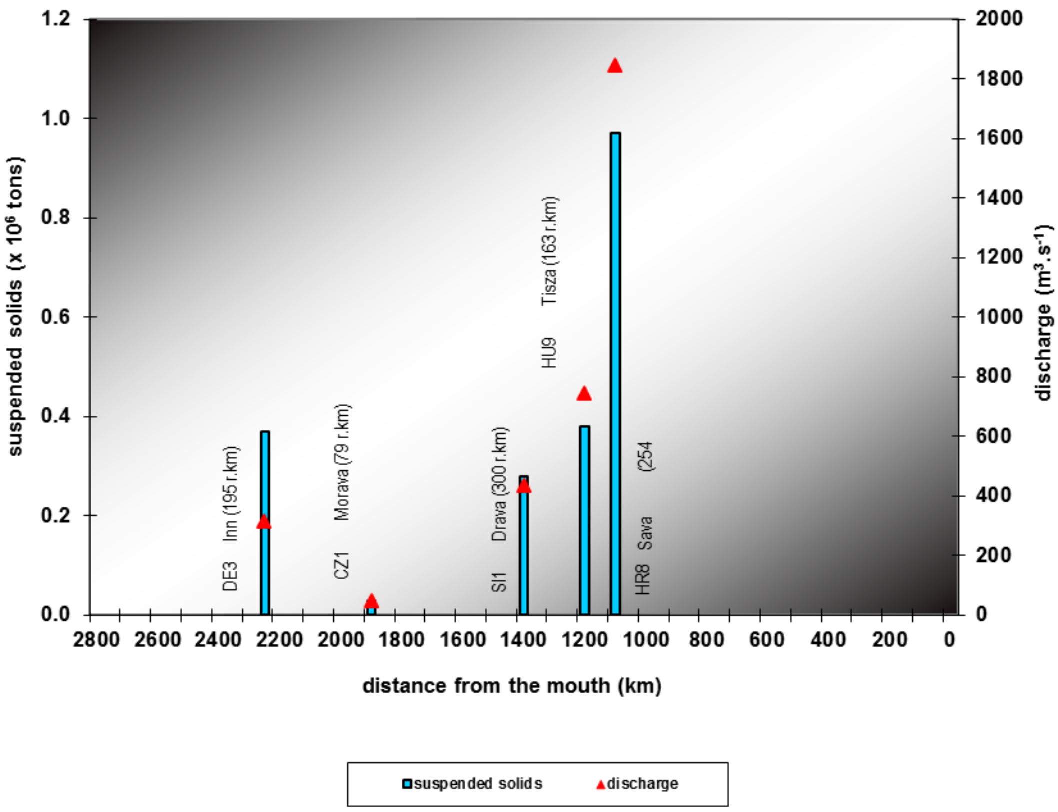


Figure 5.5.3: Annual loads of inorganic nitrogen at monitoring locations along the Danube River.

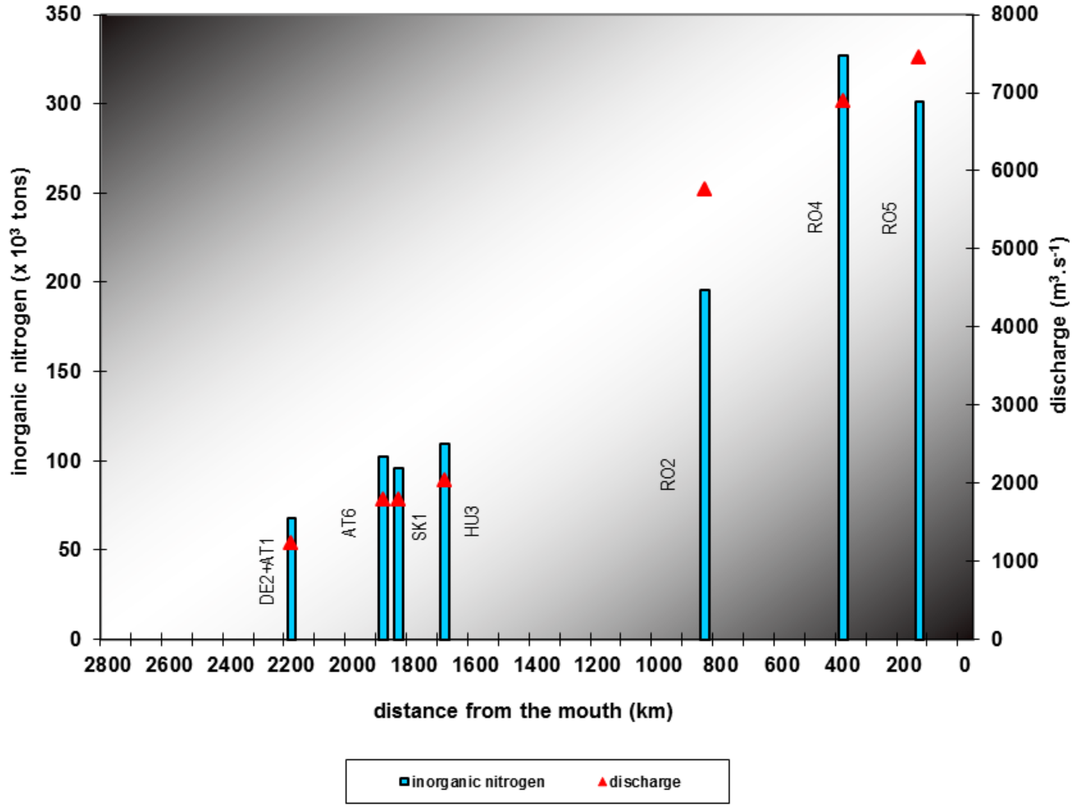


Figure 5.5.4: Annual loads of inorganic nitrogen at monitoring locations on tributaries.

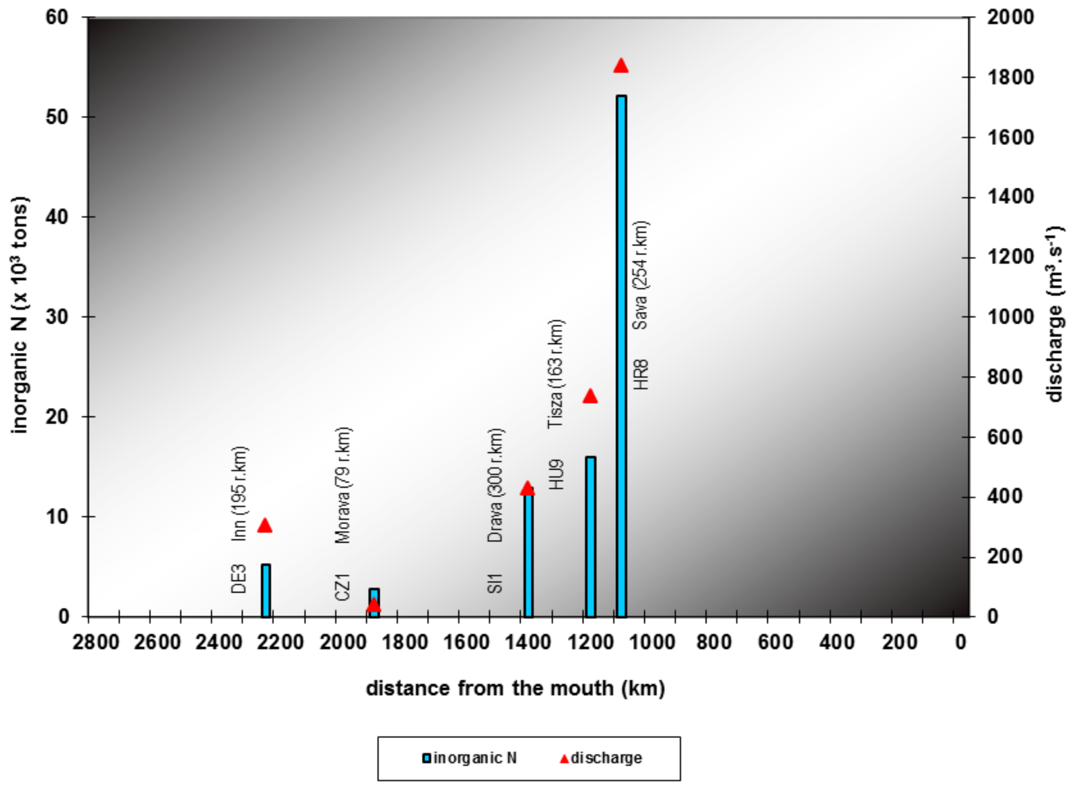


Figure 5.5.5: Annual loads of P-PO4 at monitoring locations along the Danube River.

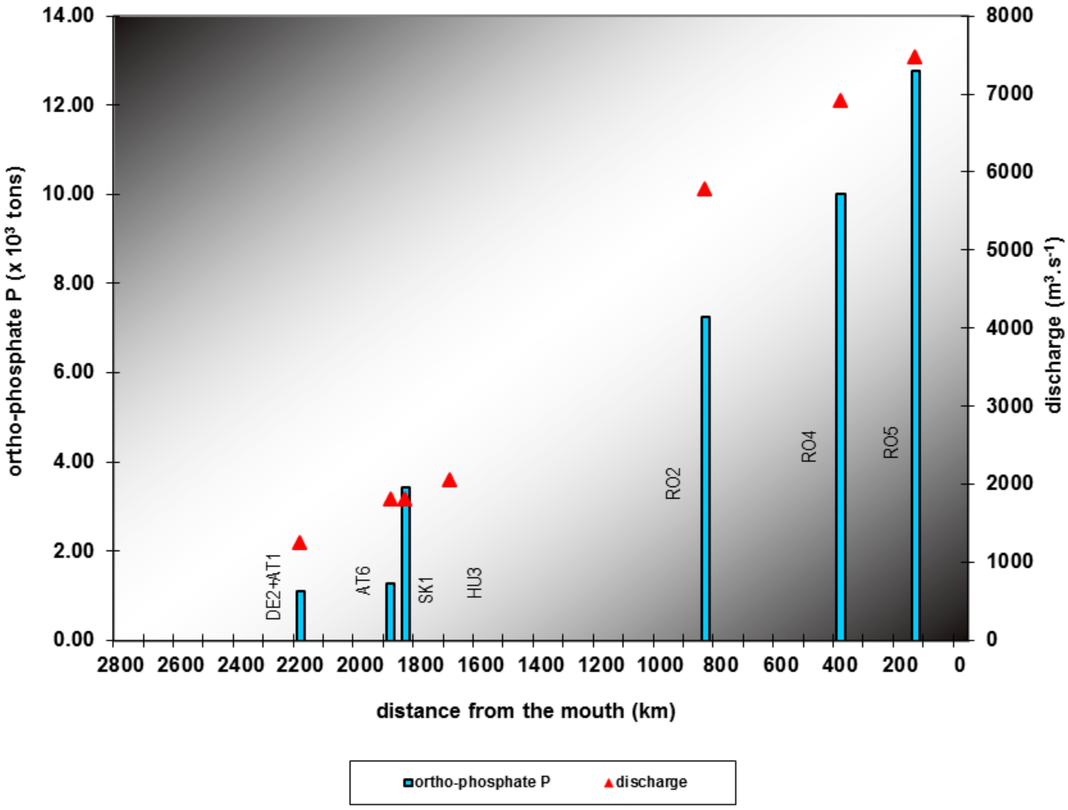


Figure 5.5.6: Annual loads of P-PO4 at monitoring locations on tributaries.

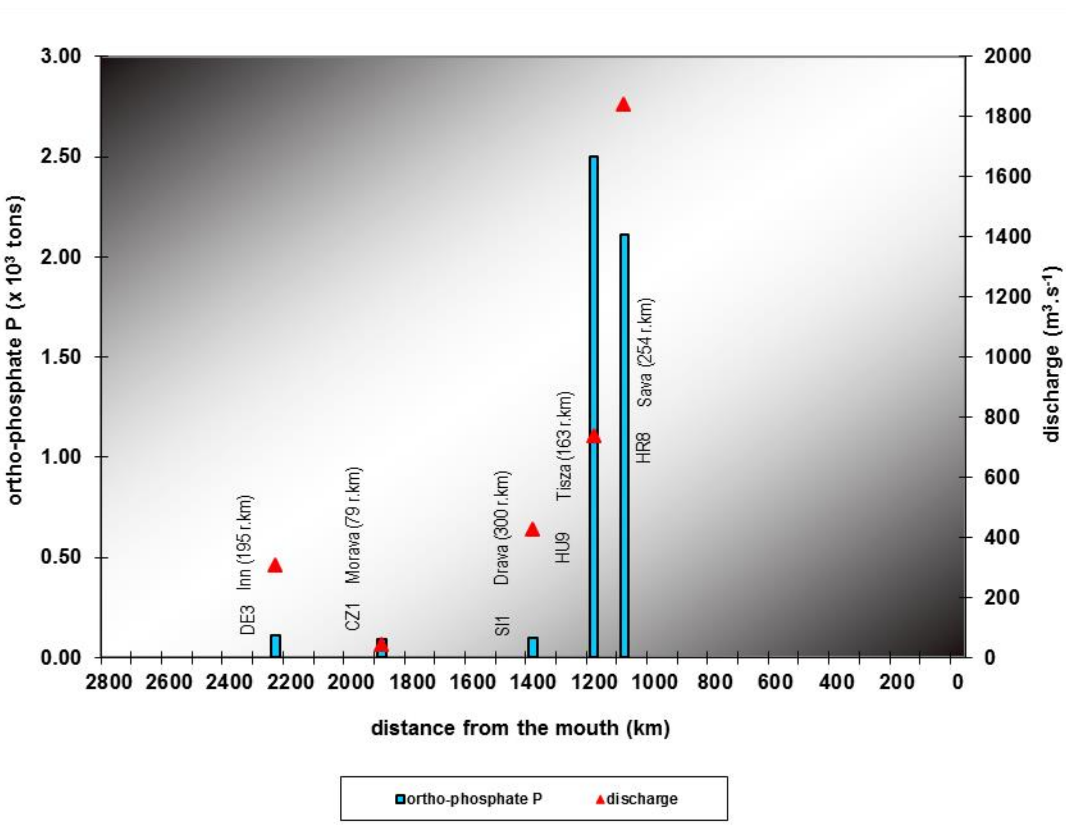


Figure 5.5.7: Annual loads of total phosphorus at monitoring locations along the Danube River.

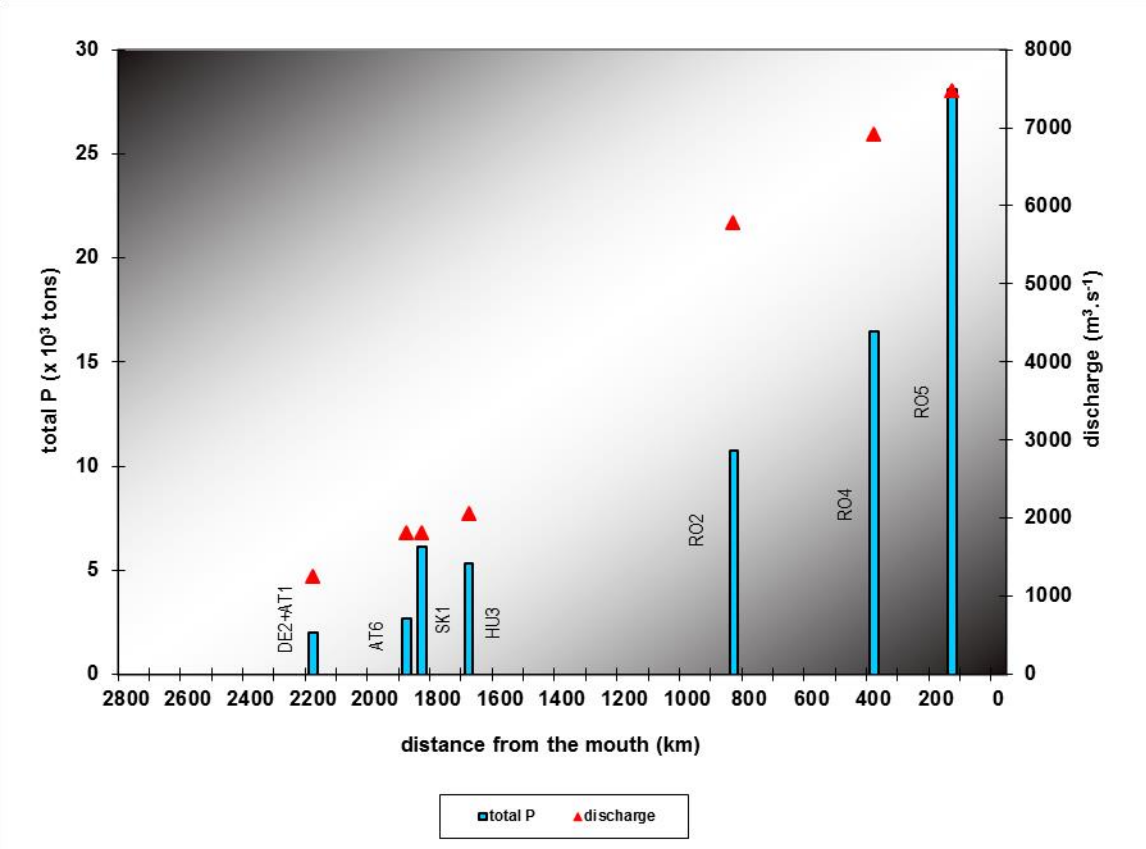


Figure 5.5.8: Annual loads of total phosphorus at monitoring locations on tributaries.

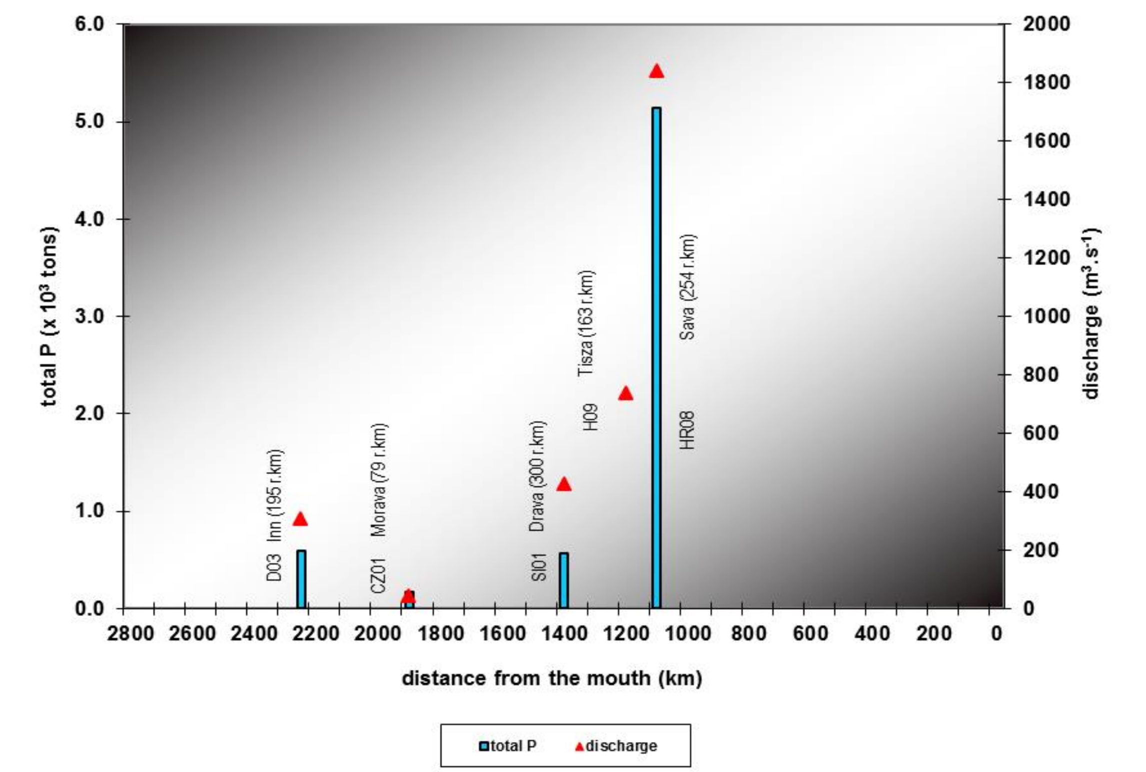


Figure 5.5.9: Annual loads of BOD5 at monitoring locations along the Danube River.

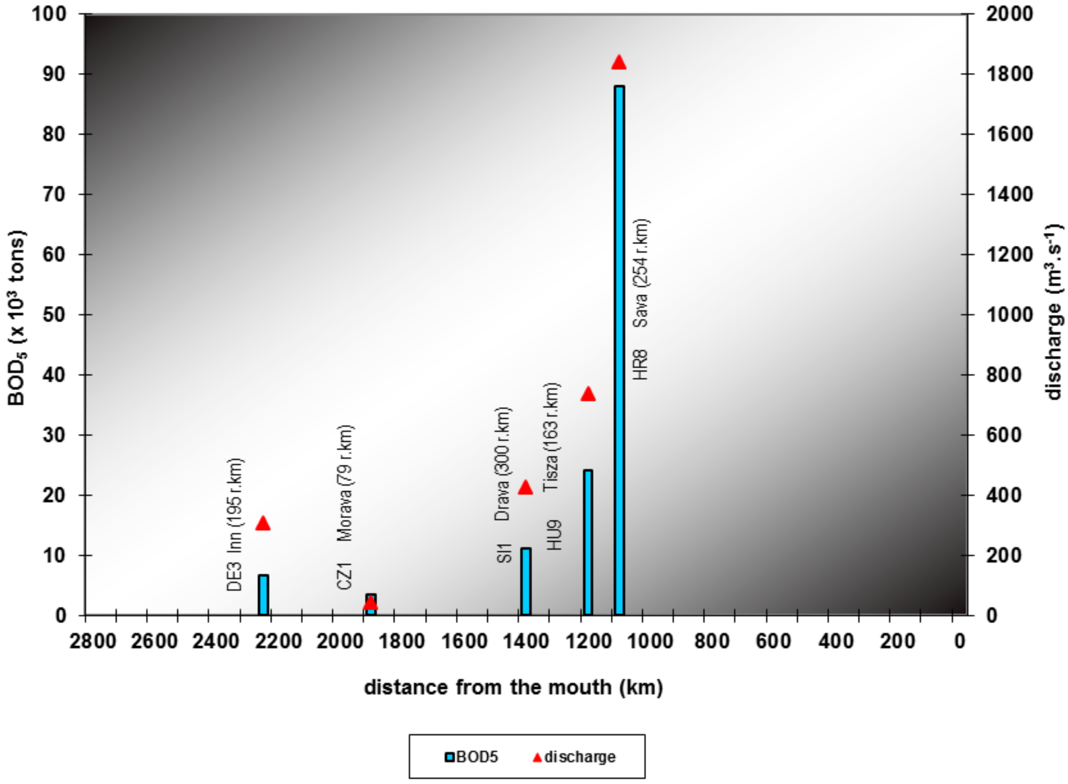


Figure 5.5.10: Annual loads of BOD5 at monitoring locations on tributaries.

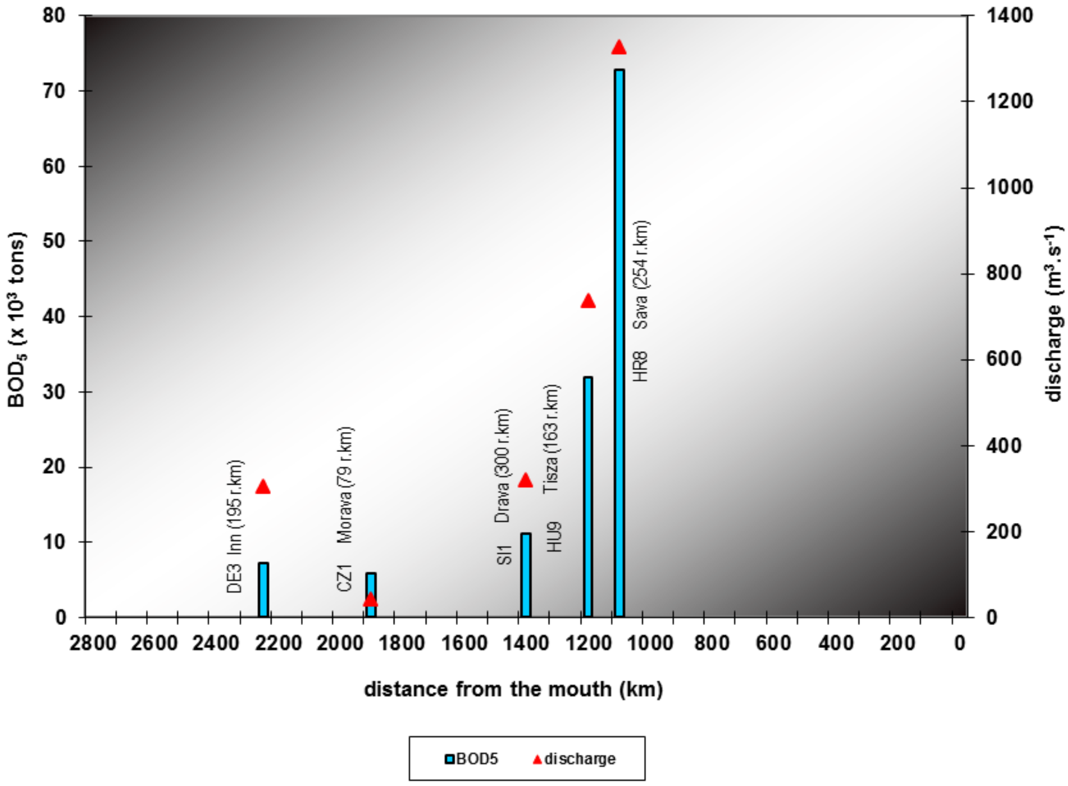


Figure 5.5.11: Annual loads of chlorides at monitoring locations along the Danube River.

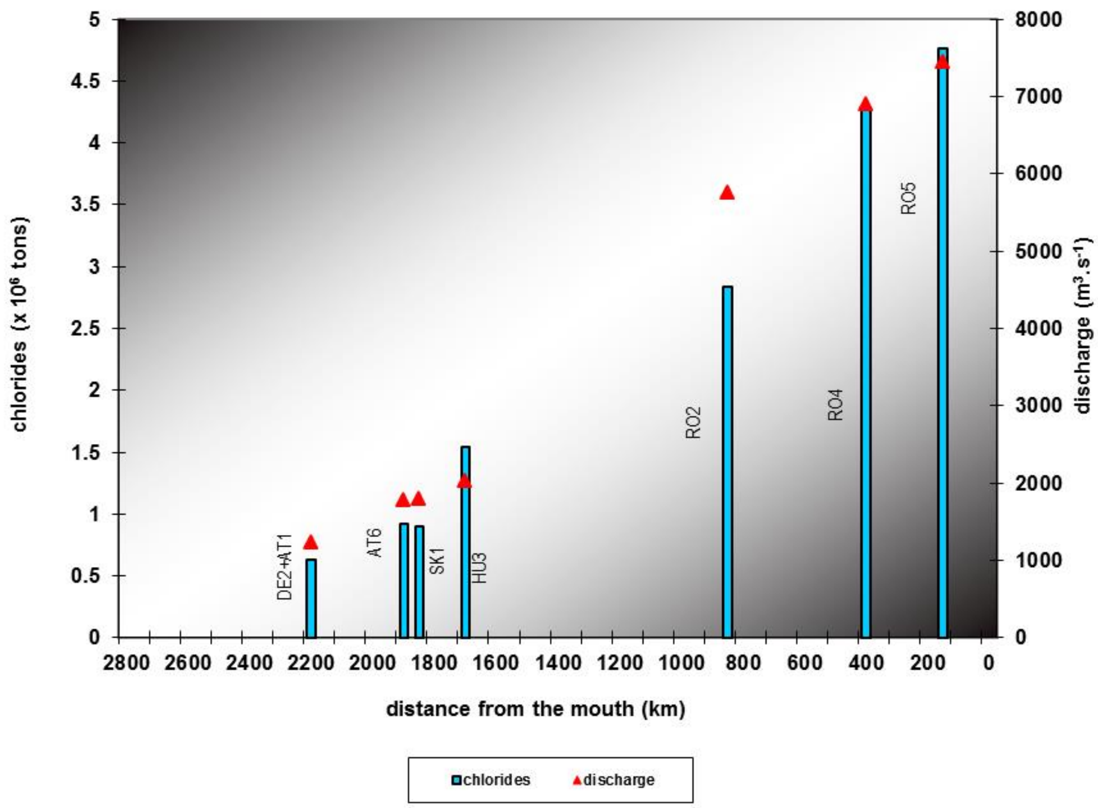


Figure 5.5.12: Annual loads of chlorides at monitoring locations on tributaries.

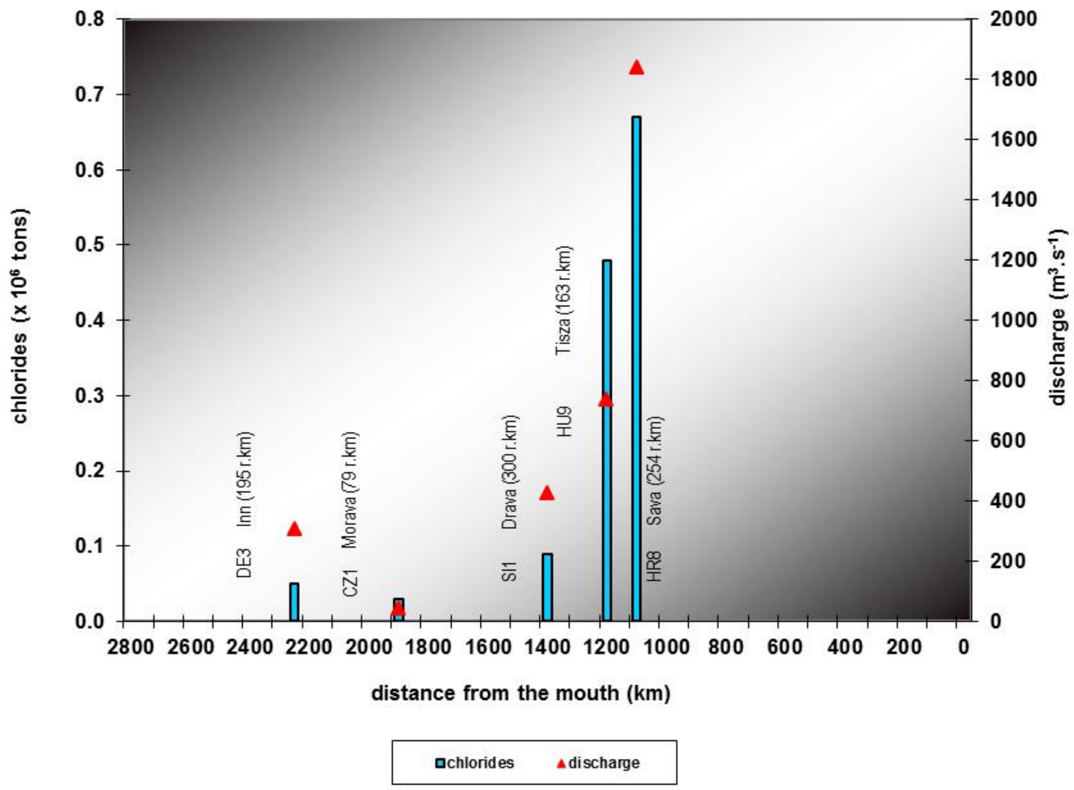


Figure 5.5.13: Trends of annual loads of suspended solids at Reni.

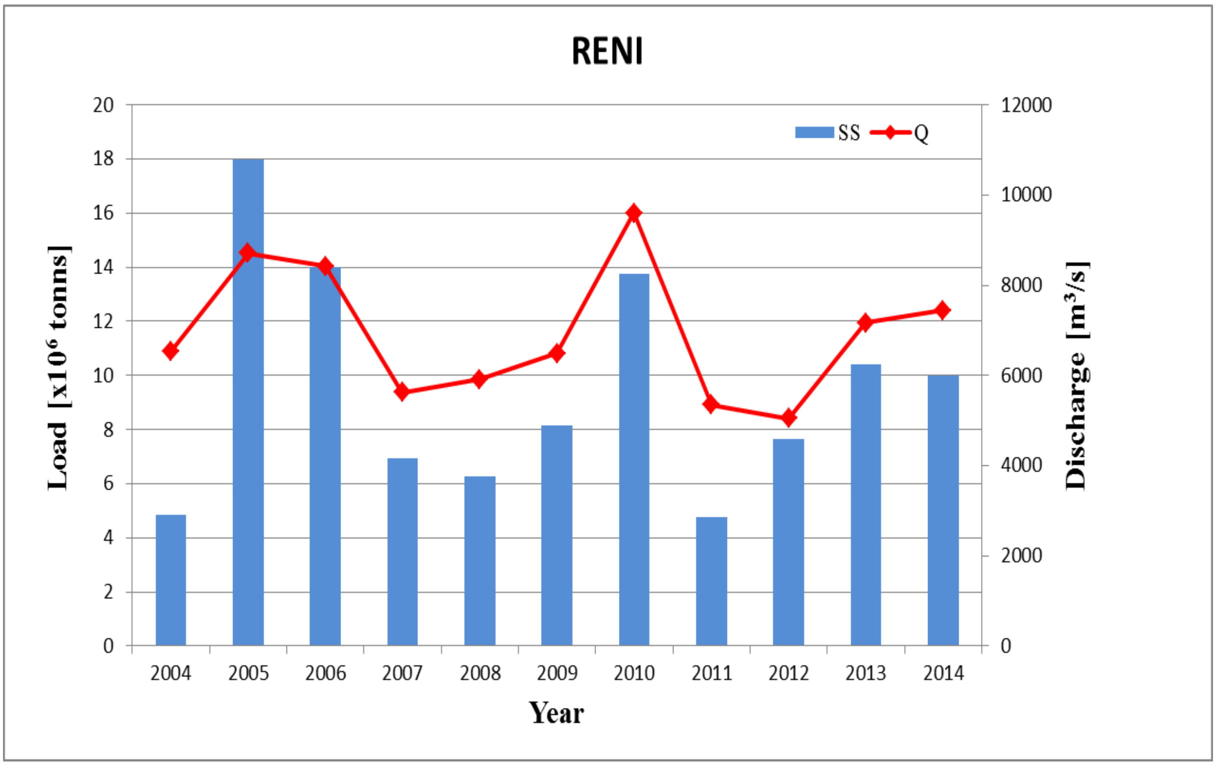


Figure 5.5.14: Trends of annual loads of inorganic nitrogen at Reni.

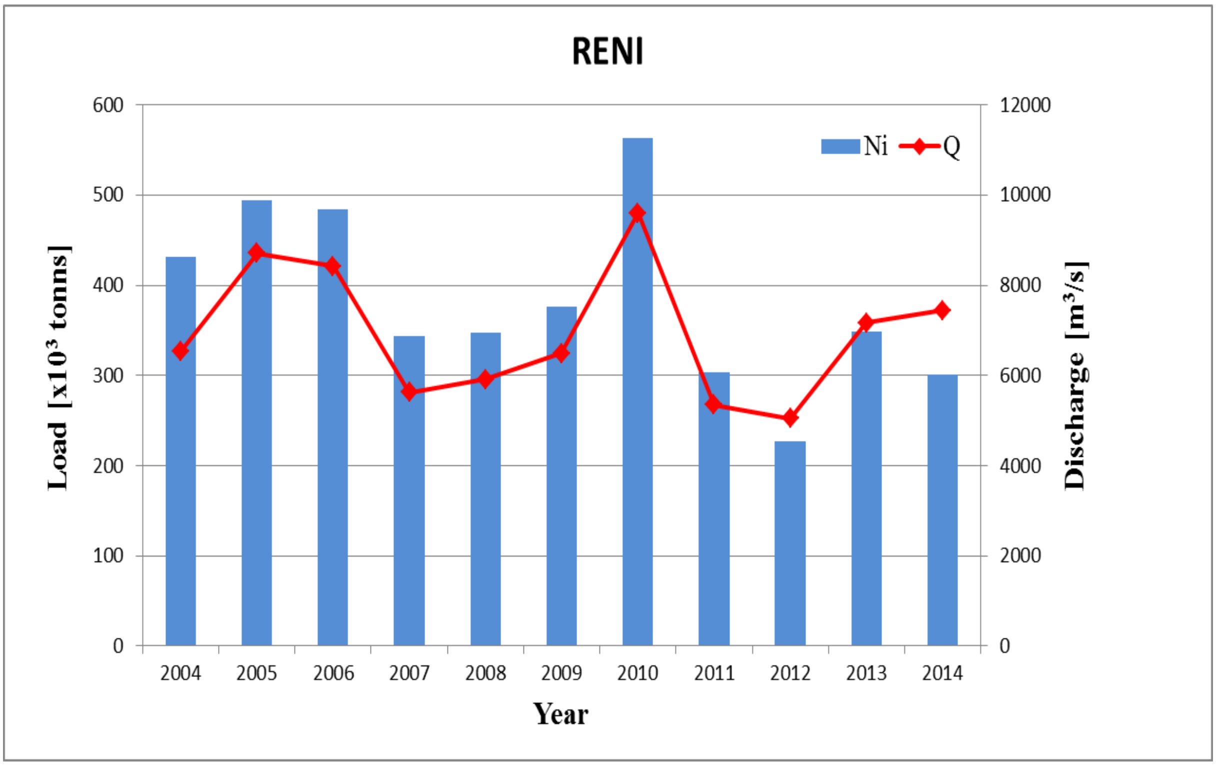


Figure 5.5.15: Trends of annual loads of P-PO4 and total phosphorus at Reni.

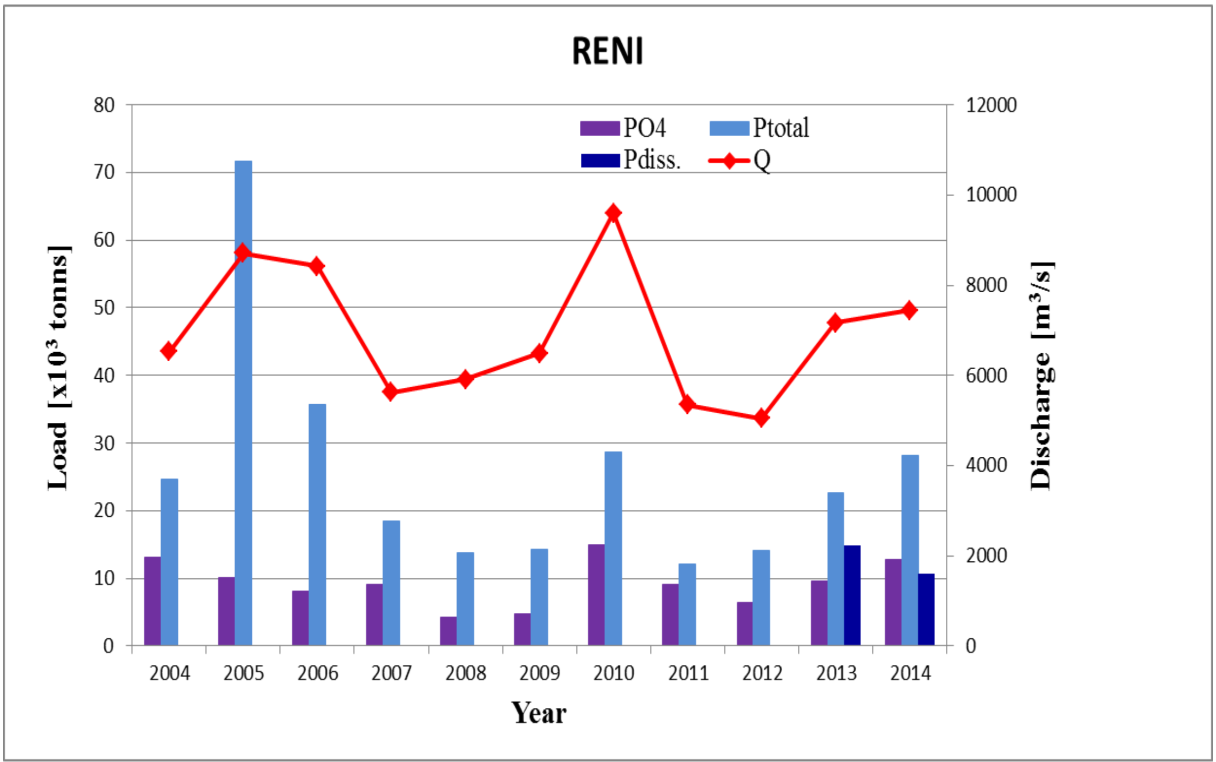


Figure 5.5.16: Trends of annual loads of BOD5 at Reni.

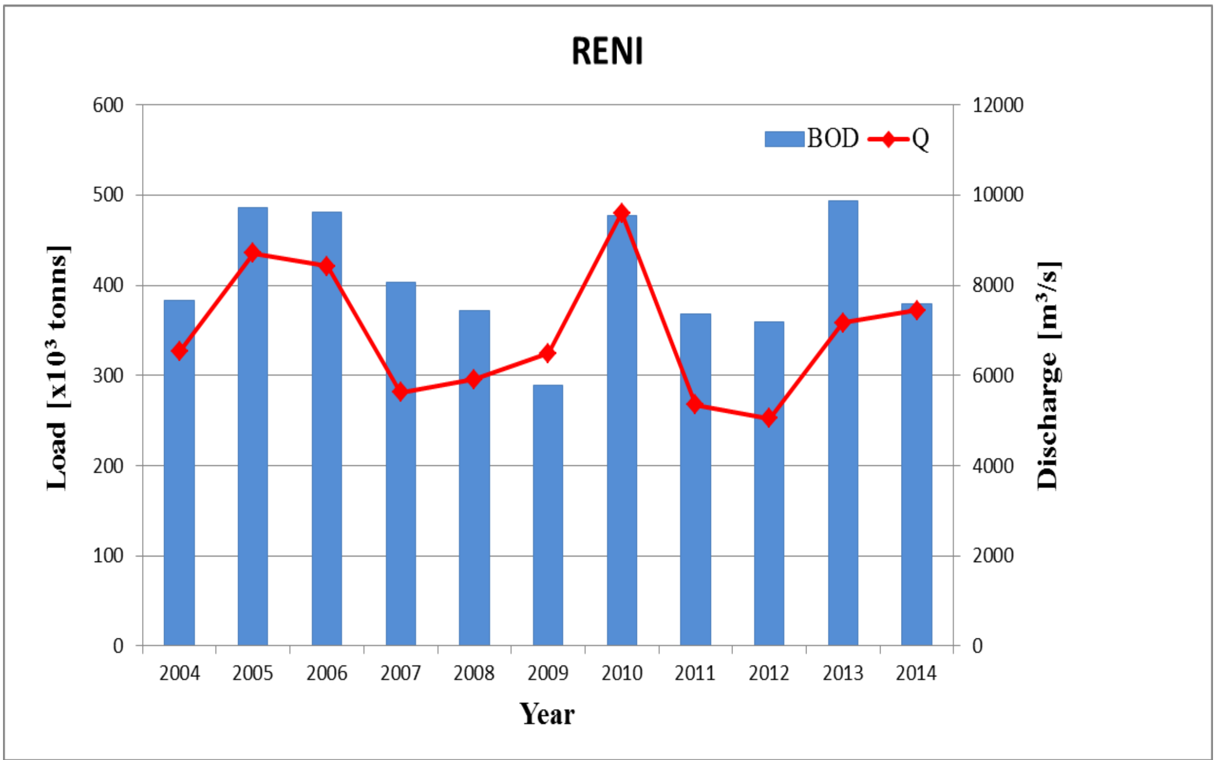


Figure 5.5.17: Trends of annual loads of chlorides at Reni.

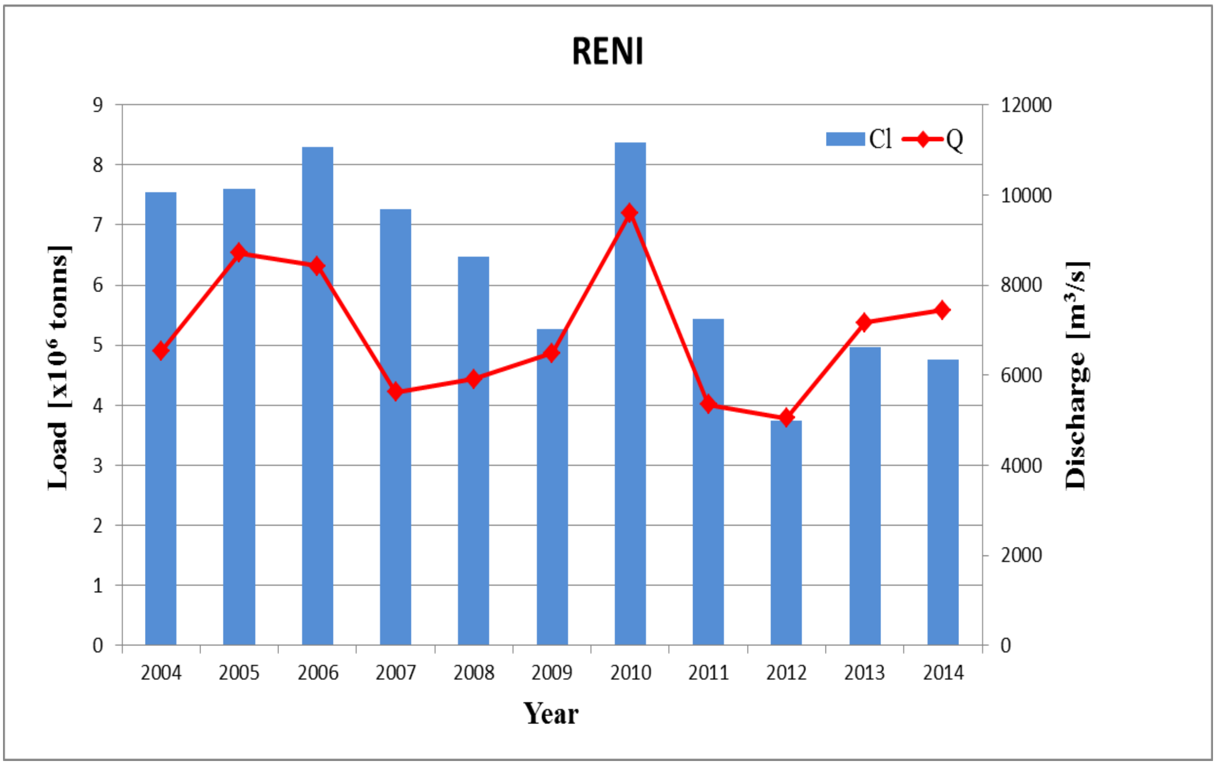
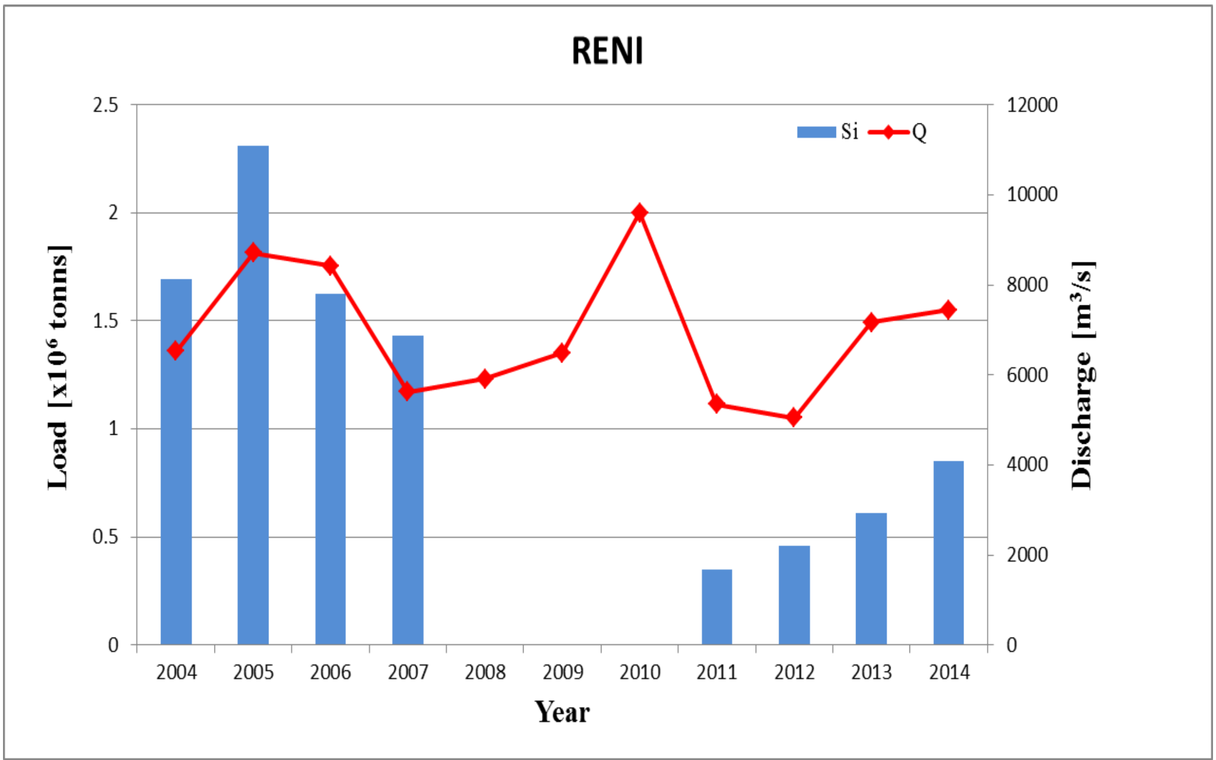


Figure 5.5.18: Trends of annual loads of silicates at Reni.



6. Groundwater monitoring

GW bodies of basin-wide importance

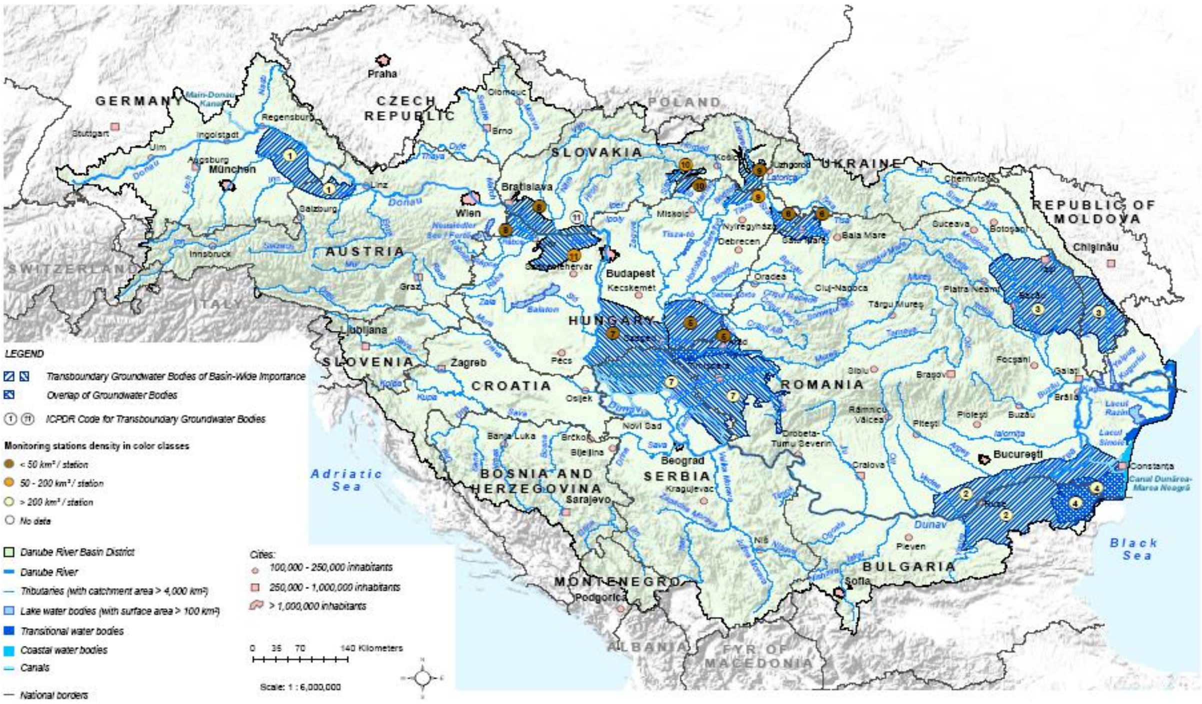
According to the Article 2 of the EU Water Framework Directive (2000/60/EC) 'Groundwater' means all water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil. The analysis and review of the groundwater bodies in the Danube River Basin as required under Article 5 and Annex II of the WFD was performed in 2004 and it identified 11 GW-bodies or groups of GW-bodies of basin-wide importance, which are shown in Map (Figure 6.1.1).

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

- important due to the size of the groundwater body which means an area larger than 4000 km² or
- important due to various criteria e.g. socio-economic importance, uses, impacts, pressures interaction with aquatic eco-system. The criteria need to be agreed bilaterally.

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

Figure 6.1: Transboundary GW-bodies of basin-wide importance and their transnational monitoring network



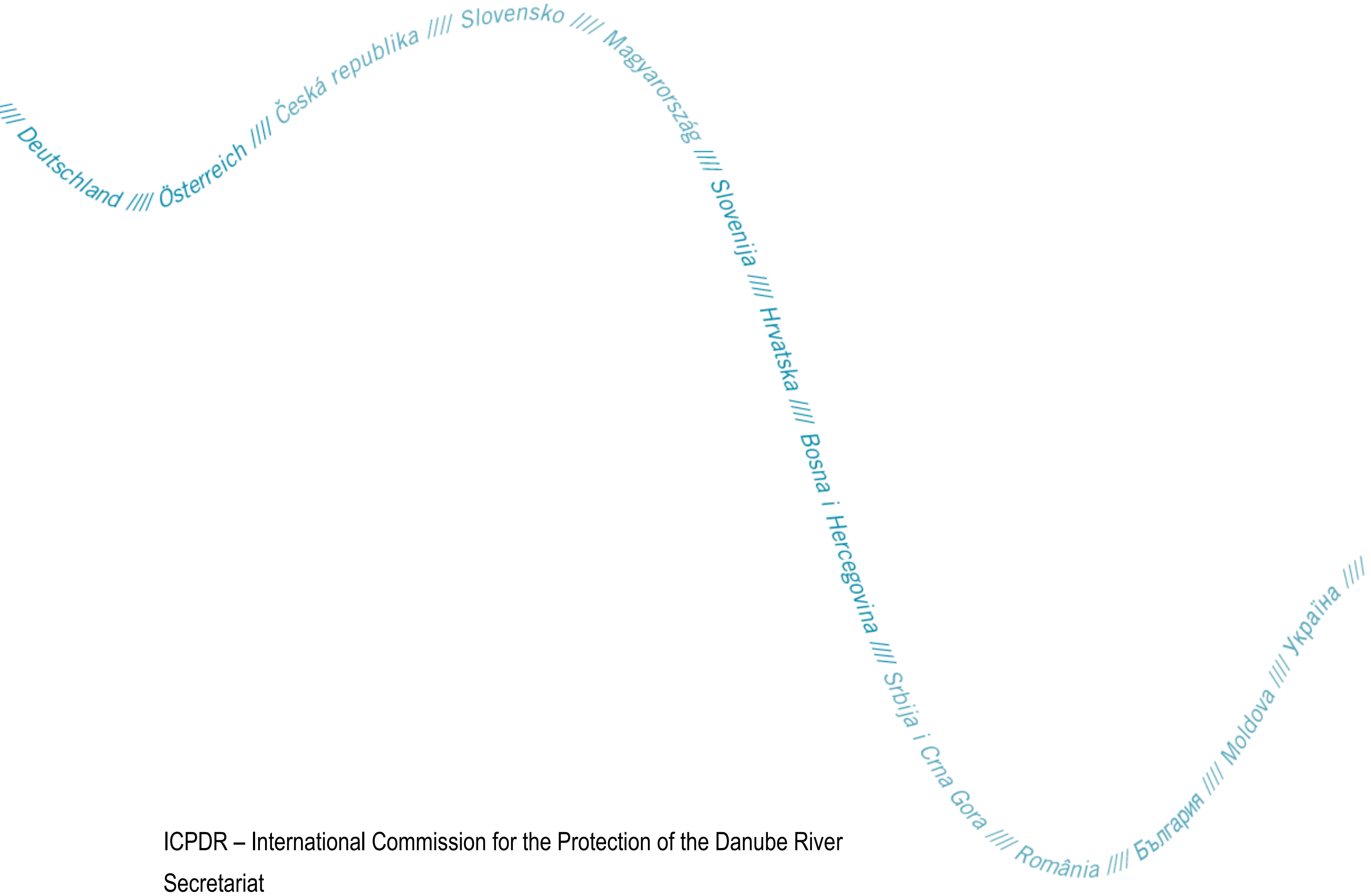
Reporting on groundwater quality

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

Groundwater monitoring under TNMN is based on a six-year reporting cycle in line with the WFD reporting requirements. Information on status of the groundwater bodies of basin-wide importance is provided in the DRBM Plans published every six years. This sufficiently allows for making any relevant statement on significant changes of groundwater status for the GW-bodies of basin-wide importance.

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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