COMPLEX MONITORING OF WATER QUALITY IN A BORDER PROFILE OF THE MORAVA RIVER ON THE TERRITORY OF THE CZECH REPUBLIC (CR)

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Abstract: This paper quotes the results of monitoring of surface water quality, suspended solids, sediments and biota, performed by the CHMI during 1999-2003 in the Lanžhot profile on the stream of the Morava River. Besides the overview of occurrence of monitored chemical matters in the individual matrices, a comparison of the measure of contamination is made with limits valid in the CR and with the goal intentions of the ICPDR. For information on quantitative parameters of pollution transported to neighbouring states, we quote the balance of yearly pollutant transport in water and in suspended solids.
Key words: quality monitoring, suspended solids, sediments, biota, pollutants, cluster analysis, suspended solids transport, pollutant transport.

1. Introduction

The Lanžhot border profile of the Morava River has been a part of the state network of water quality monitoring already since 1963. On the basis of new knowledge and information about the occurrence and influence of the polluting matters on water ecosystems and also in accordance with EU requirements in the area of water protection, the monitoring of surface water quality was extended here from 1999 by the monitoring of new matrices, namely suspended solids, sediments and biota. The profile belongs to 45 profiles of state-wide network of Complex water quality monitoring in KJV streams with the extended monitoring of chemical state from the point of view of the presence of dangerous and priority dangerous matters in the sense of the Directive of the Council 76/464/EEC and Directive 2000/60/EC.

The aim of this contribution is to point at the difference of distribution, accumulation and transport of the monitored matters in the individual matrices of the aquatic system, and thereby to document the significance of the monitoring of pollutant contents in the quoted matrices for the acquisition of complex information about the pollution of water environment.

2. Method

The methods of collection and chemical analyses are based on the EU directives, international ISO norms, Czech State Norms (CSN) and on the recommendation of WMO, and are methods accepted for the monitoring by the CHMI (Rieder et al.,1999). The qualitative parameters of water, suspended solids and sediments, i.e. the contents of heavy metals, metalloids and organic matters, including priority matters quoted in the list X of the EU Framework Directive, are being monitored 12 to 16 times a year (metals in suspended solids, metals and organic matters in water), 4 to 6 times a year (organic matters in suspended solids), 2 times a year (metals and organic matters in sediments). Accumulation of pollutants in water organisms 1 to 2 times a year during the vegetation period.

3. Selection of the evaluated matters

Selection of matters for evaluation was made according to the following criteria:

- priority dangerous matter according to appendix X of the EU directive (WFD)
- relevant matter for the territory of the CR according to the procedure COMMPS (Hypr, Halířová, Beránková, 2003).
- relevance of matter for solid matrix according to Log_{Kow}, $K_{susp.sed\text{-}water}$ and according to values under the determinability limit (DL)
- matters monitored in the biota matrix

The overview of matters relevant for the comparison of their contents in the water, suspended solids, sediment and biota matrices are quoted in Table1 (Hypr, Halířová, Beránková, 2003).

The selection of matters for the detailed evaluation of risk was further narrowed according to the signal value of the exceedance of qualitative limit of the Ministry of Environment (ME). Those matters were chosen whose 90 percentile concentration or maximum value of concentration during the years 1999-2003 exceeded on one of the monitored profiles on the Morava River at least the qualitative limit B (increased to risk concentration).

Table 1. Selection of matters relevant for common complex evaluation of matrices on the Lanžhot profile (1999-2002)

substance	RANK.cz suspended solids (SUSP)	RANK.cz sediments (SED)	SUSP %<MS	SED %<MS	Ksusp.sed-w	Ksusp.sed-w(med)	relevance according Kws and logKow	priority dangerous substances (WFD)	RANK.cz surface water	Water %<MS
As	6	7	0,0	0,0	4 486	13 800	solid + B		6	23,4
Cd	1	1	0,0	0,0	114 000	33 000	solid + B	yes	3	46,4
Cu	4	4	0,0	0,0	207 000	24 000	solid		4	6,1
Ni	2	3	0,0	0,0	11 400	25 600	solid		2	4,5
Pb	3	2	0,0	0,0	157	46 800	solid + B	yes	5	45,0
Hg	5	5	0,0	0,0	73 605	15 000	solid + B	yes	7	80,6
Zn	9	9	0,0	0,0	11 400	35 150	solid		9	15,5
hexachlorbenzen	17	20	38,2	63,0	3 147	465	water + B	yes	28	78,6
p,p' - DDT	13	14	27,3	48,1	16 248	4 211	water		17	86,2
antracen	19	19	20,8	36,9	269		water	yes	29	47,0
benzo(a)antracen	4	4	0,0	9,9	5 508	221 000	solid		4	21,2
benzo(a)pyren	2	1	0,0	8,7	12 283	184 000	solid	yes	6	17,3
benzo(b)fluoranthen	3	3	0,0	0,0	14 366	213 500	solid	yes	5	9,9
benzo(g,h,i)perylen	1	2	0,0	13,0	33 628	148 500	solid	yes	3	16,5
benzo(k)fluoranthen	-	5	1,0	15,9	54 614	176 700	solid	yes	10	29,7
dibenzo(a,h)antracen	6	7	41,7	84,6	46 175	226 000	solid			81,8
fluoranthen	16	12	0,0	1,9	1 465	123 000	solid		21	6,2
fluoren	15	15	34,8	34,1	382	43 400	solid			23,6
chrysen	9	9	1,1	13,2	7 988	296 700	solid			16,8
indeno(1,2,3-c,d)pyren	7	6	0,5	15,4	42 063	161 212	solid	yes	8	52,6
naftalen	36	30	46,3	21,9	76		water	yes	40	83,1
pyren	8	8	1,1	5,0	451	169 000	solid		11	75,0
aldrin	24	18	33,9	28,6	28 900		solid		2	58,5
endrin	12	13	15,0	30,3	162	1 045	water		9	41,4
PCB 28+31	20	21	29,3	63	5 612		biota		26	57,5
PCB 52	22	25	52,2	64,4	13 484		biota		48	84,8
PCB 101	35	35	36,8	58,7	50 689		biota		51	75,9
PCB 138	25	24	31,2	45,2	233 942		biota		44	74,0
PCB 153	27	27	36,1	47,1	198 132		biota		46	77,6
PCB 180	31	28	33,2	48,1	786 339		biota		45	71,7

4. Evaluation of selected dangerous matters in individual matrices

4.1. Mutual evaluation of the occurrence of selected heavy metals, metalloids and specific organic matters in the monitored matrices

Metals

Mercury

In water, mercury was occurring in 60 % under the DL, the values were between 0.1 and 0.4 ugl^{-1}. According to the classification of water quality classes, the concentrations corresponded to III. class (polluted water). In solid matrices on the other hand, all measured values were above the DL, while generally higher values were measured in suspended solids, where they fluctuated between 0.08 and 3.5 $mgkg^{-1}$, in sediments they fluctuate between 0.2 and 0.4 $mgkg^{-1}$ with a hint of slight decrease. In organisms the values were between 0.08 and 0.9 $mgkg^{-1}$ of dry matter, the mercury mostly accumulated in fish (dace), where the values exceede the hygienic limit. In growths (a community of microorganisms and solid particles in lift) the values were between 0.9 and 0.22 $mgkg^{-1}$ of dry matter.

Arsenic

In water it occurred in 66 % under the DL, the values were between 0.7 and 2.2 ugl^{1}. According to the classification of classes of water quality, the concentrations corresponded to II. class (slightly polluted water). In the solid matrices on the other hand, all the measured values were above the DL, while generally higher values were measured in the suspended solids, where they fluctuated from 5.2 to 108.3 $mgkg^{-1}$, in sediments from 6.8 to 38.8 $mgkg^{-1}$. In organisms the values were from 0.5 to 8.9 $mgkg^{-1}$ of dry matter, in growths 2.4 to 8.5 $mgkg^{-1}$ of dry matter.

Cadmium

Values in water were in 56 % under the DL. The measured values were fluctuating from 0.01 to 0.8 ugl^{-1}. According to the classification of classes of water quality, the concentrations corresponded to II. class (slightly polluted water). In solid matrices, all measured values were above the DL, while generally higher values were measured in suspended solids, where they fluctuated from 0.2 to 18.0 $mgkg^{-1}$, in sediments from 0.4 to 2.4 $mgkg^{-1}$ with a hint of slight decrease. In organisms the values fluctuated from 0.05 to 0.99 $mgkg^{-1}$ of dry matter, while the highest values were found in the lamellibranches Dreissena polymorpha. In growths the values fluctuated from 0.46 to 1.2 $mgkg^{-1}$ of dry matter.

Lead

The values in water were in 36 % under the DL. The measured values fluctuated from 0.04 to 7.0 ugl^{-1}. According to the classification of classes of water quality, the concentrations corresponded to II. class (slightly polluted water). In solid matrices, all measured values were above the DL, while generally higher values were measured in the suspended solids, where they fluctuated from 17 to 245 $mgkg^{-1}$, most often though (50 % of the values) from 30 to 55 $mgkg^{-1}$. In sediments it occurs in a relatively narrow range of 21 to 54 $mgkg^{-1}$. In organisms the values fluctuated from 0.3 to 4.2 $mgkg^{-1}$ of dry matter, the maximum contents were found in larvae of the genus Hydropsyche. High values were found in growths: 19 to 28 $mgkg^{-1}$ of dry matter.

Chromium

Values in water were in 85 % under the DL. The measured values were fluctuating from 0.1 to 2.1 ugl^{-1}. According to the classification of classes of water quality, the concentrations were corresponding to I. class (unpolluted water). In solid matrices, all measured values were above the DL, while generally higher values were measured in suspended solids, where they fluctuated from 15.7 to 548.0 $mgkg^{-1}$, in sediments from 61.0 to 166.0 $mgkg^{-1}$. It is not monitored in organisms.

Copper

Values in water were in 4 % under the DL. The measured values were fluctuating from 1.0 to 8.5 ugl^{-1}. According to the classification of classes of water quality, the concentrations were corresponding to I. class. In solid matrices, all measured values were above the DL, while generally higher values were measured in suspended solids, where they fluctuated from 13 to 317 $mgkg^{-1}$, in sediments from 25 to 77 $mgkg^{-1}$ with a lowering tendency. It is not monitored in organisms.

Nickel

Values in water were in 8 % under the DL. The measured values were fluctuating from 1 to 11 ugl^{-1}. According to the classification of classes of water quality, the concentrations were corresponding to I. class. In solid matrices, all measured values were above the DL, while generally higher values were measured in suspended solids, where they fluctuated in the range from 11 to 332 $mgkg^{-1}$, in sediments from 50 to 88 $mg.kg^{-1}$. It is not monitored in organisms.

Zinc

Values in water were in 32 % under the DL. The measured values were fluctuating from 51 to 32 ugl^{-1}. According to the classification of classes of water quality, the concentrations corresponded to II. class (slightly polluted water). In solid matrices, all measured values were above the DL, while generally higher values were measured in suspended solids, where they fluctuated from 119 to 2449 $mgkg^{-1}$, in sediments from 137 to 334 $mgkg^{-1}$. It is not monitored in organisms.

Pesticides

Out of specific organic matters, matters of the group PAU are evaluated, as are pesticides, PCBs and chlorphenols.

p, p DDT

In water it occurred in 55 % under the DL, values were fluctuating from 2 to 52.0 ngl^{-1}. In suspended solids the values were in 25 % under the DL, the measured values were from 0.5 to 70 μgkg^{-1} with significant fluctuation. In sediments, 40 % of determination was under the limit, and the values were fluctuating irregularly from 1.3 to 24 μgkg^{-1}.
In organisms, the values were from 3.2 to 16.3 gkg^{-1} of dry matter, high concentrations were contained by the lamellibranches Dreissena polymorpha. In growths the values were from 3.4 to 6.8 μgkg^{-1} of dry matter.

p, p DDE

In water it occurred in 54 % under the DL, the values were fluctuating from 2.3 to 47.0 ngl^{-1}. In suspended solids the values were in 42 % under the DL, the measured values were fluctuating from 0.5 to 26 μgkg^{-1}, mostly though to 8 μgkg^{-1} with isolated extreme values. In sediments, 60 % of the determinations were under the limit, values fluctuated from 0.5 to 11 μgkg^{-1} with a similar scatter of values (mostly though to 4 μgkg^{-1}) as for the suspended solids. In organisms, the values were fluctuating from 18 to 148 μgkg^{-1} of dry matter, and highest concentrations were found for leech (Erpobdella octoculata) and in fish (dace). In growths the values were fluctuating from 3.6 to 31 μgkg^{-1} of dry matter.

Aldrin

In water it occurred in 96 % under the DL, the values were fluctuating from 0.1 to 221.0 ngl^{-1}. In suspended solids the values were in 33 % under the DL, the measured values fluctuated from 0.5 to 17 μgkg^{-1}. In sediments, 67 % of determinations were under the limit, values fluctuated from 0.5 to 20 μgkg^{-1} with a distinct decrease to the value of the DL. In organisms it is not monitored.

Endrin

In water it occurred in 33 % under the DL, the values were fluctuating from 0.2 to 111.0 ngl^{-1}. In suspended solids the values were in 50 % under the DL, the measured values fluctuated from 0.5 to 26 μgkg^{-1}. In sediments, 67 % of determinations were under the limit, values fluctuated from 0.5 to 13 μgkg^{-1}. Since 2002, only values under the DL occurred in both matrices. It is not monitored in organisms.

Hexachlorbenzene

In water it occurred in 85 % under the DL, values were fluctuating from 2 to 26.0 ngl^{-1}. In suspended solids, the values were in 17 % under the DL, the measured values were fluctuating from 0.5 to 23 μgkg^{-1}. In sediments, 50 % of the determinations were under the limit, values were fluctuating from 0.5 to 13 μgkg^{-1}. It is not monitored in organisms.

Polychlorinated biphenyls

In water, the individual PCB congeners occurred in 60 to 80 % under the DL, the measured values were from 0.1 to 57 ngl^{-1}, most often the measurable values occurred for congener 28. In suspended solids, the values were in 17 to 42 % under the DL, measured values were fluctuating from 0.5 to 24 μgkg^{-1}. In sediments, they were in 30 to 70 % under the DL, values were fluctuating from 0.5 to 48 μgkg^{-1}. Most often, measurable values occurred in both solid matrices for congener 28. In organisms, the sum of 6 indicator congeners was evaluated, and the values were fluctuating from 67 to 230 μgkg^{-1} of dry matter, maximum values were found in the larvae Hydropsyche. In growths, the concentrations were fluctuating from 21 to 72 μgkg^{-1} of dry matter.

Polyaromatic hydrocarbons

Benzo(g,h,i)perylene ocurred in water in 37 % under the DL, the values were fluctuating from 1.6 to 70 ngl^{-1}. In suspended solids, the values were in 25 % under the DL, measured values irregularly fluctuated from 0.5 to 1740 μgkg^{-1}. In sediments, 10 % of determinations were under the DL, values fluctuated from 0.5 to 536 μgkg^{-1}. It is not monitored in organisms.

Benzo(a)pyrene

In water it occurred in 44 % under the DL, values were fluctuating from 1.5 to 36.0 ngl^{-1}. In suspended solids values were only in 8 % under the DL, the measured values were fluctuating significantly from 0.5 to 2045 μgkg^{-1}. In sediments, all determinations were above the limit, values fluctuated from 61 to 742 μgkg^{-1}. It is not monitored in organisms.

Benzo(b)fluoranthene

In water it occurred in 24 % under the DL, values were fluctuating from 2 to 110.0 ngl^{-1}. In suspended solids, all measured values were above the DL, measured values fluctuated from 276 to 2129 μgkg^{-1}. In sediments, 17 % of the determinations were under the limit, values significantly fluctuated from 0.5 to 1269 μgkg^{-1}. It is not monitored in organisms.

Benzo(a)antracene

In water it occurred in 38 % under the DL, values were fluctuating from 2 to 35.0 ngl^{-1}. In suspended solids, all measured values were above the DL, the values fluctuated from 128 to 915 μgkg^{-1}. In sediments, all measured values were above the DL, values fluctuated from 70 to 450 μgkg^{-1}. It is not monitored in organisms.

Dibenzo(a,h)antracene

In water it occurred in 90 % under the DL, values were fluctuating from 2 to 7 ngl^{-1}. In suspended solids, 60 % of the values were under the DL, values fluctuated from 0.5 to 155 μgkg^{-1}. In sediments, 33 % of the values were under the DL, and the values fluctuated from 0.5 to 322 μgkg^{-1}. It is not monitored in organisms.

Indeno(1,2,3-c,d)pyrene

In water it occurred in 76 % under the DL, values flactuated from 1.7 to 60 ngl^{-1}. In suspended solids, 8 % of the values were under the DL, and the values fluctuated from 0.5 to 1358 μgkg^{-1}. In sediments, 10 % of the values were under the DL, and the values fluctuated from 12.5 to 1621 μgkg^{-1}. It is not monitored in organisms.

<u>Pyrene</u>

In water it occurred in most of the cases above the DL, values fluctuated from 2.1 to 160 ngl^{-1}. In suspended solids, the values were above the DL and fluctuated from 367 to 3307 μgkg^{-1}. In sediments, 10 % of the values were under the DL and the values fluctuated from 0.5 to 1286 μgkg^{-1}. It is not monitored in organisms.

<u>Chrysene</u>

In water it occurred in 23 % under the DL, values fluctuated from 2 to 680 ngl^{-1}. In suspended solids, all values were above the DL and fluctuated from 194 to 2031 μgkg^{-1}. In sediments, the values were above the DL and fluctuated from 71 to 808 μgkg^{-1}. It is not monitored in organisms.

<u>Benzo(k)fluoranthene</u>

In water it occurred in 47 % under the DL, values fluctuated from 1.1 to 31 ngl^{-1}. In suspended solids, all values were above the DL and fluctuated from 100 to 1026 μgkg^{-1}. In sediments, 10 % of the values were under the DL, and values fluctuated from 13 to 361 μgkg^{-1}. It is not monitored in organisms.

<u>Fluorene</u>

In water it occurred in 25 % under the DL, values fluctuated from 2 to 90 ngl^{-1}. In suspended solids, 42 % of the values were under the DL, and values fluctuated from 0.5 to 444 μgkg^{-1}. In sediments, 67 % of the values were under the DL, and values fluctuated from 0.5 to 138 μgkg^{-1}. It is not monitored in organisms.

<u>Fluoranthene</u>

In water it occurred in 3 % under the DL, values fluctuated from 2 to 220 ngl^{-1}. In suspended solids, 8 % of the values were under the DL, and values fluctuated from 0.5 to 3773 μgkg^{-1}. In sediments, 20 % of the values were under the DL, and values fluctuated from 0.5 to 1426 μgkg^{-1}. It is not monitored in organisms.

<u>Antracene</u>

In water it occurred in 14 % under the DL, values fluctuated from 2 to 50 ngl^{-1}. In suspended solids, 8 % of the values were under the DL, and values fluctuated from 0.5 to 1095 μgkg^{-1}. In sediments, 30 % of the values were under the DL, and values fluctuated from 0.5 to 306 μgkg^{-1}. It is not monitored in organisms.

<u>Naphtalene</u>

In water it occurred in 32 % under the DL, values fluctuated from 0.1 to 90 ngl^{-1}. In suspended solids, 67 % of the values were under the DL, and values fluctuated from 0.5 to 1185 μgkg^{-1}. In sediments, 50 % of the values were under the DL, and values fluctuated from 0.5 to 525 μgkg^{-1}. From half of 2001, all values in sediments are under the DL, similarly in suspended solids with the exception of only one value in 2003. It is not monitored in organisms.

<u>Chlorinated phenols</u>

In water, most of the values of the representatives of this group occurred under the DL (91 – 100 %). In suspended solids, 2,4,5, trichlorphenol mostly occurs (33 % under the DL) and 2,4,6 trichlorphenol (25 % under the DL), and values in the overwhelming majority fluctuated to 500 μgkg^{-1} with solitary maxima. In sediments, 2,4,5, trichlorphenol again mostly occurs (2.5 – 100 μgkg^{-1} with only one extreme value of 2800 gkg^{-1}) and terachlorphenols (with values to 200 μgkg^{-1}). They are not monitored in organisms.

From the quoted occurrence of selected matters for the period of 1999-2003, the following conclusions follow with respect to the relationship of matter-matrix:

- between the individual matrices, substantial differences exist in the occurrence of
- monitored matters
- metals are generally better identifiable in the suspended solids and sediments matrix, where they-as opposed to water-always occur in measurable values
- suspended solids as opposed to sediments show higher overall contents of monitored matters
- specific organic matters, namely indicator polymers PCB and chlorinated pesticides accumulate more in the biota matrix
- evaluation of the loading of the ecosystem only on the basis of data from point samples of water often does not provide an objective information about the overall quality of surface water.

4.2. Basic qualitative evaluation of contents of selected dangerous matters in the water, suspended solids and sediments matrices

The evaluation of the loading of individual matrices was performed in the case of water by classification according to the CSN 75 7221 – Classification of the quality of surface waters, in the case of suspended solids and sediments according to the Methodical Directive of the ME from 1996 "Criterions of pollution of soils and groundwater" (Table 2). At the same time, a comparison was made with the goal intentions of the MKOD. For a biological matrix, with the exception of fish, criteria are not determined.

Table 2. Delineation of categories according to ME Criteria of pollution of soils and groundwaterfor the evaluation of the contents of dangerous matters in suspended solids and sediments

ME criteria	Categorisation
A	corresponds to natural contents of monitored matter, the exceeding of limit A is judged as a slight increase of the loading
B	corresponds to increased contents, the exceeding of limit B is judged as tion, which can have negative influence on the health of man and on the individual components of the environment
C	the exceeding of limit C represents pollution, which can mean significant risk of the endangering of human health and other components of the environment

<u>Water</u>

With view to the problematic determination of a series of matters in the water matrix, from the view of CSN 75 7221 only a narrowed selection of matters may be classified, namely arsenic, chromium, cadmium, copper, nickel, lead, mercury, zinc and the sum of PAU. For an orientation look at the quality of the water matrix, 90 percentiles of yearly data sets were classified.

The contents of chromium in the evaluated period correspond to class I (unpolluted water). Contents of copper and zinc fluctuate between class I and II, contents of arsenic, cadmium, nickel and lead are on the level of class II (slightly polluted water). Loading by mercury and PAU is out of the evaluated pollutants most significant and corresponds to class III (polluted water).

From the point of view of goal limits of the ICPDR, medians of yearly data sets of the PAU sum do not comply with the goal limit, with the exception of the year 2003. On the other hand the yearly medians in the case of chromium, cadmium, copper, nickel, lead and mercury do comply with the goal limits of the ICPDR. As far as p,p-DDT is concerned, its yearly medians meet the ICPDR goals, with the exception of the year 2000.

Suspended solids

An overview of statistical parameters of selected dangerous matters and their qualitative evaluation in the suspended solids matrix is presented by Table 3. The qualitative limit of at least category B (increased pollution) is exceeded by the maximum values of metals content, namely arsenic, chromium, cadmium and nickel. In the case of organic matters, it is only benzo(a)pyrene and 2,4,6 trichlorphenol.

Arsenic – into category C (risk pollution) fall 3 high values (4.8 % of the data set). The remaining values are at the level of geogennous background or represent a slight increase of anthropogennous origin. The mentioned three high remote values were found in the years 1999 (91.0 $mgkg^{-1}$), 2000 (90.0 $mgkg^{-1}$) and 2003 (108.3 $mgkg^{-1}$).

Total chromium – with the exception of two values exceeding the limit of categories B and C (at the break of the years 1999 and 2000, 494 and 548 $mgkg^{-1}$), all other values (97.2 %) fall into category corresponding to geogennous background, or to slightly increased pollution.

Cadmium – practically all values are at the level of slight pollution. Only one value (1.6 % of the set) exceeds the limit of category B (18.0 $mgkg^{-1}$).

Nickel – relatively homogenneous field of data is mostly at the level of categories of geogennous background or slight pollution (category A), only in exceptional cases it reaches or minutely exceedes limit of category B. Overall however 4.2 % of the data, which are four values of the data set, as deviating remote values fall into category C. These high values were measured on 5th December 2001 (264 $mgkg^{-1}$), 10th December 2002 (225.3 $mgkg^{-1}$), 18th February 2003 (332.5 $mgkg^{-1}$) and 18th November 2003 (332.4 $mgkg^{-1}$) and they signal a possible worsening of state due to more frequent and more massive episodical anthropogenneous contamination.

Benzo(a)pyrene – values of the content of benzo(a)pyrene are usually up to 1500 $mgkg^{-1}$ and most of the data are at the level of the category of slight anthropogenneous pollution. Two remote values differ from this, namely on 13th September 2001 (2045 μgkg^{-1}) and 27th November 2001 (1918 μgkg^{-1}).

From the point of view of goal limits of the ICPDR, medians of yearly sets of nickel and copper do not comply with the limit. In the case of cadmium, only median of the year 2003 complies, and in the case of mercury and chromium, already years 2001, 2002 and 2003 comply. Medians of the contents of lead and arsenic comply with the ICPDR goal in all the monitored five years. The sum of PAU nor the sum of PCB in the monitored years 2001 and 2002 do not comply with the MKOD goals.

Table 3. Overview of statistical parameters of selected dangerous matters and their qualitative evaluation in suspended solids matrix

Lanžhot (1999-2003)	statistics and evaluation according to limits of ME							%< MS	% of exceedance of ME limits			
substance	MIN	MED	AVG	P75	P90	MAX	Count		A1	A2	B	C
As	5,2	21,70	28,03	39,275	55,33	108,3	62	0,0	66,1	29,0	0,0	4,8
Be	0,29	1,50	1,62	1,9	2,764	3,85	45	0,0	100,0	0,0	0,0	0,0
Cr total	15,7	103,2	135,76	168	248	548	71	0,0	66,2	31,0	1,4	1,4
Cd	0,21	1,50	2,39	2,6	5	18	62	0,0	1,6	96,8	1,6	0,0
Cu	13,4	65,00	80,85	90	142,7	317,3	71	0,0	54,9	45,1	0,0	0,0
Ni	11,1	73,00	88,24	94,65	142,4	332,4	71	0,0	28,2	64,8	2,8	4,2
Pb	17	43,00	51,55	54	82	245	71	0,0	88,7	11,3	0,0	0,0
Hg	0,08	0,70	0,94	1,35	2,1	3,5	56	0,0	35,7	58,9	5,4	0,0
Zn	118,8	347,00	452,59	528,5	684	2449	71	0,0	1,4	97,2	1,4	0,0
antracen	0,5	227	308,83	503,25	561,3	1095	12	8,3	33,3	66,7	0,0	0,0
benzo(a)antracen	128	709,00	643,40			915	5	0,0	0,0	100,0	0,0	0,0
benzo(a)pyren	0,5	1019,50	988,33	1416,25	1870,6	2045	12	8,3	8,3	75,0	8,3	8,3
benzo(b)fluoranthen	276	1151,50	1145,25	1476,25	1868,2	2129	12	0,0	0,0	100,0	0,0	0,0
benzo(g,h,i)perylen	0,5	669,00	670,25	1184	1505	1740	12	25,0	33,3	66,7	0,0	0,0
benzo(k)fluoranthen	101	523,00	543,08	681,25	929,5	1026	12	0,0	0,0	100,0	0,0	0,0
dibenzo(a,h)antracen	0,5	0,5	46,70			155	5	60,0	80,0	20,0	0,0	0,0
fluoranthen	0,5	2043,50	1949,83	2809,5	3393,6	3773	12	8,3	8,3	91,7	0,0	0,0
fluoren	0,5	32,50	79,58	87,5	181,7	444	12	41,7	83,3	16,7	0,0	0,0
chrysen	194	1162,00	1120,67	1420,75	1766,5	2031	12	0,0	0,0	100,0	0,0	0,0
indeno(1,2,3-c,d)pyren	0,5	516,00	580,25	863,75	1319,9	1358	12	8,3	8,3	91,7	0,0	0,0
naftalen	0,5	0,00	148,00	112,5	293,4	1185	12	66,7	66,7	33,3	0,0	0,0
pyren	367	1827,50	1829,83	2380	3065,8	3307	12	0,0	0,0	100,0	0,0	0,0
aldrin	0,5	2,50	3,58	4	6,7	17	12	33,3	100,0	0,0	0,0	0,0
endrin	0,5	1,00	4,29	5,5	7	26	12	50,0	100,0	0,0	0,0	0,0
p,p'-DDT	0,5	13,50	21,97	38,75	47,9	69,6	12	25,0	91,7	8,3	0,0	0,0
2,3,4,5-tetrachlorfenol	5	100	382,00			1000	5	40,0	40,0	60,0	0,0	0,0
2,3,4,6-tetrachlorfenol	5	5	283,00			700	5	60,0	60,0	40,0	0,0	0,0
2,4,5-trichlorfenol	5	75,5	91,83	199,25	200	200	12	33,3	41,7	58,3	0,0	0,0
2,4,6-trichlorfenol	5	200,00	324,75	305,75	770	1600	12	25,0	33,3	58,3	8,3	0,0
2,4-dichlorfenol	5	36	124,75	200	200	600	12	50,0	50,0	50,0	0,0	0,0
2,5-dichlorfenol	5	5	84,00			400	5	80,0	80,0	20,0	0,0	0,0
2-monochlorfenol	5	5,00	73,75	5	32	800	12	83,3	91,7	8,3	0,0	0,0
pentachlorfenol	5	5,00	102,17	74	388,1	500	12	75,0	75,0	25,0	0,0	0,0
PCB 101	0,5	1,85	3,68	7,25	8	10	12	41,7	no limit			
PCB 138	0,5	2,55	4,61	7,075	10,63	19	12	41,7	no limit			
PCB 153	0,5	3	3,64	4,025	6,8	14	12	16,7	no limit			
PCB 180	0,5	2,8	5,84	7,25	17	24	12	41,7	no limit			
PCB 28+31	0,5	9,00	9,89	14,25	20,79	24,3	12	16,7	no limit			
PCB 52	0,5	3,00	5,46	9,25	11,8	19	12	41,7	no limit			

Sediments

An overview of statistical parameters of selected dangerous matters and of their qualitative evaluation in the sediments matrix is presented in Table 4. Contents of matters not even by their maxima exceede qualitative limit of category B (according to criteria of ME of CR) with the exception of 2,4,5 trichlorphenol. In this case the solitary extremely high value (2800 μgkg^{-1} from 18th September 2000) differs from other values, which are mostly under the limit of detection.

From the point of view of goal limits ICPDR medians of yearly data sets of nickel do not comply with the goal limit. In the case of chromium, median of the years 2001 and 2003 complies, medians of the cadmium contents comply with the limit in 2002 and 2003, and in the case of copper, already years 2001, 2002 and 2003 comply. Medians of contents of mercury, lead and arsenic comply with the ICPDR goal in all monitored five years. Sum PAU in the evaluated years 1999 – 2002 and sum PCB in the years 2001 and 2002 do not comply with the ICPDR goals and exceedes them.

Table 4. Overview of statistical parameters of selected dangerous matters and their qualitative evaluation in sediments matrix

Lanžhot (1999-2003)	statistics and evaluation according to limits of ME							%< MS	% of exceedance of ME limits			
substance	MIN	MED	AVG	P75	P90	MAX	Count		A1	A2	B	C
As	6,8	14,80	16,78	17,275	23,77	38,8	10	0,0	90,0	10,0	0,0	0,0
Be	0,8	1,9	1,95	2,2	3,02	3,2	10	0,0	100,0	0,0	0,0	0,0
Cr total	61,4	97,10	105,31	123,575	155,2	166	10	0,0	80,0	20,0	0,0	0,0
Cd	0,4	1,10	1,09	1,4	1,59	2,4	10	0,0	20,0	80,0	0,0	0,0
Cu	24,5	36,60	42,65	54	61,7	77	10	0,0	90,0	10,0	0,0	0,0
Ni	49,5	64,30	66,28	76,7	83,5	88	10	0,0	40,0	60,0	0,0	0,0
Pb	21,1	35,95	37,24	41,675	46,8	54	10	0,0	100,0	0,0	0,0	0,0
Hg	0,2	0,30	0,30	0,375	0,4	0,4	10	0,0	100,0	0,0	0,0	0,0
Zn	137	268,50	252,50	308,75	322,3	334	10	0,0	10,0	90,0	0,0	0,0
antracen	0,25	122,5	120,10	172,75	225,9	306	10	30,0	40,0	60,0	0,0	0,0
benzo(a)antracen	68	286	264,00	369	420,2	449	7	0,0	14,3	85,7	0,0	0,0
benzo(a)pyren	61	431,50	401,90	545,5	628,6	742	10	0,0	10,0	90,0	0,0	0,0
benzo(b)fluoranthen	0,25	523,00	578,17			1269	6	16,7	16,7	83,3	0,0	0,0
benzo(g,h,i)perylen	0,25	207,00	207,60	255	329,9	536	10	10,0	10,0	90,0	0,0	0,0
benzo(k)fluoranthen	12,5	165,50	166,65	220,25	280,9	361	10	10,0	10,0	90,0	0,0	0,0
dibenzo(a,h)antracen	0,25	47	123,08			322	3	33,3	66,7	33,3	0,0	0,0
fluoranthen	0,25	739,5	656,60	967	1193,8	1426	10	20,0	30,0	70,0	0,0	0,0
fluoren	0,25	0,00	33,00			138	6	66,7	100,0	0,0	0,0	0,0
chrysen	71	408,00	409,40	538,5	691	808	10	0,0	0,0	100,0	0,0	0,0
indeno(1,2,3-c,d)pyren	12,5	206,50	348,75	344	492,4	1621	10	10,0	20,0	80,0	0,0	0,0
naftalen	0,25	53,00	113,70	118,75	294,6	525	10	50,0	50,0	50,0	0,0	0,0
pyren	0,25	705,00	609,40	796,25	981,8	1286	10	10,0	10,0	90,0	0,0	0,0
aldrin	0,25	0,25	4,50			20	6	66,7	100,0	0,0	0,0	0,0
endrin	0,25	0,50	3,17			13	6	66,7	100,0	0,0	0,0	0,0
p,p'-DDT	1,25	5,15	8,22	13,5	17,61	24	10	40,0	100,0	0,0	0,0	0,0
2,3,4,5-tetrachlorfenol	2,5	2,5	68,33			200	3	66,7	66,7	33,3	0,0	0,0
2,3,4,6-tetrachlorfenol	0,25	0,5	33,33			100	3	66,7	66,7	33,3	0,0	0,0
2,4,5-trichlorfenol	2,5	2,50	485,00			2800	6	66,7	66,7	16,7	0,0	16,7
2,4,6-trichlorfenol	2,5	2,50	18,75			100	6	83,3	83,3	16,7	0,0	0,0
2,4-dichlorfenol	2,5	2,50	18,75			100	6	83,3	83,3	16,7	0,0	0,0
2,5-dichlorfenol	2,5	2,5	2,50			2,5	3	100,0	100,0	0,0	0,0	0,0
2-monochlorfenol	2,5	2,50	8,58			39	6	83,3	100,0	0,0	0,0	0,0
pentachlorfenol	2,5	2,5	2,50			2,5	6	100,0	100,0	0,0	0,0	0,0
PCB 101	0,25	1,25	2,88	2,75	8,4	12	10	60,0	no limit			
PCB 138	1	2,725	5,01	5,75	14,1	15	10	30,0	no limit			
PCB 153	1	1,625	2,54	3,5	4,35	7,5	10	30,0	no limit			
PCB 180	0,25	1,25	2,32	2,975	4,46	8,6	10	50,0	no limit			
PCB 28+31	1,25	5,35	9,30	7,225	18,3	48	10	40,0	no limit			
PCB 52	0,25	1,25	3,38	4,0625	6,4	19	10	70,0	no limit			

<u>Biota</u>

In the biota matrix it is possible to evaluate concentrations of monitored parameters only in fish according to allowable limits for fish meat (public notice of the Ministry of Health 289/1997 Sb.).

For the monitored metals, limits were significantly exceeded for mercury in all years (maximum value in 2002 was 0.9 $mgkg^{-1}$ of dry weight), for arsenic and lead the measured values slightly exceeded the determined limit in 2002 and 2003. Concentration of polychlorinated biphenyls (sum of indicator congeners) and chlorinated pesticides (sum of isomers p,p-DDT) did not exceede limit values.

4.3. Evaluation of differences of monitored matrices by associative and factor analysis

Results of laboratory analyses of collected samples were processed for period of 2001 to 2003. Emphasis was put on the influence of contents of matters of matrices of riverine environment on the biota matrix, and on the representatives of the aquatic community, respectively. By this the selection of data series of matter contents in water, sediment and suspended solids was directed in such a way, as to correspond to data of collection of representatives of aquatic communities, or to correspond to exposure time, during which these representatives were in contact with the riverine environment.

Monitored were: benthos (Erpobdella and Hydropsychidae), dace, Dreissena polymorpha and growths.

The selection of the evaluated matters includes: As, Pb, Cd, Hg, p.p-DDT, p.p-DDD, p.p-DDE, alpha-HCH, beta-HCH, gamma-HCH (lindan), hexachlorbenzene, PCB 28+31, PCB 52, PCB 101, PCB 138, PCB 153 and PCB 180.

Data sets were compiled into a basic data matrix. For the evaluation of data, more-dimensional data analysis techniques were used, namely factor analysis (FA), advanced factor analysis (PCA) and associative analysis (StatSoft, program STATISTICA).

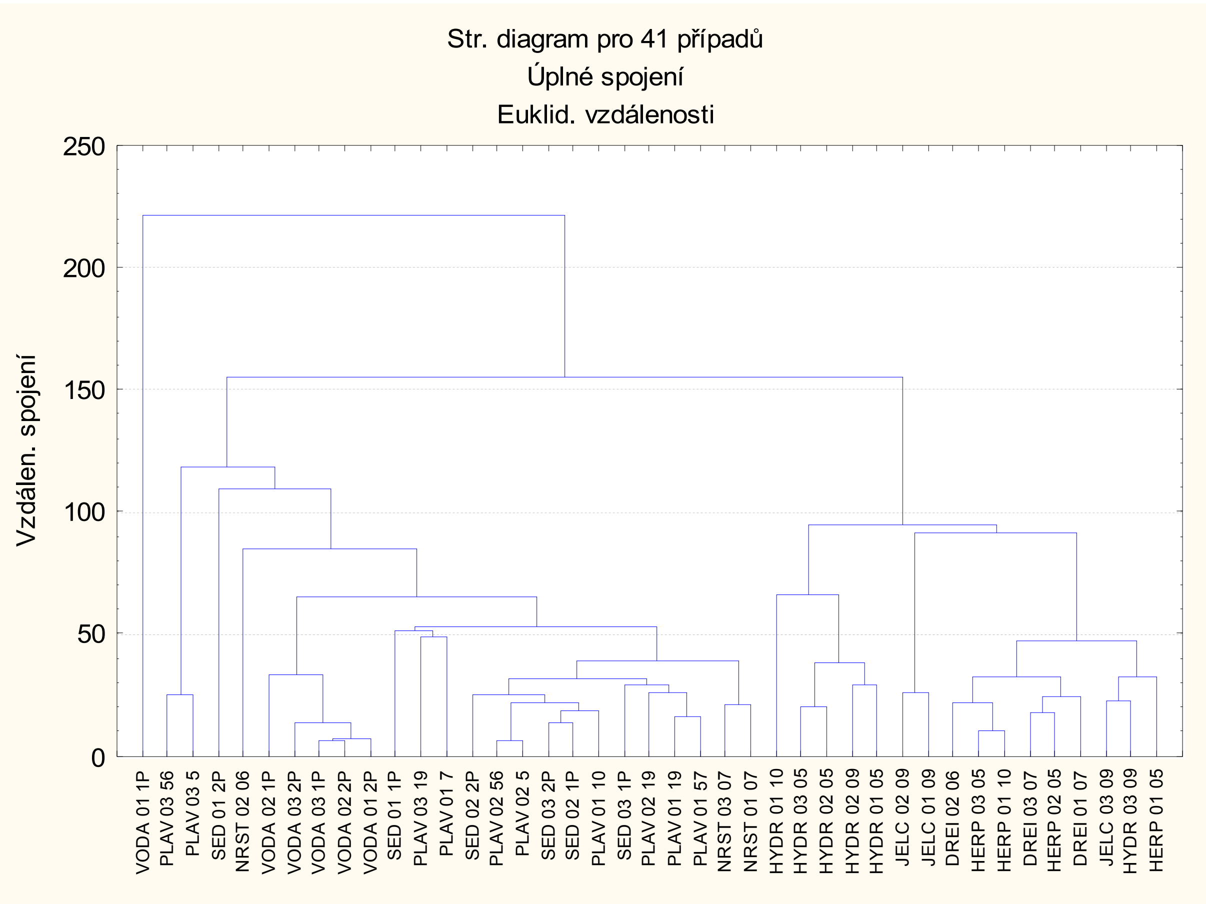


Figure 1. Dendrogram of association of cases into clusters

Overview of differences according to groups, or matrices, and according to main components is presented by Table 5 of entry data arranged according to results of association and respecting both FA and PCA factor analysis.

Table 5 Contents of selected metals and organic matters in individual matrices and assorted clusters

	CLUSTER	As	Pb	Cd	p,p'-DDE	PCB 101	PCB 138	PCB 153	PCB 180	p,p'-DDD	p,p'-DDT	Hg	alfa-HCH	beta-HCH	gama-HCH	HXLB	PCB 28+31	PCB 52
VODA 01 1P	11	1,00	1,34	0,15	6,95	2,00	2,77	200,00	2,00	10,88	7,02	0,14	3,88	5,87	4,47	2,00	3,17	2,00
PLAV 03 56	12	9,78	34,47	1,23	6,01	1,09	4,36	1,97	2,14	51,10	52,61	1,60	0,50	0,50	0,50	0,97	23,51	0,50
PLAV 03 5	13	11,36	43,15	1,26	7,80	0,50	3,40	1,40	1,50	67,60	69,60	1,92	0,50	0,50	0,50	0,50	24,30	0,50
SED 01 2P	14	12,80	21,10	0,60	4,00	3,00	6,00	4,00	4,00	2,00	24,00	0,30	5,00	4,00	80,00	13,00	48,00	5,00
NRST 02 06	15	5,05	20,00	0,99	7,10	6,20	7,90	9,10	6,60	3,00	6,00	0,22	1,00	1,70	1,00	68,60	1,80	1,80
VODA 02 1P	121	1,05	1,32	0,12	10,83	3,20	2,50	2,82	2,10	10,53	7,90	0,11	15,43	24,15	12,60	11,40	5,98	3,50
VODA 03 2P	121	1,10	1,63	0,12	2,00	2,00	2,00	2,00	2,00	2,00	2,00	0,11	2,00	11,42	10,52	2,00	2,00	2,00
VODA 03 1P	121	1,28	1,22	0,11	2,00	2,00	2,00	2,00	2,00	2,00	2,00	0,12	2,00	2,00	2,00	2,00	2,00	2,00
VODA 02 2P	121	1,30	2,28	0,14	2,78	2,25	2,15	2,53	2,37	4,22	2,92	0,10	2,10	6,27	4,95	2,00	2,88	3,83
VODA 01 2P	121	1,10	1,82	0,21	2,78	2,08	2,40	2,02	3,23	2,47	4,47	0,12	5,23	2,47	2,32	2,30	6,52	3,37
SED 01 1P	1221	38,80	29,10	2,40	11,00	0,00	14,00	1,00	2,00	12,00	14,00	0,40	15,00	10,00	22,00	7,00	4,00	0,25
PLAV 03 19	1221	16,55	37,95	1,14	7,81	2,28	3,72	2,71	2,75	31,83	37,82	0,60	0,92	0,92	0,92	1,55	17,25	1,71
PLAV 01 7	1221	13,07	34,83	0,84	26,00	8,00	19,00	3,00	18,00	4,00	33,00	0,24	11,00	5,00	2,00	3,00	0,50	19,00
SED 02 2P	1222	14,60	35,70	0,40	0,25	8,00	5,00	4,00	1,00	0,25	12,00	0,30	0,25	0,00	0,00	3,00	15,00	19,00
PLAV 02 56	1222	18,02	44,77	1,25	4,93	9,85	0,50	6,94	7,99	0,50	1,07	0,41	0,78	0,51	2,16	2,00	11,00	9,02
PLAV 02 5	1222	11,96	47,25	1,00	5,00	9,99	0,50	7,00	8,00	0,50	0,52	0,50	0,51	0,50	2,01	2,00	11,00	9,00
SED 03 2P	1222	6,80	37,70	0,60	0,25	0,00	4,20	2,00	3,30	0,25	3,30	0,20	0,25	0,00	0,00	1,30	6,70	0,25
SED 02 1P	1222	17,70	35,90	1,10	2,00	2,00	1,00	2,00	0,25	1,00	7,00	0,20	0,25	4,00	0,00	2,00	7,00	0,25
PLAV 01 10	1222	7,30	45,20	4,50	1,03	5,51	2,66	2,59	0,58	0,52	10,27	0,20	0,80	0,61	0,92	3,42	16,09	3,07
SED 03 1P	1223	22,10	33,90	0,40	2,60	0,00	1,10	1,10	0,25	13,30	16,90	0,20	0,25	0,00	0,00	0,25	7,30	0,25
PLAV 02 19	1223	21,96	39,65	1,24	2,50	6,21	2,39	6,18	9,08	2,39	15,33	0,76	13,71	13,65	7,86	5,43	10,55	8,44
PLAV 01 19	1223	18,92	50,56	2,00	10,00	3,53	7,86	1,85	5,37	2,39	16,11	0,68	5,37	5,34	2,84	3,21	4,56	6,17
PLAV 01 57	1223	9,46	40,04	1,15	14,90	4,04	9,24	1,68	8,75	2,16	16,65	0,18	5,46	6,05	1,48	3,00	0,52	9,23
NRST 03 07	1224	2,37	19,40	0,46	3,63	3,97	3,90	5,25	4,10	1,50	5,03	0,09	1,00	1,00	1,00	1,77	2,87	1,97
NRST 01 07	1224	8,50	28,00	0,92	9,60	12,10	8,10	10,90	9,20	4,60	3,40	0,22	1,00	1,00	1,40	2,70	7,40	12,60
HYDR 01 10	21	2,40	4,00	0,27	50,40	26,70	67,30	72,70	53,70	3,20	7,90	0,49	1,00	1,00	1,00	3,10	14,40	9,90
HYDR 03 05	21	0,50	2,14	0,16	15,70	18,50	46,10	55,40	34,20	2,80	17,20	0,19	1,00	1,00	1,00	21,10	9,30	8,00
HYDR 02 05	21	1,24	1,70	0,25	14,20	9,80	35,40	44,20	28,00	1,90	12,80	0,12	1,00	1,00	1,00	18,10	14,20	5,10
HYDR 02 09	21	1,25	2,95	0,29	21,90	15,00	39,60	48,80	27,40	1,60	4,50	0,09	1,00	1,00	8,20	1,00	31,50	9,60
HYDR 01 05	21	1,40	2,60	0,20	24,80	28,30	54,30	60,00	40,00	3,10	5,80	0,47	1,00	1,00	1,00	6,80	22,30	9,30
JELC 02 09	222	1,40	0,23	0,04	89,50	21,10	44,60	54,00	35,20	10,80	7,80	0,90	1,00	1,00	1,70	5,10	6,10	5,90
JELC 01 09	222	0,50	0,50	0,05	105,00	13,40	37,40	40,60	29,60	9,30	3,20	0,72	1,00	1,00	1,00	3,60	13,80	4,90
DREI 02 06	221	1,96	0,57	0,91	50,60	26,60	27,80	35,10	19,00	20,00	16,30	0,08	1,00	2,55	1,00	1,33	17,20	13,40
HERP 03 05	221	1,30	3,17	0,28	49,10	16,80	31,70	35,60	8,10	18,90	9,80	0,20	1,00	1,00	1,00	2,10	12,20	4,90
HERP 01 10	221	3,10	1,60	0,25	45,50	19,40	32,20	34,60	3,60	21,30	9,60	0,60	1,00	1,00	1,00	1,00	19,90	3,80
DREI 03 07	221	8,92	0,58	0,92	42,60	23,80	21,60	27,40			12,10	0,15	1,00	1,50	1,77	3,63		6,17
HERP 02 05	221	2,37	2,70	0,50	35,20	13,40	23,10	24,10	3,70	12,10	7,60	0,46	1,00	1,00	1,00	3,00	11,60	4,70
DREI 01 07	221	5,20	0,26	0,96	42,90	20,50	20,20	26,10	14,30	15,30	12,50	0,12	1,00	3,20	1,00	7,20	28,00	4,10
JELC 03 09	221	0,93	0,20	0,03	22,10	13,60	14,70	19,90	12,10	2,70	3,47	0,59	1,00	1,25	1,10	2,05	3,23	3,30
HYDR 03 09	221	0,50	1,97	0,28	21,70	10,10	24,30	29,70	15,80	2,00	14,80	0,10	1,00	1,30	4,10	7,00	14,70	5,10
HERP 01 05	221	1,80	1,90	0,20	21,50	9,30	23,60	24,00	6,50	12,60	3,50	0,66	1,00	2,20	1,00	1,00	24,90	20,90

Note: data about contents of selected matters for metals are in $mgkg^{-1}$ and in the case of organic matters in μgkg^{-1}. In water the contents of metals are in mgl^{-1} and organic matters in ngl^{-1}. Clusters are shown in colour, as are elements of main components and in the column of contents values on relative scale low, medium and high.

In the monitored period and from the point of view of the selection of analysed matters and matrices, there appears a substantial difference in the contents of the evaluated selection of the matters between matrices. The time changes of the contents of the matters in matrices play a smaller role, and a dependence of contents of the matters in the representatives of the aquatic community just on the changes of contents of these matters in other matrices has not been manifested. This dependence could manifest itself apparently only during an inter-profile comparison in the case of a substantial difference of the contents of matters in the same matrices. A larger concentration of metals (As, Pb, Cd) are bonded to the matrix of suspended solids and sediments.

On the other hand a larger concentration of organic matters, namely p,p-DDE, PCB 101, PCB 138, PCB 153 and PCB 180 are in the biota matrix. Low values of matter concentrations in the water matrix of course do not necessarily mean the influencing of biota by the quality of solid matrices. Still a substantial role is played by the used scale and the distribution of matter between the matrices. The solitary piece of data of concentration of matter of 1 $mg.kg^{-1}$ in suspended solids corresponds approximately to 0.1 $\mu g.l^{-1}$ of river water and so in 1 m^3 of water with an average contents of suspended solids there is in some cases of the given matter more bonded to water than to a solid matrix. An influence has not in the last place also the chemical character and the accessibility of forms of matter occurrence for the particular biological type. Growths have joined to the cluster of the collected sediments and suspended solids. They show medium to high values of As, Pb, and Cd, and also of p,p.DDE, PCB 101, PCB 138, PCB 153 and PCB 180.

The deliminated main components and relationships or data structure are equal with the output of analyses of more-dimensional procedures made on data sets in profiles Děčín, Srbsko and Pohansko (Leontovyčová, Vejvodová, Hypr, 2002).

4.4. Transport of dangerous matters in river environment

The calculation of transport of the amount of pollutants bonded to suspended solids represents an orientation look at the amount of dangerous matters carried from the territory of the CR to neighbouring states. It comes out of a relatively exact determination of the amount of transported suspended solids, namely on the basis of data from daily monitoring of suspended solids concentration. There is a to-date complicated problem of how to express the dependence of suspended solids concentration on the discharge of water. With respect to a lot of hard-to-describe factors of river environment and countryside, which influence otherwise surely causative relationship between these values, various models and correlations are loaded with inaccuracy, which causes their practical non-usability. Various course and parameters of discharge curves and "suspended solids waves" are shown in Figure 2.

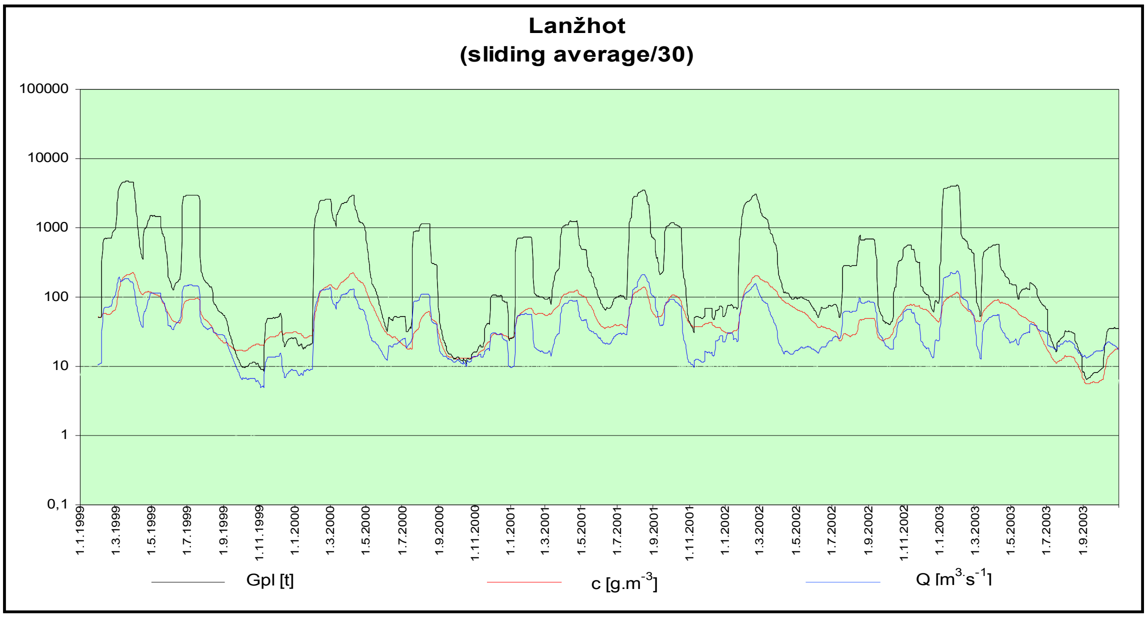


Figure 2. Simplified illustration of the course of changes of water discharge(Q) and relationships to suspended solids(c) waves and transport of suspended solids(G_{pl})

If the amount of suspended solids transported in the course of "suspended solids waves" are not documented by detailed measurement, the data on the amount of transported suspended solids will be to a great extent inaccurate.

A bigger problem for the expression of the amount of transported pollutants is the unsatisfactory frequency of collection for analyses, and technically, financially and organisation-wise difficult securing of the collection just during the occurrence of suspended solids waves. This brings an error to the calculation of transport of dangerous matters bonded to suspended solids, and the calculation has an orientation character.

We quote orientation data of transport of matters bonded to suspended solids in the following Table 6 and in graphs in Figures 3 – 6.

Table 6. Values of yearly suspended solids transport (G_{pl}) and dangerous matters bonded to them (G_{subst}) in profile Lanžhot

year	G_{pl}	As	Cr	Cd	Ni	Hg	Zn	2,4,6 trichlorfenol	benzo(a)pyren
	[t]							kg	
1999	316 451	6,81	45,51	0,59	19,68	0,47	92,50		
2000	225 749	7,45	55,23	1,18	20,99	0,25	124,54		
2001	224 881	5,59	20,06	0,41	18,25	0,12	101,75	68,0	270,0
2002	177 758	4,95	15,46	0,27	13,41	0,14	65,47	109,6	245,0
2003	195 696	4,22	26,52	0,39	48,22	0,15	100,39	11,1	209,6

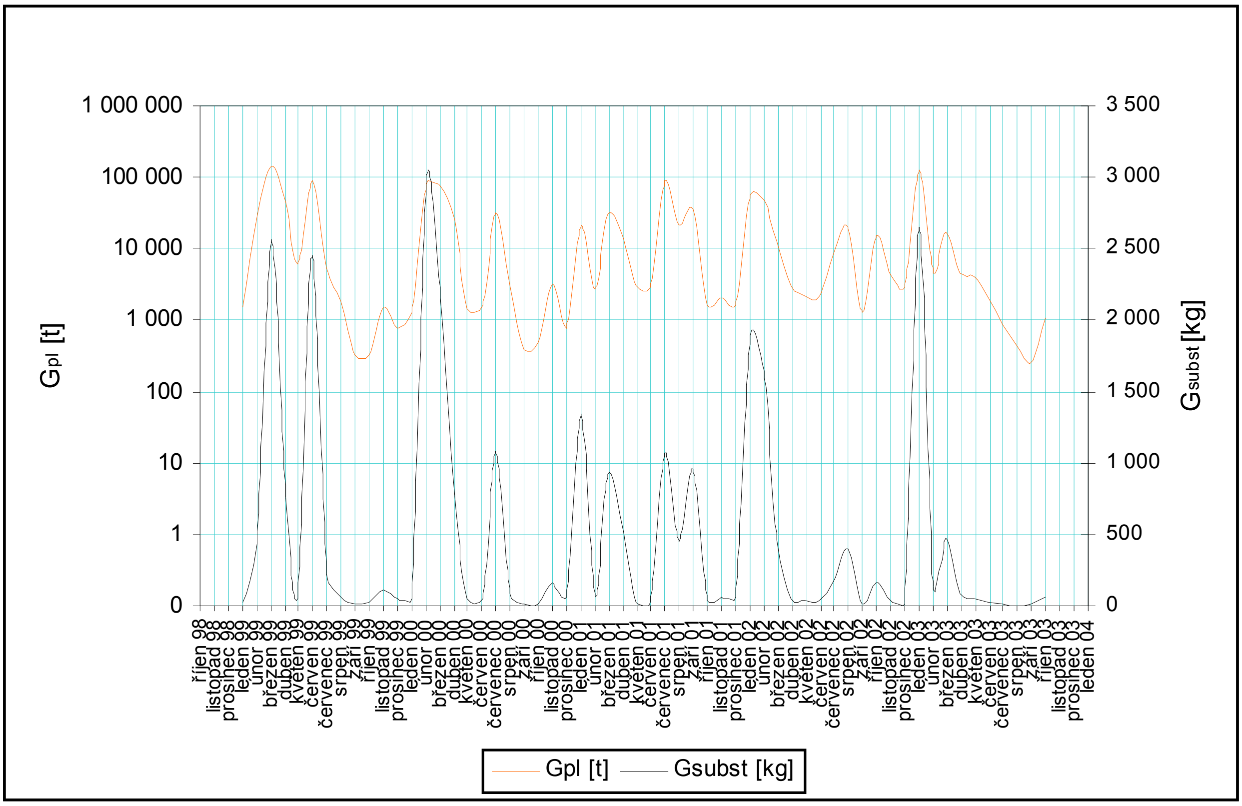
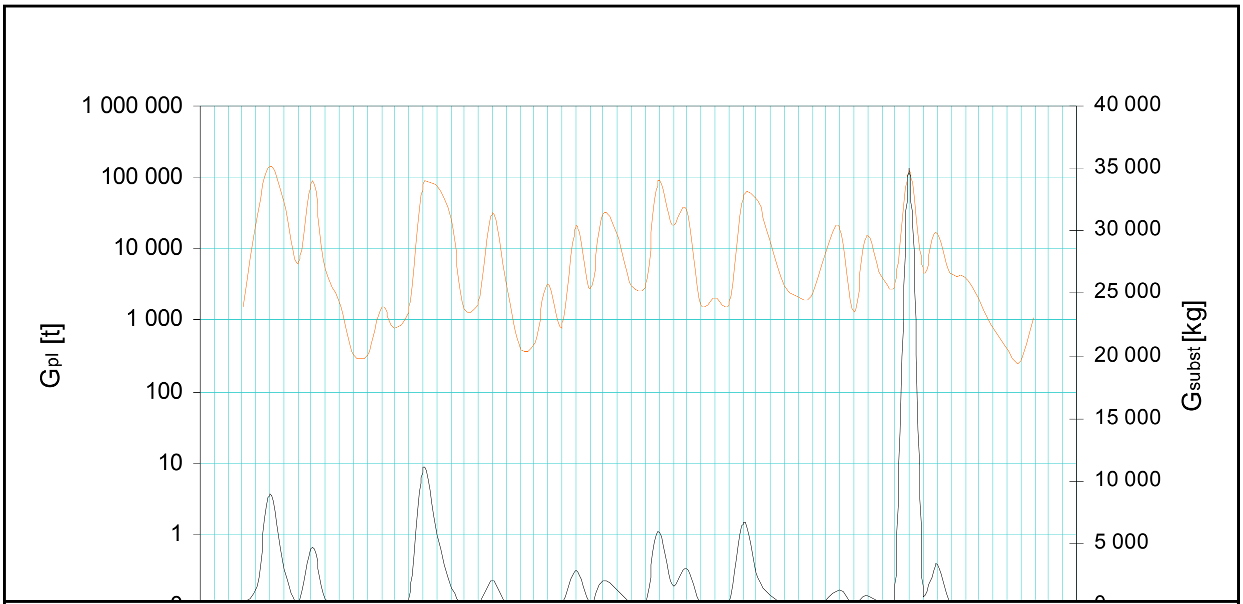


Figure 3. Graph showing course of changes of the amount of suspended solids transport and As in profile Lanžhot during 1999-2003

Figure 4. Graph showing course of changes of the amount of suspended solids transport and Ni in profile Lanžhot during 1999-2003



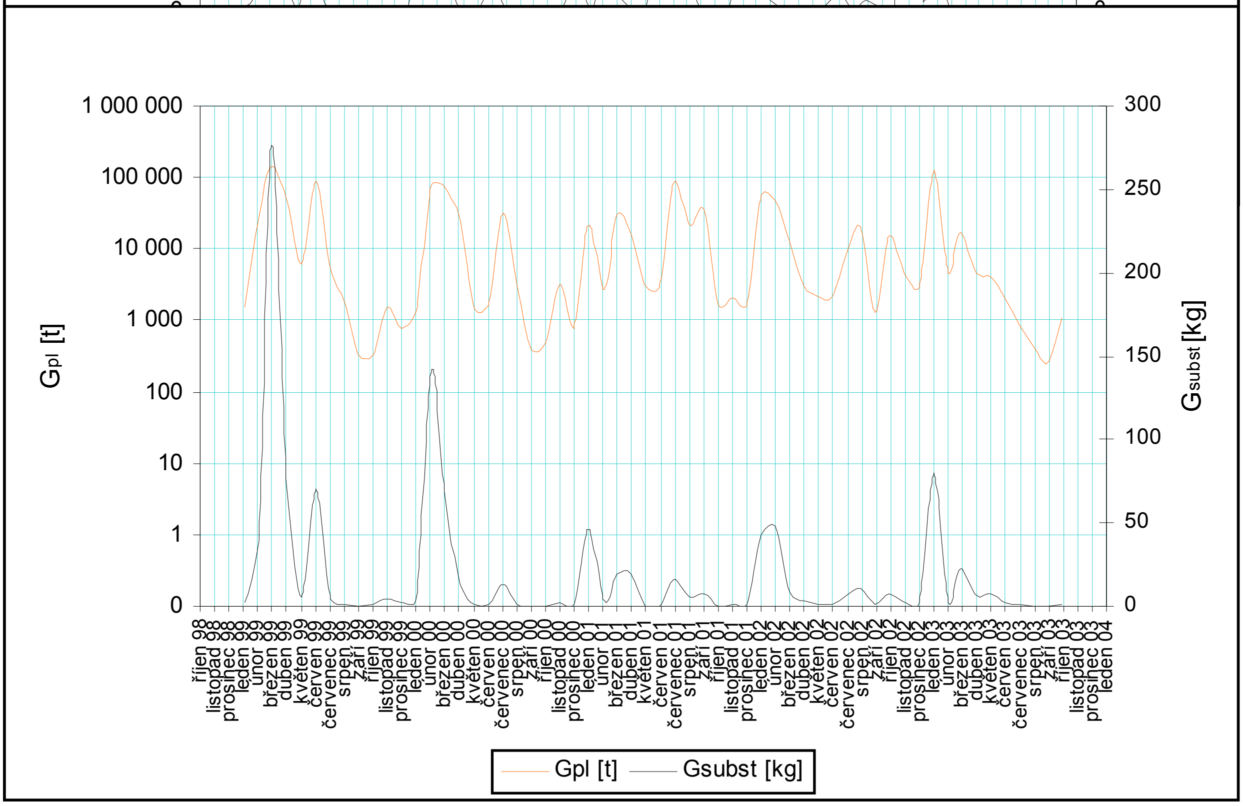
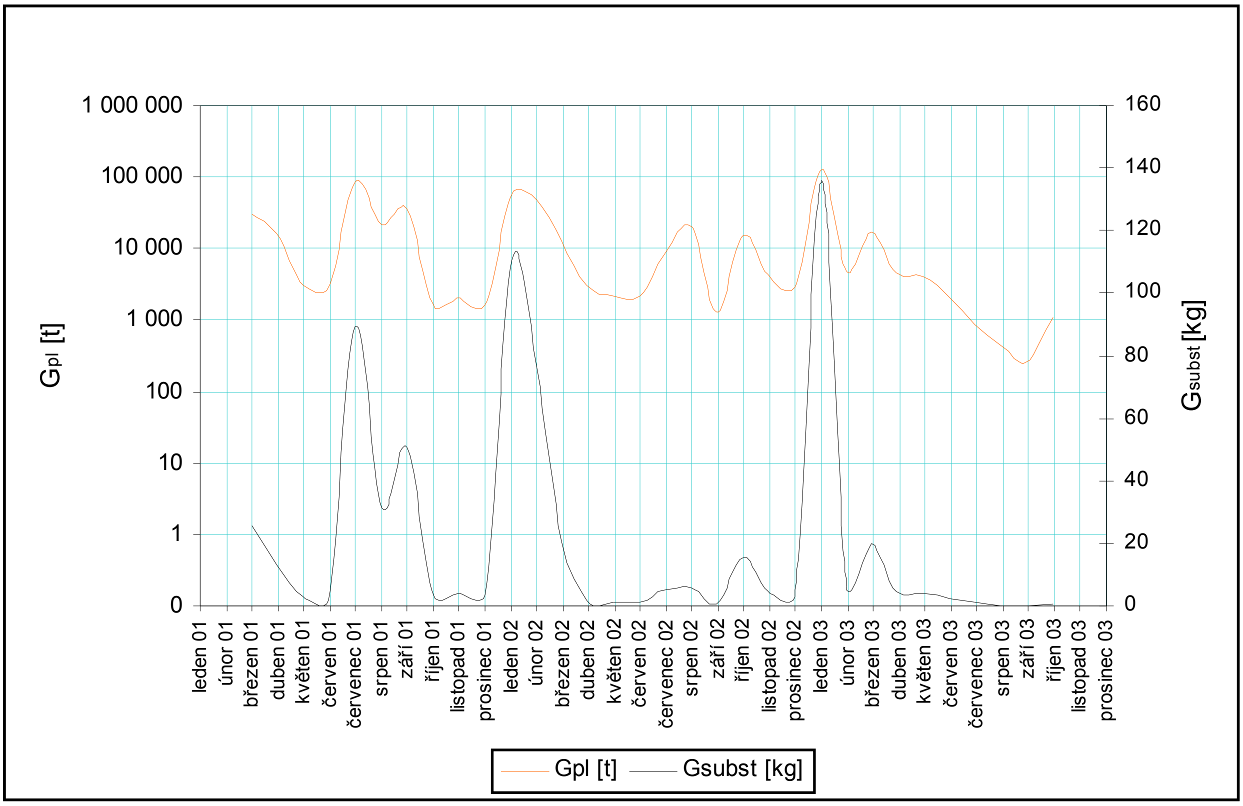


Figure 5. Graph showing course of changes of the amount of suspended solids transport and Hg in profile Lanžhot during 1999-2003

Figure 6. Graph showing course of changes of the amount of suspended solids transport and benzo(a)pyrene in profile Lanžhot during 2001 – 2003



The relationship of the runoff of pollutants to the transport of suspended solids is obvious. Even though it is influenced by the calculation and the values of the transported amounts depend greatly on discharge, not always the increased transport of suspended solids means also an increased transport of pollutants, and the correlation relationship does not have to be too close. Also, transported amounts of pollutants among each other usually do not have such an agreement as can be seen e.g. for benzo(a)pyrene and benzo(b) fluoranthene.

Calculation of the amount of transported pollutants bonded to the water matrix has more accurate entries into the calculation thanks to a practically continuous water discharge measurement. However as far as the determination of contents of matters bonded to this matrix is concerned, it is a similar problem as for the case of suspended solids, i.e. for a more accurate determination of the amount of transported matters there would have to be a different collection frequency.

Table 7. Values of yearly runoff of selected matters in water in profile Lanžhot

year	As	Cr	Cd	Ni	Hg	Zn	2,4,6 trichlorfenol	benzo(a)pyren
	[t]						kg	
1999	2,53	2,37	0,37	6,70	0,26	27,48		14,5
2000	1,75	2,30	0,63	5,84	0,17	17,84	3,6	13,0
2001	2,08	2,03	0,46	7,12	0,27	19,18	1,4	33,7
2002	2,21	2,13	0,46	4,69	0,21	18,49	0,2	10,6
2003	1,04	0,97	0,11	1,79	0,12	6,71	0,1	3,6

By a simple comparison of yearly runoff of matters in water and in suspended solids we find, that the transported amounts of dangerous matters bonded to suspended solids are usually several times higher than in water, and as far as chromium, benzo(a)pyrene and especially 2,4,6 trichlorphenol are concerned, the differences are even higher.

In this context it is also necessary to mention the question of the need of more accurate than orientation data on the amounts of transported matters. We presume, that the gradual introduction of automatic collection apparatuses controlled by a pressure or a silt-measurement sensor, will enable the gathering of more accurate information about the daily contents of suspended solids especially during quick and extraordinary rainfall-runoff situations, or will bring a more accurate information about qualitative parameters on the basis of poured-together samples.

For the qualitative evaluation of matrices of riverine environment, the small frequency of sample collection is being replaced by the growing length of time series of monitoring.

5. Conclusion

From the mutual evaluation of the occurrence of selected heavy metals, metalloids and specific organic matters in the monitored matrices for the period of 1999 – 2003 and from the factor and cluster analysis, the following can be concluded:

- substantial differences in the amount of monitored matters exist between individual matrices
- suspended solids show higher overall amounts of monitored matters than sediments
- metals are usually better identifiable in the suspended solids and sediments matrix, where as opposed to water they always occur in measurable values
- specific organic matters, especially indicator polymers PCB and chlorinated pesticides accumulate more in the biota matrix
- larger metal concentrations (As, Pb, Cd) are bonded to the suspended solids and sediments matrix than in the biota matrix
- time changes of matter contents in individual matrices did not manifest themselves in the contents of these matters in the representatives of the aquatic community
- low values of matter concentrations in the water matrix do not necessarily mean the influencing of biota by the quality of solid matrices. A substantial role is played also by the used scale and the division of the matter between matrices, as well as by the length of exposition of the biota, chemical character and accessibility of forms of matter occurrence for each particular biological kind.
- in cluster analyses, the growths were joined into a cluster of sampled sediments and suspended solids. They show medium to high values of As, Pb, Cd, p,p-DDE, and PCB 101, PCB 138, PCB 153 and PCB 180.
- loading of individual matrices is in most cases mostly at the level of slight anthropogennous pollution, only in suspended solids limits were sporadically exceeded for risk pollution in the contents of Cr, Ni and benzo(a)pyrene, and limits of increased pollution for Hg, Cd and Zn.
- the goal limits of MKOD are not met in the last year of monitoring only by Cu and Ni in solid matrices
- usually quoted runoff of dangerous matters only in water is non-representative and significantly under-estimating the overall perspective of the matter transport in water environment. This information is best supplemented by the evaluation of matter transport in suspended solids.

It may be said, that the evaluation of the loading of water ecosystem only on the basis of data from point water samples often does not provide an objective information about the overall quality of surface water. It is just the complex conception of monitoring that enables the reliable control of the influence of waste water release, and the verification of the effectivity of programs of measures, accepted within the framework of the lowering and the gradual elimination of dangerous matters in the water environment, as required by the EU.

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