AUGUST 2002 FLOOD EVENTS IN THE CZECH REPUBLIC – SOME EVIDENCE ON THE EXTENT OF POLLUTION DIFFUSED DURING THE FLOOD

Vladimir Chour

HYDROPROJEKT CZ a.s., Taborska 31, 140 16 Praha, Czech Republic

ABSTRACT

During about first half of August 2002, an extraordinary atmospheric circulation pattern in Middle Europe resulted in 10 or even more days of continuous heavy rainfall over extensive parts of both Danube, and Elbe watersheds consequently leading to extremely severe flood events namely in Austria, Hungary, Czech Republic and Germany. Preliminary information on the flood damages in the Czech Republic was presented already on the Amsterdam IWA DP Conference in October 2002. Results and conclusions of surveys comparing flood severity, pre-flood vs. flood-period monitoring of principal pollutants concentrations in two profiles of Elbe river, i. e. below flooded Spolana Neratovice Chemical Plant and in Decin town near the Czech-Germany border, survey of Elbe river sediments, residual pollution in agricultural soils flooded by Elbe river and some other available evidence concerning pollutants diffused during the flood events is presented. It is concluded from the survey results that large amounts of pollutants were detached and transported by the rainfall-initiated runoff and flood flows events affecting extremely large area. Still these flows can be classified as storm-water runoff or white flows that, compared by concentrations, are less polluted than the dry weather flows. However, the pollution level is still relatively high and – in addition to local accident leakages of dangerous elements - urban storm-water inputs from streets, roads and other areas impacted by traffic, are responsible for most of the pollution by toxic micro-pollutants. They also carry high concentrations of suspended solids originated mostly from soil erosion and river sediments detachment. The level of typical organic pollution parameters such as BOD or COD were commonly relatively low.

INTRODUCTION

During about first half of August 2002, an extraordinary atmospheric circulation pattern in Middle Europe resulted in 10 or even more days of continuous heavy rainfall over extensive parts of the Czech Republic territory (Figure. 1).

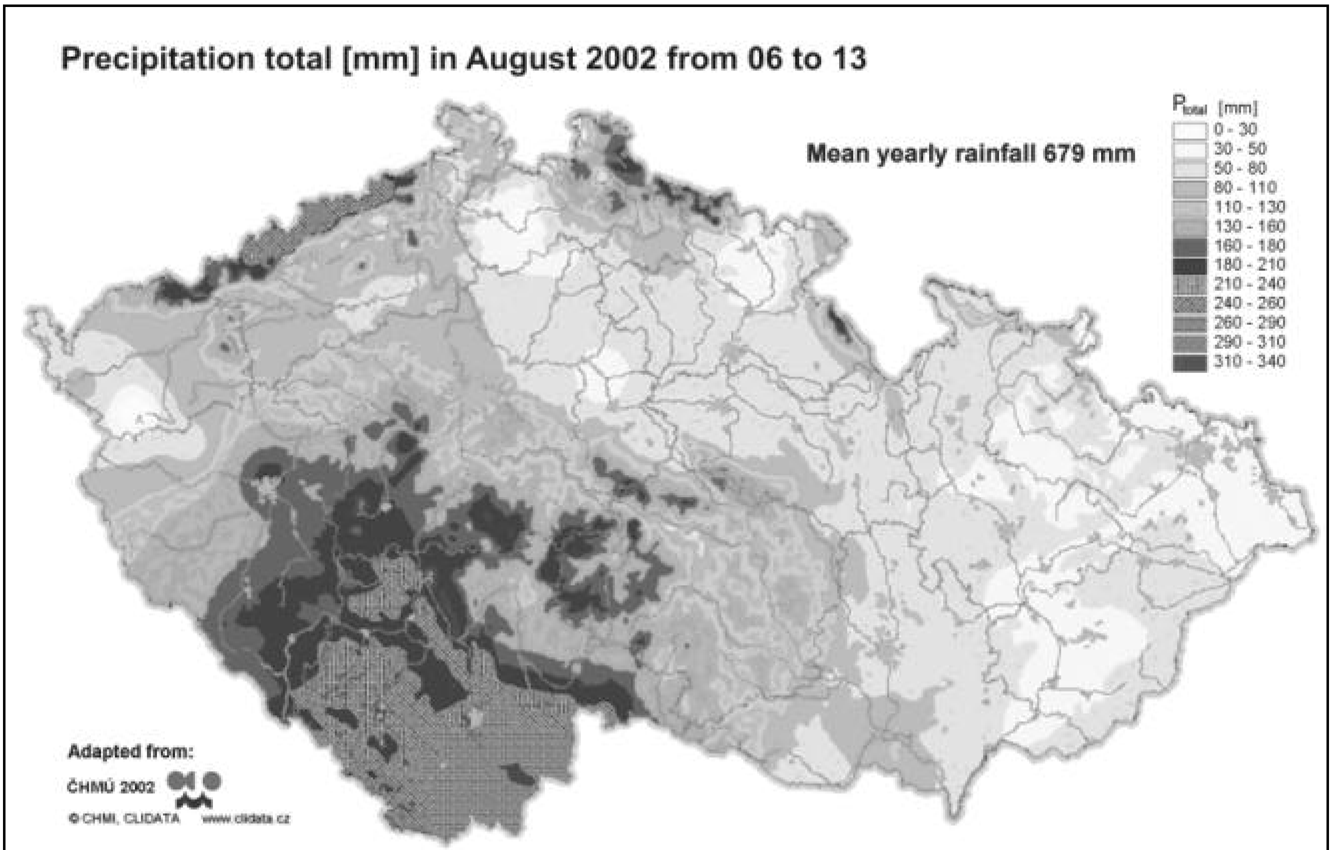

Figure. 1. Pattern of the August 2002 rainfall on the Czech Republic territory

As a result of the rainfall, extraordinary heavy floods characterized by peak flows often considerably overreaching 100 years of return period (Q_{100}) occurred during the week following after 12^{th} August namely on the Vltava river and subsequently on the Elbe below its confluence with Vltava (Figures. 2, 3). High backwater also flooded a number of communities on Elbe above the confluence including the chemical plant Spolana Neratovice.

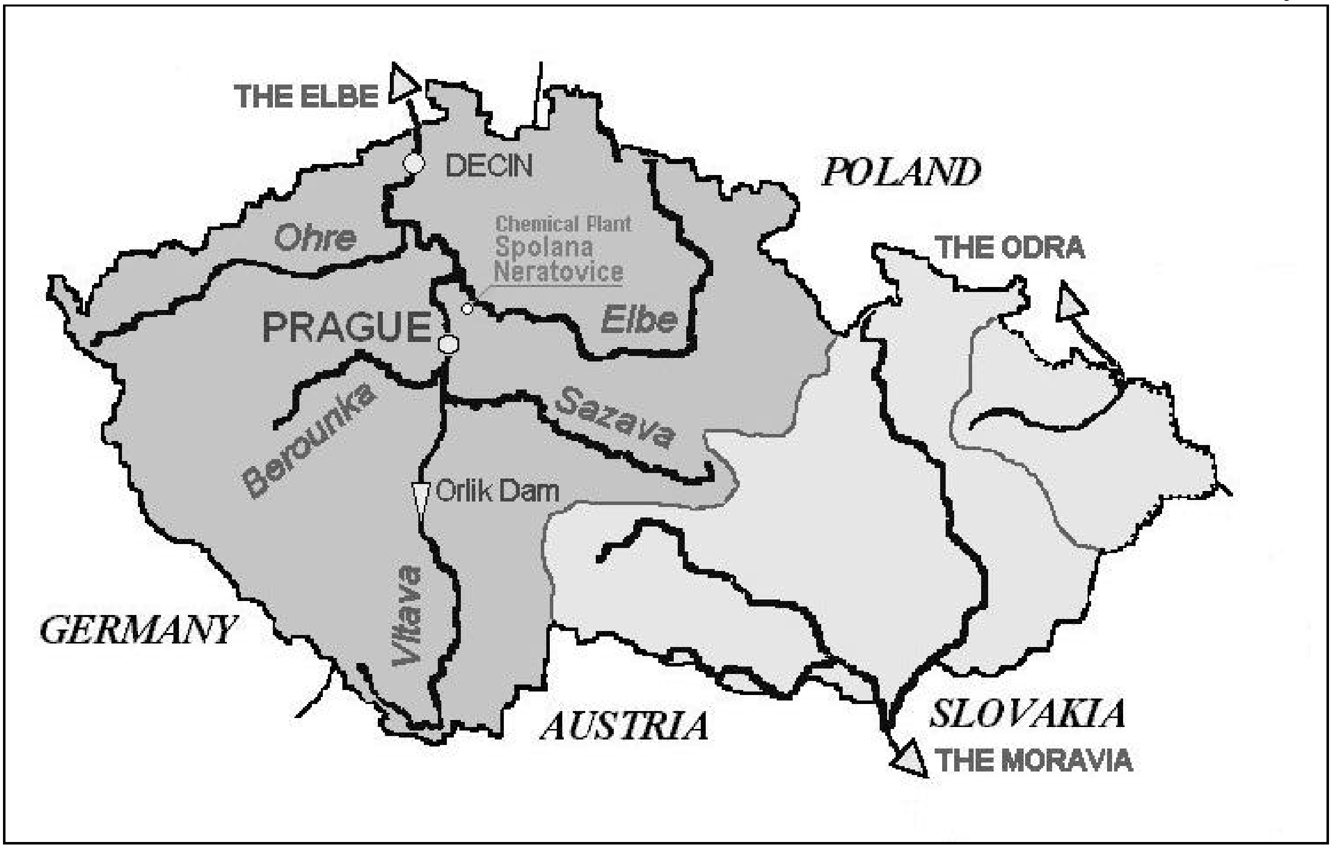

Figure. 2. The Elbe watershed scheme on the Czech territory (dark shaded)

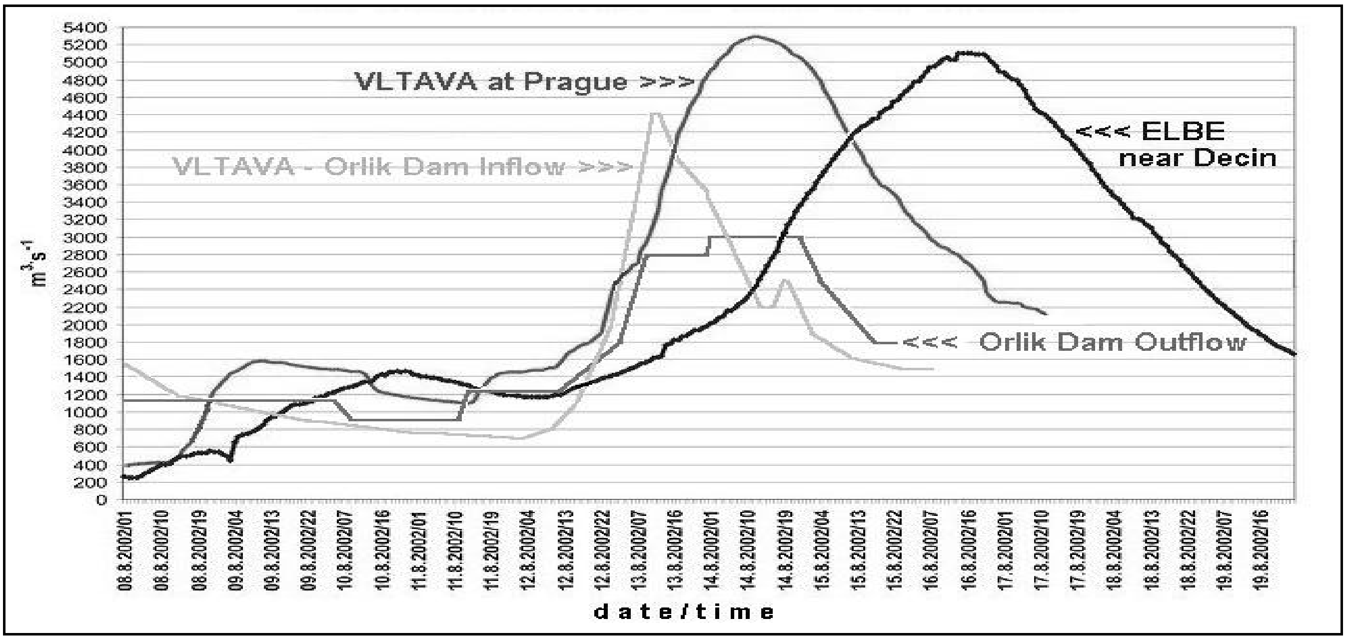

Figure. 3. Course of the flood in three characteristic river profiles, e.g. at Orlik, the largest water reservoir/dam on the Vltava river, at Prague and near Decin town on the Elbe.

MATERIAL AND METHODS

Elbe water quality monitoring (Data from Povodi Labe, Hradec Kralove, published at http://www.pla.cz/)

In accordance with the International Commission for Elbe Protection monitoring programme, in total 166 water quality parameters including classical organic pollution, nutrients, basic chemical composition, heavy metals, specific organic compounds and bacterial pollution are regularly monitored at defined river profiles. Due to anticipated uncontrolled discharges of dangerous and other pollutants during the August flood events, an extraordinary special monitoring was performed between 16th August and 9th September at five checking profiles located on the Elbe section between Neratovice and the Czech/ Germany boundary profile. In addition standard monitoring was performed at Obristvi (below Neratovice) and Decin profiles on 21st August.

During the special flood monitoring campaign (August 16 –September 10, 2002) 7to 11 samples had been analysed at each of five selected monitoring profiles. Water quality parameters that continuously were found below the measurement detection limits were excluded, while all others were subjected to systematic statistic analyses leading to determination of mean, minimum, and maximum concentrations and number of samples. The received data were compared with those obtained by the regular water quality monitoring for the selected period from January 1, 2000 up to September 9, 2002. The following can be briefly concluded from the comparison:

Organic Pollution

Patterns of organic pollution were well characterized by the COD_{Mn}, COD_{Cr} and TOC parameters. Increased concentrations occurred during the flood wave initial rise, however, recorded maximum values were not higher that values recorded during previous two years both at Obristvi and Decin profiles of Elbe (Figure. 4 a,b.) Also permissible concentration limits fixed in the Czech government decree No. 82/1999 Col. in agreement with the EU legislation were not overreached. Only one sample at Obristvi profile exhibited the COD_{Cr} and TOC parameters just equal to the relevant concentration limit.

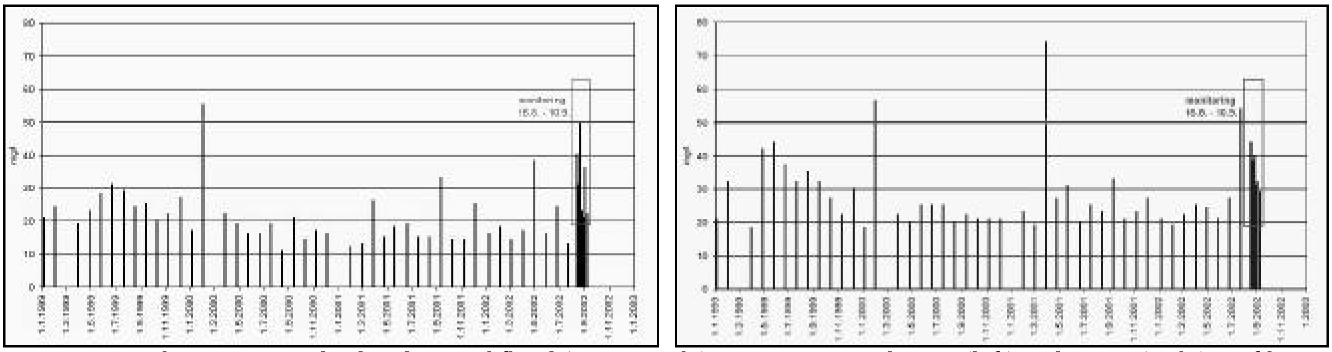

Figure. 4 a,b. COD_{Cr} standard and special flood (in rectangle) monitoring at Obristvi (left) and Decin (right) profiles

Nutrients

As concerns nutrients, only increased concentrations of ammonium nitrogen had been registered. Values overreaching maximum concentrations from previous two years (up 1.6 mg/l NH_4-N) were recorded at Obristvi profile. It is assumed that considerable part of this increase is attributable to flushing of rather big amount of ammonium salts from the Spolana Neratovice chemical plant. However, in this case the permissible limit equal to 2.5 mg/l NH_4-N was not reached. Ammonium nitrogen concentrations at Decin profile had not overreached two-year maximums and were at about one halve of those recorded at Obristvi (Figure. 5 a,b).

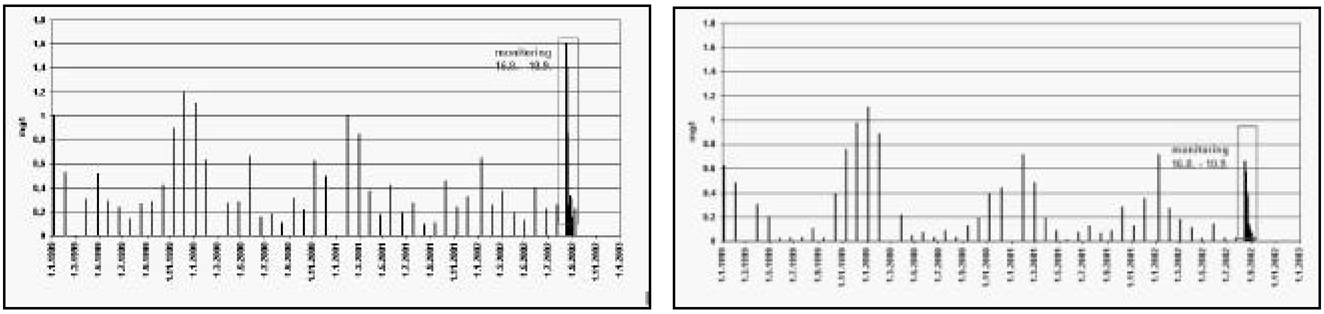

Figure. 5 a,b. NH_4-N_r standard and special flood (in rectangle) monitoring at Obristvi (left) and Decin (right) profiles

AOX

The AOX parameter expressing summary pollution with specific organic compounds had not revealed any practical increase in concentrations if compared with the previous time period. The permissible concentration limit equal to 50 ìg/l had never been overreached at Obøíství, while just one sample at Decin showed concentration increased by 30 = over this limit.

Short-time increase of 1,2-dichlorethane over 10 ìg/l of permissible limit at Obristvi had served as an evidence of some leakage of this substance from Spolana Neratovice chemical plant. The maximum monitored value of 12 ìg/l is however lower than maximums temporarily recorded there in past times. The plant is now a subject of increased attention paid by the Czech environmental inspection. No increased concentration of 1,2-dichlorethane was monitored at Decin where maximum measured concentration was 0.41 ìg/l.

Hydrocarbons

Non-polar extractable matter (or hydrocarbon oil index) parameter had shown short-term pollution at both Obristvi and Decin profiles. Samples with about 10 % concentration increase above 0.2 mg/l of permissible limit were sporadically detected as well, as samples overreaching maximum concentrations monitored during last two years (Figure. 6a,b).

Leakages of oil substances from un-sufficiently secured oil tanks and other facilities are supposed to be principal sources of this kind of pollution.

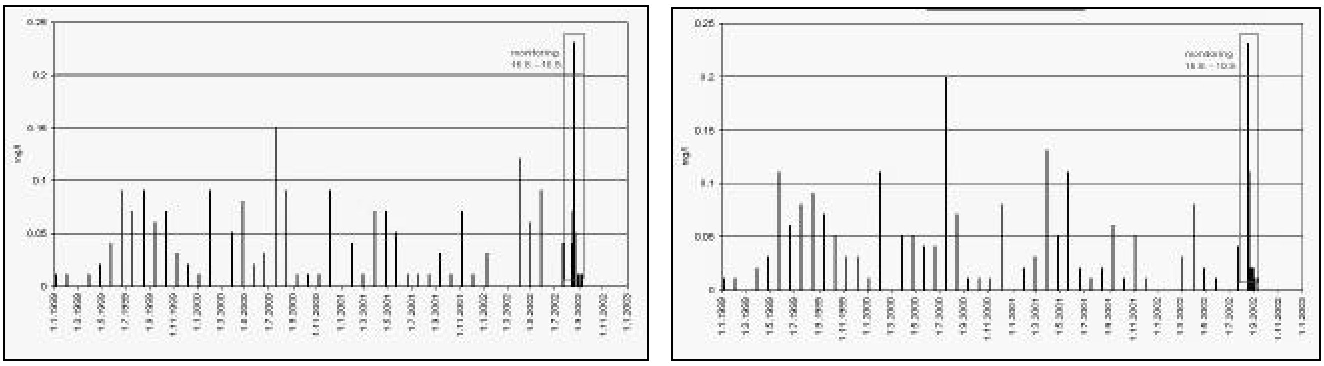

Figure. 6 a,b. Standard and special flood (in rectangle) monitoring of non-polar extractable matter at Obristvi (left) and Decin (right) Elbe profiles

Metal concentrations :.

At both Obristvi and Decin profiles, different level of iron (Figure. 7 a,b), manganese, arsenic, aluminium concentrations increases were detected, while copper and zinc contents remained practically without any changes. Permissible concentration limit was overreached only with iron concentration (0.2 mg/l) at Decin profile. Maximum values recorded during previous two-year period were nor overreached by any of surveyed parameters with exception of lead, that namely at Obristvi profile showed several-times increase of concentrations. One of the extreme value. i.e. 87,1 ìg Pb/l might probably be put in connection with escape of pollutants from Neratovice chemical plant. However, this assumption could not have been confirmed by any other survey, and, permissible limit of 100 ìg Pb/l have never been overreached.

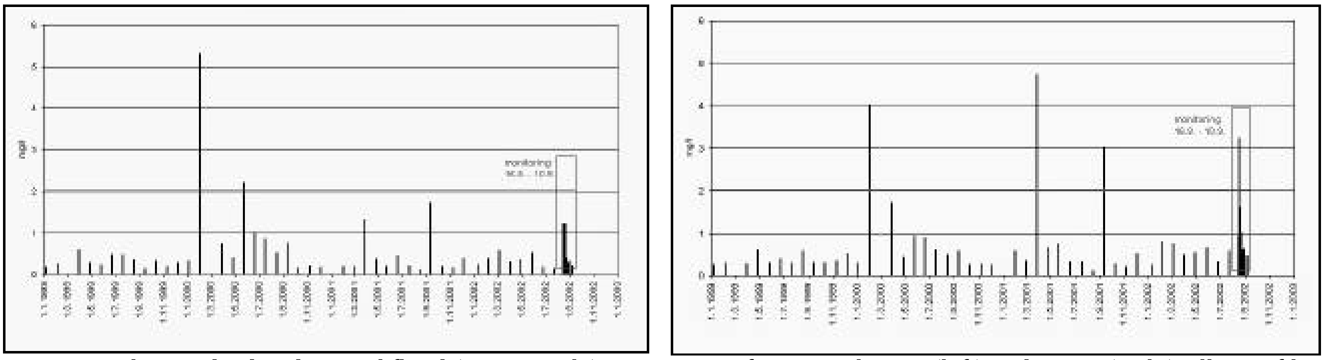

Figure. 7 a,b. Standard and special flood (in rectangle) monitoring of iron at Obristvi (left) and Decin (right) Elbe profiles

Elbe sediment quality monitoring

The following table shows summarized data of the Povodi Labe, Hradec Kralove monitoring, actualised to September 6, 2002, published at http://www.pla.cz/):

From Table 1 it can be concluded that increase of AOX level to about two-year maximum values were recorded on 19th and 20th August monitoring at both Obristvi and Decin. Dramatic increase up to about 100-times compared with the previous were recorded at Decin with beta-HCH and p,p-DDT. Most probable cause of this increase is in detachment of old sediments contaminated in past times from the former DDT-production plant at Usti nad Labem that was closed many years ago. Compared with previous three-year period, both classical pollution and heavy metals parameters displayed substantially lower values.

Contamination of flooded agricultural soils

First complex sampling and analyses of soil contamination had been performed by the state water administration board SVHS Brno during summer-autumn period on several hundred hectares of agricultural land near the confluence of Ohre and Elbe rivers focused on contents of dangerous elements (As, Be, Cd, Co, Cr, Mo, Ni, Pb, V, Zn and Hg), adsorbed organically bounded chlorine (AOCl), non-polar extractable matter (NEL), polychlorinated bi-phenyls (PCB), soil acidity and basic nutrients (Nmin, P, K, Mg and Ca). Surveyed values were compared with maximum permissible values set out in Czech government decrees No. 13/1994 Coll. and No. 275/1998 Coll. values.

From the survey results it can be concluded that neither dangerous elements nor dangerous organic compounds contents were generally influenced by soil flooding. Surveyed values were substantially lower than maximum permissible limits and similar to found in other agricultural soils. Similar conclusion is valid as concerns basic agrochemical properties of flooded soils. Limited areas of land, namely local depressions with heavy clay sub-layers suffered for relatively longer time by water-logging.

Table I. Review of Elbe sediment quality monitoring

Sampled profile >>>		Elbe Obristvi		Elbe Decin		Elbe Loubi right bank	Elbe Loubi left bank	Target of ICPE*
Parameter	Unit	8/19/02	Mean 1999 - 2001	8/20/02	Mean 1999 - 2001	8/21/02	8/21/02	
TOC	mg/kg	31700.0	10950.0	2800.0	9814.0	4900.0	18600.0	
AOX	mg/kg	43.0	18.0	54.0	18.0	15.0	59.0	50
P total	mg/kg	1580.0	2763.0	1000.0	3363.0	510.0	1710.0	
Fe	mg/kg	22300.0	42567.0	18600.0	45871.0	13400.0	21700.0	
Mn	mg/kg	841.0	1588.0	521.0	2921.0	282.0	1060.0	
Zn	mg/kg	200.0	480.0	148.0	862.0	62.0	277.0	200
Ni	mg/kg	25.0	52.0	24.0	68.0	14.0	26.0	60
Pb	mg/kg	51.0	100.0	28.0	135.0	22.0	60.0	100
As	mg/kg	11.0	25.0	6.0	23.0	8.0	11.0	30
Cu	mg/kg	34.0	106.0	29.0	108.0	11.0	40.0	80
Se	mg/kg	<1,0		<1,0		<1,0	<1,0	
Hg	mg/kg	0.60	1.8	0.30	2.7	0.20	0.80	0.8
Cd	mg/kg	1.10	3	0.30	3.6	0.10	1.30	1.5
Ag	mg/kg	<1.0	<1.0	<1.0	<1.0	<1,0	<1,0	
V	mg/kg	48.0	79	40.0	89	30.00	52.0	
Cr	mg/kg	56.0	112	45.0	126	30.00	63.0	150
Al	mg/kg	27100	44850	15900	42086	12600	25900	
Co	mg/kg	9.0	20	9.0	27	6.0	10.0	
Ba	mg/kg	148	354	143	478	70	161	
Be	mg/kg	1.30	3.1	1.00	3.5	1.00	1.50	
Mo	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	
c-l,2-DCE	μg/kg	<20,00		<20,00		<20,00	<20,00	
TCM	μg/kg	<20,00	<50	<20,00	<50	<20,00	<20,00	
1,2-DCEt	μg/kg	<20,00	<50	<20,00	<50	<20,00	<20,00	
TCE	μg/kg	<20,00	<50	<20,00	<50	<20,00	<20,00	
benzen	μg/kg	<20,00	<50	<20,00	<50	<20,00	<20,00	
toluen	μg/kg	79.00	121	72.00	138	<20,00	131.00	
xyleny	μg/kg	<20,00	<50	<20,00	<50	<20,00	20.00	
EtB	μg/kg	<20,00	<50	<20,00	<50	<20,00	<20,00	
TTCE	μg/kg	30.00	<20	<20,00	<20	<20,00	45.00	
CB	μg/kg	<20,00	<50	<20,00	<50	<20,00	<20,00	
1,3-DCB	μg/kg	<20,00	46	<20,00	46	<20,00	<20,00	
1,4-DCB	μg/kg	39.00	90	23.00	74	<20,00	34.00	
1,2-DCB	μg/kg	<20	<50	<20,00	<50	<20,00	<20,00	
1,2,4-TCB	μg/kg	8.90	24	12.00	40	<5,00	17.00	
naftalen	μg/kg	126	149	83	116	129	156	
PCB 28	μg/kg	7.2	7.5	7.7	7	3	4.4	
PCB 52	μg/kg	6	6.3	6.5	5.6	<3	3.9	
PCB 101	μg/kg	6.5	6.2	5.2	13	23	5.5	
PCB 118	μg/kg	<3		<3		5.5	<3	
PCB 138	μg/kg	15	6.6	3	31	57	6.5	
PCB 153	μg/kg	16	5.1	13	27	80	9.8	
PCB 180	μg/kg	12	5	9.2	23	75	8.1	
alfa-HCH	μg/kg	<3.0	<5.0	<3.0	<5.0	<3,0	<3,0	
HCB	μg/kg	11.0	7.8	20.0	105	18.0	51.0	40
pentaCB	μg/kg	<5.0		<5.0		<5,0	<5,0	
beta-HCH	μg/kg	8.6	<5.0	960.0	<5.0	<3,0	<3,0	
gama-HCH	μg/kg	<3.0	<5.0	<3.0	<5.0	<3,0	<3,0	10
p,p-DDE	μg/kg	16.0	5.2	25.0	20	3.8	50.0	
p,p-DDD	μg/kg	11.0	6	120.0	11	<3,0	38.0	
p,p-DDT	μg/kg	29.0	8	25800.0	46	19.0	230.0	
PAU-6	μg/kg	2160	933	777	639	1600	2950	
fenanthrene	μg/kg	234.0	743	58.0	67	200.0	402.0	
anthracene	μg/kg	105	70	42	<50	74	172	
fluoranthen	μg/kg	808	273	316	229	616	1250	
pyrene	μg/kg	657	269	235	137	545	1020	

* ICPE – International Commission for the Protection of the Elbe founded according to the EU Council Decision 91/598/EEC of 18 November 1991 91/598/EEC (OJ L 321, 23.11.1991 p.24)

The above results must not be generalized, as they are valid for surveyed area only. However, an assumption can be formulated that there are relatively low level of soil agrochemical damage at locations far from flood-generated pollution sources, e.g. chemical plants. Systematic additional survey of soils near such plants is planned by the Czech ministries of agriculture and environment.

DISCUSSION AND CONCLUSIONS

The monitoring and surveys data evidenced that large amounts of pollutants were detached and transported by the runoff and flood flows initiated by storm events affecting extremely large area. Still these flows could be classified (Novotny, 2003) as storm-water runoff or white flows that, compared by concentrations, were generally equal or less polluted than the dry weather flows and/or flood flows monitored during previous years. However, the pollution level was still relatively high and – in addition to local accident leakages of dangerous elements from chemical plats etc. - urban storm-water inputs from streets, roads and other areas impacted by traffic, were apparently responsible for most of the pollution by toxic micro-pollutants. They also carried high concentrations of suspended solids originated mostly from soil erosion and river sediments detachment. The levels of typical organic pollution parameters such as BOD or COD were relatively low.

ACKNOWLEDGEMENT
Most of the data used in the article were gathered by the author from numerous Internet websites and/or mostly short newspaper and journal articles. Thanks should be therefore expressed to all of these anonymous persons that provided very valuable set of information on the August 2002 flood in the Czech Republic.

REFERENCES
Martinek, P. – Verner, S. (2002): Vyhodnoceni jakosti vody Labe v prubehu povodnove situace 16.8. – 10.9.2002 (Assessment of Elbe river water quality during floods events on August 16 – September 9, 2002). Povodi Labe, Hradec Kralove, September 2002 (Czech at http://www.pla.cz/)

Novotny, V. (2003): Diffuse pollution - a regional outlook. Paper prepared for publication, Vodni hospodarstvi Journal, No. 6/2003