ICPER workshop ICPER, Ministry of the Environment of the Czech Republic

Bedeutung der Altsedimente der Elbe und Ihrer Seitenstrukturen im Abschnitt von Pardubice bis Moldaumündung für das Sedimentmanagement im Einzugsgebiet der Elbe

Význam zatížených sedimentů v Labi a jeho postranních strukturách v úseku od Pardubic po soutok s Vltavou pro management sedimentů v povodí Labe

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Prague, 28.5.2015

- **part of ELSA project - Schadstoffsanierung Elbsedimente**

http://www.elsa-elbe.de/

= restoration of polluted Elbe sediments

Source: HPA - METHA

- ***Main partner:***

Freie und Hansestadt Hamburg

- Behörde für Stadtentwing und Umwelt
Amt für Umweltschutz,
Wasserwirtschaft

Hamburg Port Authority - Hafeninfrastruktur,
Infrastruktur Wasser

- ***Main researcher:***

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- ***Co-researchers:***

Povodí Labe, s.p., Hradec Králové – ***Ing. Jiří Medek, Ing. Stanislav Král***
Geomin, s.r.o., Jihlava - ***RNDr. Michal Černý, Ing. Miroslav Žáček, Ph.D.***
DHI, a.s., Praha - ***Ing. Petr Jiřinec, RNDr. Jana Kaiglová***

Phases, goals and methods

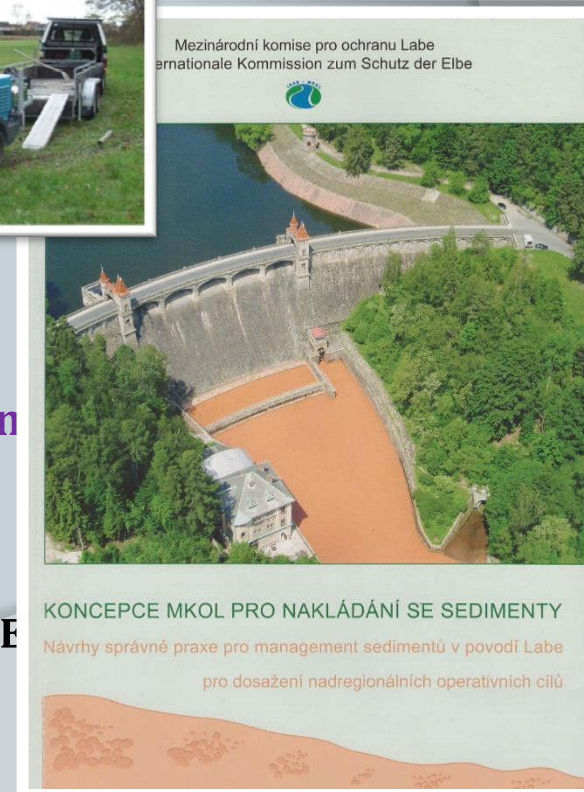
- **identification of the most contaminated localities in the middle course of the Elbe River** - project focused on side river structures

- **monitoring plan**

Phase 1 - mixed samples of subaquatic sediments from fluvial lakes (oxbow/cut lakes)
Phase 2 – subaquatic cores from fluvial lakes (oxbow/cut lakes) + floodplain cores

- **evaluation of sediment contamination**

grain structure analyses, chemical analyses
evaluation according to the methodology of the FGG Elbe and ICPER



- **estimation of sediment volume**

maps, measurements, field survey

- **risk assessment of the flood remobilisation of sedimen**

mathematical modelling

- **complex risk assessment of selected localities**

evaluation according to the methodology of the FGG Elbe and ICPE

- **suggestions and measures**

Localities and sources of pollution:

- **Pardubice region:**

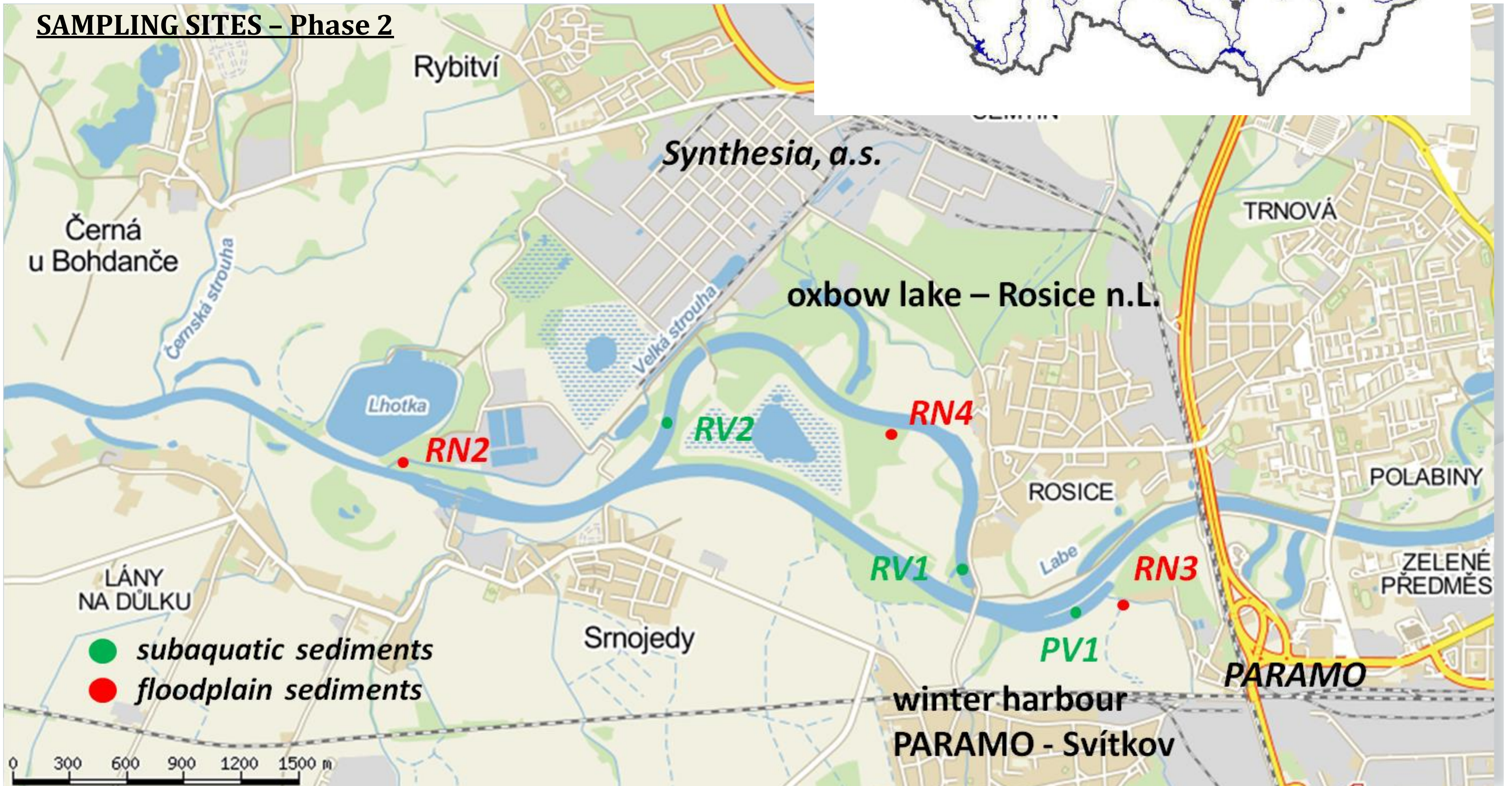
Synthesia, a.s. - chemical factory - originally Explosia, later VCHZ Synthesia

- production of explosives, substances for production of explosives, pigments, dyes , AOX, other chemicals…

PARAMO, a.s. - refinery

- lubrication oils, plastic lubricants, asphalt products

SAMPLING SITES – Phase 2

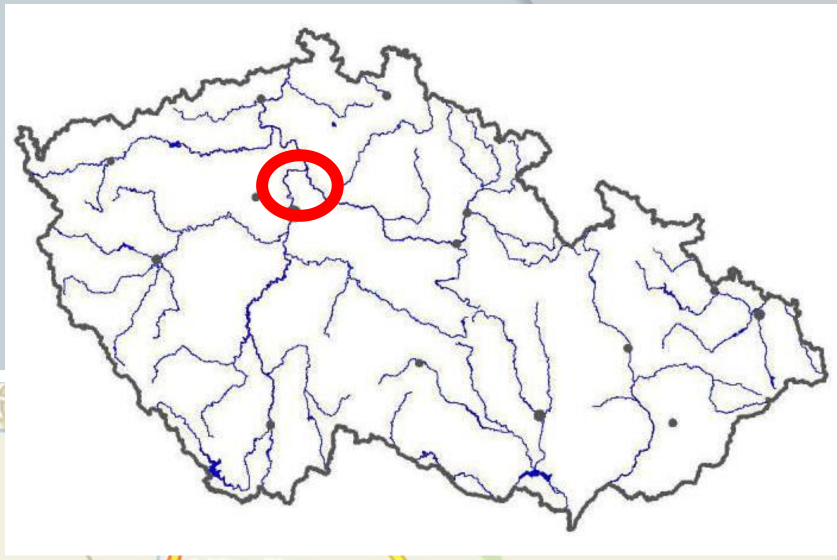


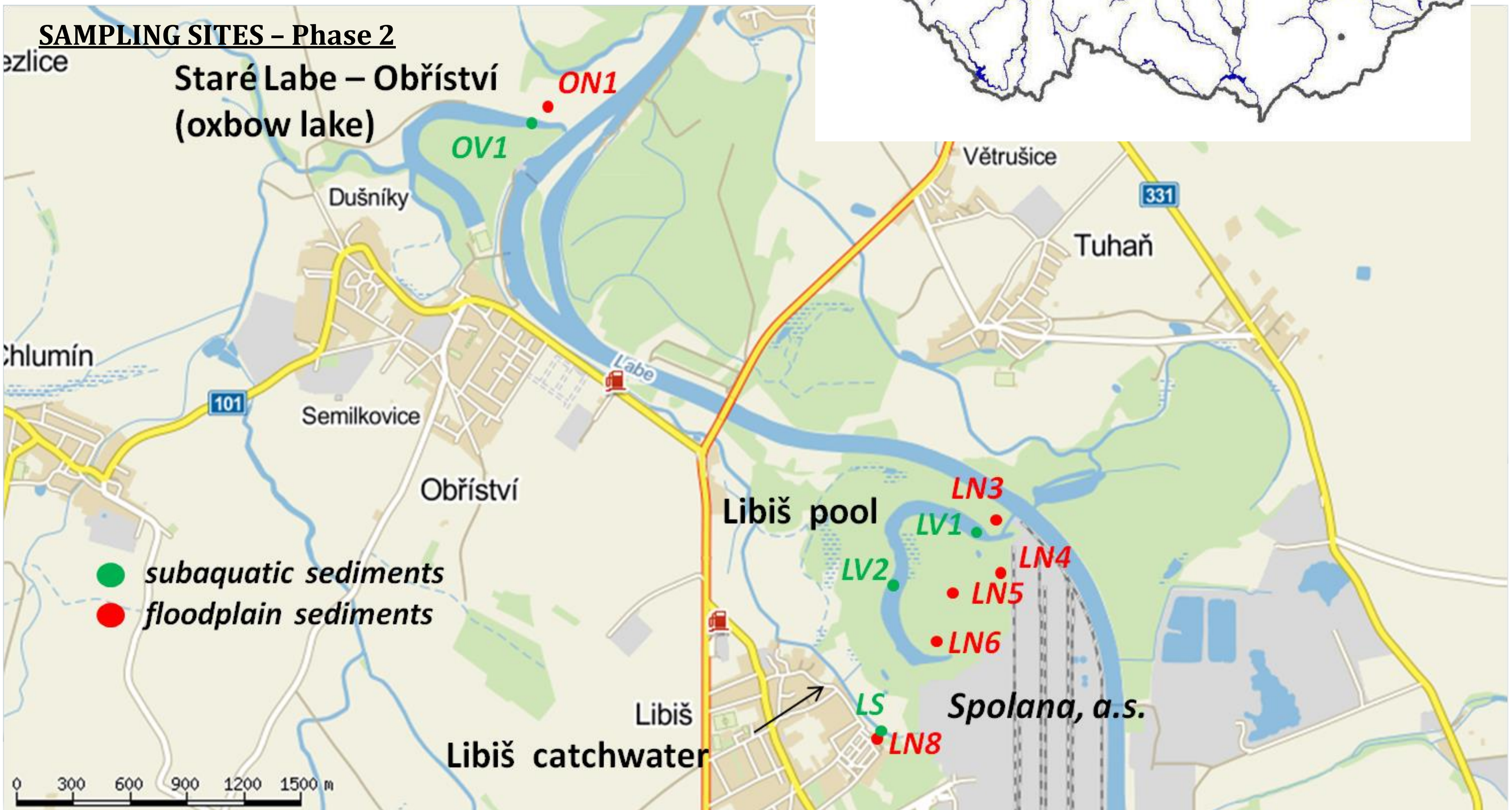
Localities and sources of pollution:

- **Neratovice and Obříství:**

Spolana, a.s., **- chemical factory,**

- linear alpha olefins, Hg from chlorine production by the use of outdated amalgam electrolysis, DDT, lindan and dioxins from herbicide and Agent Orange production)

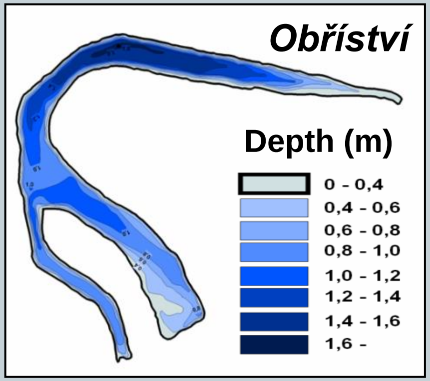


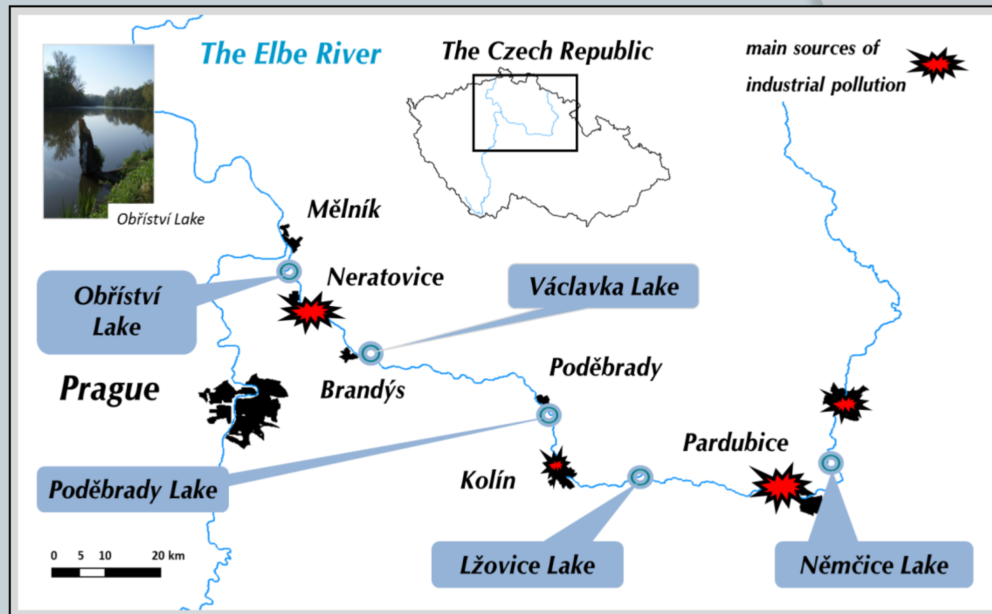


Research – Faculty of Science, Charles University in Prague
Department of physical geography and geoecology

- **Complex limnological studies of selected fluvial lakes – the Elbe River**

Bathymetry
Water quality
Hydrobiology
Sediment pollution
Vegetation
Sedimentation dynamics





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- *Šnajdr, M. (2002): Limnologické poměry, kvalita vody a sedimentů v mrtvém labském rameni u Obříství. Diplomová práce. PřF UK, Praha, 86 s.*
- *Šobr, M. (2007): Jezera České republiky - Fyzickogeografické a fyzikálně limnologické poměry. Disertační práce. PřF UK, Praha, 235 s.*
- *Turek, M. (2004): Komplexní limnologická studie odstaveného starého ramene Libišská tůň v PR Černínovsko.Diplomová práce. PřF UK, Praha, 82 s*

Sediment evaluation

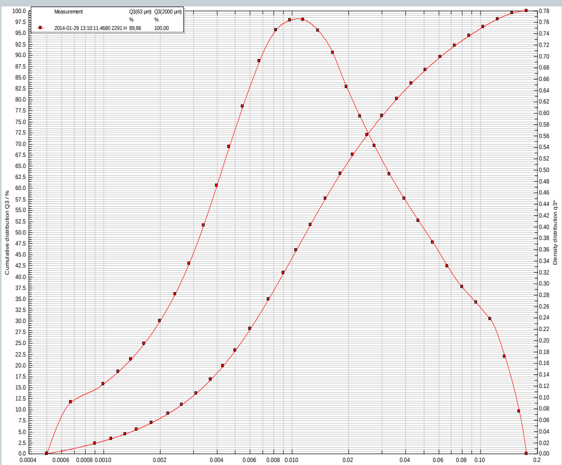
- **pollution assessment according to the Sedimentmanagementkonzept by the FGG Elbe and ICPER**

= environmental quality standards
2008/105/ES

- **other substances:**

NES, C10-40, phenanthren, pyrene, benzo(a)anthracene, chrysene

- **Grading curves**



- **Sediment quantity**

oxbow lake by Rosice: 37 500 m³
winter harbour PARAMO: 13 000 m³
Libiš pool: 76 000 m³
Libiš catchwater: 9 500 m³
Staré Labe u Obříství
(oxbow lake): 71 000 m³

Číslo	Substance	Unit	Lower Limit Value		Upper Limit Value	Source - Upper Limit Value
1	Mercury	mg/kg	< 0,15	0,15 - 0,47	0,47	23/2011 Sb.
2	Cadmium	mg/kg	< 0,22	0,22 - 2,3	2,3	23/2011 Sb.
3	Lead	mg/kg	< 25	25 - 53	53	23/2011 Sb.
4	Zinc	mg/kg	< 200	200 - 800	800	OGewV 2011
5	Copper	mg/kg	< 14	14 - 160	160	OGewV 2012
6	Nickel	mg/kg	-		3	23/2011 Sb.
7	Arsenic	mg/kg	< 7,9	7,9 - 40	40	OGewV 2012
8	Chromium	mg/kg	< 26	26 - 640	640	OGewV 2012
9	α-HCH	µg/kg	< 0,5	0,5 - 1,5	1,5	GÜBAK 2009
10	β–HCH	µg/kg	-		> 5	RHmV 2009
11	γ-HCH	µg/kg	< 0,5	0,5 - 1,5	1,5	GÜBAK 2009
12	p,p´DDT	µg/kg	< 1	1.3	3	GÜBAK 2009
13	p,p´DDE	µg/kg	< 0,31	0,31 - 6,8	6,8	de Deckere et al.2011
14	p,p´DDD	µg/kg	< 0,06	0,06 - 3,2	3,2	de Deckere et al.2011
15	PCB-28	µg/kg	< 0,04	0,04 - 20	20	OGewV 2012
16	PCB-52	µg/kg	< 0,1	0,1 - 20	20	OGewV 2012
17	PCB-101	µg/kg	< 0,54	0,54 - 20	20	OGewV 2012
18	PCB-118	µg/kg	< 0,43	0,43 - 20	20	OGewV 2012
19	PCB-138	µg/kg	< 1	1. - 20	20	OGewV 2012
20	PCB-153	µg/kg	< 1,5	1,5 - 20	20	OGewV 2012
21	PCB-180	µg/kg	< 0,44	0,44 - 20	20	OGewV 2012
22	Pentachlorbenzene	µg/kg	< 1	1 - 400	400	23/2011 Sb.
23	Hexachlorbenzol	µg/kg	< 0,0004	0,0004 - 17	17	23/2011 Sb.
24	Benzo(a)pyrene	mg/kg	< 0,01	0,01 - 0,6	0,6	de Deckere et al.2011
25	Anthracene	mg/kg	< 0,03	0,03 - 0,31	0,31	23/2011 Sb.
26	Fluoranthene	mg/kg	-		> 0,18	23/2011 Sb.
27	Σ PAHs 5	µg/kg	< 0,6	0,6 - 2,5	> 2,5	23/2011 Sb.
28	TBT	µg/kg	-		> 0,02	23/2011 Sb.
29	Dioxine/Furane	ng TEQ/kg	< 5	5. - 20	> 20	Evers et al. 1996

PAU 5 = benzo(b)fuoranthene, benzo(k)fluoranthene, benzo(a)pyrene, benzo(ghi)perylene, indeno(cd)pyrene

Pollution assessment – Phase 2 Pardubice region

- concentration < Lower Limit Value green; concentration > Lower Limit Value and < Upper Limit Value yellow; concentration > Upper Limit Value red; concentration without possibility of classification blue

R = Rosice
P = harbour PARAMO
N = floodplain core
V = lake core
1=20cm 2=30cm
3=30cm 4=70cm

Parameter	Zn	Ni	Pb	As	Cu	Hg	Cd	Cr	PCB 28	PCB 52	PCB 101	PCB 118	PCB 138	PCB 153	PCB 180
Upper Limit	800	3	53	40	160	0,47	2,3	640	20	20	20	20	20	20	20
Sample	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
RN2/1	387	39	37	37	29	0,4	1,0	100	<1	1	6	2	16	19	18
RN2/2	229	39	62	40	27	0,6	0,7	93	<1	<1	<1	<1	2	2	2
RN2/3	189	54	37	30	13	0,2	0,2	60	<1	<1	<1	<1	<1	<1	<1
RN2/4	165	47	52	41	14	1,5	0,2	64	<1	<1	<1	<1	<1	1	1
RN3/1	329	40	101	38	39	0,5	0,5	85	5	<1	<1	<1	3	3	3
RN3/2	304	42	94	43	39	0,5	0,5	88	<1	<1	<1	<1	3	2	5
RN3/3	142	37	42	37	13	0,1	0,2	66	<1	<1	<1	<1	<1	1	1
RN3/4	107	37	39	35	4	0,1	0,1	60	3	<1	<1	<1	<1	<1	<1
RN4/1	231	37	62	31	25	0,2	0,4	64	<1	<1	<1	<1	<1	<1	<1
RN4/2	98	26	29	40	2	0,2	0,2	43	1	<1	<1	<1	2	2	2
RN4/3	146	42	49	48	11	0,2	0,3	72	<1	<1	<1	<1	<1	<1	<1
RN4/4	117	38	36	42	3	0,2	0,2	59	<1	<1	<1	<1	<1	<1	<1
RV1/1	249	33	55	16	41	0,4	0,7	63	2	2	3	2	7	10	9
RV1/2	427	42	74	7	77	0,5	1,8	150	5	13	6	4	15	21	17
RV1/3	422	42	83	17	74	0,5	3,4	229	6	11	9	4	19	25	21
RV1/4	591	39	77	15	66	0,5	2,3	201	11	19	13	6	25	34	30
RV2/1	1050	47	144	5	140	1,2	3,2	342	2	4	11	6	17	20	16
RV2/2	577	39	121	10	82	0,9	0,6	178	2	3	5	5	10	10	6
RV2/3	522	42	115	9	73	0,8	1,2	167	2	2	5	4	8	8	5
RV2/3	444	41	111	14	65	0,7	1,2	158	16	14	27	23	28	32	9
PV/1	**1780**	45	181	23	238	4,4	2,7	71	25	13	34	13	69	88	74
PV/2	1290	58	142	18	211	2,0	2,7	83	69	47	32	15	92	102	103
PV/3	**1430**	61	385	15	240	2,2	3,0	116	51	64	51	25	114	130	126
PV/4	**1610**	55	381	22	170	2,0	3,0	115	18	16	30	14	58	73	63

Pollution assessment – Phase 2 Pardubice region

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1=20cm 2=30cm
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Parameter	alfa-HCH	HCB	pentaCB	beta-HCH	gama-HCH	p,p-DDE	p,p-DDD	p,p-DDT	PAU-5	anthracene	fluoranthene	b(a)pyrene	C10-C40	NES	TBT
Upper Limit	1,5	17	400	>5	1,5	6,8	3,2	3	>2,5	0,31	>0,18	0,6			>0,02
Sample	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	mg/kg	mg/kg	µg/kg
RN2/1	<3	<3	<3,0	<3	<3	4	<3	17	774	63	419	211	<100	263	
RN2/2	<3	<3	<3,0	<3	<3	<3	<3	<3	192	24	116	47	<100	61	
RN2/3	<3	<3	<3,0	<3	<3	<3	<3	<3	<29	5	9	5	<100	167	
RN2/4	<3	<3	<3,0	<3	<3	<3	<3	<3	<28	10	17	7	<100	34	
RN3/1	<3	6	<3,0	<3	<3	<3	4	9	3327	813	2060	992	390	443	
RN3/2	<3	4	<3,0	<3	<3	<3	6	49	707	37	264	138	250	270	
RN3/3	<3	<3	<3,0	<3	<3	<3	<3	<3	144	21	74	36	<100	115	
RN3/4	<3	<3	<3,0	<3	<3	<3	<3	<3	92	19	63	24	<100	21	
RN4/1	<3	<3	<3,0	<3	<3	<3	<3	<3	<24	13	40	7	<100	60	
RN4/2	<3	<3	<3,0	<3	<3	<3	<3	<3	147	20	80	36	<100	195	
RN4/3	<3	<3	<3,0	<3	<3	<3	<3	<3	205	27	126	57	<100	130	
RN4/4	<3	<3	<3,0	<3	<3	<3	<3	<3	98	20	76	24	<100	17	
RV1/1	<3	<3	<3,0	<3	<3	8	7	7	2361	185	1420	681	270	1878	12,0
RV1/2	<3	<3	<3,0	<3	<3	12	6	<3	2534	214	1750	469	710	2666	86,0
RV1/3	<3	<3	<3,0	<3	<3	18	8	7	3423	250	1880	915	1300	3193	180,0
RV1/4	<3	<3	<3,0	<3	<3	39	22	<3	4794	347	2620	1230	2100	3612	56,0
RV2/1	<3	<3	<3,0	<3	<3	86	56	<3	7622	824	4480	1840	10600	13211	<2,0
RV2/2	<3	<3	<3,0	<3	<3	36	26	<3	6783	607	4170	1830	2600	4475	3,7
RV2/3	<3	<3	<3,0	<3	<3	16	12	<3	6296	636	3590	1590	1300	3027	2,6
RV2/3	<3	<3	<3,0	<3	<3	<3	<3	<3	4791	619	2800	1120	1300	3043	<2,0
PV/1	<3	21	<3,0	<3	<3	38	54	5	5470	590	2080	1650	30000	39125	440,0
PV/2	<3	46	<3,0	<3	<3	62	90	25	8590	4820	7620	4220	190000	273693	
PV/3	<3	134	<3,0	<3	<3	150	980	41	8540	3040	2820	3730	220000	331531	
PV/4	<3	136	<3,0	<3	<3	48	100	6	4050	580	1590	1480	40000	33819	

Pollution assessment – Phase 2 Neratovice and Obříství

- concentration < Lower Limit Value green; concentration > Lower Limit Value and < Upper Limit Value yellow; concentration > Upper Limit Value red; concentration without possibility of classification blue

O = Obříství, L = Libiš
N = floodplain core
V = lake core, S = catchwater
1=20cm 2=30cm 3=30cm
4=50/70cm 5,6,7=50cm

Parameter	Zn	Ni	Pb	As	Cu	Hg	Cd	Cr	PCB 28	PCB 52	PCB 101	PCB 118	PCB 138	PCB 153	PCB 180
Upper Limit	800	3	53	40	160	0,47	2,3	640		20	20	20	20	20	20
Sample	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
ON1/1	313	39	86	31	68	1,1	1,00	83	3	10	5	1	4	11	9
ON1/2	623	48	162	50	106	3,5	2,5	154	<1	<1	<1	<1	3	4	5
ON1/3	364	47	111	40	61	1,6	1,1	101	4	<1	<1	<1	<1	1	1
ON1/4	291	44	106	68	49	1,3	0,8	95	4	<1	<1	<1	<1	1	1
LN3/1	411	47	75	32	64	0,6	0,9	82	6	6	3	1	4	6	5
LN3/2	213	37	66	58	41	0,9	0,6	71	2	2	2	<1	4	7	5
LN3/3	235	44	74	27	32	0,5	0,5	79	1	<1	<1	<1	<1	1	<1
LN3/4	125	38	49	21	13	0,2	0,1	59	<1	<1	<1	<1	<1	<1	<1
LN4/1	207	38	72	33	27	1,0	0,3	78	3	1	<1	<1	2	3	2
LN4/2	175	44	69	57	23	0,6	0,2	75	<1	<1	<1	<1	<1	2	2
LN4/3	165	41	51	23	13	0,2	0,1	70	<1	<1	<1	<1	<1	<1	<1
LN4/4	169	40	44	21	11	0,1	0,2	63	3	1	<1	<1	<1	1	2
LN4/5	177	40	38	18	8	0,2	0,4	53	<1	<1	<1	<1	<1	<1	<1
LN6/1	154	33	56	26	24	1,5	0,1	61	<1	<1	4	1	5	15	9
LN6/2	172	38	56	22	12	0,5	0,2	67	<1	<1	<1	<1	<1	2	<1
LN6/3	184	40	37	39	10	0,1	0,3	62	6	1	1	<1	<1	<1	<1
LN6/4	178	41	34	14	7	0,1	0,4	57	16	3	<1	<1	<1	<1	<1
LN8/1	222	39	105	28	62	1,1	0,4	67	<1	<1	3	<1	5	11	8
LN8/2	171	38	57	20	31	0,4	0,3	63	<1	<1	1	<1	2	4	3
LN8/3	190	38	65	19	35	0,6	0,3	64	<1	<1	2	<1	3	6	5
LN8/4	144	38	61	19	17	0,4	0,2	63	<1	<1	<1	<1	<1	<1	<1
LN8/5	151	53	43	17	30	0,3	0,2	71	5	<1	<1	<1	<1	<1	<1
LN8/6	100	51	24	26	22	0,2	0,1	54	<1	<1	<1	<1	<1	<1	<1
LN8/7	40	18	18	5	<2	0,2	<0,1	39	6	1	<1	<1	<1	<1	<1
LS/1	938	61	179	83	288	14,0	2,2	84	26	17	150	31	360	540	450
LS/2	226	40	54	47	69	3,2	0,7	65	7	5	12	3	49	50	46
OV1/1	391	33	97	9	130	1,7	2,0	103	13	61	20	3	14	21	18
OV1/2	399	31	107	9	134	2,4	2,3	115	32	46	16	5	19	29	26
OV1/3	335	29	77	9	104	2,2	2,9	91	200	84	31	19	26	37	25
OV1/4	584	50	146	11	178	7,3	4,1	173	45	34	26	16	29	39	31
LV1/1	865	57	131	15	153	5,7	4,0	124	51	39	31	13	44	62	48
LV1/2	2330	50	223	20	203	14,0	5,0	236	12	10	9	5	11	13	9
LV1/3	787	33	164	29	83	4,0	2,2	96	<1	<1	1	<1	2	2	1
LV1/4	167	37	64	6	31	0,5	0,5	62	<1	<1	<1	<1	<1	<1	<1
LV2/1	480	37	96	20	66	2,0	0,9	68	3	3	2	1	4	5	3
LV2/2	141	29	56	8	28	0,5	0,5	49	<1	<1	<1	<1	<1	<1	<1
LV2/3	152	40	65	5	23	0,3	0,5	61	4	<1	<1	<1	<1	<1	<1

Pollution assessment – Phase 2 Neratovice and Obříství

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1=20cm 2=30cm 3=30cm
4=50/70cm 5,6,7=50cm

Parameter	alfa-HCH	HCB	pentaCB	beta-HCH	gama-HCH	p,p-DDE	p,p-DDD	p,p-DDT	PAHs 5	anthracene	fluoranthene	b(a)pyrene
Upper Limit	1,5	17	400	>5	1,5	6,8	3,2	3	>2,5	0,31	>0,18	0,6
Sample	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
ON1/1	<3	7	<3,0	<3	<3	14	12	50	1273	103	626	359
ON1/2	<3	4	<3,0	8	<3	15	7	19	757	59	437	170
ON1/3	<3	<3	<3,0	<3	<3	5	<3	5	293	25	99	82
ON1/4	<3	<3	<3,0	<3	<3	10	<3	7	875	62	485	228
LN3/1	<3	4	<3,0	<3	<3	12	8	5	2399	212	1380	666
LN3/2	<3	7	<3,0	3	<3	33	7	12	2139	267	1230	627
LN3/3	<3	<3	<3,0	<3	<3	6	<3	<3	417	46	203	106
LN3/4	<3	<3	<3,0	<3	<3	<3	<3	<3	2356	329	1410	749
LN4/1	<3	3	<3,0	<3	<3	25	<3	8	322	33	175	84
LN4/2	<3	<3	<3,0	<3	<3	15	<3	4	122	11	62	35
LN4/3	<3	<3	<3,0	<3	<3	<3	<3	5	<17	8	7	<5
LN4/4	<3	<3	<3,0	<3	<3	<3	<3	<3	71	9	13	5
LN4/5	<3	<3	<3,0	<3	<3	<3	<3	3	<24	13	11	6
LN6/1	<3	25	<3,0	<3	<3	330	9	410	191	20	192	46
LN6/2	<3	5	<3,0	<3	<3	62	<3	47	32	27	15	7
LN6/3	<3	<3	<3,0	<3	<3	51	<3	7	<17	16	11	<5
LN6/4	<3	<3	<3,0	<3	<3	9	<3	7	48	14	31	14
LN8/1	<3	52	<3,0	<3	<3	980	15	420	379	33	204	104
LN8/2	<3	26	<3,0	<3	<3	540	9	215	340	24	176	93
LN8/3	<3	18	<3,0	<3	<3	324	6	130	168	19	103	43
LN8/4	<3	<3	<3,0	<3	<3	9	<3	4	<17	10	7	<5
LN8/5	<3	<3	<3,0	<3	<3	47	<3	19	37	18	24	10
LN8/6	<3	<3	<3,0	<3	<3	15	<3	6	37	17	14	9
LN8/7	<3	<3	<3,0	<3	<3	<3	<3	<3	<30	8	24	<5
LS/1	34	110	18,0	63	16	260	1380	890	10220	1150	9050	2740
LS/2	14	19	5,0	13	6	60	345	79	148	34	156	36
OV1/1	<3	<3	<3,0	<3	<3	8	4	<3	1962	488	1320	490
OV1/2	<3	<3	<3,0	<3	<3	10	6	<3	2034	2080	1310	467
OV1/3	<3	8	<3,0	<3	<3	21	9	4	1823	1740	991	432
OV1/4	<3	5	<3,0	<3	<3	30	26	<3	2522	1030	1320	662
LV1/1	4	7	<3,0	4	<3	91	135	4	2600	734	1580	568
LV1/2	10	8	4,1	<3	<3	220	113	5	4189	466	2270	898
LV1/3	<3	<3	<3,0	<3	<3	<3	<3	<3	3016	259	1670	704
LV1/4	<3	<3	<3,0	<3	<3	<3	<3	<3	143	41	93	29
LV2/1	4	7	<3,0	<3	<3	82	66	3	1629	165	857	308
LV2/2	<3	<3	<3,0	<3	<3	<3	<3	<3	959	120	436	229
LV2/3	<3	<3	<3,0	<3	<3	<3	<3	<3	237	34	18	15

Conclusions from chemical analyses

most polluted cores from Pardubice region:

PV (subaquatic samples from winter harbour PARAMO)
RV2 (subaquatic samples from oxbow lake by Rosice – part open to the river)

\+ several samples from floodplain cores:
RN3 (floodplain core by winter harbour PARAMO)

- Pb, Cu
- HCB (slightly higher concentrations)
- anthracene, benzo(a)pyrene,
- fluoranthene (series of samples high conc.)
- C_{10}-C_{40}, TBT

winter harbour PARAMO

Libiš catchwater

most polluted cores from Neratovice and Obříství:

LS (subaq. samples from Libiš catchwater)
LV1 (subaq. samples from NE part of Libiš pool)
OV1 (subaq. samples from Staré Labe by Obříství taken near the Elbe River)

\+ upper layers from several floodplain cores:
LN8 (floodplain core by Libiš catchwater)
LN3 (floodplain core taken between Libiš pool and the Elbe River)
ON (floodplain core taken at Staré Labe by Obříství and the Elbe River)

- Hg, Cd
- PCB (subaquatic sediments only)
- forms of HCH
- DDX
- fluoranthene (very high only in several samples taken in Libiš catchwater)

Modelling of sediment remobilisation

→ **the main aim was to find when the sediment remobilisation starts**

input data:

- extend of polluted sediments in the researched lakes
- results from grain structure analyses (upper layer of subaq. sediments – grain size 0,007-0,039 mm)
- concentrations of suspended load during floods March/April 2006 and June 2013 from Valy and Obříství station and hydrological data from limnigraphic stations Němčice, Přelouč, Kostelec n.L., Vraňany (the Moldau River) – floods 2002, 2006, 2013

application of 2D hydrodynamic model of the Elbe River
application of MIKE 21 C software for simulation of sediment transport

Pardubice

- flood from the Elbe River
- flood from the Jesenčanský brook

Neratovice – Libiš pool

- flood from the Elbe River
- flood from Libiš catchwater

Obříství

- flood from the Elbe River
- flood from the Moldau River
- flood from the Černavka brook

grade of sediment removal risk	interval characteristics
1	less than $Q_{80\text{-day}}$
2	middle characteristics of the interval $Q_{30\text{-day}}$
3	upper limit on Q_1
4	characteristics of the interval (in 2/3) Q_2; lower limit Q_1
5	middle characteristics of the interval Q_5
6	middle characteristics of the interval Q_{20}; upper limit Q_{50}
7	more than Q_{50}

- the method of rainfall-runoff modelling applied on small streams (10-year rainfall with the duration of 1 hour on a saturated catchment); application of MIKE 11R RR software

Modelling of sediment remobilisation

sediment remobilisation criteria:

- sediment erosion in the zones of polluted sediments at least 1mm/hour repeatedly
- suspended load conc. (from the zones of polluted sediments) exceeded 0,5 g.m^{-3} in the Elbe River

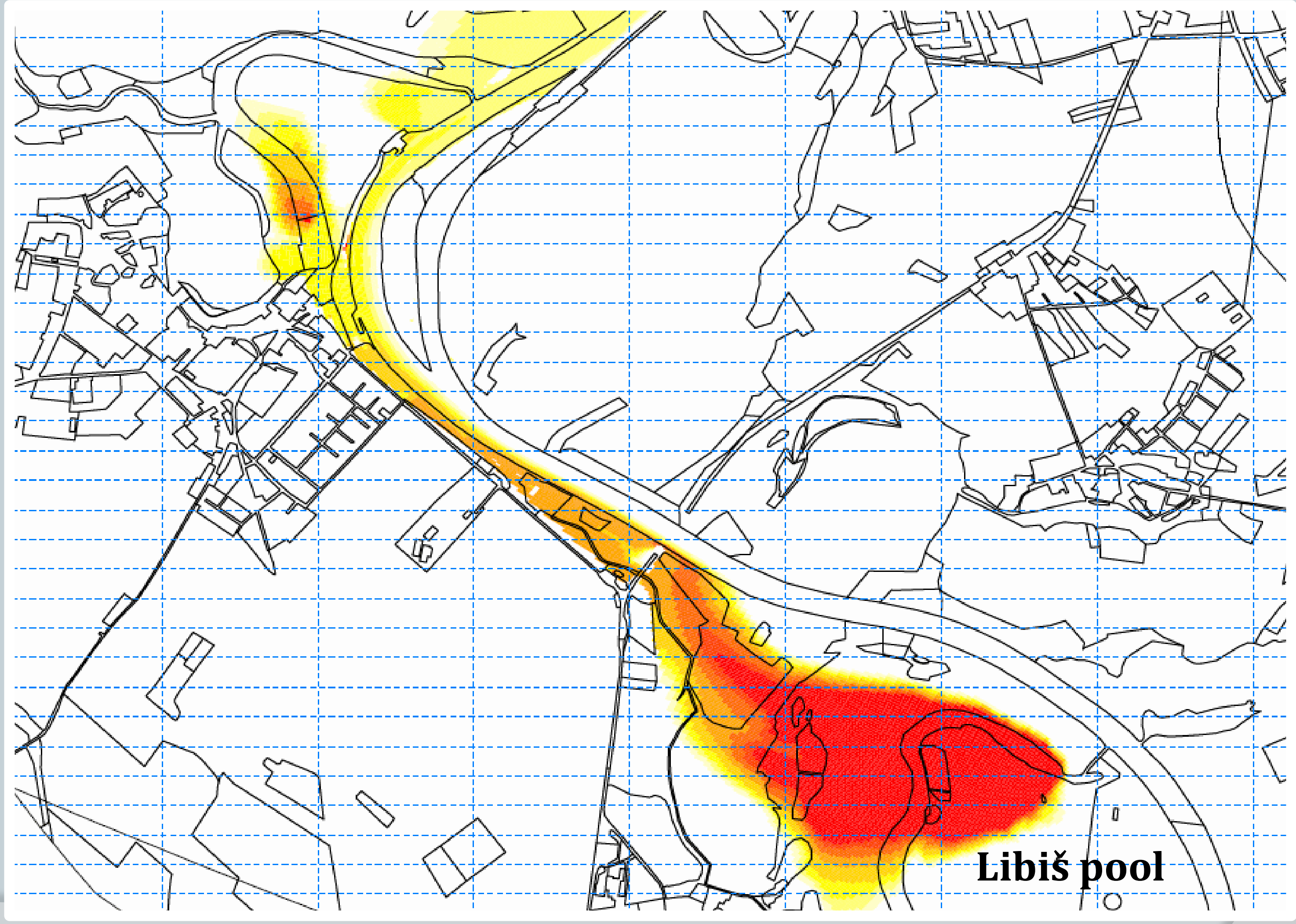
Locality	discharge at the beginning of remobilisation		suspended matter concentration in the Elbe River	grade of sediment removal risk	hydrological characteristics	Description of the beginning of sediment remobilisation
	at the locality	LGS Přelouč				
	Q (m^3.s^{-1})	Q (m^3.s^{-1})	c (g.m^{-3})			
oxbow lake by Rosice (RV1-2)	912	903	0,7	7	Q_{50} - Q_{100}	The oxbow lake is flown through with the stream from the right side inundation area significantly; suspended matter concentrations > 0,5 g.m^{-3} reach the Elbe River.
winter harbour PARAMO (PV1)	994	978	0,5	7	> Q_{100}	The lower part of the dividing embankment between the Elbe River and the winter harbour PARAMO is overflown by this discharge. The increasing discharge in the harbour is bringing up the suspended load in higher concentrations into the Elbe River.
the Jesenčanský brook - mouth (RN3)	9 (the Jesenčanský brook - mouth)		1,8	6	Q_{10} (the Jesenčanský brook - mouth)	Short torrential flood causes remobilisation of sediments in the riverbed of the Jesenčanský brook as well as the bottom of the winter harbour PARAMO.

Locality	discharge at the beginning of remobilisation		suspended matter concentration in the Elbe River	grade of sediment removal risk	hydrological characteristics	Description of the beginning of sediment remobilisation
	LGS Kostelec	LGS Vraňany				
	Q (m^3.s^{-1})	Q (m^3.s^{-1})	c (g.m^{-3})			
Staré Labe - Obříství (OV1)	**1406**	1066	0,3	7	> Q_{100} (Kostelec)	Wide concentrated stream flows into the Elbe River.
Staré Labe - Obříství (OV1)	128	**1748**	2	5	< Q_5 (Vraňany)	Stream from the Moldau River flows through the oxbow lake in the direction of the Elbe River flow. Eroded areas at the right bank of the lake near the mouth into the Elbe River are filled with the material from the right bank of the Černavka brook mouth.
Staré Labe - Obříství (OV1) - the Černavka brook - mouth	13,5 (the Černavka brook - mouth)		---	---	Q_{10} (the Černavka brook - mouth)	Short torrential flood from the Černavka brook causes only the increase of waterlevel by 50 cm in the lake; the sediments are remobilised, but settle down in the lake again without reaching the Elbe River.
Libiš pool (LV1-2)	**1210**	196	0,2	6	< Q_{50} (Kostelec)	Concentrated stream lows from the Libiš pool into the Elbe River, concentrations more than 0,1 mg.l^{-1} are increasing continuously
Libiš catchwater (LS)	4,5 (Libiš catchwater)		---	---	Q_{10} (Libiš catchwater)	Sediments are remobilised with a short flood, but settle down in the inundation area without reaching the Elbe River.

Modelling of sediment remobilisation

- example of MIKE 21 C simulations - concentrations of suspended matter flushed out from Libiš pool and Staré Labe at Obříství - the Elbe River flood Q = 1210 m^3s^{-1}

Staré Labe – Obříství (oxbow lake)



Complex risk assessment of selected localities

- evaluation according to the Sedimentmanagementkonzept FGG Elbe and ICPER (4 grades) based on:
  sediment contamination/volume of polluted sediments/grade of sediment remobilisation risk

Locality	grade of risk	grade of sediment remobilisation risk	Volume	Sediment quality														
				DDX	HCB	HCH	PCB	PAHs 5	b(a)pyrene	anthracene	fluoranthene	TBT	Hg	Cd	Pb	Cu	other metals	NES C10-C40
oxbow lake Rosice - Phase 1 (R 1-3)		7									X							X
oxbow lake Rosice - Phase 2 (RV1-2)								X	X		X	X						XX
winter harbour PARAMO - Phase 1 (B)		7 - Elbe		XX	X		X	X	XX	X	XX			X	XX			XX
winter harbour PARAMO - Phase 2 (PV1)		6 - Jesenčan.b.		X			X	X	X	X	XX	XX			X			XX
floodplain at Velká strouha (RN2)																		
floodplain at the Jesenčanský brook (RN3)											X							
floodplain at oxbow lake by Rosice (RN4)																		
Libiš pool - Phase 1 (L 1-3)		6		X							X		XX	X				
Libiš pool - Phase 2 (LV1-2)																		
Libiš catchwater - Phase 1				XX	X	X							XX	X				
Libiš catchwater - Phase 2 (LS)				XX			XX	X	X		XX		XX					
oxbow lake Staré Labe by Obříství - Phase 1 (O1-2)		5 - Moldau										X						
oxbow lake Staré Labe by Obříství - Phase 2 (OV1)		7 - Elbe								X		X	X					
floodplain at Libiš pool (LN3)																		
floodplain at Libiš pool and Spolana (LN4)																		
floodplain at Libiš pool (end) (LN6)				X														
floodplain at Libiš catchwater (LN8)				XX														
floodplain at oxbow lake Starého Labe by Obříství (ON1)																		

Contamination		low		middle		high	X	significant	XX	extreme	Grade of remobilisation risk	1	2	3	4	5	6	7
Volume (m^3)	<10 000	small	10000 - 50000	middle	>50 000	large	Complex risk of locality significance		insignificant		low		middle	X	high	

Highest complex risk of locality significance:

- winter harbour PARAMO: extreme contamination, risk of remobilisation, middle volume
- oxbow lake Staré Labe by Obříství: high-significant contamination, risk of remobilisation, large volume

Lowest complex risk of locality significance:

- floodplain sediments (low contamination, remobilisation restricted with vegetation)
- Libiš catchwater (significant-extreme pollution, remobilised sediment does not reach the Elbe River

Conclusion, suggestion

Libiš pool at Spolana,a.s.

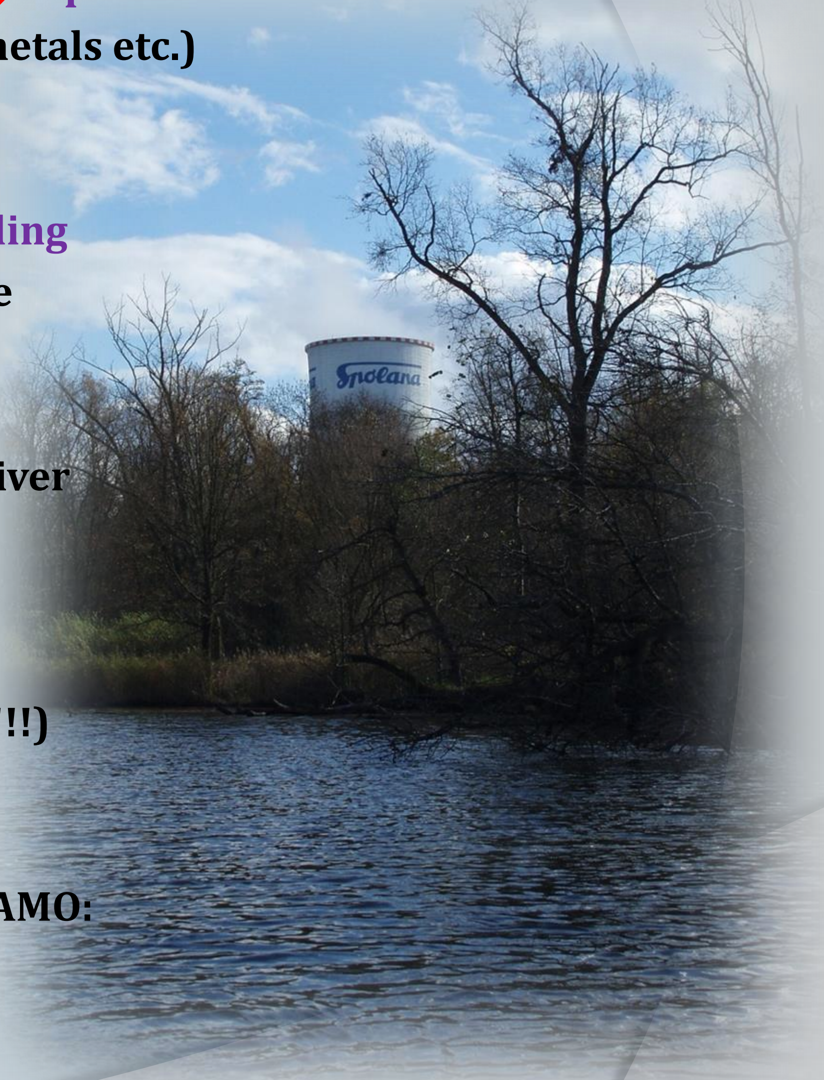
- additional monitoring of risk localities → specification of contamination extent
- contamination forms (Speciation analysis of metals etc.)
- dating
- geophysical survey (extend of load)
- verification of sediment remobilization modelling
- restoration measures – usefulness, significance (international, local), costs...

- dredging of contaminated volume
- restriction of contamination spreading into the river

highest risk – winter harbour PARAMO
(washing up the contamination into the river!)
local risk – Libiš catchwater
(although dredged in 2004, still extreme pollution!!!)

= Specialized companies and enterprises

REMOT-MZ company – restoration of harbour PARAMO:
Volume: 13 000m^3 Price: 40 560 000 Kč



- legislation
- environmental protection of floodplain – Libiš pool part of nature preserve Černínovsko

Děkuji za pozornost!

Thank you for your attention!

Vielen Dank für Ihre Aufmerksamkeit!