



CZECH  
HYDROMETEOROLOGICAL  
INSTITUTE

## Monitoring of groundwater quality and sediment/biota

Vít Kodeš  
Section of water quality

Workshop on linkages between the Water Framework Directive (WFD) and  
Strategic Environmental Assessment Directive (SEAD) and Environmental Impact  
Assessment Directive (EIAD)

23.9.2015

[www.chmi.cz](http://www.chmi.cz)

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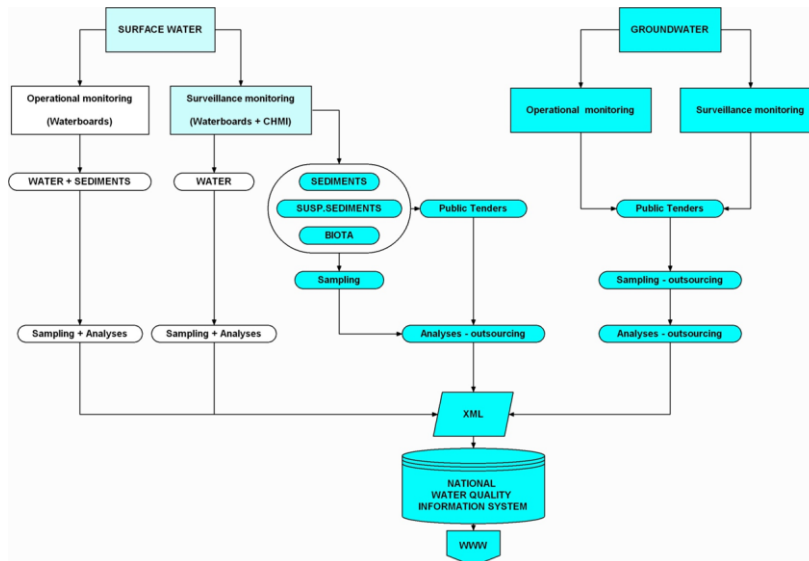
## Czech Hydrometeorological Institute

A national agency responsible for:

- monitoring in the field of meteorology/climatology,  
**hydrology**, air quality
- weather and flood forecasting
- National Information System administration e.g. data check,  
data storage, data processing and data provision to public



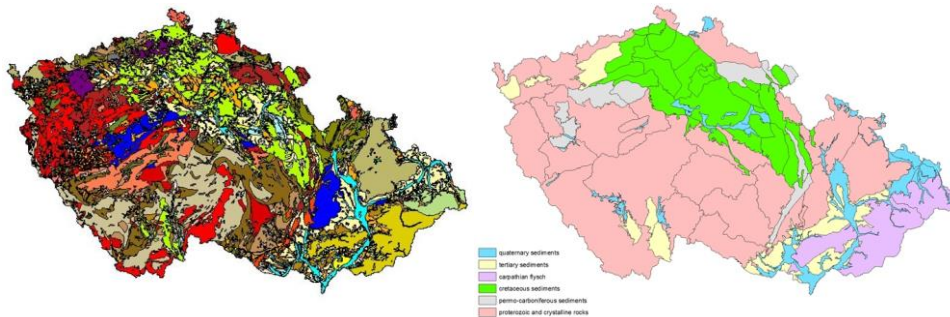
## WFD monitoring programs provision



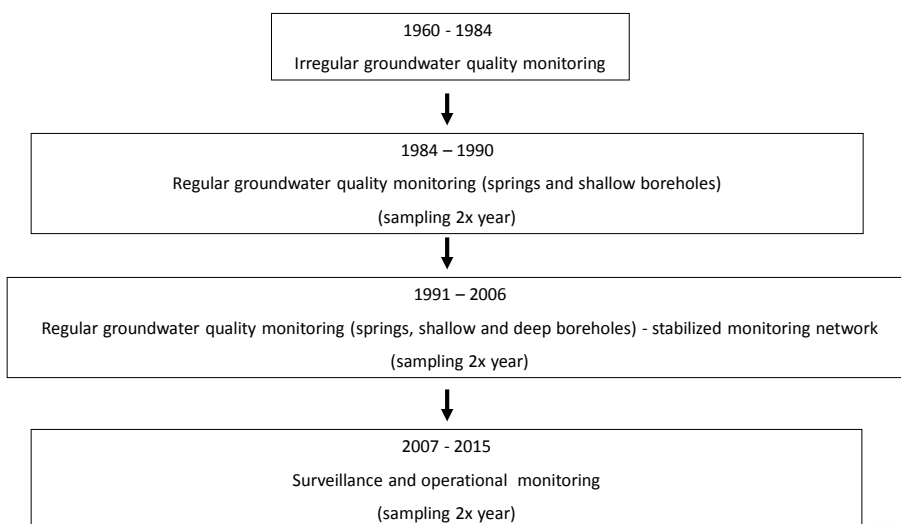
Groundwater

## Groundwater

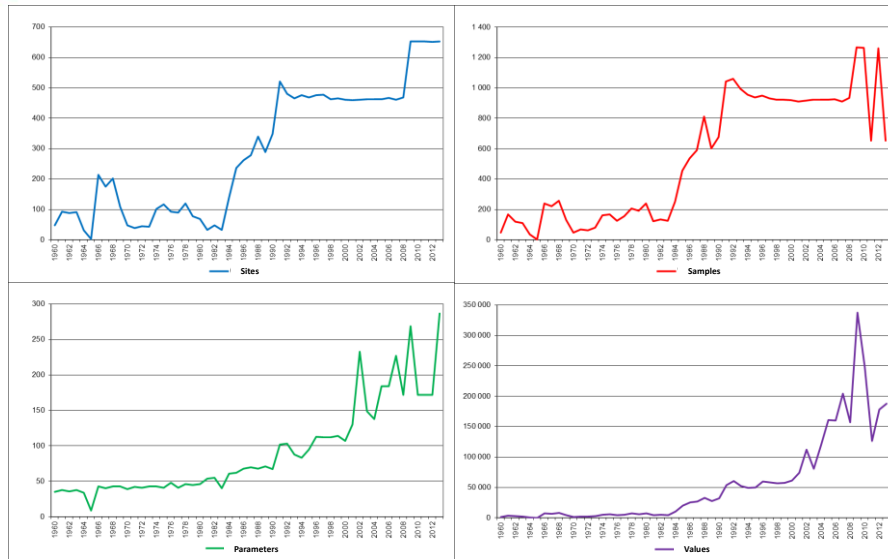
- Complex geological settings
- Various hydrogeological conditions
- Approximately 45% of drinking water supplied from groundwater resources



## Groundwater quality monitoring history



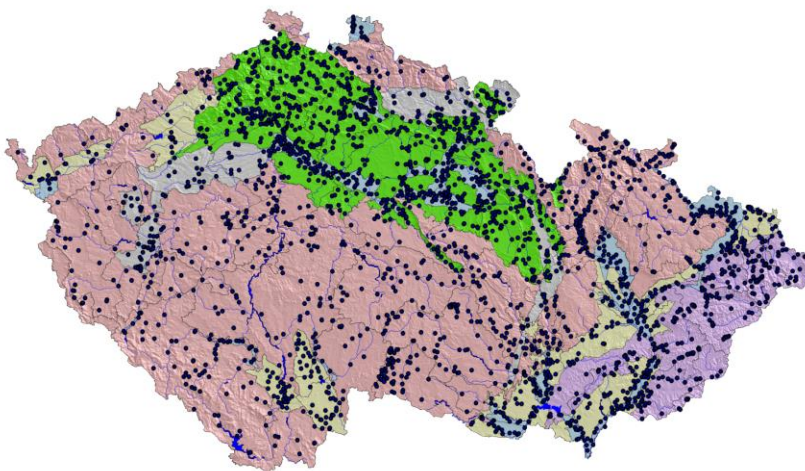
## Groundwater quality monitoring history



> 3 000 000 values since 1960



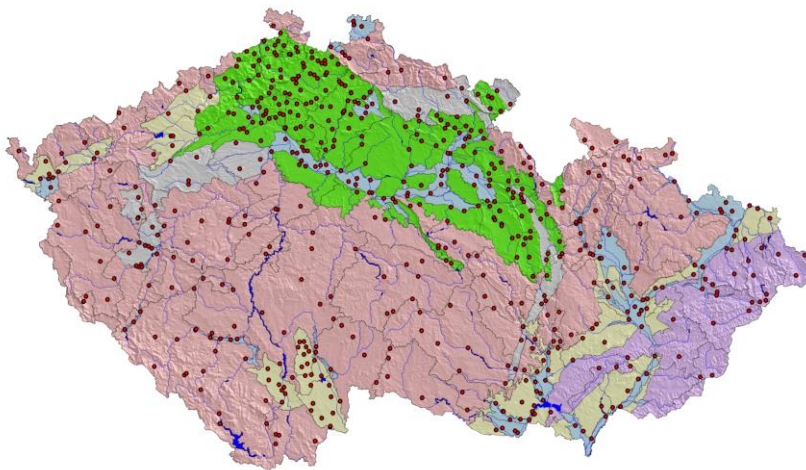
## Groundwater quantity network



2000 sites



## Groundwater quality network



660 sites



## Groundwater quality network





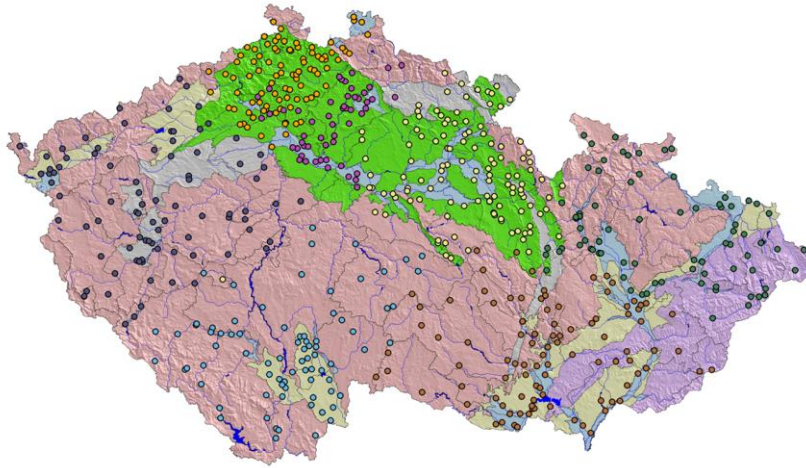
## Groundwater quality network



## Sampling



## Sampling



Two sampling campaigns – spring x autumn

660 sampling sites

7 sampling areas

Sampling depth up to 100 m



## Sampling

Wells sampled in a dynamic state (purgng)

pH, conductivity, turbidity  
and water temperature  
stabilization

Sampling time between 2-6  
hours depending on  
groundwater yield and  
pumping rate, 3-5 volumes  
of groundwater in the well



## Monitoring program definition

Monitoring sites

Sampling frequency

Requirements on sampling equipment, conservation and transport of samples (ISO 5667)

Sampling parameters – individual for each site (well) – depth, yield, pumping time

Monitored parameters

Requirements on analytical method sensitivity (limits of quantification)

Requirements on accreditation and QA/QC

Definition of the data format (XML)

Quality assurance:

Sampling crew inspections

Control samples

Accreditation according the EN ISO 17025

Data testing and verification prior saving into IS



## Sampling protocol

Time [min]	Groundwater level [m]	Water temperature [°C]	pH	Conductivity [mS/m]	Eh [mV]	Dissolved O <sub>2</sub> [mg/l]	Turbidity [NTU]	Yield Q [l/s]	Remark
0	x								
1	x							x	
2	x								
3	x								
5	x	x	x	x	x	x	x	x	
7	x								
10	x	x	x	x	x	x	x	x	
15	x								
20	x								
30	x								
45	x								
60	x	x	x	x	x	x	x	x	
90	x								
120	x	x	x	x	x	x	x	x	
150	x								
180	x	x	x	x	x	x	x	x	
240	x	x	x	x	x	x	x	x	
300	x	x	x	x	x	x	x	x	
360	x	x	x	x	x	x	x	x	





## Monitored parameters

Inorganic parameters	Chlorobenzenes
Metals	Chlorophenols
VOCs	PCBs
PAHs	PBDEs
Pesticides and metabolites	DEHP
Complexons	Radioactivity
Alkylphenols	Selected pharmaceuticals



## Data storage and processing

RDBMS Oracle + GIS (ArcGIS) + map server

Automatic data loader –XML data format for surface and groundwater quality data

QA/QC– data format control, outlier identification based on admissible concentration range definitions and comparison with historical time series

Data publication – reporting, WWW interface for public on-line access and data download



## WWW interface for public on-line access

**POVRCHOVÁ VODA**

Výběr profilu jakosti povrchových vod

Název objektu  
Kraj  
Okres  
Hydrogeologický rajón  
Vodní útvar  
Skupina objektů  
Stavování časového rozsahu pro chemická a biologická data  
Rok od 2008 Rok do 2011

Výběr parametrů filtracího formuláře  
Výběr parametrů výhledu dat  
Výběr parametrů výhledu dat

**PODZEMNÍ VODA**

Výběr profilu jakosti podzemních vod

Název objektu  
Kraj  
Okres  
Hydrogeologický rajón  
Vodní útvar  
Skupina objektů  
Stavování časového rozsahu pro chemická data  
Rok od 2008 Rok do 2011

Výběr parametrů filtracího formuláře  
Výběr parametrů výhledu dat  
Výběr parametrů výhledu dat

## Results

Most problematic groundwater pollutants:

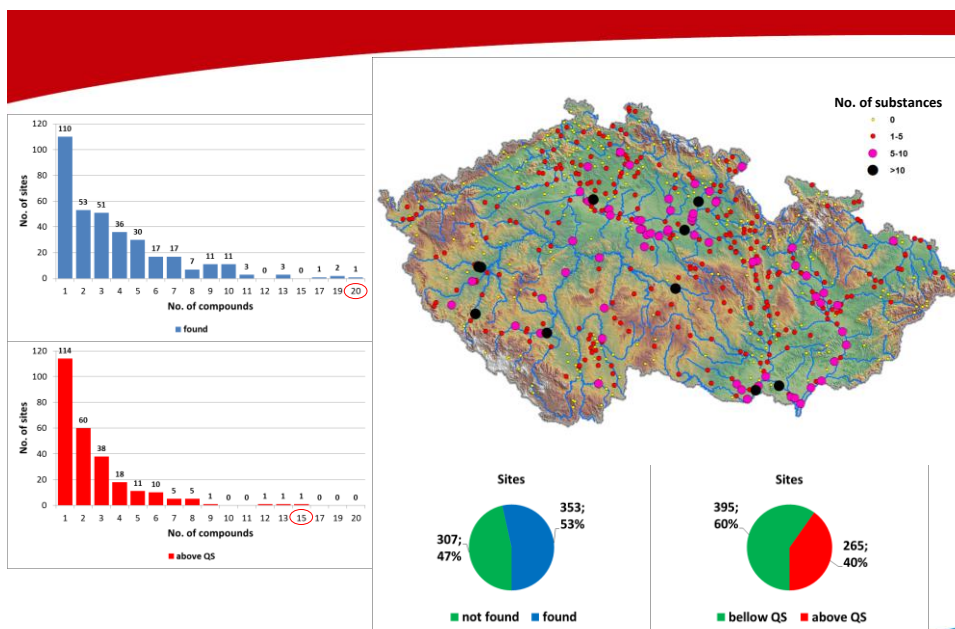
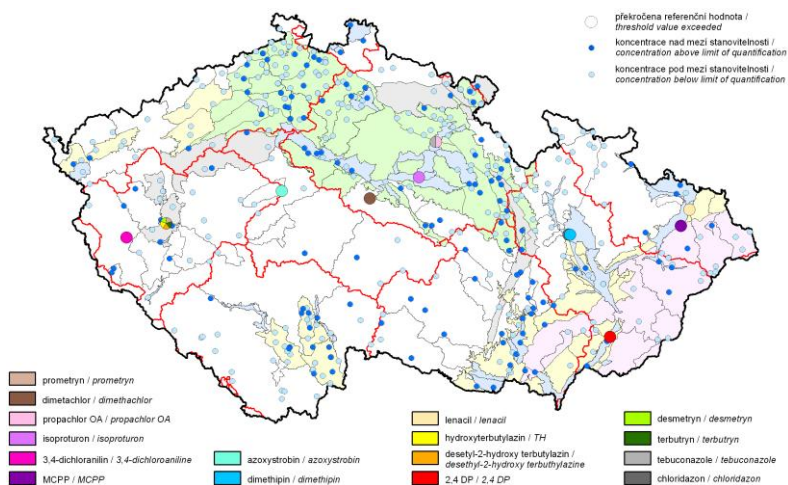
Nitrates, ammonium

Pesticides and metabolites – mainly herbicides used on rape, corn, sugar beet



## Results

Pesticides – threshold value exceeded at 1 site only



At least 1 pesticide found at 353 of 660 sites (53%)

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## Sediments and biota

## Sediments and biota

### Guidance document No. 25 on chemical monitoring of sediment and biota under the Water Framework Directive

Guidance Document No. 25  
Guidance on chemical monitoring of sediment and biota under the Water Framework Directive

**Table 1 Monitoring matrices for the priority substances and certain other pollutants listed by the EQS Directive**

The substances in red are those suggested by Directive 2008/105/EC for sediment and biota trend monitoring. The values of the log  $K_{ow}$  are taken from the Chemical Monitoring Guidance n.19. The values of BCF are taken from the datasheets of the priority substances in the public section of the CIRCA forum ([http://circa.eurpea.eu/Public/cheminfo/databases/Circaframework\\_directive\\_priority\\_substances/supporting\\_background/substance\\_sheets&module=detail&size=Title](http://circa.eurpea.eu/Public/cheminfo/databases/Circaframework_directive_priority_substances/supporting_background/substance_sheets&module=detail&size=Title))

P = preferred matrix, O = optional matrix, N = not recommended, n.a. = not applicable

Priority Substance	BCF	Log $K_{ow}$	Water	Sediment/SPM	Biota
<i>Alachlor</i>	50	3.0	P	O	N
<i>Anthracene</i>	162-1440	4.5	O	O	O
<i>Atrazine</i>	7,7-12	2.5	P	N	N
<i>Benzene</i>	13	2.1	P	N	N
<i>Brominated diphenyl ethers</i> *	14350-1363000	6.6	N	P	P
<i>Cadmium and its compounds</i>		n.a.	n.a.	n.a.	n.a.
<i>C10-13-chloroalkanes</i>	1173-40900	4.4-4.7	N	P	P
<i>Chlorfenvinphos</i>	27-460	3.8	O	O	O
<i>Chlorpyrifos (ethyl, -methyl)</i>	1374	4.9	O	O	O
<i>1,2-Dichloroethane</i>	2-10	1.5	P	N	N
<i>Dichloromethane</i>	6,4-40	1.3	P	N	N
<i>Di(2-ethylhexyl)phthalate (DEHP)</i>	737-2700	7.5	N	O	O
<i>Diazin</i>	2	2.7	P	N	N
<i>Endosulfan</i>	10-11583	3.8	O	O	O
<i>Fluoranthene</i>	1700-10000	5.2	N	P	P
<i>Hexachlorobenzene</i>	2045-230000	5.7	N	P	P
<i>Hexachlorobutadiene</i>	1,4-39000	4.9	O	O	P
<i>Hexachlorocyclohexane</i> *	220-1300	3.7-4.1	O	O	P
<i>Isoproturon</i>	2,6-3,6	2.5	P	N	N
<i>Lead and its compounds</i>		n.a.	n.a.	n.a.	n.a.
<i>Mercury and compounds</i> *		n.a.	N	O	P
<i>Naphthalene</i>	2,3-1158	3.3	O	O	O
<i>Nickel</i>		n.a.	n.a.	n.a.	n.a.
<i>Nonylphenols</i> *	1280-3000	5.5	P	P	O
<i>Octylphenol</i> *	471-6000	5.3	P	P	O
<i>Pentachlorobenzene</i>	1105-260000	5.2	N	P	O
<i>Pentachlorophenol</i>	34-3820	5.0	O	O	O
<i>Polyaromatic Hydrocarbons</i> *	9-22000	5.8-6.7	N	P	P
<i>Simazine</i>	1	2.2	P	N	N
<i>Tributyltin compounds</i>	500-52000	3.1-4.1	O	O	P
<i>Trichlorobenzenes</i>	120-3200	4.0-4.5	O	O	O
<i>Trichloroethane</i>	1,4-13	2.0	P	N	N
<i>Trifluralin</i>	2360-5674	5.3	N	P	O
<i>DDT (including DDE, DDD)</i>		6.0-6.9	N	P	P
<i>Aldrin</i>		6.0	N	P	P
<i>Endrin</i>		5.6	N	P	P
<i>Isodrin</i>		6.7	N	P	P
<i>Dieldrin</i>		6.2	N	P	P
<i>Tetrachloroethylene</i>		3.4	O	O	N
<i>Tetrachloromethane</i>		2.8	P	N	N
<i>Trichloroethylene</i>		2.4	P	N	N

## Sediments and biota

### Solid matrixes

anthracene  
aldrin  
benzo(a)pyrene  
benzo(b)fluoranthene  
benzo(g,h,i)perylene  
benzo(k)fluoranthene  
chloroalkanes C10-13  
DDT and its metabolites  
DEHP  
dieldrin  
endrin  
fluoranthene  
HCH isomers  
hexachlorobenzene  
hexachlorobutadiene  
indeno(1,2,3-cd)pyrene  
isodrin  
PBDEs  
pentachlorobenzene  
mercury  
tributyltin compounds  
trifluralin

### Water

1,2-dichlorethane  
alachlor  
atrazine  
benzene  
dichloromethane  
diuron  
isoproturon  
nonylphenols  
octylphenols  
simazine  
tetrachlorethane  
tetrachloromethane  
trichloroethene  
trichloromethane

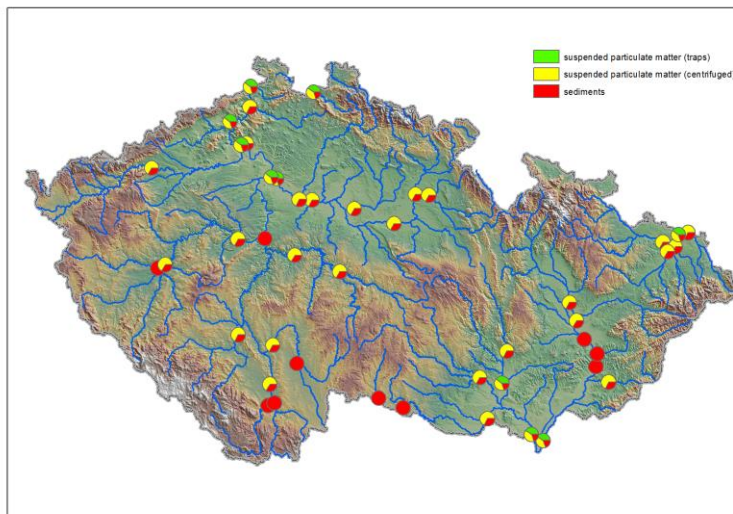
### Matrix optional

cadmium  
chlorfenvinphos  
chlorpyrifos  
endosulfan  
lead  
naphtalene  
nickel  
pentachlorophenol  
trichlorobenzenes



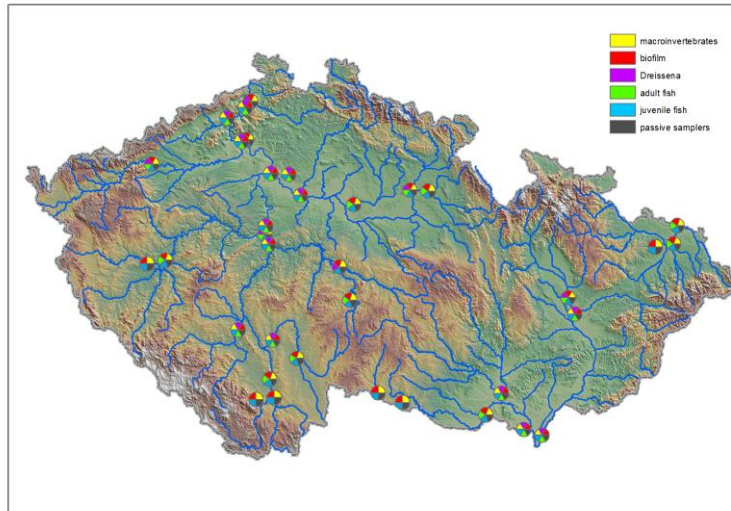
## Sediments monitoring network

46 sites (sediment, SPM) since 2000



## Biota monitoring network

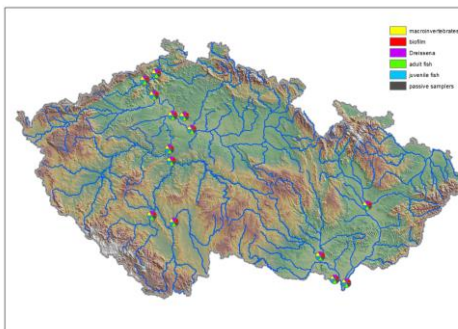
43 sites (biota, passive sampling) since 2002



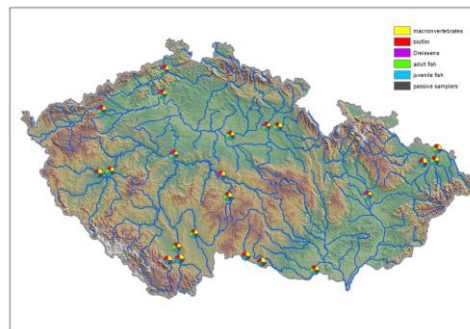
## Biota monitoring network

3 years cycle

21 sites



22 sites



## Sampling methods

- Water grab sampling
- Passive water sampling
- Sediment grab sampling
- SPM sampling (sampler)
- SPM sampling (centrifuge)
- Biota grab sampling
- Biota caging sampling



## Sampling methods

- Passive water sampling
- Sediment grab sampling
- SPM sampling (sampler)
- SPM sampling (centrifuge)
- Biota grab sampling
- Biota caging sampling

SPMD



DGT



POCIS





## Sampling methods

- Sediment grab sampling
- SPM sampling (sampler)
- SPM sampling (centrifuge)
- Biota grab sampling
- Biota caging sampling



## Sampling methods

- SPM composite sampling (sampler)
- SPM sampling (centrifuge)
- Biota grab sampling
- Biota caging sampling



## Sampling methods

- SPM sampling (centrifuge)
- Biota grab sampling
- Biota caging sampling



## Sampling methods

- Biota grab sampling (benthic invertebrates)
- Biota caging sampling



## Sampling methods

- Biota sampling  
(adult fish, juvenile fish)

Adult  
European chub (*Leuciscus cephalus*)



- Biota caging sampling

Electrofishing

Juvenile  
various species



## Sampling methods

- Biota caging sampling

Zebra mussel (*Dreissena polymorpha*) – reference site



## Sampling methods

- Biota caging sampling

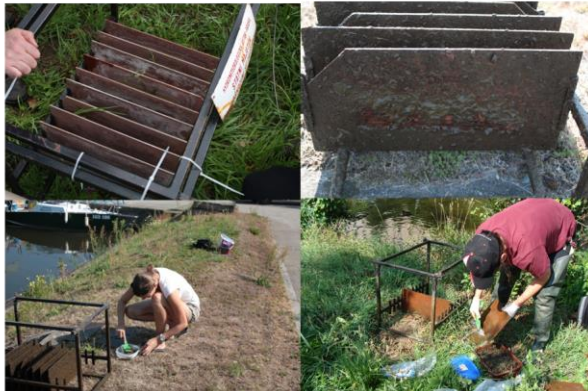
Mussels (*Dreissena polymorpha*) – deployment



## Sampling methods

- Biota caging sampling

Biofilm





## Annual sampling frequency

- Sediment grab sampling 2
- SPM sampling (sampler-trap) 4
- SPM sampling (centrifuge) 4
- Passive water sampling 2
- Fish sampling 1
- Invertebrates grab sampling 1
- Biota caging sampling 1

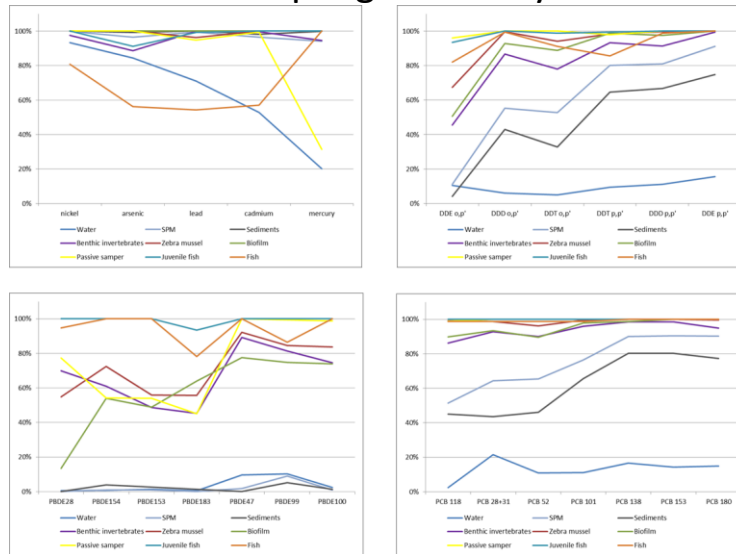


## Monitored pollutants

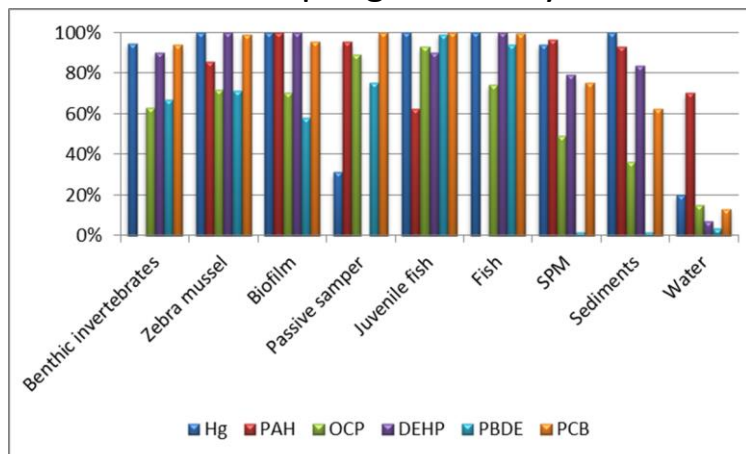
SPMD	DGT	POCIS	Sediment, SPM	Biota
Organic hydrophobic compounds, POPs	Dissolved metals	Organic polar compounds	Organic hydrophobic compounds, metals	Organic hydrophobic/ bioaccumulative compounds , metals
PCBs, PBDEs, OCPs, PAHs, PCPs, musks, HBCDD, PCDD/F	Heavy metals	Pesticides, pharmaceuticals perfluorinated compounds, illegal drugs	PCBs, PBDEs, OCPs, PAHs, DEHP, TBT, C10-13, heavy metals, HBCDD, PCDD/F	PCBs, PBDEs, OCPs, PAHs, DEHP, PFOS, heavy metals , HBCDD, PCDD/F



## Sampling efficiency




## Sampling efficiency



Comparison of percentage of positive samples for selected groups of hazardous substances in various matrixes

(no data on DEHP in passive samplers and PAHs in benthic organisms and adult fish available)



Thank you for attention, any questions?

